UNIVERSITY OF SOUTHAMPTON

FACULTY OF SCIENCE

BIOLOGY

Doctor of Philosophy

AUTUMN APPLIED PYRETHROID INSECTICIDES: CONSEQUENCES FOR THE NATURAL ENEMIES OF CEREAL APHIDS

by Andrew James Pullen

To my parents for their unfailing support both moral and financial.

ACKNOWLEDGEMENTS

Sponsorship from both MAFF and The Game Conservancy Trust is gratefully acknowledged. I would also like to thank my two supervisors Dr P.C. Jepson and Dr N.W. Sotherton for their guidance and considerable patience during the production of this thesis. The cooperation and assistance of the management and staff of the Leckford Estate, Hampshire was also much appreciated. Finally I would like to thank Mr P. Cuthbertson, Mr D. Flynn and Dr D. Morgan for their friendship and advice during the course of this study.

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ABSTRACT

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AUTUMN APPLIED PYRETHROID INSECTICIDES: CONSEQUENCES FOR THE NATURAL ENEMIES OF CEREAL APHIDS

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The thesis reports the findings of a series of field trials and semi-field experiments examining the effects of single autumn applications of pyrethroid insecticides on the non-target polyphagous predatory fauna associated with the cereal ecosystem.

Autumn applications of the pyrethroids cypermethrin (25g a.i./ha) and deltamethrin (6.25g a.i./ha) induced post-treatment reductions in all three of the major polyphagous predatory arthropod groups; the Carabidae, Staphylinidae and Linyphiidae. The organophosphate demeton-S-methyl (243.6g a.i./ha) produced significant reductions in the apparent abundance of a number of species of linyphiid spider but not in members of the Carabidae or Staphylinidae.

Populations of carabids exposed to autumn applications of pyrethroids typically underwent 70-80% reductions in apparent abundance with recovery occurring within 1-2 weeks in the case of cypermethrin (2 ha plots) and 3-5 weeks for deltamethrin (1-4 ha plots).

Staphylinids appeared to exhibit only limited susceptibility to autumn applications of cypermethrin, deltamethrin and demeton-S-methyl.

All three autumn applied aphicides typically produced significant decreases in the effective abundance of linyphiid spiders which persisted until late in the spring of the following year. Cypermethrin also induced significant reductions in the abundance of linyphiid spiders when applied to barriered plots of winter wheat during the summer. The pyrethroid-induced reductions in the abundance of spiders were frequently preceded by bouts of hyperactivity.

The relative abundances of the alternative prey groups Acari, Collembola and Diptera exhibited only slight and extremely transient reductions following autumn applications of deltamethrin and DSM.

Autumn applications of deltamethrin and DSM did not significantly impair the capacity of the predator complex to restrict the development of summer infestations of cereal aphids. During the summer, higher peak aphid densities and an associated reduction in grain quality were recorded in plots which had not been treated with an autumn aphicide.

The thesis also includes sections relating to the sublethal effects of the aphicides on predatory capacity and on carabid fecundity.

CHAPTER 1 - INTRODUCTION.

1.1 General introduction.

The aims of this research were to determine the impact of autumn applied aphicides on the complex of beneficial invertebrates associated with the cereal crop ecosystem. Primarily the effects of single applications of synthetic pyrethroid insecticides were examined with respect to polyphagous invertebrates believed to be important in the limitation of cereal aphid populations. Funding for the project came from two sources, firstly the Ministry of Agriculture, Fisheries and Food who were concerned that the lack of specificity exhibited by synthetic pyrethroids might have an adverse effect on populations of beneficial invertebrates culminating in a reduced capacity to limit the development of summer aphid infestations. The second funding body was the Cereals and Gamebirds Research Project of the Game Conservancy Trust which was interested in the effects of pyrethroids on insect species which act as components of the diet of gamebird chicks.

The main purpose of the following review is to provide a contextual framework for the project. In addition it attempts to predict the probable consequences of the autumn application of pyrethroids based upon current knowledge of the insecticidal / insectistatic properties of this group of compounds.

1.2 Aphids (Homoptera: Aphididae) as pests of cereal crops in the United Kingdom (U.K.).

There are three species generally regarded as being of importance as cereal aphid pests in the U.K.

1) The bird-cherry aphid - Rhopalosiphum padi (L.).
2) The grain aphid - Sitobion avenae (F.).
3) The rose-grain aphid - Metopolophium dirhodum (Wlk.).

R.padi is predominantly a holocyclic species generally overwintering in the egg stage on the primary host which is the bird cherry, *Prunus padus* (L.) (Tatchell *et al* 1987). Bird cherry is a deciduous shrub which is more common in Wales and the north of England but which is planted as an ornamental in the south (McClintock and Fitter, 1956; Perring and Walters, 1976). At the start of summer, alates disperse from the primary host to members of the Gramineae which act as the secondary host (Kolbe, 1969; Plumb, 1983; Tatchell *et al* 1987). During the summer a number of generations are produced on the secondary host before decreasing temperature and day length trigger the production of alate gynoparae and males which migrate to *P.padus* where egg laying oviparae are produced (Dixon and Glen, 1971). A proportion of the population overwinters anholocyclically on grasses and cereals (George, 1974; Carter *et al* 1980) and this is an important factor in the role of *R.padi* as an aphid pest of cereals. *R.padi* causes some direct feeding damage in cereal crops (Vereijken, 1979) but more significantly it acts as a vector of barley yellow dwarf virus (BYDV) (Bruehl, 1961).

The term barley yellow dwarf (BYD) encompasses a number of symptomatically similar viral diseases of Gramineae (Plumb, 1983). The name was first employed by Oswald and Houston (1951), and although Bruehl (1961) has since listed 97 species of Gramineae known to act as hosts, barley was the first recorded major host and so the descriptive term remains BYD.

The symptoms of BYDV infection vary with the host, developmental stage at the time of infection and with viral strain. Typically symptoms in plants infected at an early stage may include dwarfing, an increase in tillering and distortion of the leaves (Bruehl, 1961; Smith, 1963). Plants infected later in their development exhibit a lesser degree of stunting accompanied by a distinctive bright yellow discoloration of the leaves. Depending on the species of the host plant there may be an additional red or purple discoloration of leaf tissues (Bruehl, 1961; Smith, 1963; Gair _et al_ 1978).

Perhaps not surprisingly, BYDV causes greatest yield loss when cereals are infected at an early stage (Doodson and Saunders, 1970). Under laboratory conditions Smith _et al_ (1968) inoculated oat seedlings (three leaf stage) with BYDV and observed a 61% loss in yield per plant compared with plants infested with a similar number (one per plant) of virus free _R.padi_. In the field situation it is difficult to isolate the effects of BYDV on yield loss from those caused directly by aphid feeding. In New Zealand, Smith (1963) compared yield data from infected wheat fields with data from plots treated with organophosphates to prevent secondary spread. The yield loss attributed to BYD was estimated to be in excess of 15%. The same author estimated that BYD was responsible for an approximate 25% loss in yield for the New Zealand wheat crop of 1961. Gair (1978) quoted a figure of 50% for localized yield loss and an estimated 1% loss in the annual wheat crop in the U.K.

BYDV was first recorded in the U.K. in 1954 (Watson and Mulligan, 1957) but did not become of great significance for at least two decades with an increased prevalence paralleling the recent trend for earlier sowing of winter cereals. Early sown crops develop earlier and have a higher yield than late sown cereals (Plumb, 1983). Cereals which are drilled early have the disadvantage that seedlings are available as overwintering sites for migrant alate exules of _R.padi_. These aphids may have originated on cereals or perennial grasses infected with BYDV and so are a potential source of primary viral inoculation for the emerging crops (Tatchell _et al_ 1987). Crops infected in the autumn typically develop distinct saucer-shaped areas of yellowed plants which are increasingly stunted towards the centre. The plants in the centre are those initially colonized and infected by exules in the autumn. These act as a source of inoculum for the secondary spread of the virus caused by between-plant movements of infected apterous aphids (Plumb, 1983).

ADAS recommends control of secondary spread of the disease by the single application of an aphicide between mid October and early November. Applications of synthetic pyrethroids have been shown to provide particularly good control of BYDV (Barret et al 1981; Brain and Hewson, 1984; Kendall et al; Perrin and Gibson, 1985).

Different strains of BYDV induce symptoms of the disease with varying levels of severity and there is also some degree of specificity with regard to the ability of vector species to efficiently aquire and transmit strains (Smith et al 1976; Rochow, 1979). The most severe strains are those transmitted efficiently by R.padi while S.avenae only transmits less severe forms (Smith et al 1976; Gair et al 1978). The importance of S.avenae as a cereal pest species is a consequence of its capacity to induce damage by its feeding activity (Vereijken, 1979).

S.avenae is a monoecious species overwintering both holocyclically and anholocyclically on Gramineae (Dewar and Carter, 1984; Hand and Hand, 1986). Overwintering populations in southern England tend to be dominated by anholocyclic forms (Dewar and Carter, 1984). Such populations continue to produce alates though the winter (Dewar, 1982) but flight activity is inhibited by low temperatures until a threshold is exceeded in the spring (Walters and Dewar, 1984). This is reflected in the fact that there is a correlation between temperatures in January and February and the timing of the spring migration of S.avenae in the south (Walters and Dewar, 1986). Summer outbreaks of S.avenae in cereals are more probable following large, early spring migrations (Carter, Dixon and Rabbinge, 1982; Walters, Watson and Dixon, 1983). In addition, plants infested at an earlier developmental stage suffer a greater final yield loss than more mature plants

(Lee, Wratten and Kenyi, 1981; Kieckhefer and Kantack, 1988).

S.avenae exhibits a preference for feeding on the ear where it is able to reproduce more rapidly than on other parts of the plant (Vereijken, 1979). As a direct result of S.avenae feeding on the developing ear the cereal plant suffers a reduction in the average grain weight (Vereijken, 1979). George and Gair (1979) estimated yield losses of approximately 12.5% as a result of summer outbreaks of S.avenae in winter wheat. Yield losses increase with increasing numbers of aphids per ear (Rautapaa, 1966 and Vereijken, 1979) but there does not appear to be a significant correlation between loss and peak numbers per ear (George and Gair, 1979; Vereijken, 1979; Entwistle and Dixon, 1987). This may be because timing and duration of infestation are also important factors in determining the level of yield reduction (Wratten, Lee and Stevens, 1979). Feeding aphids produce honeydew which encourages the growth of a variety of fungal species on the ear and results in additional yield loss besides that caused directly by feeding. Vereijken (1979) concluded from field trials that, in the absence of a fungicide treatment, the losses caused by fungi feeding on honeydew amounted to approximately 50% of the total yield reduction.

The most effective treatment to prevent economic damage by S.avenae is the application of a selective aphicide on the completion of ear emergence (G.S.59. Zadoks), (George and Gair, 1979).

M.dirhodum like R.padi is dioecious and may overwinter either holocyclically on its primary host Rosa spp. or anholocyclically on Gramineae (Hand and Williams, 1981). M.dirhodum only efficiently acquires and transmits less severe forms of BYDV than does R.padi making it less significant as a vector (Smith et al 1976). M.dirhodum exhibits a preference for feeding on the leaves of cereal plants rather than the ears (Vereijken, 1979) causing reductions in yield and grain quality but only at comparatively high densities ie in excess of 50 aphids per tiller (Vereijken, 1979).

1.3 The role of natural enemies in the control of cereal aphid populations.

Invertebrates capable of influencing the development of aphid populations fall into three categories;

i) Parasitoids.
ii) Aphid-specific predators.
iii) Polyphagous predators.

Cereal aphids are parasitized by a number of species of Hymenoptera, predominantly members of the family Aphidiidae. Powell (1982) simulated different overwintering parasite population densities by the spring release of Metopolophium festucae (Theo.) which had been artificially infected with Aphidius uzbekistanicus (Luz.). There was found to be a negative correlation between the initial spring density of parasitized Metopolophium and the final summer density of S.avenae. The Aphidiid parasitoids Aphidius picipes (Nees) and Praon volucre (Haliday) have also been shown to influence the population growth of S.avenae (Ankersmit, 1982).

Aphid-specific predators include adult coccinellids and the larval stages of both syrphids (eg. Episyrphus balteatus (Degeer) (Diptera: Syrphidae) and coccinellids (eg. Coccinella septempunctata (L.) (Coleoptera: Coccinellidae). It is advantageous for aphid-specific species to reproduce in areas of high aphid density in order to ensure an adequate food supply for their offspring and for this reason they only tend to become an important factor well into the aphid establishment phase (Chambers et al 1986).

In cereal crops the range of polyphagous predatory invertebrates includes members of the Acari, Araneae, Carabidae, Dermaptera, Diptera and Staphylinidae. It is well documented that aphids form part of the diet of a large proportion of the polyphagous predatory species which inhabit cereal fields.

Some evidence is provided directly by observations in the field (Nentwig, 1980; von Nyffeler and Benz, 1982; Sunderland et al 1986).

Many members of the Carabidae ingest solid fragments of their prey so that aphid remains may be detected by microscopic analysis of the gut contents (eg. Sunderland, 1975; Hengeveld, 1980; Sunderland and Vickerman, 1980; Loughridge and Luff, 1983; Scheller, 1984; Griffiths et al 1985; Chiverton, 1987; Sunderland et al 1987).

In the case of spiders and other fluid feeders consumption of aphids can be determined by means of an enzyme-linked immunosorbent assay (ELISA) (Chiverton, 1982; Crook and Sunderland, 1984; Sopp and Chiverton, 1987; Sunderland et al 1987).

The frequently observed negative correlation between predator density and the peak level of aphid infestation provides circumstantial evidence for the role of the predator complex in the regulation of cereal aphid populations (Potts and Vickerman, 1974; Ekbom and Wiktelius, 1985). Artificial manipulation of predator densities using barriered plots provides further evidence for a causal relationship between the density of natural enemies, during the aphid establishment phase, and the peak aphid density (Edwards et al 1979; DeClercq and Pietrazko, 1982; Chambers et al 1983; Chiverton, 1986).

The most efficient means of restricting aphid outbreaks is the elimination of immigrants before they are able to begin reproduction. Although they consume prey other than cereal aphids, polyphagous predators are present in the field during the crucial establishment phase and some have been shown to consume aphids at low aphid densities (Sunderland and Vickerman, 1980).

There have been attempts to produce a ranking of the relative importance of the polyphagous predators associated with the cereal ecosystem. The earliest attempts at providing such a ranking adopted a somewhat simplistic approach being based solely on a combination of predator density and the proportion of each predatory species found to contain solid aphid remains (Sunderland and Vickerman, 1980). As was pointed out by Wratten et al (1984) the concept of predatory indices would be vastly improved by the incorporation of a number of additional factors. These included the need to consider the relative abilities of predatory species to disperse from overwintering refugia and variations in the timing of this event. Another factor which may be important in determining the relative efficacy of a predator is the ability to produce a numerical response to what amounts to a heterogeneously distributed food resource. Sunderland and Vickerman's paper of 1984 ignored the role of fluid feeding predators such as linyphiid spiders and also did not take into account any differences in the rates of consumption. To some extent these anomalies have since been rectified by the inclusion of data from studies employing the ELISA system (Sunderland et al 1987).

The literature indicates that there are no hard and fast rules as to which predatory species will be of particular importance in any specific situation but it is clear that the predatory complex as a whole does have a role in inhibiting the outbreak of cereal aphid infestations.

1.4 Pyrethroid insecticides.

1.4.1 Development.

The pyrethroid insecticides are derivatives of the pyrethrins, a group of esters which occur naturally in the flowers of a number of species of Chrysanthemum including C.cinerariaefolium and C.roseum (Compositae) (Staudinger and Ruzicka, 1924).

The earliest records attributing insecticidal properties to these plants date from the seventeenth century (Ruigt, 1985). The commercial production of pyrethrum powder was established in Europe by the middle of the nineteenth century (Casida, 1980). By the 1940s world production of pyrethrum was centred on East Africa and this remains the case to the present day (Starke, 1981).

The natural pyrethrins have the advantage of low mammalian toxicity but the disadvantage of low photostability (Ruzo and Casida, 1981) a factor which limits their effectiveness as agricultural insecticides in field crops. The first photostable synthetic analogue (pyrethroid) of the pyrethrins, permethrin, was developed as a result of research carried out at Rothamsted Experimental Station in the U.K. (Elliot et al 1973a, 1973b).

The improved resistance to photodegradation combined with the development of increased insecticidal activity in subsequent pyrethroids has opened up new avenues of usage in the field of crop protection. Compared with many organochlorine and organophosphate insecticides the pyrethroids have the advantage of lower mammalian toxicity combined with reduced persistence in the environment making them less of an ecological hazard. From the growers' point of view the speed of biodegradation of the pyrethroids means that treatments can be applied nearer to the time of harvest without the risk of excessive levels of pesticide residue in the crop.

1.4.2 Mode of action.

Literature on the pyrethroids frequently divides them into two groups based on differences in the symptomology of their intoxicant effects on mammals and also loosely on structural differences (Gray and Soderlund, 1985). Type I compounds including permethrin, tetramethrin, allethrin and the pyrethrins induce a body tremor (T) syndrome which is similar to that observed in DDT poisoning (Soderlund and Bloomquist, 1989). Type II compounds including cypermethrin, deltamethrin and fenvalerate are associated with the so-called choreoathetosis / salivation (CS) syndrome which is characterised by convulsions and excessive salivation. The differences in symptomology are generally, though not absolutely, correlated with the presence or absence of an alpha-cyano-3-phenoxybenzyl group. The early pyrethroids which constitute the majority of type I compounds do not contain the alpha-cyano group while the majority of type II compounds possess it.

Differences in intoxicant effect in invertebrates have also been reported (Ruigt, 1985; Gammon et al 1981). Type I compounds rapidly induce a state of incoordination and partial or total paralysis known as knockdown. At lower doses it is possible for complete recovery from knockdown to occur. The intoxicant action of type II compounds is more prolonged with insects passing through a sequence of conditions including excitation / hyperactivity, incoordination, prostration, progressive paralysis and finally mortality. The duration of each stage of intoxication is dependent upon the particular compound involved and the size of the dose applied (Pichon et al 1987).

The symptoms exhibited in both vertebrates and invertebrates are indicative of a neurotoxic effect. The difference in intoxicant action observed between type I and II pyrethroids is reflected at the neurological level. Compounds not containing an alpha-cyano group prolong the falling phase of the action potential and induce repetitive discharges prior to blocking nerve conduction (Lund and Narahashi, 1981a; Leake et al 1987; Narahashi, 1987; Soderlund and Bloomquist, 1989). Alpha-cyano compounds do not induce repetitive discharges but produce a depolarization of the nerve which is dependent upon the frequency of stimulation and results in the blocking of nerve conduction (Lund and Narahashi, 1983; Vijverberg _et al_ 1987; Soderlund and Bloomquist, 1989).

In both cases the effects are prevented by reducing the concentration of sodium ions in the medium surrounding the nerve (Pichon _et al_ 1987) or by the introduction of tetrodotoxin (TTX) which specifically blocks the voltage-dependent sodium channels of the nerve membrane (Pichon _et al_ 1987; Soderlund and Bloomquist, 1989). These factors indicate that the sodium channel is the primary target for the neurotoxic action of the pyrethroids. Tetramethrin has been shown to modify both open and closed channels causing them to become activated and inhibiting their closure (Lund and Narahashi, 1981b). The prolonged conductance of sodium leads to a progressive depolarization and nerve block. In the case of type II compounds it has been shown that some of the channels are modified almost indefinitely (Lund and Narahashi, 1983). Pichon _et al_ (1987) calculated that the disruption of normal nerve function required the modification of less than 5% of the sodium channels of the nerve membrane which goes some way to explaining the considerable insecticidal efficacy of the pyrethroids. Species-dependent differences in sodium channel binding sites are almost certainly a contributory factor in explaining differences in susceptibility to pyrethroids (Vijverberg _et al_ 1987).

Narahashi (1987) suggested that the differences in action of type I and II pyrethroids could be explained by the fact that non alpha-cyano compounds blocked calcium channels in addition to disrupting sodium channels.

There is some evidence for an effect on the receptor-channel complex of the invertebrate neurotransmitter gamma aminobutyric acid (GABA) (Lawrence and Casida, 1983) but the concentrations required for a significant effect were shown to be several orders of magnitude higher than those needed for nerve block by modification of sodium channels (Narahashi, 1987).

The progression from irritation to mortality observed in intoxicated insects is indicative of a sequential poisoning from the peripheral, sensory system to the central nervous system. Treatment of house-flies, Musca domestica (L.), with pyrethroids results in the uncoupling of the usually coordinated flight activity prior to the final inhibition of motor activity, a fact which supports the idea of an initial bias towards peripheral sites of action (Adams and Miller, 1980).

Physiological resistance to pyrethroids is not only related to species-dependent differences in the site of primary lesion but is also governed by the ability of the organism to detoxify the insecticide. The importance of esterase activity in the in vivo metabolism of pyrethroids can be demonstrated by the synergistic action of esterase-inhibiting organophosphates (Jao and Casida, 1974). Hydrolysis occurs in a variety of insect tissues including the cuticle and gut (Abdel-Aal and Soderlund, 1980).

1.4.3 The commercial uses of pyrethroids.

The range of commercial uses for which the pyrethroids are suited is largely governed by the physicochemical properties of the group. The highly lipophilic nature of these compounds inhibits translocation within plants making the pyrethroids unsuitable as sysytemic agents. This characteristic combined with low volatility indicates that the pyrethroids are best suited to the role of contact insecticides (Graham-Bryce, 1987).

The lack of specificity in the insecticidal action of the pyrethroids has both advantages and disadvantages. One of the more positive aspects of their broad spectrum nature is the resultant diversity of potential applications. The pyrethroids have not only proved to be effective regulators of a variety of pests of agricultural crops (including cereal aphids) but they are also successfully employed within a number of other areas of pest control. These include silviculture, public health, veterinary and horticultural entomology.

Public health pests exhibiting susceptibility to pyrethroids include cockroaches (Chadwick, 1979), body lice (Nassif et al 1980) and numerous dipteran vectors of disease including the malarial mosquitoes (Barlow et al 1977).

Dipteran pests such as biting-flies are also important targets for pyrethroids within the field of veterinary entomology (Blackman and Hodson, 1977; Bailie and Morgan, 1980).

Pyrethroids provide effective protection against a diversity of lepidopteran larvae which have the potential to damage an extremely wide range of crops including cotton, peas, tobacco and various fruits (Piedallu and Roa, 1981).

Thysanoptera which are serious pests of onions, soft fruits and many ornamental plant species are also highly susceptible to applications of synthetic pyrethroids (Piedallu and Roa, 1981).

1.4.4 The potential impact of autumn applied pyrethroids on beneficial invertebrates in cereal crops.

The limited environmental persistence of the pyrethroids is one of the advantages that they have over other groups of insecticides. Biological inactivation is facilitated by a strong tendency for adsorption to colloidal particles in soil (Harris and Turnbull, 1978). This is then followed by metabolism through various combinations of oxidation, hyroxylation and hydrolysis depending upon the compound in question (Aizawa, 1982).

Some examples of the half lives of pyrethroids in soils are given in Table 1.1

Table 1.1 Table showing half lives in soils for a number of pyrethroids.

Pyrethroid	Half life in soil. (Source).
Cypermethrin	2½ weeks (2), 2-3 weeks (4).
Deltamethrin	10-11 weeks at 10°C., 5-6 weeks at 20°C, (6)
Fenpropanate	8 weeks (2).
Fenvalerate	9 weeks (2), 6 weeks (5).
Permethrin	9 days(1),5 weeks(2),6-12 days(3),6 weeks(5)

Sources.
(1). Briggs, 1985.
(2). Harris *et al* 1981.
(3). Kaneko *et al* 1978.
(4). Roberts and Standen, 1977.
(5). Williams and Brown, 1979.
(6). Hill and Schaalje, 1985.

The major disadvantage of the pyrethroids is the lack of specificity in their insecticidal action which consequently places beneficial invertebrates at risk. Recommendations for the use of pyrethroids in U.K. cereals up to 1990 provided a degree of selectivity by temporal means. During the period recommended for application to control BYDV (mid October to mid November) many of the important polyphagous predators will have dispersed to field boundaries which act as overwintering sites (Sotherton, 1984, 1985). Until 1990 there was a moratorium on summer use, when highly ranked predators would have been directly exposed. In 1990 however, deltamethrin and fastac have been approved for use as summer aphicides

The species most at risk from direct insecticidal effects in the autumn will be those which overwinter in the field itself either as adults (eg. *Bembidion obtusum*

(Serville.) (Coleoptera, Carabidae) or as larvae (eg. Nebria brevicollis (F.) (Coleoptera, Carabidae).

Mortality from the neurotoxic action of pyrethroids may result from i) direct exposure, ii) contact with a contaminated substrate or iii) consumption of contaminated prey (Dunning et al 1982).

In the field situation those individuals suffering from knockdown are potentially capable of recovery but are at risk of predation by scavengers or mortality from dessication if they are immobilised away from shelter. The latter is particularly true in the case of arthropods susceptible to disruption of their neurohaemal organs and the associated diuresis which has been observed in some invertebrates (Casida and Maddrell, 1971; Soderlund, 1979).

It was shown in the previous section that one of the symptoms of pyrethroid intoxication is irritability / hyperactivity resulting from disruption of the sensory nervous system. The progressive nature of pyrethroid intoxication from the sensory to the central nervous system may provide some invertebrates with the ability to exhibit repellence from contaminated prey or substrates thus preventing direct mortality. Haynes (1988) employed the term 'behavioural resistance' to describe the ability to perceive and positively respond to the presence of an insecticide. The resulting response may manifest itself in the form of emigration from an hostile environment or as an antifeedant effect in the case of contaminated prey.

The broad spectrum nature of the pyrethroids means that their application may result in a reduction of the alternative prey of polyphagous predators. Food availability is an important factor in determining the levels of both activity and fecundity exhibited by predatory invertebrates. For example, Grum (1971) and Lenski (1984) observed that hungry individuals of the genus Carabus (L.) were characterized by high mobility.

Walking behaviour in carabid beetles can be separated into two distinct forms, i) directed / straight walk and ii) random walk (Baars, 1979; Mols, 1979, 1984). Directed walk is characterized by high speed and low frequency of turning while random walkers exhibit an increased turning rate and lower basic mobility. The mode of activity adopted is dependent upon the degree of hunger experienced by the beetle. The motivational status of the beetle is dependent upon how full or empty its digestive tract is (Mols, 1979, 1984). Directed walkers have empty or nearly empty digestive tracts while random walkers have a higher proportion of their gut capacity filled.

Random movement effectively produces a home range for the individual (Burt, 1943; Grum, 1983). The size of the home range will be dependent upon the hunger of the carabid and so to some extent will be determined by prey density. Grum (1983) calculated a home range of less than $12m^2$ for Pterostichus oblongopunctatus (L.) engaged in random walk while the search area of hungry beetles increased to around $80m^2$. In the case of Pterostichus coerulescens (L.) and Calathus melanocephalus (L.) the switch from random to directed movement resulted in an increase in maximum daily displacement from 13m to 87m and from 6.5m to 36m respectively (Baars, 1979). Random walk maintains the beetle in the vicinity of its most recent food source while directed walk serves to promote dispersal to more hospitable areas.

Reduced food availability following pesticide application may lead to an increase in the proportion of directed walkers in the population consequently resulting in dispersal from the treated area. The rate of reinvasion of the treated area will be determined by a combination of the speed with which the food source recovers and the general mobility of the predator concerned. This assumes that no repellency is involved.

In the event of a long term shortage of food carabids adopt an energy conserving strategy by decreasing their activity (Grum, 1983). In the field this may occur in situations where the treated area exceeds the directed-walk home range of the species. Since home range is dependent upon general mobility (Grum, 1983) one would expect this situation to arise more frequently in the case of smaller, less mobile, ground-active insects.

The positive correlation between food availability and egg production is well documented for a number of species of Coleoptera including C.melanocephalus (Baars and van Dijk, 1984); Carabus limbatus (Say.) (Lenski, 1984); P.oblongopunctatus (Heessen, 1980) and P.coerulescens (van Dijk, 1983; Baars and van Dijk, 1984).

Lenski (1984) found that supplementing the food of adult C.limbatus not only resulted in increased larval numbers but also caused the larvae to be produced earlier. Since the experiments involved semi-field populations it is not possible to determine whether this resulted from earlier egg laying or from the promotion of larval development due to higher yolk content of the eggs.

When food is limited female carabids overwintering as adults may adopt either of two strategies (Murdoch, 1966; Baars and van Dijk, 1984). Energy may be invested in the production of eggs at the cost of reduced overwintering success or fat deposition may take priority in order to improve adult survival. Murdoch 1966 observed the two strategies in the carabid Agonum fuliginosum (Panzer.) in separate years. The factors determining which strategy is employed are unclear.

Egg production in spiders also exhibits a positive correlation with the availability of food (Riechert and Tracy, 1975; van Wingerden, 1978; Wise, 1975). Mean egg weight is determined by food availability in some but not all species (Turnbull, 1962; Riechert and Tracy, 1975). The amount of yolk present in the egg is potentially an important factor in determining the viability of the resultant spiderling.

Limiting the amount of food available during development of the spiderling reduces the rate of growth and increases the number of nymphal instars required to reach maturity (Wise, 1975; Martiniuk and Wise, 1985, Miyashita, 1968, 1977). This effectively reduces the rate of population growth. In addition, earlier instars have a reduced rate of overwintering success when compared with mature nymphs (Martiniuk and Wise, 1985).

The final adult size of spiders is determined by the availability of food during development (Wise, 1975) and in female spiders size at maturity is positively correlated with fecundity (Wise, 1975; Toft, 1976).

A considerable number of spider species living in temperate zones are winter active even to the point of exhibiting subnivean activity (Aitchison, 1984). This capability is a result of the presence of 'antifreeze' agents in the haemolymph. The supercooling points of winter active spiders and insects are reduced by high concentrations of glycerol and glycoproteins (Duman, 1979; Husby and Zachariassen, 1980). In some cases these compounds are capable of lowering the freezing point of the haemolymph to -6 to -7 degrees C. (Husby and Zachariassen, 1980).

It seems probable that the levels of the antifreeze agents will be determined by the quantity and quality of the available food. The level of thermal hysteresis depends upon the concentration of the antifreeze agents in the body fluids (Duman, 1980). It is plausible that the reduced availability of prey following the application of a pesticide will inhibit the accumulation of the appropriate proteins. This may manifest itself in a reduced ability to successfully overwinter in exposed habitats such as autumn sown cereal fields.

A more direct insectistatic effect has been observed in the cotton stainer Dysdercus similis (F.) (Raghunatha Rao et al, 1986). Treatment of final instar larvae with an analogue of fenvalerate resulted in the production of female adultoids with abnormally developed ovaries. Reductions in the number of oocytes and the degree of vitellogenesis led to the production of a small number of non-viable eggs. The adultoids also exhibited a disruption in the pattern of their mating behaviour.

The potential consequences of the autumn application of a pyrethroid are summarised below in Figure 1.1.

The study was based around a series of field trials and semi-field experiments which examined the effects of single applications of pyrethroid insecticides on the epigeal arthropod fauna associated with the cereal ecosystem. The trials were structured so as to permit the examination of both lethal and sublethal (or insectistatic) effects on the major polyphagous predator groups the Carabidae, Staphylinidae and Linyphiidae and on their alternative prey. Concentrating the work around field studies permitted a number of additional problems to be examined simultaneously. For example, variations in the rate of population recovery resulting from differences in the size and replication of experimental plots and from the use of barriered areas provides information on the mechanism of recovery within treated plots. It also has implications for future experimental design and raises questions about the validity of trials used by agrochemical companies to justify the environmental safety of their products. Figure 1.2 attempts to explain the philosophy behind the research by relating the potential effects of pyrethroid application to the various components of the project.

Fig. 1.1
Autumn application of a pyrethroid insecticide - a summary of the potential impact on the predatory community.

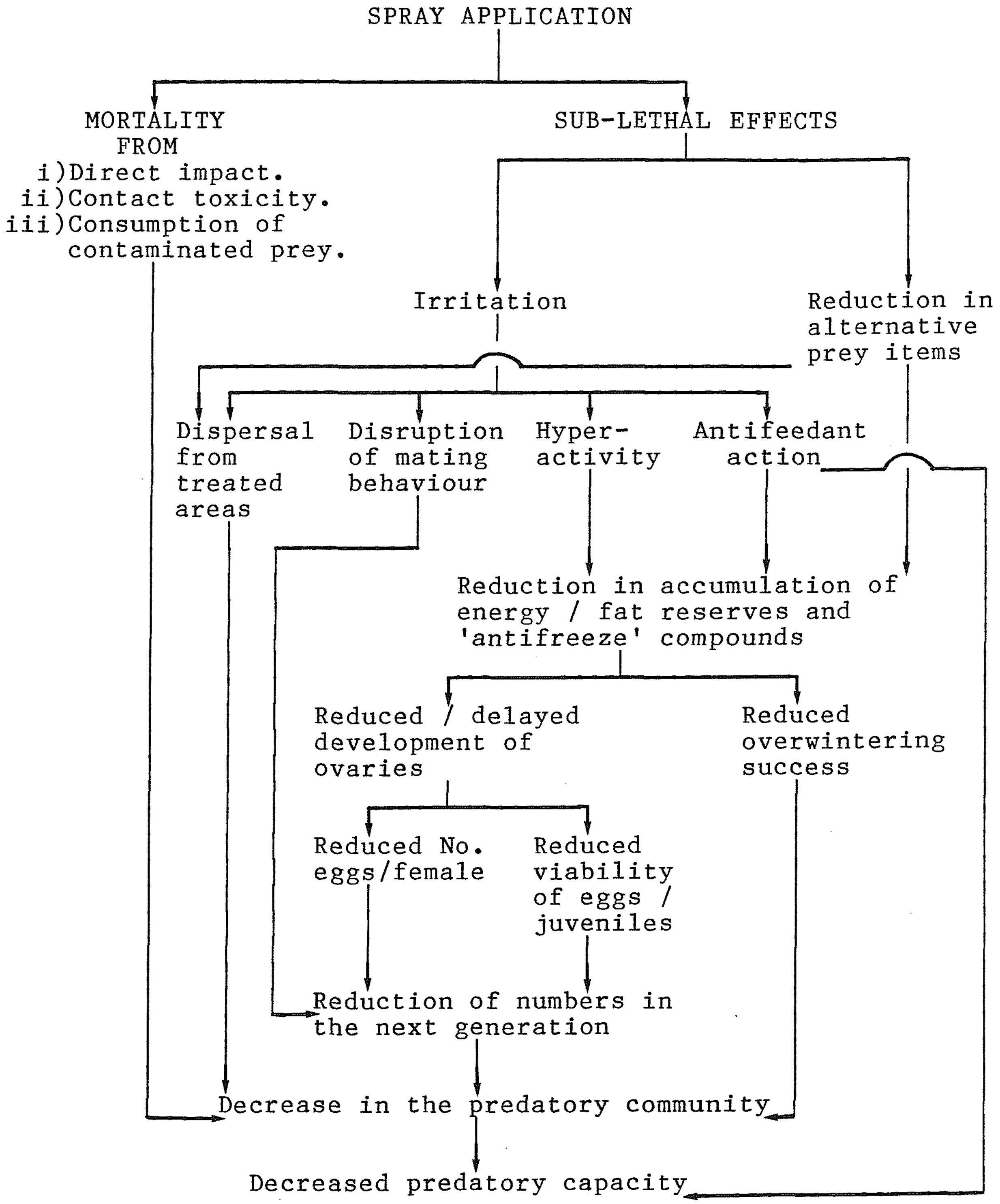


Fig. 1.2 An overview of the project.

1) EFFECTIVE ABUNDANCE OF POLYPHAGOUS PREDATORS.

(a) Pitfall data (Chapters 2-5).

(b) D-vac data (Chapter 4).

(c) Spider web densities (Chapter 5).

2) FECUNDITY OF PREDATORS AND VIABILITY OF IMMATURES.

(a) Dissection of Trechus quadristriatus (Schrank) - Maturity of ovaries and no. eggs/female (Chapter 4).

(b) Transition between instars - Nebria brevicollis (F.) larvae. (Chapter 4).

3) OVERWINTERING SUCCESS OF PREDATORS.

(a) Barriered sub-plots (Chapter 5).

4) PREDATORY CAPACITY OF THE POLYPHAGOUS ARTHROPOD COMMUNITY.

(a) Artificial prey cards (Chapter 3).

(b) Crop contents of Pterostichus melanarius (Illiger) (Chapter 3).

(c) Crop contents of Trechus quadristriatus (Schrank) (Chapter 4).

(d) Comparative levels of summer aphid infestation and crop yield (Chapter 4).

5) IRRITANT EFFECTS ON PREDATORS.

(a) Post-treatment peaks in activity abundance (Chapters 2-5).

(b) Dissections of T.quadristriatus - % of crops full/empty immediately post-treatment (Chapter 4). *

6) EFFECTIVE ABUNDANCE OF ALTERNATIVE PREY.

(a) Pitfall data (Chapters 2-5).

(b) Dietary components of Pt.melanarius (Chapter 3).

* Assumes that activity is hunger dependent. This implies that an irritant effect will therefore lead to an increase in the proportion of predators with full crops which are collected in passive traps such as pitfalls.

CHAPTER 2 - CYPERMETHRIN FIELD TRIAL (AUTUMN 1985).

2.1 Introduction.

The results from several field studies involving cereal crops have indicated that the autumn application of cypermethrin produces a significant but transient suppression of the abundance of a number of non-target invertebrate species (Feeney, 1982; Cole and Wilkinson, 1984, 1985; Inglesfield 1984, 1985; Cole et al 1986). Cole et al (1986) reported that the autumn application of cypermethrin to winter wheat (25g a.i/ha) produced significant reductions in 6% of the arthropod taxa collected in pitfall traps.

The primary objectives of this field trial were to determine the composition of the epigeal arthropod fauna at the time of aphicide application and to assess the degree of severity and duration of any adverse impact on non-target invertebrates. The trial also had a supplementary function in that it provided the author with valuable experience in the sampling and identification of the relevant pest and polyphagous predatory species.

2.2 Estimates of abundance.

2.2.1 Materials and methods.

The trial was carried out in two fields of winter wheat (cv. Moulin) on the 'hill site, 9/10' Charity Down Farm, Longstock, Hampshire, U.K. (see map, Appendix 1.2).

Each field of approximately 4ha was divided equally into a treatment area and a control area. Cypermethrin was applied in the form of a 10% emulsifiable concentrate (EC) at the manufacturers recommended rate of 25g a.i./ha. The pesticide was applied on 29-10-85 using a 'Chafer Pathfinder' hydraulic spray unit fitted with an 18m spray boom and 'Chafer Red Cone' nozzles. The spray unit was operated at a pressure of 1.6 bar and a tractor speed of 10km/h, delivering 220l/ha of spray solution.

The aphicide was applied within the period recommended by ADAS for the control of BYDV. The crop was at the 2-leaf growth stage (Zadoks G.S.12) at the time of treatment.

The relative abundance of arthropods was determined in two ways. i) A grid of five gutter traps was placed in the centre of each plot with four traps effectively forming the corners of a square of sides 60m, with a single trap in the centre of each group. Each gutter trap consisted of a section of plastic guttering fitted with a t-junction and a short length of down-pipe at one end. A fluid filled collecting cup was inserted into the down-pipe in order to retain any arthropods which entered the trap. ii) In addition the treatment and control plots of Field 1 both contained a 3x3 grid of pitfall traps. Each pitfall trap comprised a 7cm diameter, white-plastic, drinking cup inserted into a short length of drain pipe in order to facilitate the emptying and resetting of the traps. A dilute solution of detergent was used as the collecting fluid in both the pitfall traps and the gutter traps.

Collection of trapped invertebrates commenced on 15-10-85 for the pitfall traps, 18-10-85 for the gutter traps in Field 1 and 29-10-85 for the gutter traps in Field 2. Traps were examined at approximately weekly intervals until the trial was terminated on 10-05-86.

All catches were transferred to 70% alcohol before sorting and identification under binocular microscope.

A sign test (Steel and Torrie, 1980) was applied to each set of pitfall trap data in order to detect any significant trends in the size of treatment catches relative to those from the control plots.

The sign test is simply the application of the formula:-

$$X^2 = \frac{(n_1 - n_2)^2}{n_1 + n_2}$$

where n_1 is the number of sampling occasions on which post-treatment catches are higher in treated plots than those in control plots and n_2 is the number of occasions when the opposite is the case. The formula is suitable for testing H_0:p=0.5 (Steel and Torrie, 1980) and assumes a single degree of freedom for use in X^2 tables. Results from the sign tests are presented in Table 2.1.

2.2.2 Results

Due to the comparatively low numbers of invertebrates trapped at the site it was not possible to apply statistical analysis to the data for individual species. It was only possible to analyse data for the total adults of the natural enemy groups Carabidae, Staphylinidae and Araneae and for the alternative prey groups Acari, Collembola and Diptera.

The pitfall trap data for Field 1 are presented as log(n+1) transformed, no./trap/day values in Appendices 2.1-2.6 and as graphs showing treatment values as a percentage of control catches in Figures 2.1-2.6. Results from the gutter trap catches are summarised in a similar manner in Appendices 2.7-2.12 and in Figures 2.7-2.12.

Specific dates relating to the numbers of days before or after treatment are provided in Appendix 2.13.

Carabidae (Appendices 2.1, 2.7, 2.8; Figures 2.1, 2.7, 2.8).

Samples of Carabidae collected from pitfall traps in the autumn were numerically dominated by small beetles belonging primarily to the genus Bembidion. The larger carabid Nebria brevicollis (F.) was also initially well represented in catches but appeared to enter a phase of reduced adult activity at about the same time as the field trial commenced. Immediately after application of the pesticide the relative abundance of adult Carabidae exhibited a marked reduction to less than 50% of the values observed in the untreated area (Fig. 2.1). The decrease in effective abundance on days 2 and 3 after treatment was followed by an apparent increase to approximately twice the level observed in the untreated area. The carabid population in the plot treated with cypermethrin then exhibited a further decline in activity-density for a number of sample dates.

Due to a combination of the flinty nature of the soil and the fact that the experimental plots were on a slope, it proved difficult to maintain the edges of the gutter traps level with the soil surface. As a consequence, the gutter traps were comparatively inefficient at collecting the smaller carabids so that the samples obtained tended to be dominated by large beetles such as Harpalus rufipes (Degeer) and P.melanarius. This may go some way to explaining the differences observed when comparing the graphs obtained for the relative abundances of Carabidae trapped using the two different methods (Figs. 2.1 and 2.7). Immediately after spray application the samples collected from the gutter traps in Field 1 exhibited a sharp increase in the the effective abundance of the larger carabid species (Fig 2.7). This was followed by an equally abrupt decrease in the level of activity abundance to approximately 50% of the control values on days 2 and 3 after treatment. Samples collected from the gutter traps in field 2 indicated that on days 21, 142 and 160 the treatment values for the effective abundance of adult Carabidae were reduced to less than 50% of control levels.

Staphylinidae (Appendices 2.2, 2.9, 2.10; Figures 2.2, 2.9, 2.10).

At the time of spray application the staphylinid species exhibiting the highest activity-density was Xantholinus linearis (Olivier). The relative abundance of adult staphylinids, as determined by pitfall traps, decreased immediately after treatment with cypermethrin (Fig. 2.2). The apparent differences between treatment and control values were transient with recovery occuring within nine days. On day 21 after spray application the number of adult staphylinids collected in the treatment traps was approximately eight times that for the untreated control. Trapping rates in the cypermethrin plot were markedly higher than those in the control area on the majority of the subsequent sample dates. Samples collected during the spring were dominated by large numbers of small species of Aleocharinae. The application of a sign test to the pitfall trap data failed to reveal any pronounced trends in the post-treatment abundance of staphylinids.

Samples collected from the gutter traps in Field 1 (Fig. 2.9) exhibited pre-treatment differences seven and fourteen days before the pesticide was applied. On these dates a far larger number of staphylinids were trapped in the area which had been designated for treatment with cypermethrin. Application of the pyrethroid resulted in a temporary decline in the activity-density of staphylinids in the cypermethrin plot. The result of a sign test confirmed the presence of a general tendency for the post-treatment trapping levels to be highest in the area treated with cypermethrin ($p<0.05$) (Table 2.1).

Gutter trap specimens collected from Field 2 (Fig. 2.10) also indicated a transient decrease in the effective abundance of staphylinids in the plot which had been sprayed with the pyrethroid. No persistent post-treatment trends were detected in the relative abundance of adult Staphylinidae in Field 2.

Araneae **(Appendices 2.3, 2.11, 2.12; Figures 2.3, 2.11, 2.12).**

Catches of Araneae were dominated by members of the family Linyphiidae and in particular by specimens of <u>Erigone atra</u> (Blackwall). Pitfall trap data from Field 1

(Fig. 2.3) indicated that the application of cypermethrin resulted in an immediate reduction in the effective abundance of spiders in the treated area. There was a rapid resurgence in the rate at which spiders were trapped in the cypermethrin plot. This involved a brief sevenfold increase in the activity-density of the spider population. The relative abundance of total Araneae in the treatment area then underwent a progressive decline. The majority of samples collected after this point indicated a persistent reduction in the spider community associated with the cypermethrin plot. This trend was confirmed by means of a sign test (Table 2.1).

Gutter trap data from Field 1 (Fig. 2.11) also indicated that pesticide application resulted in a transient decrease in the apparent abundance of spiders. The temporary reduction was again followed by a brief increase in relative abundance in the area which had been treated with the pyrethroid. A sign test failed to detect an overall trend towards a population reduction ($p>0.05$). On days 135, 142 and 160 the treatment values were reduced to less than 40% of the trapping rates in the unsprayed area.

In the second field (Fig. 2.12) there was also an initial reduction in post-treatment activity-density for total spiders. As with the data sets from Field 1 the apparent reduction was followed by a marked resurgence in activity abundance. Gutter trap samples collected from the control area in the spring yielded consistently higher numbers of spiders than were obtained from traps in the treated plot. The application of a sign test did not reveal any general trends over the course of the field trial.

Acari (Appendix 2.5; Figure 2.4).

A sign test indicated that there were no pronounced post-treatment trends in the relative abundance of total Acari ($p>0.05$).

Collembola (Appendix 2.4; Figure 2.5).

On four out of the five pre-treatment sample dates the trapping rates for Collembola were higher in the control section of Field 1 than in the corresponding treatment area (Fig. 2.5). A sign test (Table 2.1) indicated that there was a pronounced tendency for the post-treatment abundance of Collembola to be higher in the area which had been sprayed with cypermethrin ($p<0.05$).

Diptera (Appendix 2.6; Figure 2.6).

At the time of spray application the samples of Diptera collected from the pitfall traps were dominated by large numbers of 'winter gnats' belonging to the family Trichoceridae. Pre-treatment trapping rates for total Diptera had been consistently lower in the cypermethrin plots. Following the application of cypermethrin the relative abundance of Diptera in the treated plot displayed a further decrease. This apparent decline in the effective abundance of total Diptera was short lived with trapping levels in the untreated area exceeding those in the treated area within fourteen days of spray application. The samples collected during the spring were largely composed of individuals of the dung-fly species *Scatophaga stercoraria* (L.) (Scatophagidae: Diptera). This was probably a consequence of the close proximity of the field site to an area used as pasture for a dairy herd. The application of a sign test failed to detect any general trends in the post-treatment levels of comparative abundance for Diptera.

Fig. 2.1 Total adult Carabidae (pitfall data, Field 1).
Total adult Carabidae trapped in the treatment area as a percentage of the control values.

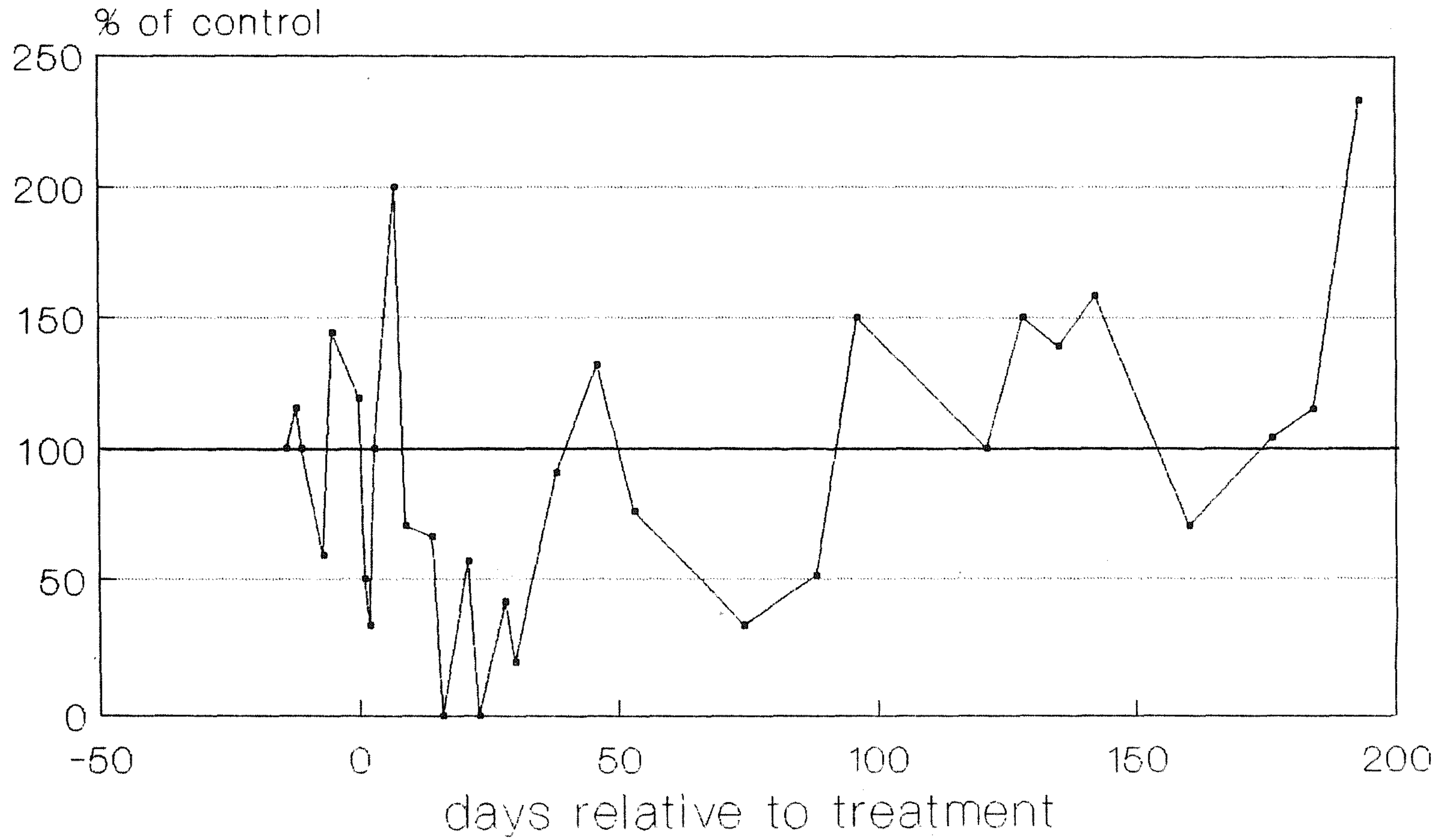


Fig. 2.2 Total adult Staphylinidae (pitfall data, Field 1).
Total adult Staphylinidae trapped in the treatment area as a percentage of the control values.

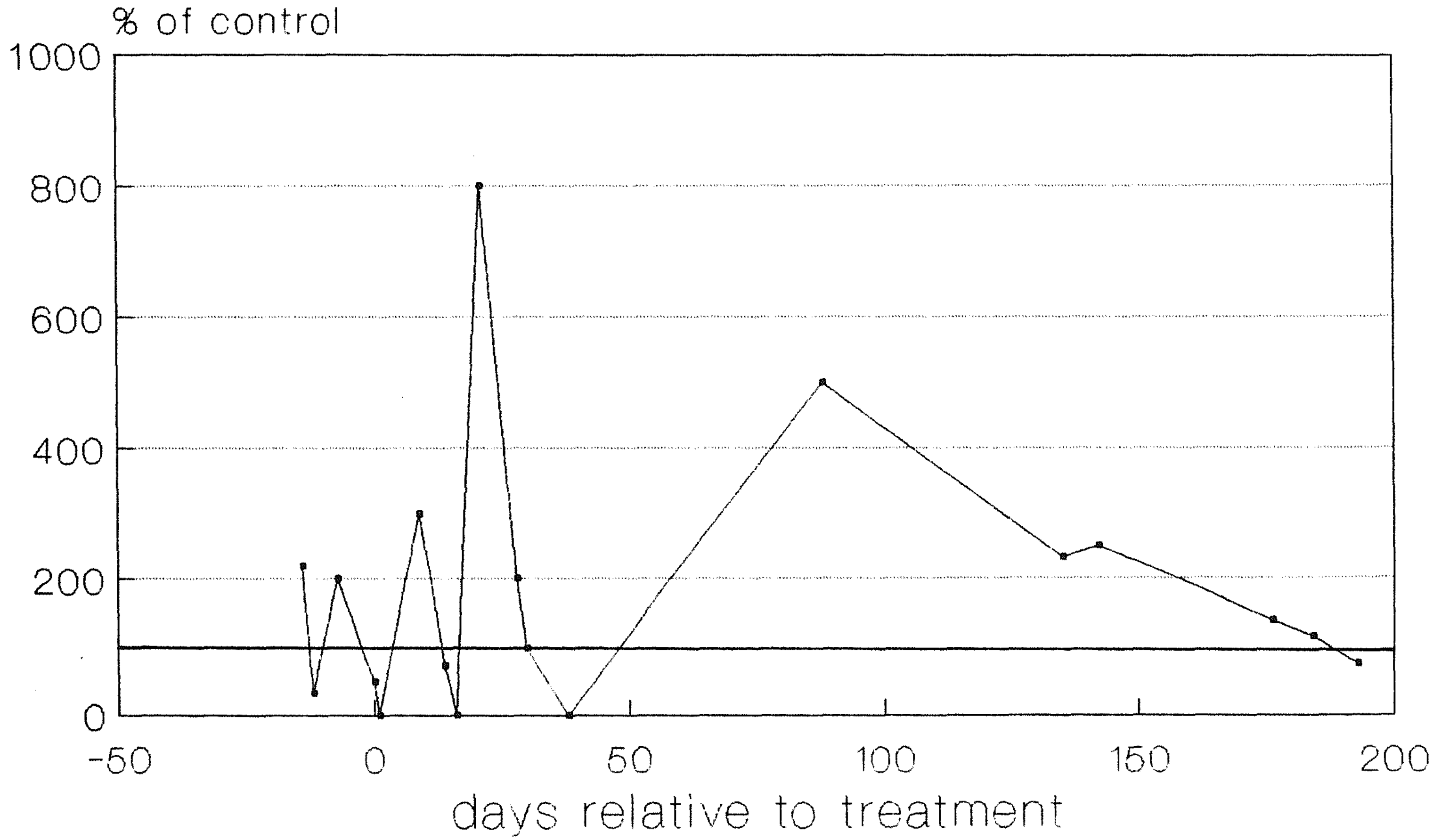


Fig. 2.3 Total adult Araneae (pitfall data, Field 1).
Total adult Araneae trapped in the treatment area as a percentage of the control values.

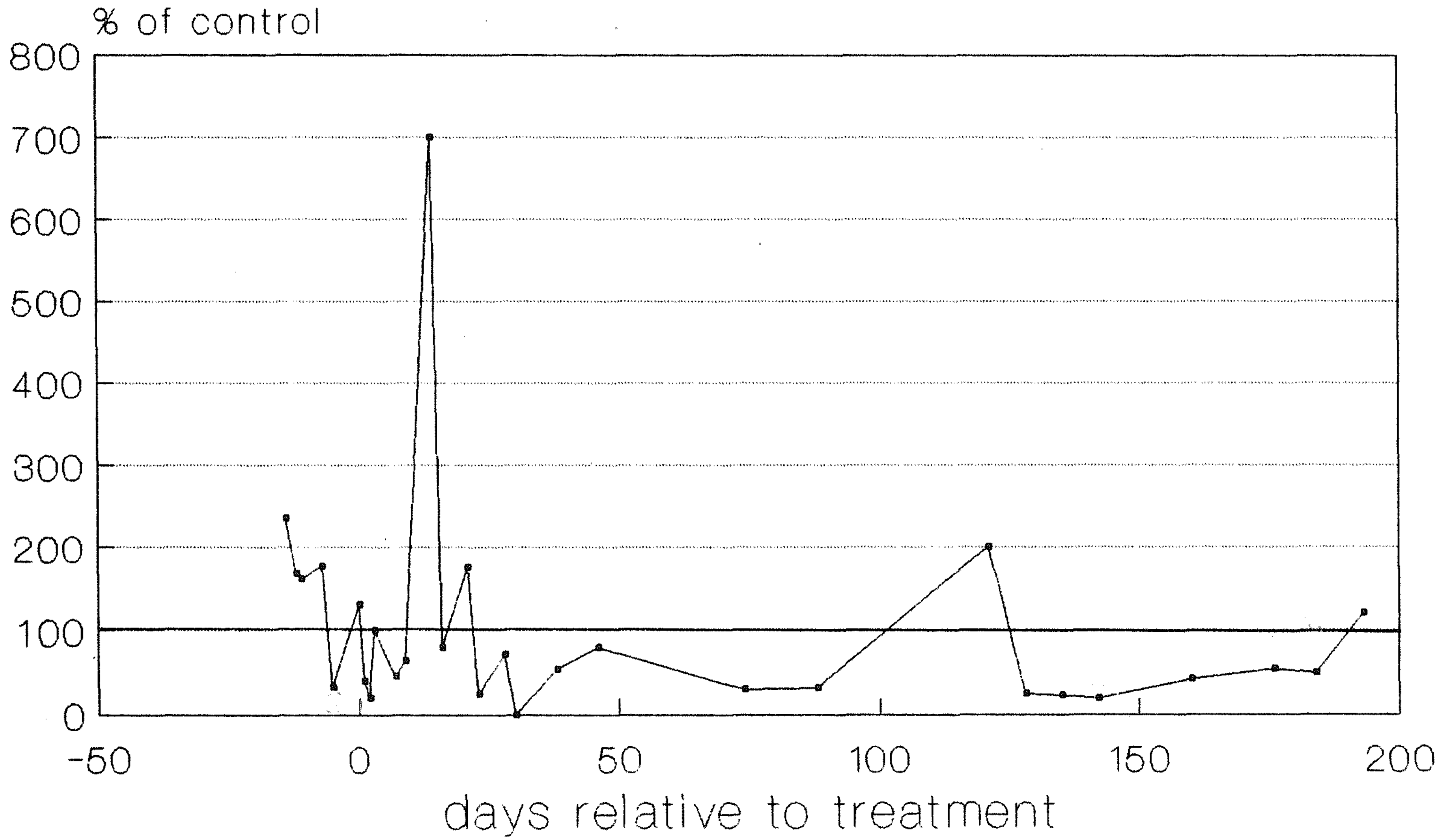


Fig. 2.4 Acari (pitfall data, Field 1).
Total Acari trapped in the treatment area as a percentage of the control values.

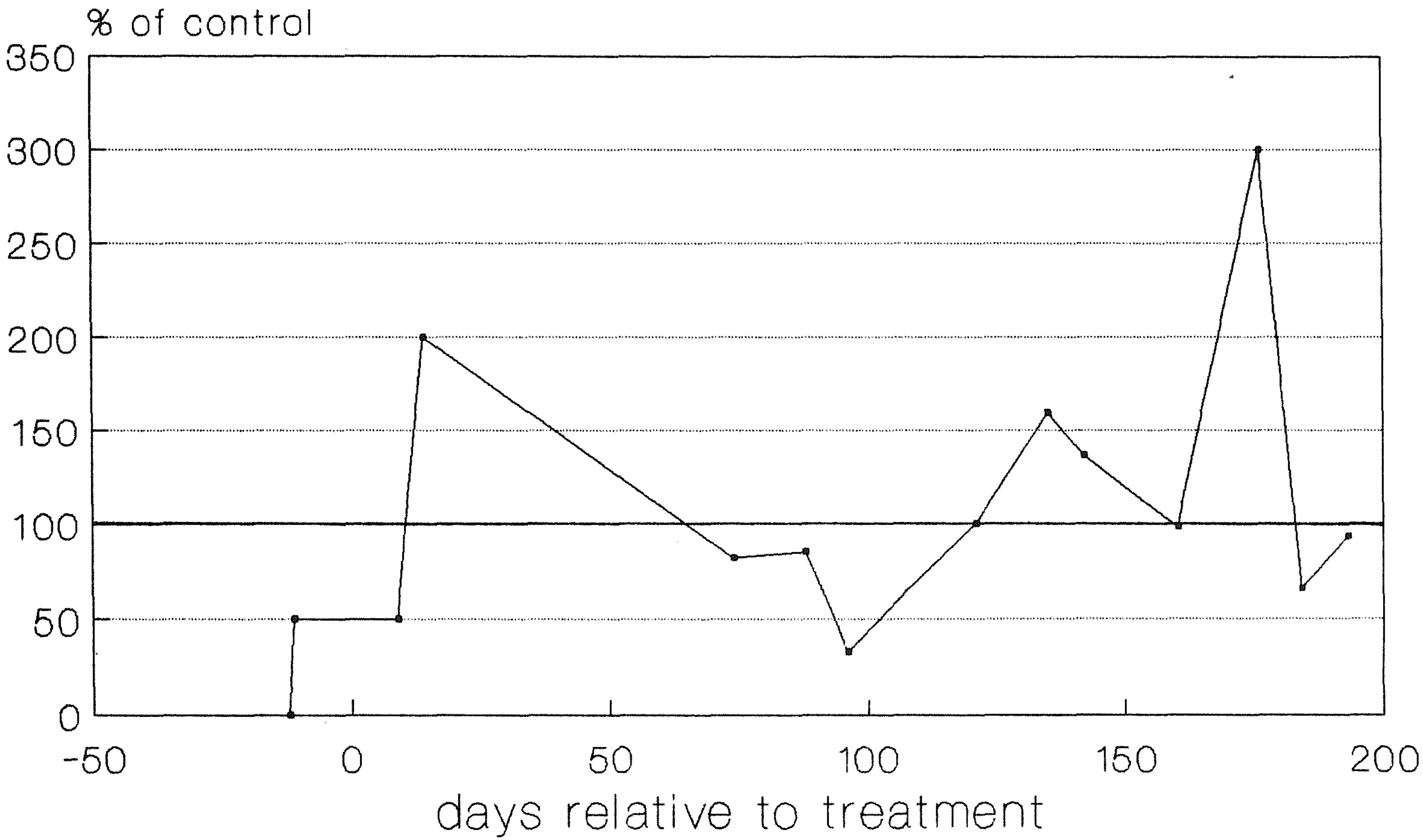


Fig. 2.5 Collembola (pitfall data, Field 1).
Total Collembola trapped in the treatment area as a percentage of the control values.

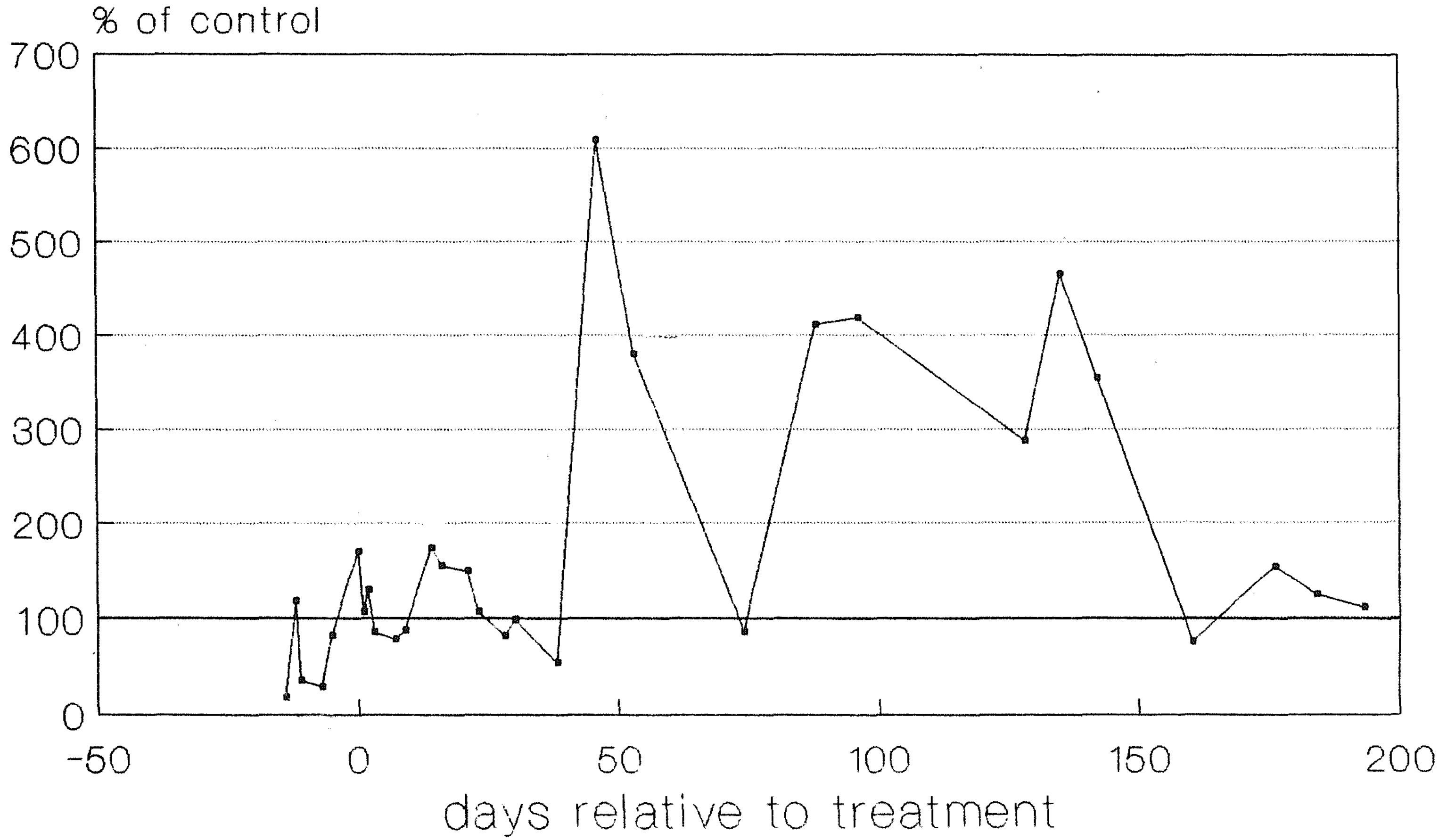


Fig. 2.6 Diptera (pitfall data, Field 1).
Total Diptera trapped in the treatment area as a percentage of the control values.

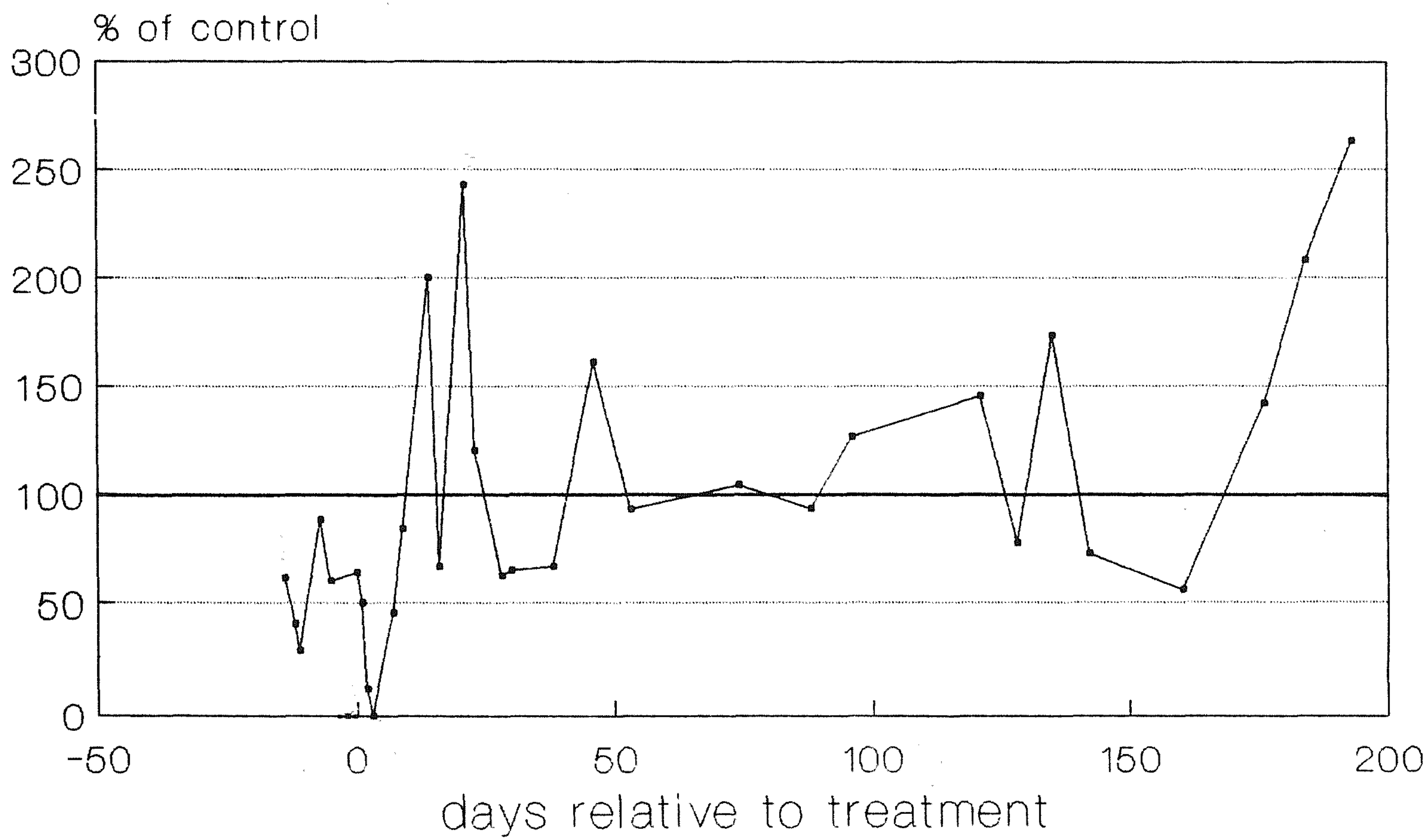


Fig. 2.7 Carabidae (gutter trap data, Field 1).
Total adult Carabidae trapped in the treatment area as a percentage of the control values.

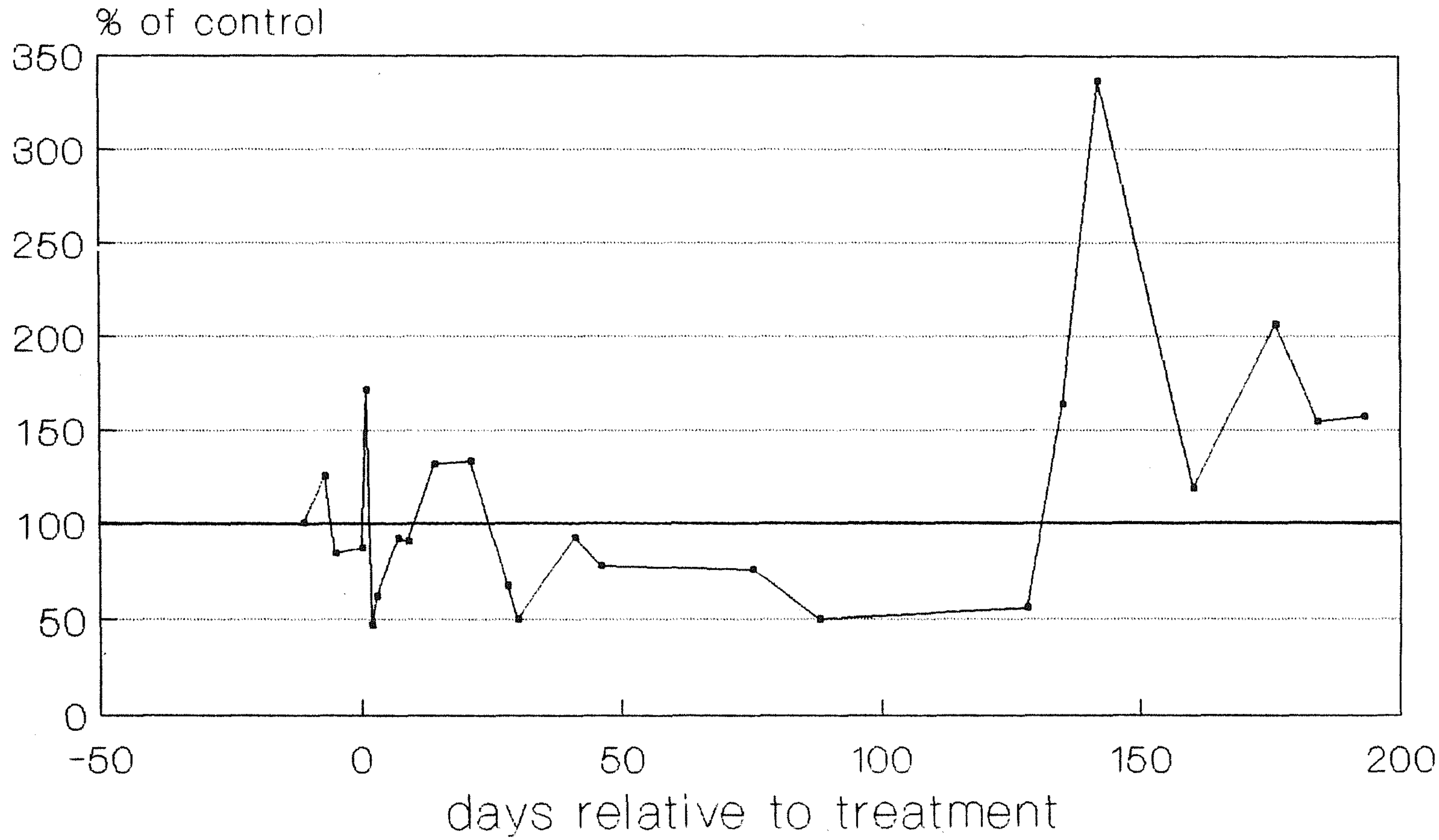


Fig. 2.8 Carabidae (gutter trap data, Field 2).
Total adult Carabidae trapped in the treatment area as a percentage of the control values.

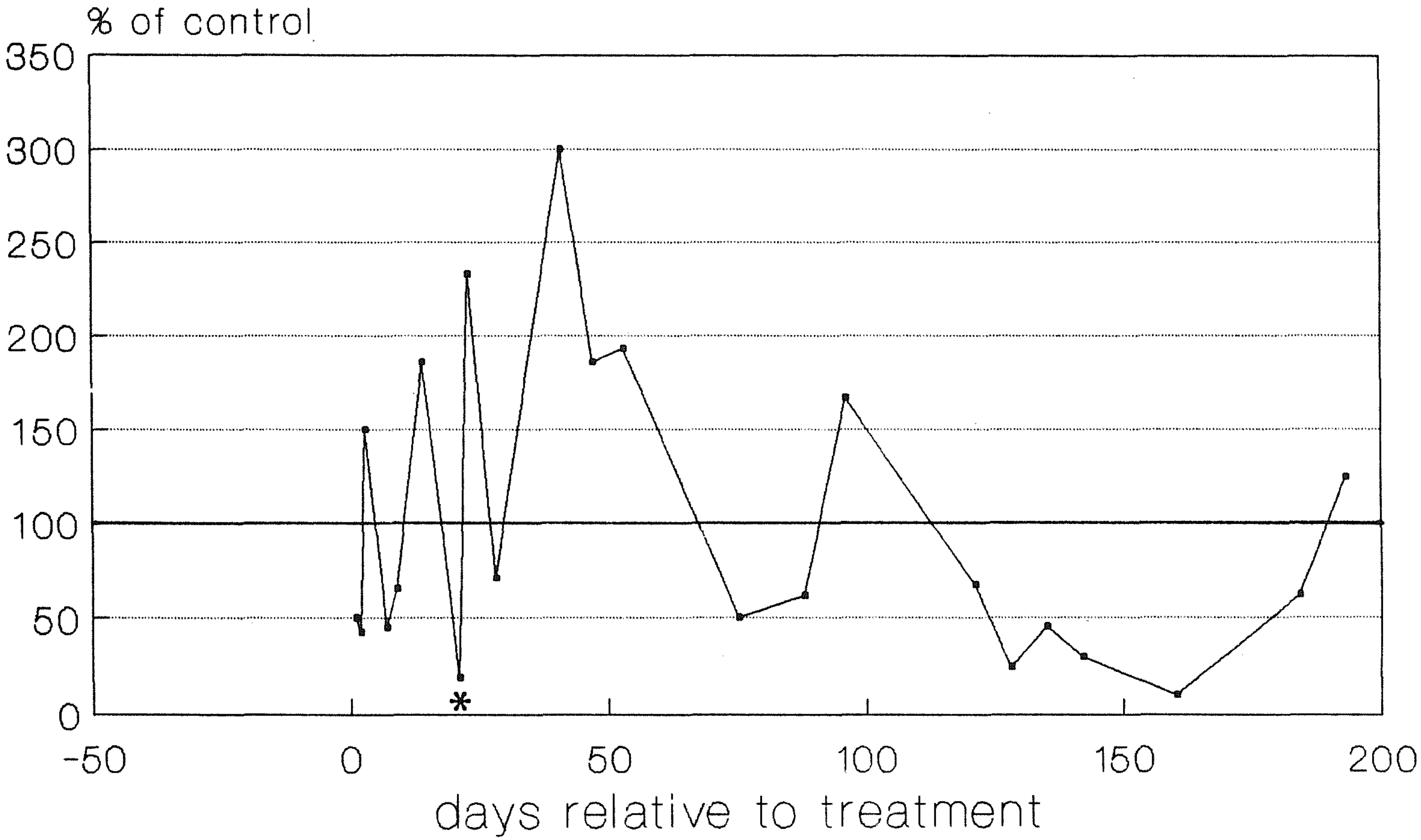


Fig. 2.9 Staphylinidae (gutter trap data, Field 1).
Total adult Staphylinidae trapped in the treatment area as a percentage of the control values.

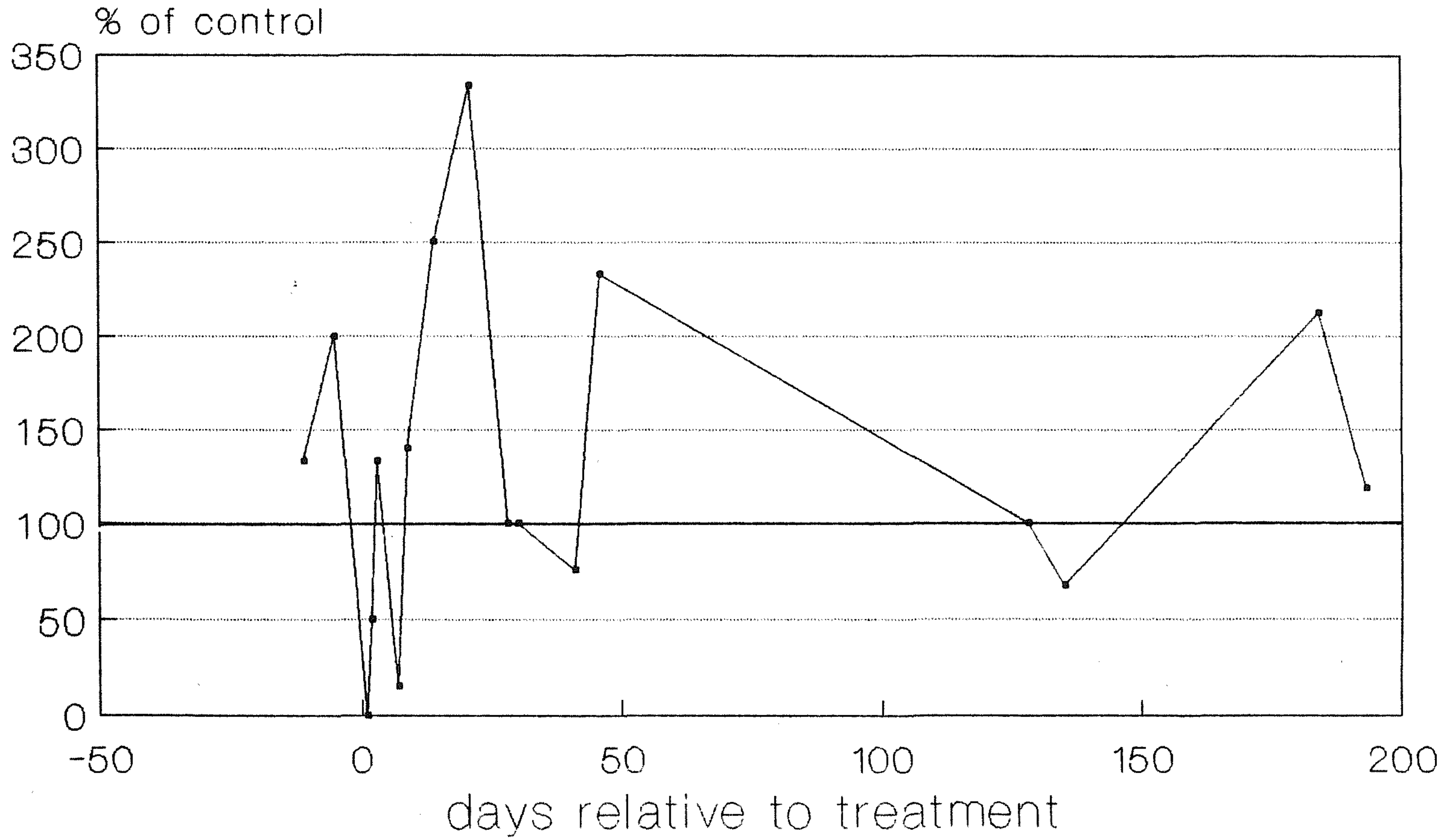


Fig. 2.10 Staphylinidae (gutter trap data, Field 2).
Total adult Staphylinidae trapped in the treatment area as a percentage of the control values.

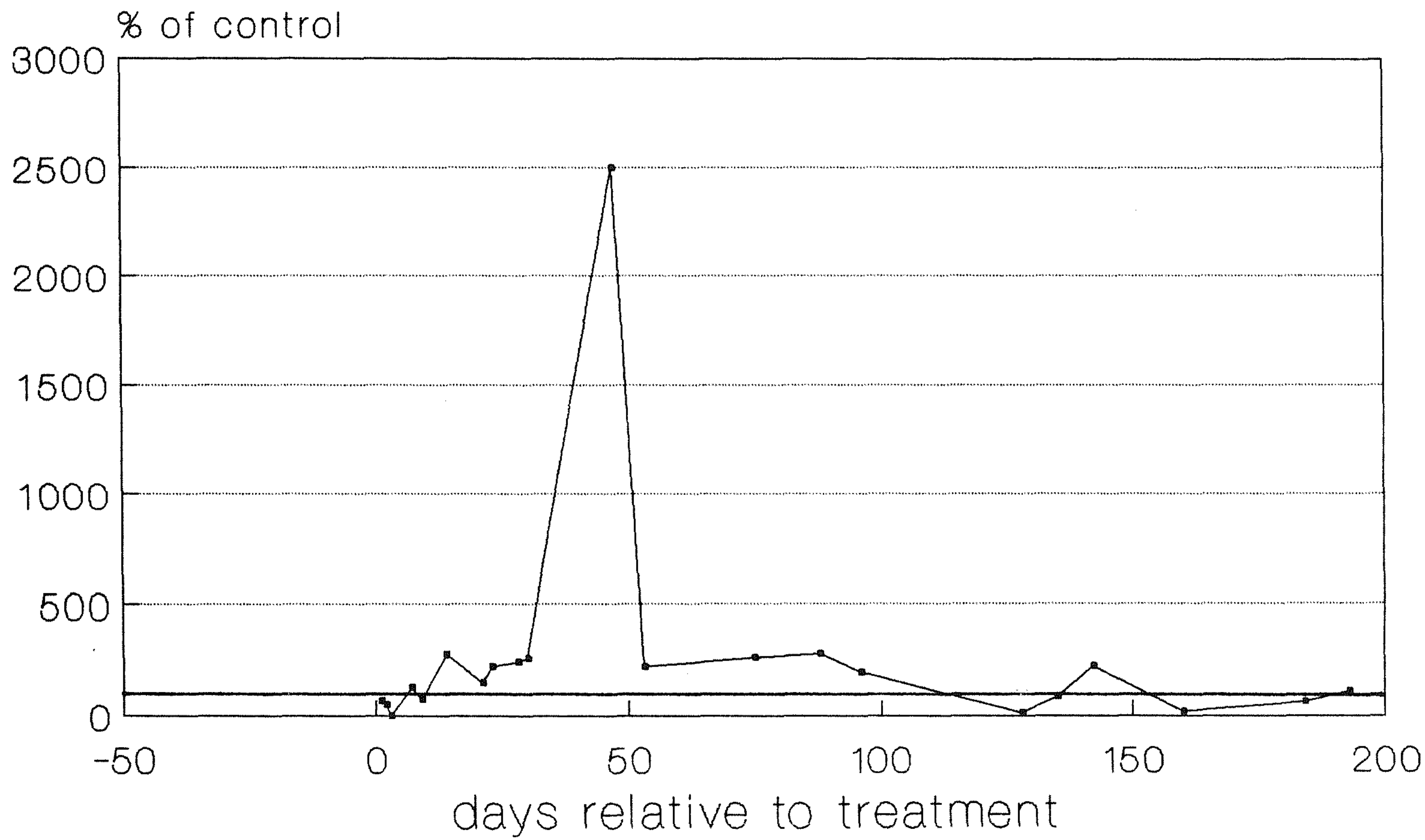


Fig. 2.11 Araneae (gutter trap data, Field 1).
Total Araneae trapped in the treatment area as a percentage of the control values.

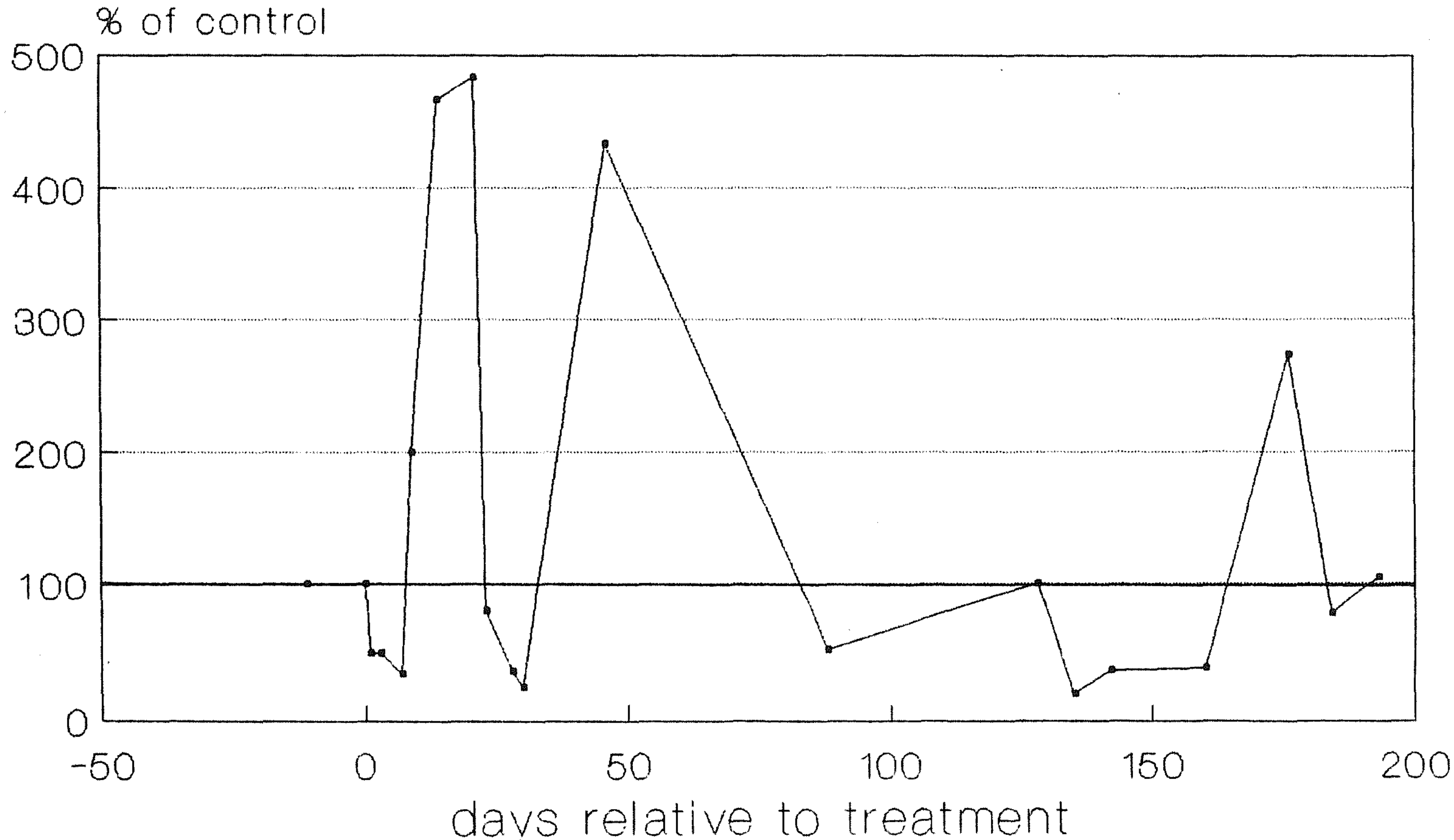


Fig. 2.12 Araneae (gutter trap data, Field 2).
Total Araneae trapped in the treatment area as a percentage of the control values.

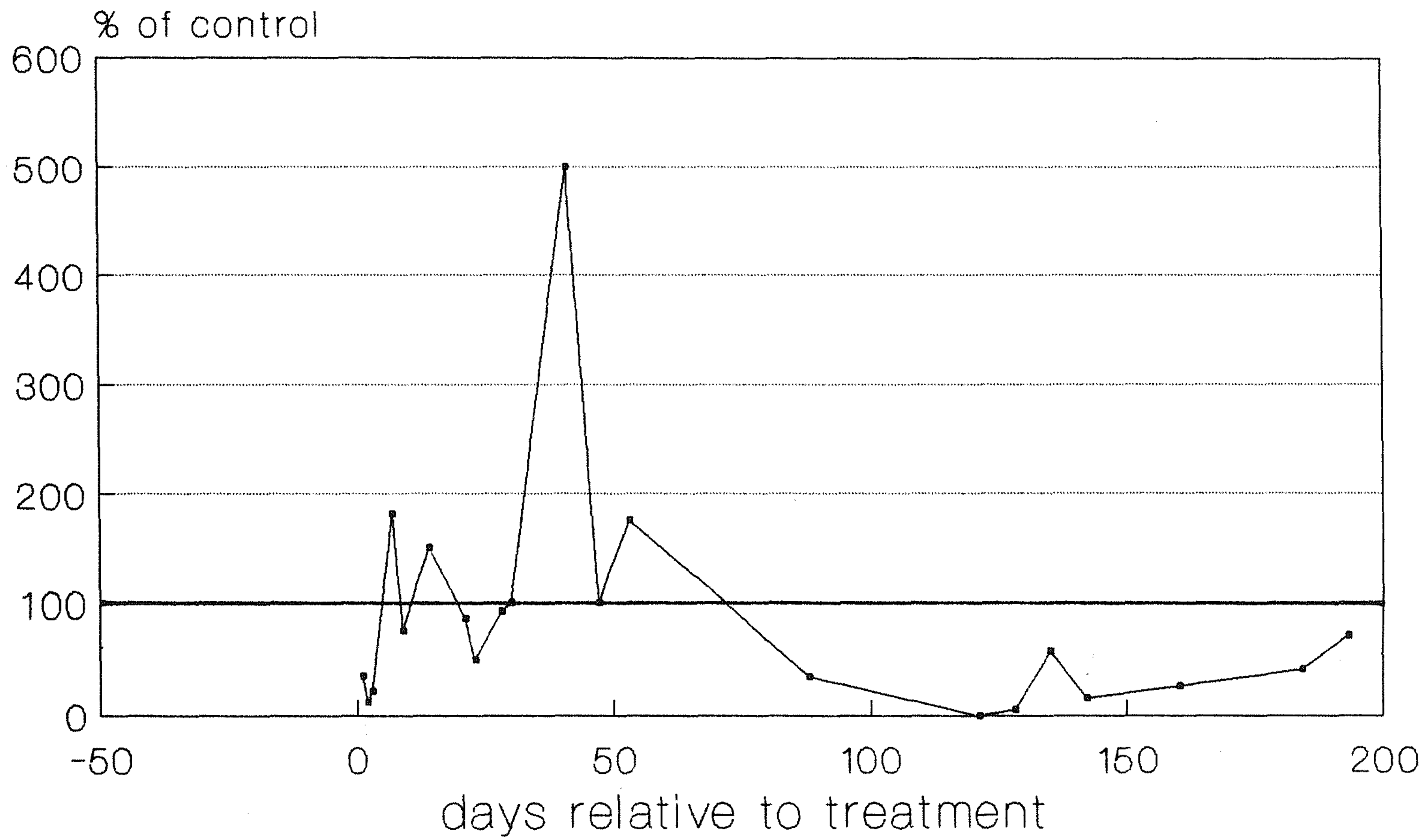


Table 2.1
Summary of results for autumn 1985 cypermethrin field trial.

Dates on which treatment catches were 20% higher than those in control plots are indicated with + while occasions on which control catches were 20% higher than those in treated areas are depicted by a - symbol; / indicates that no samples were collected on that particular date.

N.B. The significance level for sign tests was set at $P<0.05$.

(Pf1) = pitfall trap data from field 1.
(G1) = gutter trap data from field 1.
(G2) = gutter trap data from field 2.

	DAYS RELATIVE TO TREATMENT									
Species/Group	-14	-12	-11	-07	-05	00	01	02	03	07
Carabidae (Pf1)				-	+		-	-		+
" (G1)	/	/		+			+	-	-	
" (G2)	/	/	/	/	/	/	-	-	+	-
Staphylinidae (Pf1)	+	-		+		-	-			
" (G1)	/	/	+		+		-	-	+	-
" (G2)	/	/	/	/	/	/	-	-	-	+
Araneae (Pf1)	+	+	+	+	-	+	-	-		-
" (G1)	/	/					-		-	-
" (G2)	/	/	/	/	/	/	-	-	-	+
Acari (Pf1)		-	-							
Collembola (Pf1)	-		-	-	-	+		+		-
Diptera (Pf1)	-	-	-		-	-	-	-	-	-

Table 2.1 (continued).
Summary of results for autumn 1985 cypermethrin field trial.

Dates on which treatment catches were 20% higher than those in control plots are indicated with + while occasions on which control catches were 20% higher than those in treated areas are depicted by a - symbol; / indicates that no samples were collected on that particular date.

N.B. The significance level for sign tests was set at $P<0.05$.

(Pf1) = pitfall trap data from field 1.
(G1) = gutter trap data from field 1.
(G2) = gutter trap data from field 2.

	DAYS RELATIVE TO TREATMENT									
Species/Group	09	14	16	21	23	28	30	38	41	46
Carabidae (Pf1)	−	−	−	−	−	−	−		/	+
" (G1)		+		+		−	−	/		−
" (G2)	−	+		−	+	−		/	+	/
Staphylinidae (Pf1)	+	−	−	+		+		−	/	
" (G1)	+	+		+				/	−	+
" (G2)	−	+		+	+	+	+	/		/
Araneae (Pf1)	−	+	−	+	−	−	−	−	/	−
" (G1)	+	+		+	−	−	−	/		+
" (G2)	−	+			−			/	+	/
Acari (Pf1)	−	+							/	
Collembola (Pf1)		+	+	+		−		−	/	+
Diptera (Pf1)		+	−	+	+	−	−	−	/	+

Table 2.1 (continued).
Summary of results for autumn 1985 cypermethrin field trial.

Dates on which treatment catches were 20% higher than those in control plots are indicated with + while occasions on which control catches were 20% higher than those in treated areas are depicted by a - symbol; / indicates that no samples were collected on that particular date.

N.B. The significance level for sign tests was set at $P<0.05$.

(Pf1) = pitfall trap data from field 1.
(G1) = gutter trap data from field 1.
(G2) = gutter trap data from field 2.

	DAYS RELATIVE TO TREATMENT									
Species/Group	47	53	74	75	88	96	121	128	135	142
Carabidae (Pf1)	/	-	-	/	-	+		+	+	+
" (G1)	/	/	/	-	-			-	+	+
" (G2)	+	+	/	-	-	+	-	-	-	-
Staphylinidae (Pf1)	/			/	+				+	+
" (G1)	/	/	/						-	
" (G2)	+	+	/	+	+	+		-		+
Araneae (Pf1)	/		-	/	-		+	-	-	-
" (G1)	/	/	/		-				-	-
" (G2)		+	/		-		-	-	-	-
Acari (Pf1)	/		-	/		-			+	+
Collembola (Pf1)	/	+		/	+	+		+	+	+
Diptera (Pf1)	/			/		+	+	-	+	-

Table 2.1 (continued).
Summary of results for autumn 1985 cypermethrin field trial.

Dates on which treatment catches were 20% higher than those in control plots are indicated with + while occasions on which control catches were 20% higher than those in treated areas are depicted by a - symbol; / indicates that no samples were collected on that particular date.

N.B. The significance level for sign tests was set at $P<0.05$.

(Pf1) = pitfall trap data from field 1.
(G1) = gutter trap data from field 1.
(G2) = gutter trap data from field 2.

	DAYS RELATIVE TO TREATMENT				
Species/Group	160	176	184	193	Sign test
Carabidae (Pf1)	-			+	
" (G1)		+	+	+	
" (G2)	-	/	-	+	
Staphylinidae (Pf1)		+		-	
" (G1)			+		+
" (G2)	-	/	-		
Araneae (Pf1)	-	-	-		-
" (G1)	-	+	-		
" (G2)	-	/	-	-	
Acari (Pf1)		+	-		
Collembola (Pf1)	-	+	+		+
Diptera (Pf1)	-	+	+	+	

2.3 Discussion.

Data sets for the Coleopteran families Carabidae and Staphylinidae indicate short term decreases in relative abundance immediately following the autumn application of cypermethrin.

In the case of total adult carabids the initial decrease to an average of 41% of control values two days after treatment was followed by an apparently complete recovery within two months of application. Similar transient decreases have been reported by other workers (Feeney, 1982; Cole and Wilkinson, 1984, 1985; Cole et al 1986). Cole and Wilkinson (1986) observed post-treatment depressions in carabid abundance to approximately 30-40% of the control levels. Cole et al (1986) detected a suppression in the effective abundance of total adult Carabidae which lasted for approximately one month after the application of cypermethrin. Feeney (1982) observed an initial reduction in the effective abundance of *Trechus quadristriatus* (Schrank) to 31% of the control value with population recovery apparently occurring within three weeks of treatment. *T.quadristriatus* was one of the more abundant carabids at the Longstock site. It is difficult to make a direct comparison with the data obtained by Inglesfield (1984, 1985) as a lower rate of cypermethrin was applied (15g a.i./ha) and the experimental design does not include any control areas. Despite an apparent decrease in carabid trapping levels to 59% of the pre-treatment levels Inglesfield (1982) does not consider this to be a significant effect.

Edwards et al (1984) exposed the carabid beetle *Pterostichus cupreus* (L.) to a range of concentrations of cypermethrin under controlled laboratory conditions. Contact with soil which had been sprayed at the commercially recommended rate (25g a.i./ha), and direct exposure to spray both resulted in high levels of knockdown and a limited amount of mortality. In the case of contaminated soil there was 20% mortality after six days and direct spraying resulted in the death of 7% of the *P.cupreus*. Simulation of field conditions by the inclusion of barley plants reduced mortality to zero although there was still a high incidence of knockdown. The decrease in mortality was probably a consequence of the interception of spray by the barley plants leading to a reduction in the dose acquired by the beetles. A fivefold increase in the spray rate did not lead to an increase in mortality through exposure to contaminated soil. Direct spraying with the higher rate (125g a.i./ha) caused fatalities in 20% of treated beetles and application under simulated field conditions resulted in 60% mortality. As with the commercially recommended rate there was a high incidence of knockdown followed by recovery for all treatments. The apparently rapid resurgence in carabid activity after an initial abrupt decrease may be related to this ability of pyrethroids to induce knockdown. It is possible that an element of the initial transient decrease in activity abundance is the result of knockdown of beetles followed by recovery. Decreases at later stages may be interpreted as resulting from the progressive accumulation of a lethal dose of pesticide through consumption of contaminated prey and/or contact with sprayed surfaces, or emigration due to a shortage of prey.

The relative abundance of adult staphylinids decreased immediately after treatment but the apparent differences were transient. Similar temporary depressions in staphylinid numbers have been reported by Cole and Wilkinson (1984), and Cole *et al* (1986). Cole and Wilkinson (1984) observed a temporary depression in effective abundance to approximately 38% of control values.

Pitfall samples of Araneae were dominated by members of the Linyphiidae. Following treatment with cypermethrin the relative abundance of Araneae typically exhibited a temporary suppression which was rapidly succeeded by a brief increase in the rate of capture. As described in the introductory chapter, low level intoxication of the peripheral nervous system may lead to irritant effects which are manifested as hyperactivity in some arthropods. The apparent transient increase in the effective abundance of spiders may be a consequence of increased activity resulting from stimulation of peripheral sensory nerves. Temporary reductions in the abundance of total Linyphiidae have been reported by other workers (Cole and Wilkinson, 1984; Inglesfield, 1984, 1985; Cole et al 1986). Cole and Wilkinson (1984), and Inglesfield (1984) observed initial decreases to approximately 55% of control levels with recovery occurring within two to four weeks of treatment. None of the authors mentioned above detected differences persisting to the following spring/summer. All three data sets obtained in this trial indicate that spider populations were markedly depressed during March and April of the following year. This suggests that the autumn application of cypermethrin may result in either reduced overwintering success for spiders in the treated areas or dispersal from such areas.

Pre-treatment trapping levels of Collembola tended to be higher in the control plot of Field 1 (Fig. 2.5). The autumn application of cypermethrin resulted in a reversal of the situation such that post-treatment trapping levels exhibited a tendency to be higher in the area which had been sprayed with the pyrethroid. It is significant that the prolonged increase in the numbers of Collembola coincides with a trend towards a persistent reduction in the relative abundance of spiders (Fig. 2.3, Table 2.1) which are important predators of the order (van Wingerden, 1978; Aitchison, 1984; Sunderland et al 1986).

The application of cypermethrin did not appear to disrupt the mite community which also acts as a source of alternative prey for polyphagous predatory species.

Diptera also form part of the diet of many polyphagous predators and in addition some dipteran species are themselves entomophagous. Data relating to catches of total Diptera (Fig. 2.6) indicate that values were reduced in the treatment areas on days 2 and 3 after spray application. This apparently transient effect on Diptera is consistent with the temporary post-treatment reduction in members of the Empidoidea which was observed by Inglesfield (1985).

As with the data of Cole and Wilkinson (1984, 1985) the limited degree of replication and extremely low densities of predatory species mean that the extent of impact is almost certainly underestimated.

CHAPTER 3 - CYPERMETHRIN MULTIPLE RATE BARRIER TRIAL (SUMMER 1986).

3.1 Introduction.

Until 1990 pyrethroids were only recommended for autumn application in U.K. cereals to control pests such as the yellow cereal fly Opomyza florum (F.) and the aphid vectors of cereal viruses (Knight and Oakley, 1983).

In field trials which specifically related to the summer application of cypermethrin, Cole et al (1986) observed transient reductions in approximately 4% of taxa collected in pitfall traps. Shires (1985) detected temporary decreases in the effective abundance of predatory beetles which persisted for approximately one month after the application of cypermethrin to barriered plots.

Following the summer application of deltamethrin (6.25g a.i./ha) Fischer and Chambon (1987) observed a significant short term reduction in the abundance of P.melanarius but no apparent effects on any other species of carabid. Vickerman et al (1987) detected a temporay depression in the abundance of total Carabidae in plots of winter wheat which had been treated with deltamethrin (6.25g a.i./ha) during the summer. Spring and summer applications of deltamethrin at the higher rate of 7.5g a.i./ha both failed to produce significant negative effects in any species of carabid (von Rzehak and Basedow, 1982; Basedow et al 1985). Research groups in both France and Germany have detected significant reductions in the numbers of staphylinid beetles and linyphiid spiders within plots treated with deltamethrin (Fischer and Chambon, 1987; von Rzehak and Basedow, 1982; Basedow et al 1985). Linyphiids appear to be particularly susceptible to summer sprays of deltamethrin with significant reductions persisting for up to six weeks after treatment (Basedow et al 1985). Vickerman et al (1987) recorded a transient 20% reduction in the apparent abundance of staphylinids following the summer application of deltamethrin (6.25g a.i./ha).

Chiverton (1984) initially observed a significant reduction in the activity abundance of P.melanarius after the summer application of fenvalerate (100g a.i./ha). This event was subsequently followed by an apparent recovery in the population to the extent that after 5-6 weeks capture rates in the treated plots were significantly higher than in the controls. Poehling (1989) did not detect a significant difference in the abundance of P.melanarius in pitfall samples collected ten days after the application of fenvalerate. During the same period numbers of the staphylinid Philonthus rotundicollis decreased to approximately 45% of the control values. The rate of capture of male O.apicatus fell to less than 40% of the control value while E.atra proved to be even more susceptible with values obtained in the treatment plots being reduced to 23% of those in the untreated areas.

The aims of the field trial were;

i) To utilise the summer increase in activity abundance and diversity of polyphagous predatory species to provide supportive evidence for the effects observed following the autumn application of cypermethrin when the low densities of many species affected the likelihood of resolving significant effects.

ii) To elucidate the potential impact on non-target arthropods should the pyrethroids be recommended for use as summer aphicides in U.K. cereal crops. This has since occurred and hence the data may contribute to the current debate concerning pyrethroid side effects.

iii) To monitor the effects of treatment on the availability of alternative prey and relative rates of predatory capacity of polyphagous invertebrate species.

iv) To determine the potential benefits of altering the rate of pesticide application in terms of hazard to beneficial invertebrates.

There were three major components of the field trial.

1) Monitoring the impact of cypermethrin on the relative abundance of the polyphagous invertebrate community by means of pitfall traps.

2) Measuring changes in the consumption of alternative prey through a comparison of the prevalence of the major dietary components in the gut contents of P.melanarius.

3) The use of artificial prey to determine changes in the level of predatory capacity within barriered plots.

3.2 Estimates of abundance.

3.2.1 Materials and Methods.

The experiment was carried out in Field 13 of New Farm, Leckford, Hampshire, U.K. (see map, Appendix 1.1).

During June of 1986 a strip of twenty, 10m x 10m polythene barriers was erected in a field of winter wheat (cv. Mission). The barriers were constructed from a 60cm deep section of polythene buried to a depth of approximately 15cm. The polythene was suspended by nylon rope between 2" square wooden corner posts and 1" square intermediate supports. Each barrier was separated from its nearest neighbour by a distance of 5m.

Prior to the application of the pesticide the numbers of predators within the barriers were enhanced by the introduction of Bembidion lampros (Herbst), Pterostichus melanarius (Illiger) and Trechus quadristriatus (Schrank) which had been collected from other parts of the estate. Approximately one hundred T.quadristriatus, fifty B.lampros and fifty P.melanarius were released into each plot during the week prior to the application of the pesticide.

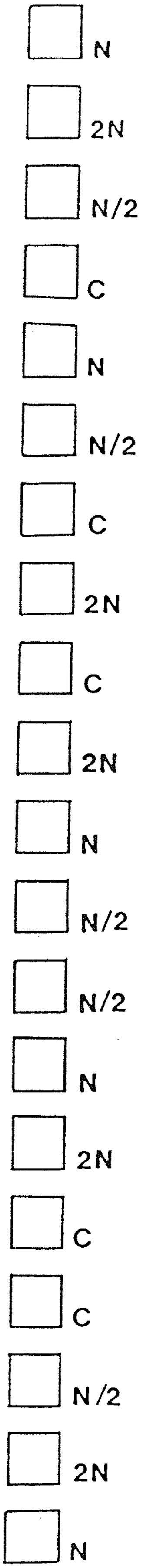
Cypermethrin (10% EC) was applied to the plots using an 'Azo' knapsack sprayer. The sprayer was calibrated to deliver 220 l/ha water at a pressure of 3 bar with the operator moving at a 'brisk walk' equating to 10 km/h. The experiment took the form of a randomized complete block trial with five replicates of each treatment (Fig. 3.1). The treatments were 25g a.i./ha (field rate, N), 50g a.i./ha (2N), 12.5g a.i./ha (N/2) and unsprayed control (C).

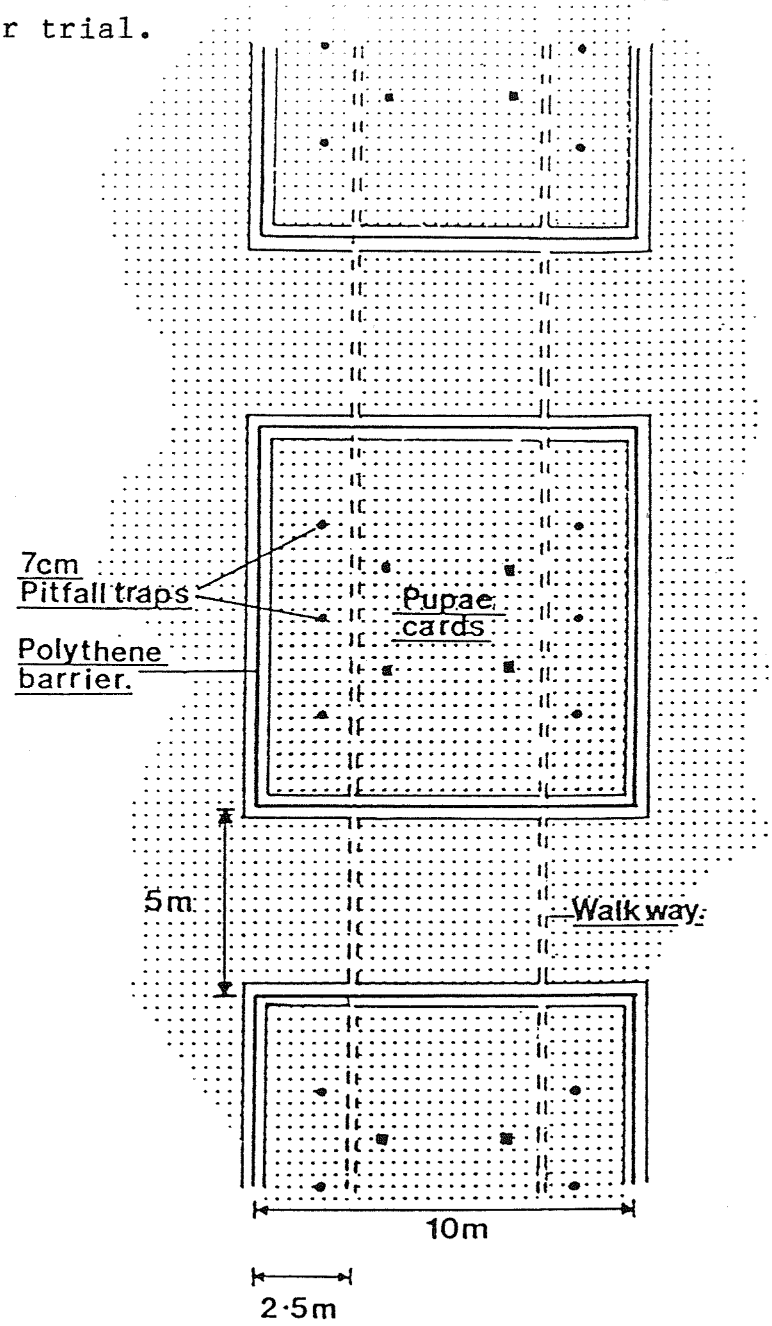
The aphicide was applied with the crop at growth stage 61 (Zadoks).

Each plot contained six pitfall traps in a 2x3 grid (Fig. 3.1). The pitfalls traps were white-plastic vending cups (diameter 7cm) part filled with a trapping solution of 5% formalin with a few drops of detergent added to reduce surface tension. The traps were emptied every 3-6 days from three days pre-treatment to twenty-five days post-treatment. The experiment was terminated at this stage as a progressive decline in trapping levels within the untreated enclosures indicated that the plots were beginning to become trapped out.

Specimens collected from the pitfall traps were transferred to 70% alcohol before examination and identification under low power binocular microscope.

Fig. 3.1 Plot layout for the multiple rate cypermethrin barrier trial.





Where

N=Normal field rate.

2N=Double rate.

N/2=Half rate.

and C=Control. (Water)

3.2.2 Results.

Analysis of data was by means of a series of one-way ANOVAs and multiple range comparisons (95% confidence intervals, treatment d.f.=3) of log(n+1) transformed numbers of individuals per trap per day using Statgraphics (vers. 2.0). In addition to multiple range comparisons by 95% confidence intervals the data were also subjected to Tukey's w procedure and Scheffe's S procedure (Steel and Torrie, 1987) which are considered to be less conservative methods of analysis (Jones, 1984). On the whole there were very few differences between the outcomes of the three different multiple range tests. Comprehensive listings of F-ratios and significance levels for the ANOVAs are provided in Appendices 3.1-3.15.

Figures 3.2-3.13 and 3.15-3.17 show pitfall trap catches in the treatment plots as a percentage of those in the untreated enclosures. In order to reduce 'noise', points were excluded on dates where the calculation of percentage values was dependent upon the trapping of a solitary specimen within the control plots.

In addition, a sign test (Steel and Torrie, 1987) was applied to each set of pitfall trap data in order to detect any significant trends in the size of treatment catches relative to those from the control plots. The null hypothesis was tested at p=0.05. Results from the sign test comparing values from 2N treated plots and control plots are presented in Table 3.1, those for normal rate plots in Table 3.2 and those for N/2 treated plots are shown in Table 3.3.

Carabidae (Appendices 3.1, 3.2; Figures 3.2, 3.3).

Despite the pre-treatment supplementation of the carabid population the rate of capture of carabids in all plots was surprisingly low. The dominant carabid in the pitfall trap samples was P.melanarius and this is the only member of the family for which individual statistical analysis was possible. Data for P.melanarius are presented in Appendix

3.1 and Figure 3.2. Data for catches of total adult Carabidae are presented in Appendix 3.2 and Figure 3.3.

In treated plots P.melanarius exhibited a decrease in relative abundance immediately after the application of the cypermethrin. In the case of plots treated with normal rate and half the normal field rate this decrease was significant ($p<0.05$) when compared with catches in the control plots. Catches had recovered to control levels by twelve days after treatment and by sixteen days after spray application the 2N treated plots had a relative abundance which was significantly higher than control levels ($p<0.05$).

At no stage in the experiment were catches of total adult carabids in the treated enclosures significantly different from those in the control plots ($p>0.05$) (Fig. 3.3).

Staphylinidae (Appendix 3.3; Figure 3.4).

Rates of capture of adult Staphylinidae were extremely low and samples were dominated by small Aleocharinae. Three days after spray application pitfall trap catches of staphylinids were significantly higher ($p<0.05$) in the enclosures sprayed with the recommended rate of cypermethrin than in plots associated with any of the other three treatments (Appendix 3.3). Samples collected from 2N and N/2 treated plots twelve days after pesticide application were significantly reduced ($p<0.05$) relative to those in the control and normal (N) rate plots. The trapping rates for adult staphylinids in the 2N treated plots were also significantly reduced ($p<0.05$) relative to the control values in samples collected twenty-two days after spray application (Appendix 3.3). The apparent differences in relative abundance of staphylinids did not appear to be correlated with the rate of pesticide applied (Fig. 3.4).

Linyphiidae (Appendices 3.4-3.12; Figures 3.5-3.14).

The pitfall trap samples were dominated by large numbers of linyphiid spiders. The numbers trapped were large enough to permit the individual analysis of the species Erigone atra (Blackwall), Erigone dentipalpis (Wider), Oedothorax fuscus (Blackwall) and Meioneta rurestris (C.L.Koch). Data are also presented for totals of the sub-families Erigoninae and Linyphiinae, and for total Linyphiidae. Totals of adult male and female linyphiids were analysed separately in order to determine if there were any sex related differences in effect. Changes in the proportion of males in the linyphiid population are indicated in Figure 3.14.

The three rates of cypermethrin induced a similar effect on the relative abundance of all of the groups of Linyphiidae which were analysed. Immediately after application there was typically a significant ($p<0.05$) increase in the capture rates of linyphiids in treated plots compared with those in the control barriers. This brief increase in effective abundance was then followed by a decrease in rates of capture in treated plots. This depression in numbers persisted until the termination of the experiment twenty-five days after application of the pyrethroid.

The initial stimulatory effect of cypermethrin appears to have been more pronounced in the Linyphiinae (Fig. 3.10) than in the second linyphiid sub-family the Erigoninae (Fig. 3.8). However, the subsequent reductions in activity abundance proved to be more extreme in the case of the Erigoninae.

Comparison of the effects on total adult male Linyphiidae (Appendix 3.11; Figure 3.12) and total adult females (Appendix 3.12; Figure 3.13) suggests a greater increase in the relative abundance of females immediately after spray application but a less severe suppression of female numbers following the initial peak. Both of these effects would result in males constituting a smaller proportion of the total catch of linyphiids within the treated plots. This is confirmed to some extent in Figure 3.14. Analysis of variance, of arc sine transformed values for males as a percentage of total Linyphiidae, revealed significant differences ($p<0.05$) between control plots and enclosures treated with twice the normal field rate for two of the post-treatment sample dates. These were days 3 and 16 after treatment.

Diptera (Appendices 3.13, 3.14; Figures 3.15, 3.16).

After spray application the pitfall trap catches of both adult Syrphidae and total Diptera increased relative to the control levels. Differences were significant ($p<0.05$) until sixteen days after treatment when trapping levels declined to control values.

Sitobion avenae (F.) (Appendix 3.15, Figure 3.17).

All three rates of cypermethrin resulted in catches of S.avenae which were consistently higher in the treated plots than in the untreated enclosures ($p<0.05$).

It had originally been intended that the impact of cypermethrin on the aphidophagous larval stages of Syrphidae and Coccinellidae would also be monitored but the numbers present were too low to permit statistical analysis.

Fig. 3.2 Pterostichus melanarius (Illiger).

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

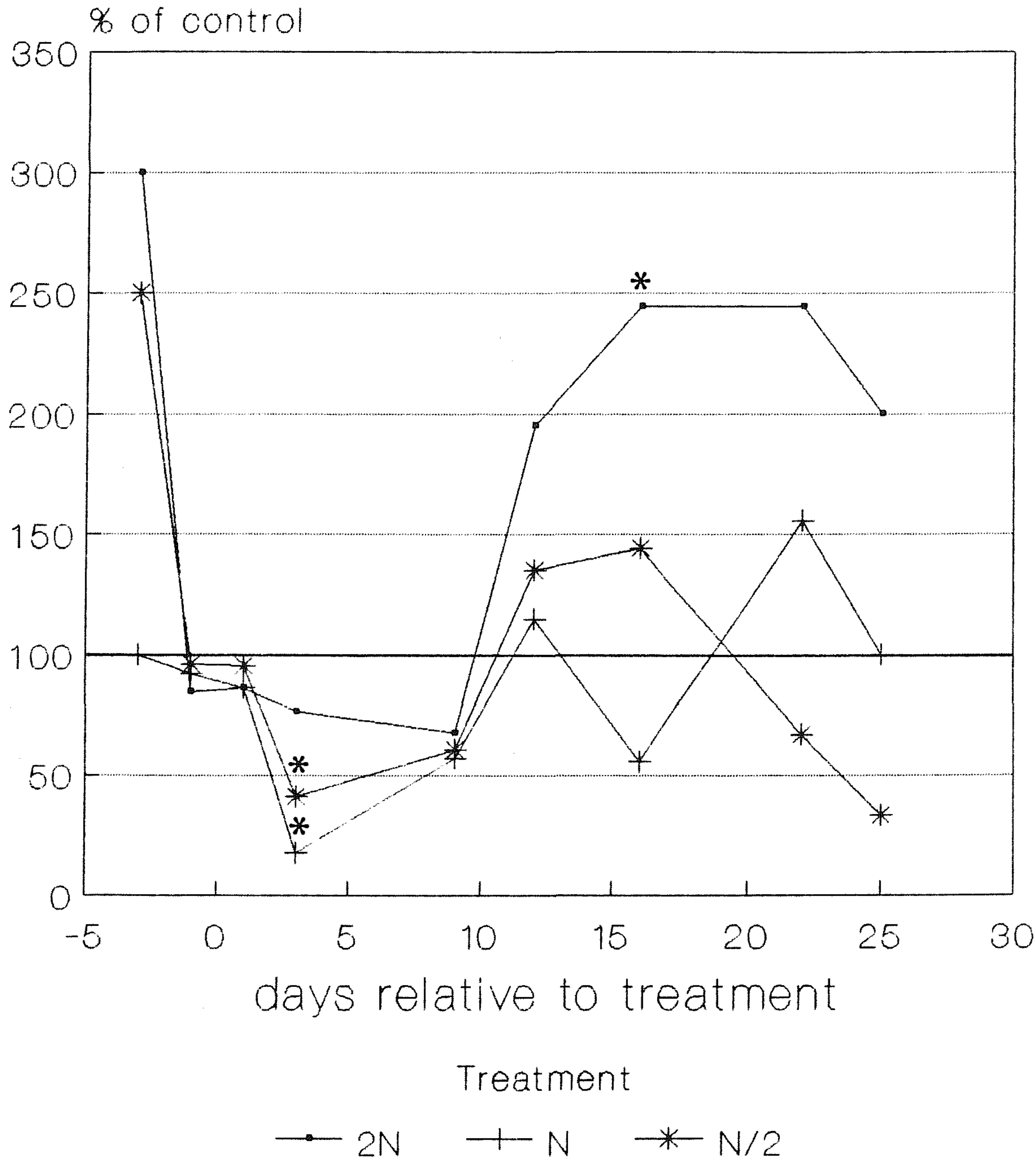


Fig. 3.3 Total adult Carabidae.

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

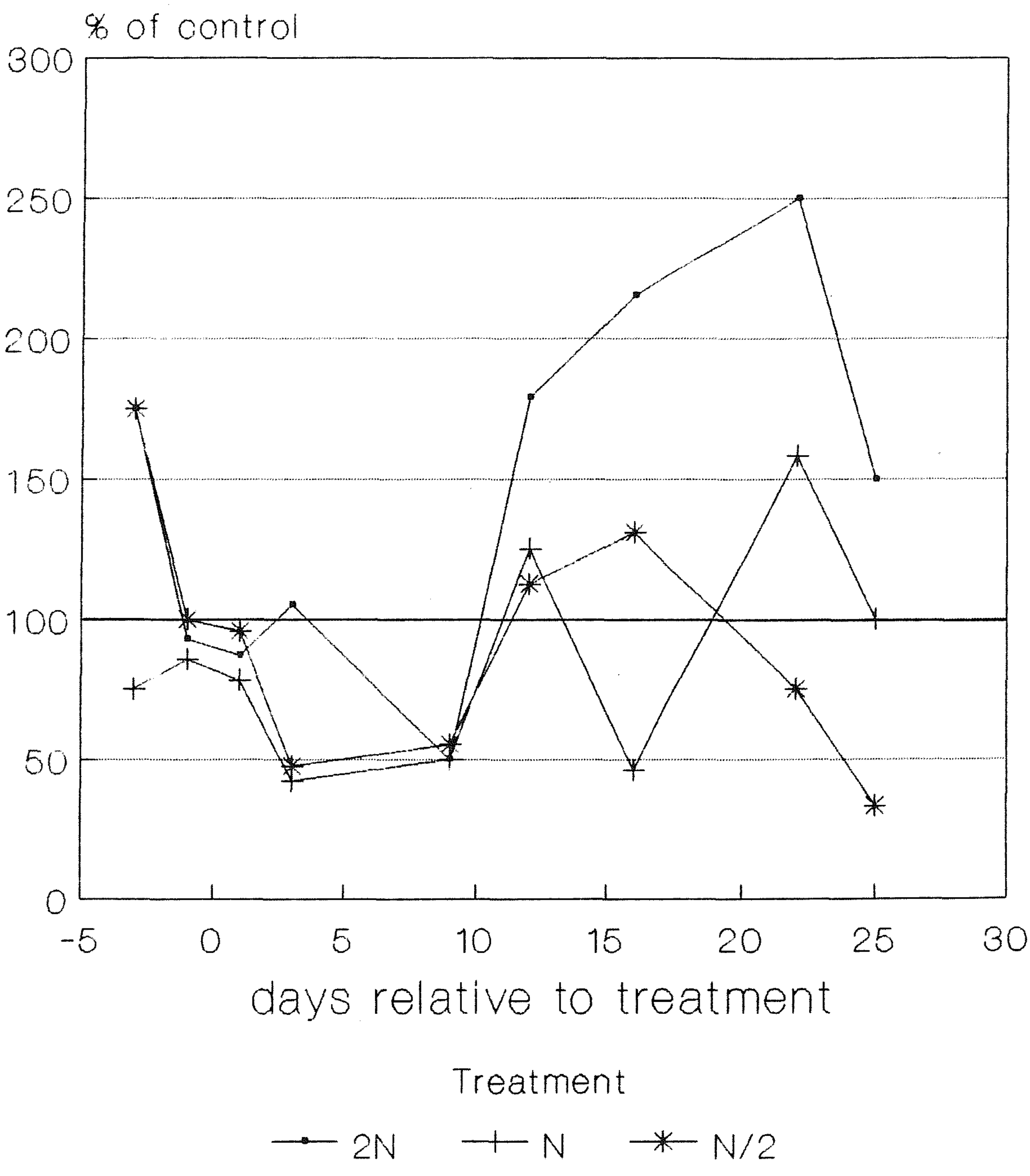


Fig. 3.4 Total adult Staphylinidae.

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

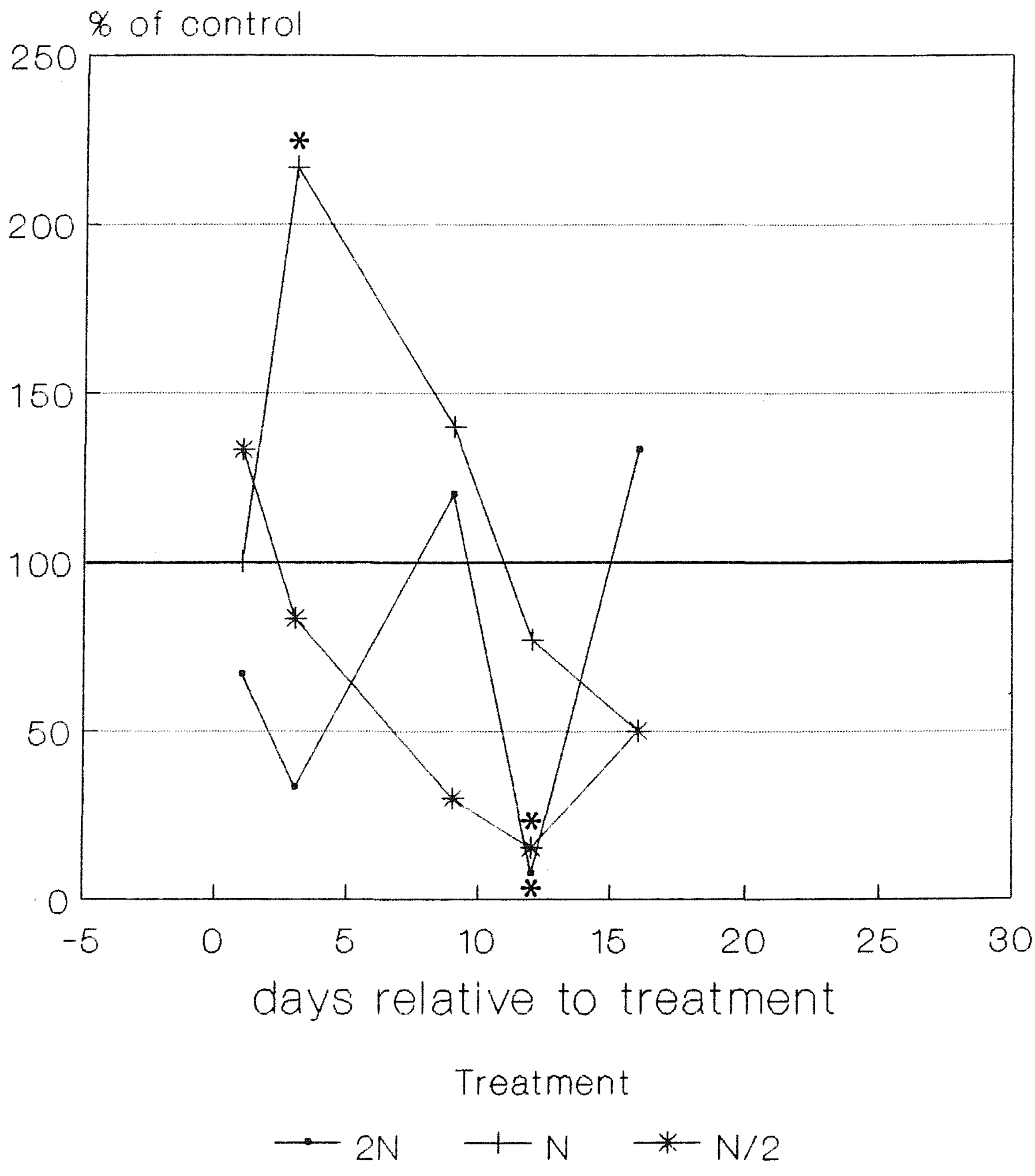


Fig. 3.5 <u>Erigone atra</u> (Blackwall).

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

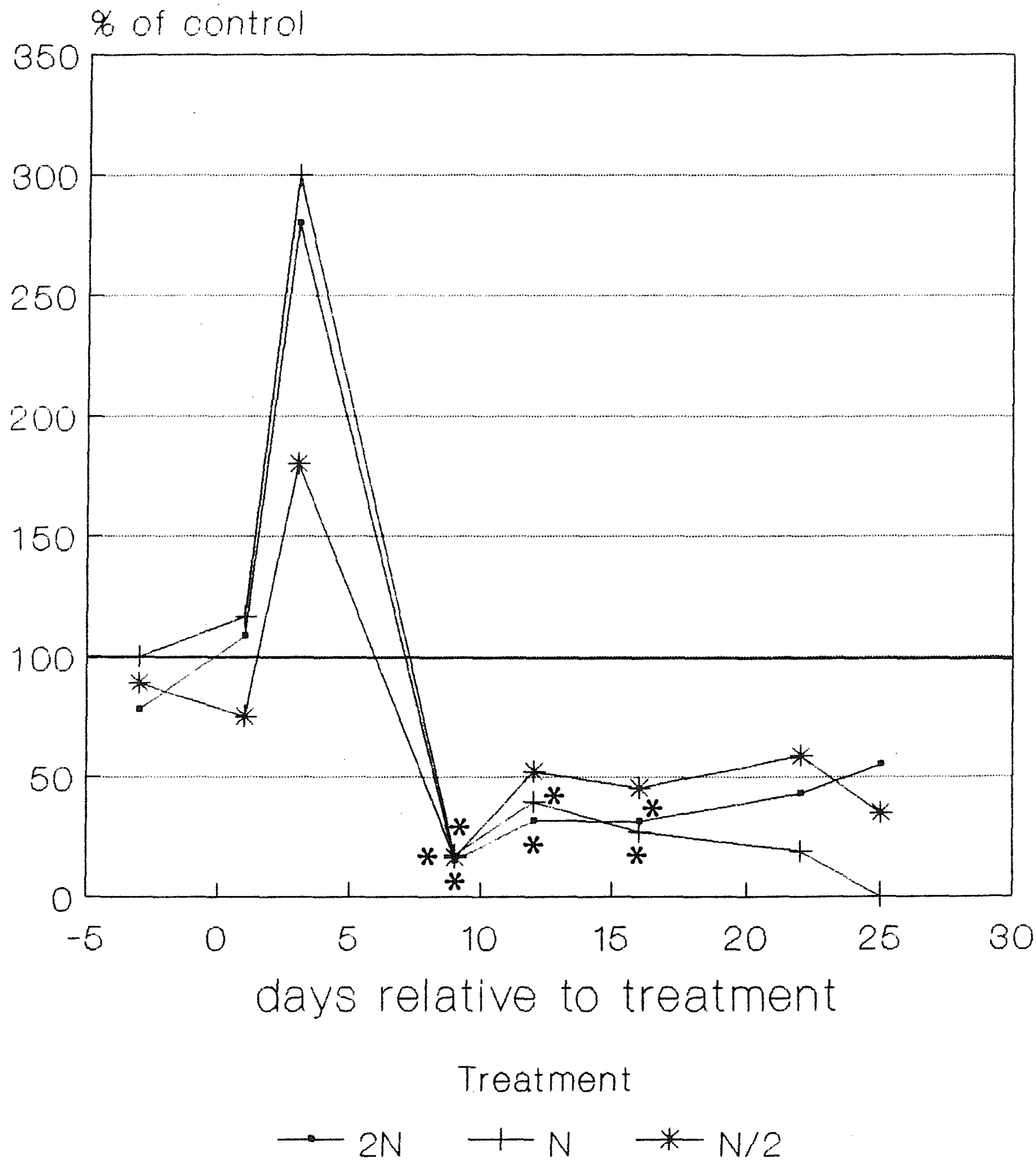


Fig. 3.6 <u>Erigone dentipalpis</u> (Wider).

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

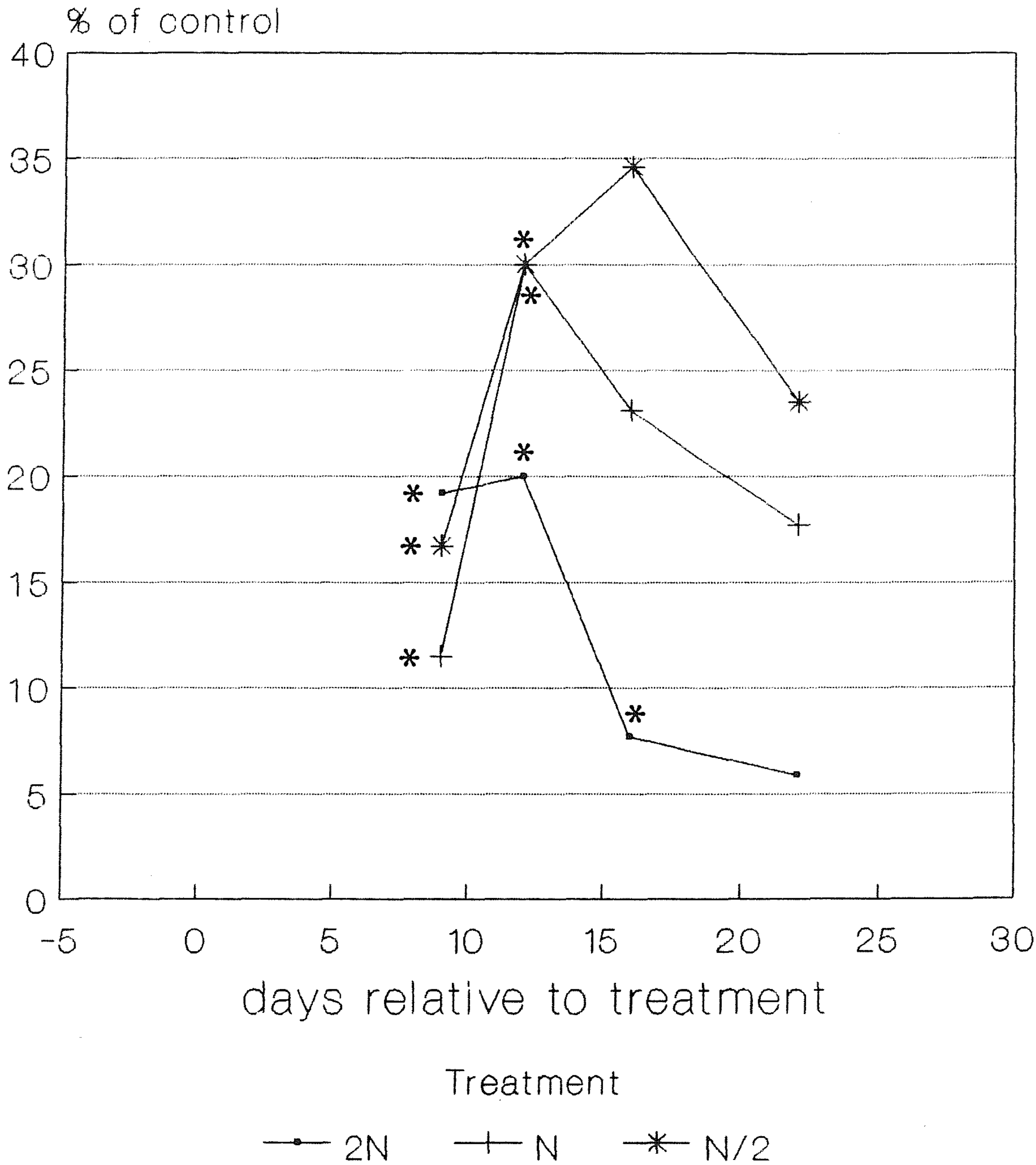


Fig. 3.7 Oedothorax fuscus (Blackwall).

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

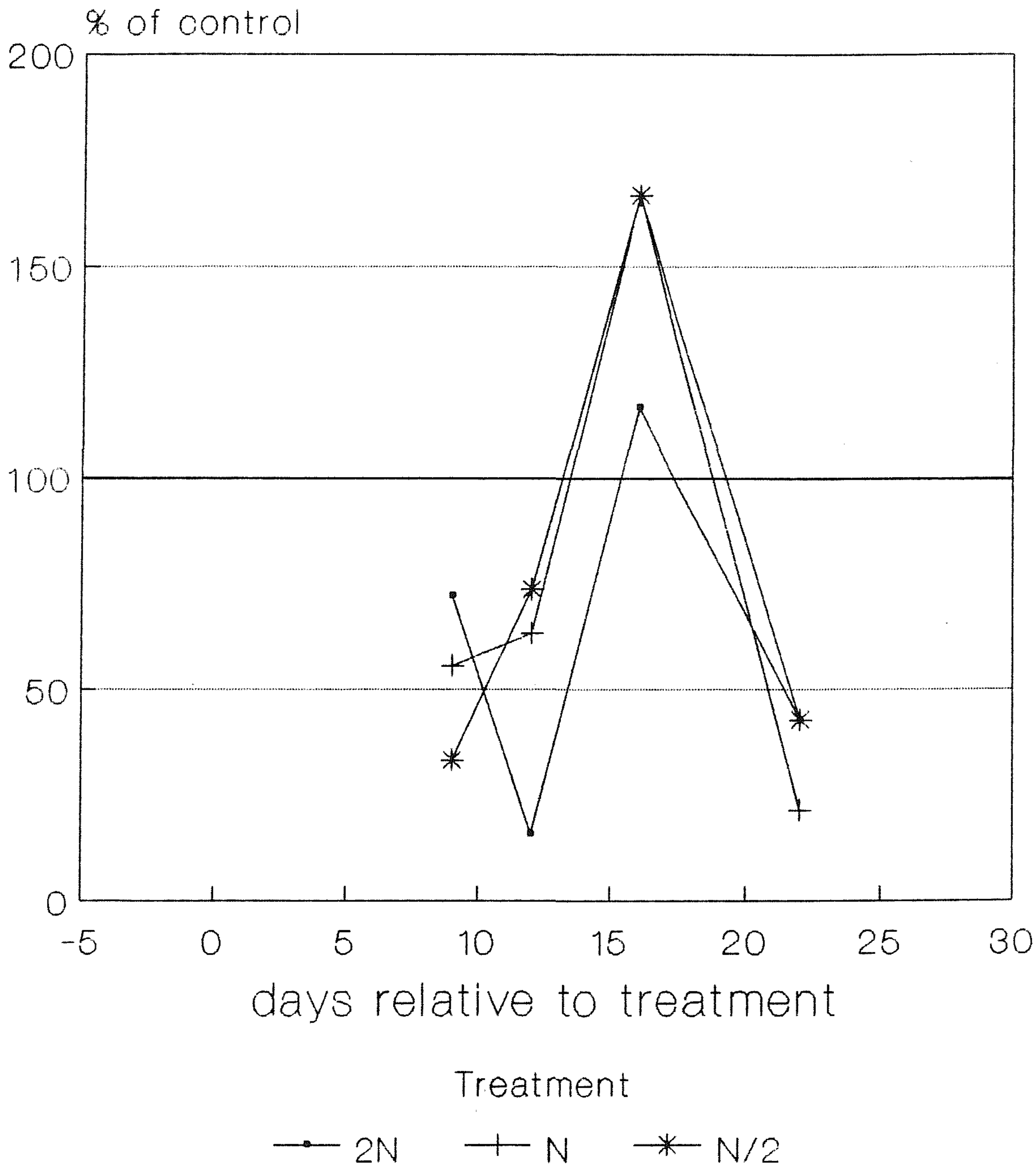


Fig. 3.8 Total Erigoninae.

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

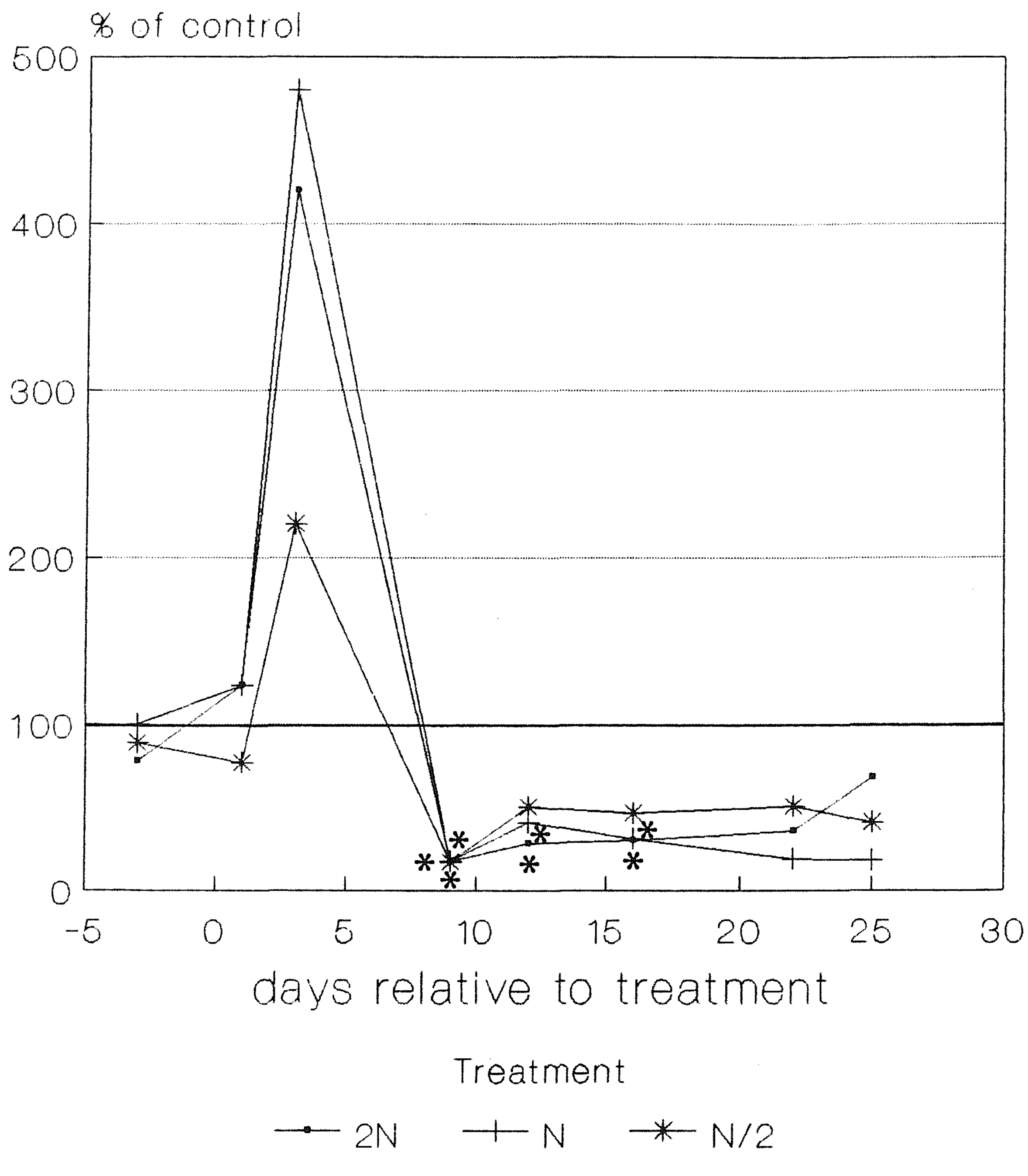


Fig. 3.9 <u>Meioneta</u> <u>rurestris</u> (C.L.Koch).

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

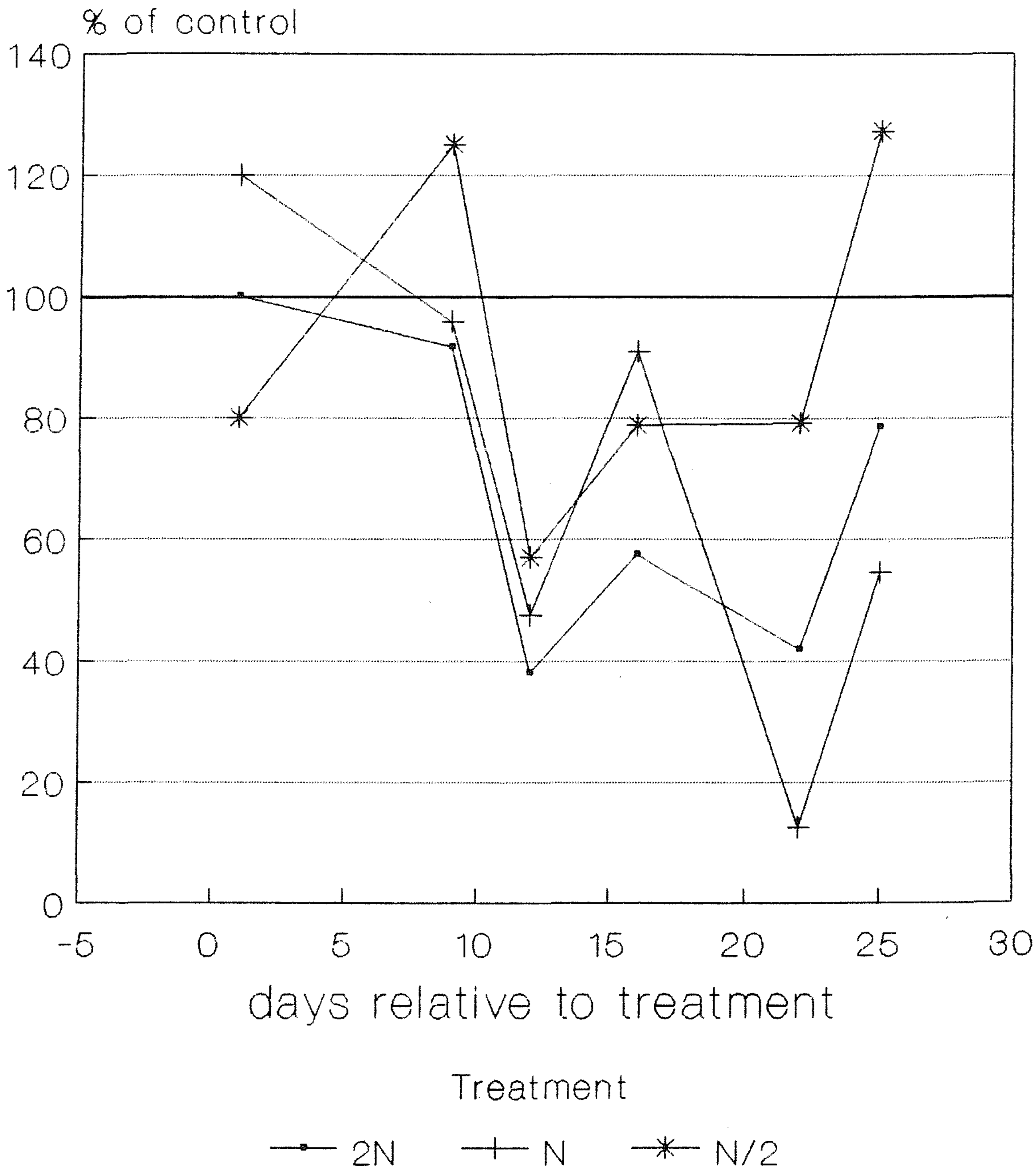


Fig. 3.10 Total Linyphiinae.

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

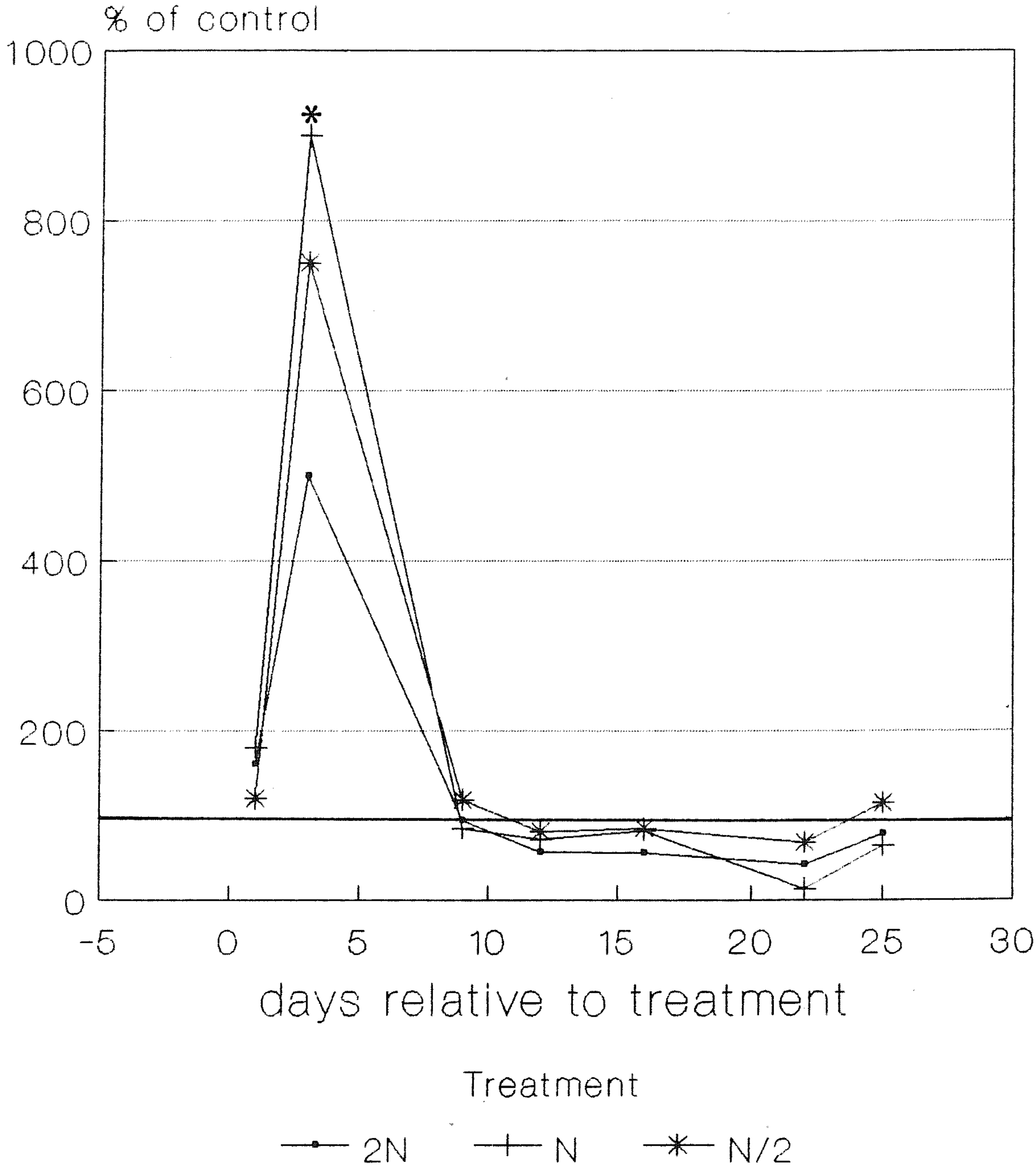


Fig. 3.11 Total Linyphiidae.

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

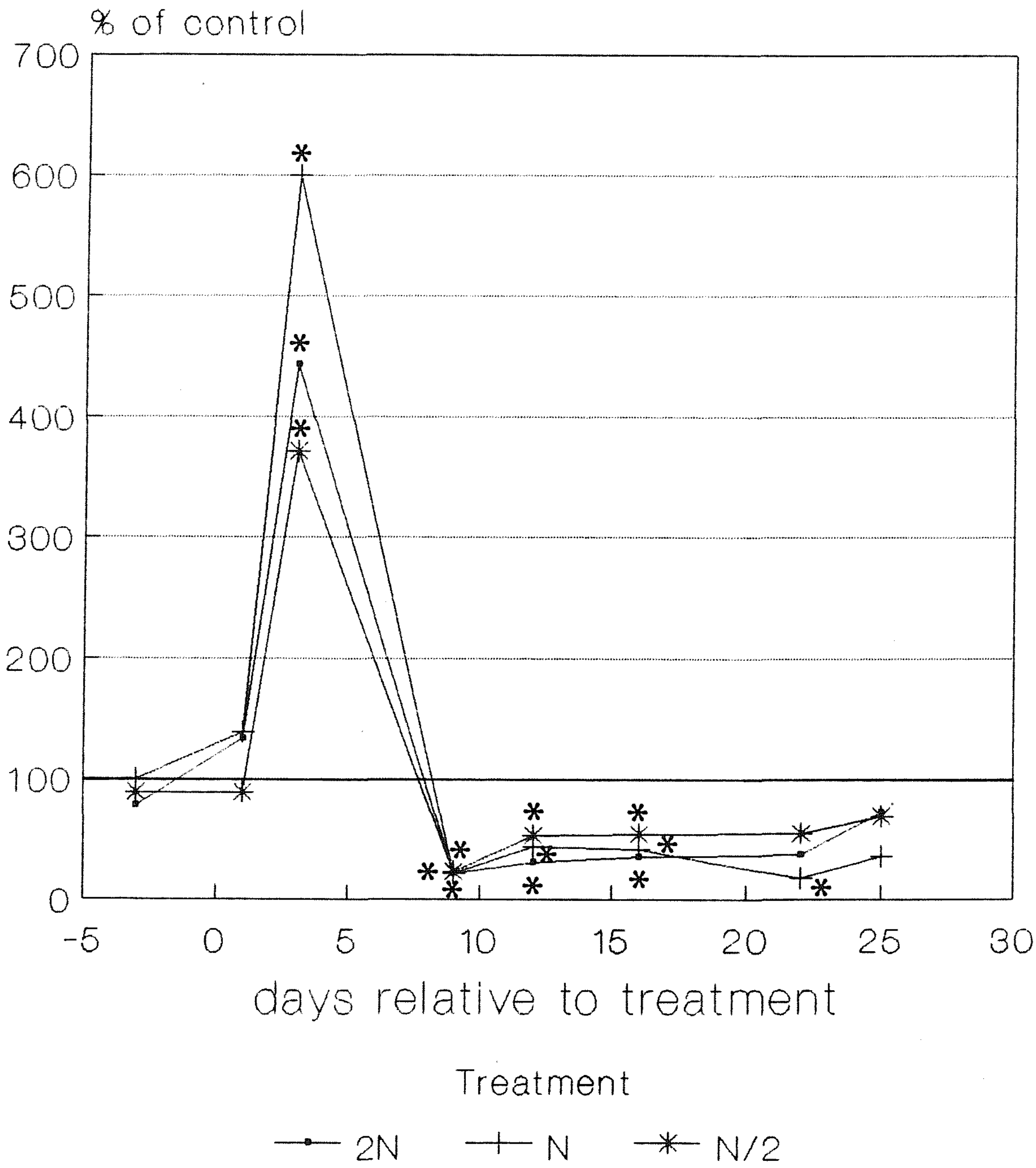


Fig. 3.12 Male Linyphiidae.

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

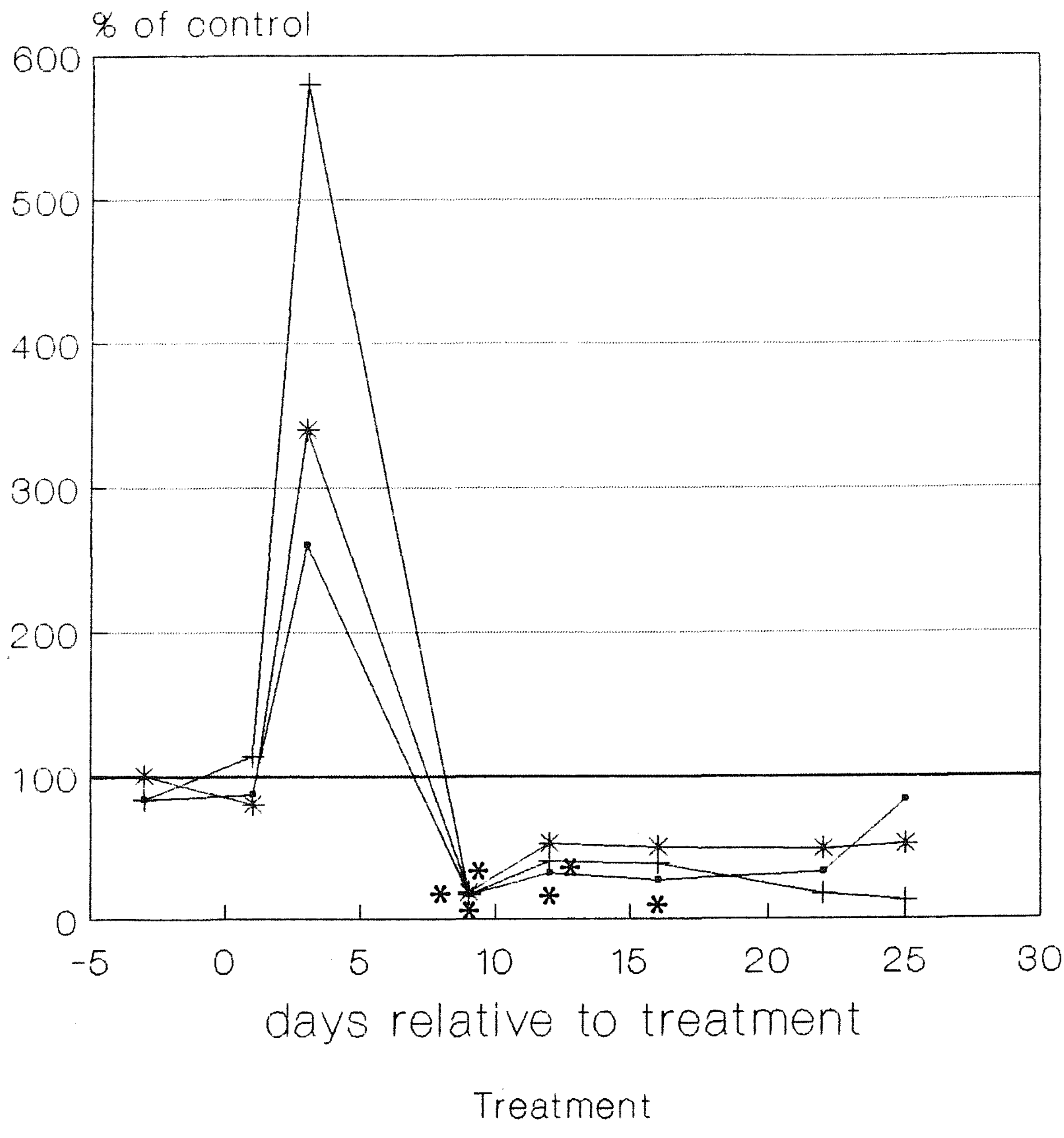


Fig. 3.13 Female Linyphiidae.

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

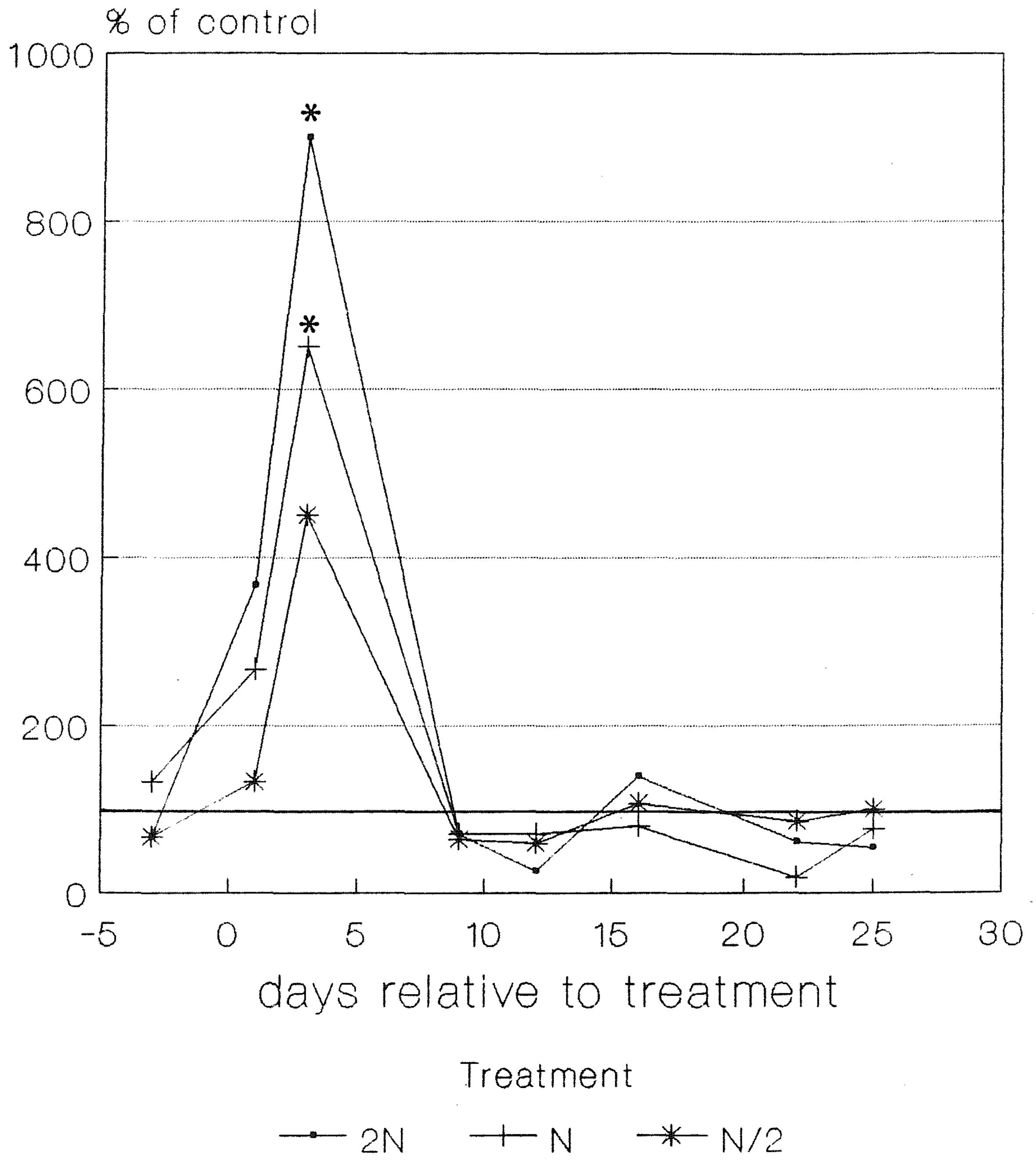


Fig. 3.14 Males as a percentage of total Linyphiidae.

For each sample date, points labelled with the same letter are not significantly different according to 95% confidence intervals (p>0.05, ANOVA).

N=Normal field rate of 25g a.i./ha.

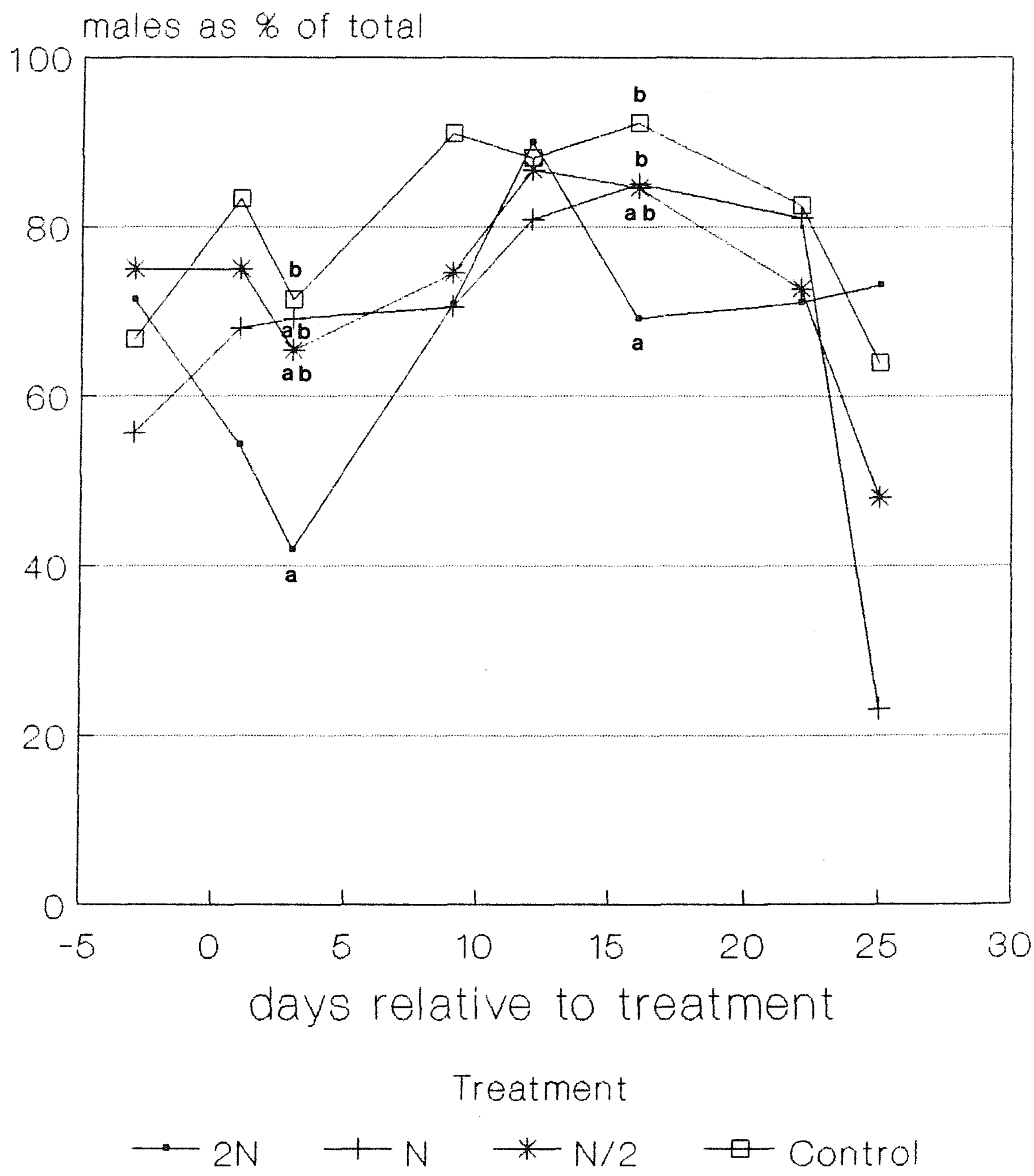


Fig. 3.15 Syrphidae.

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

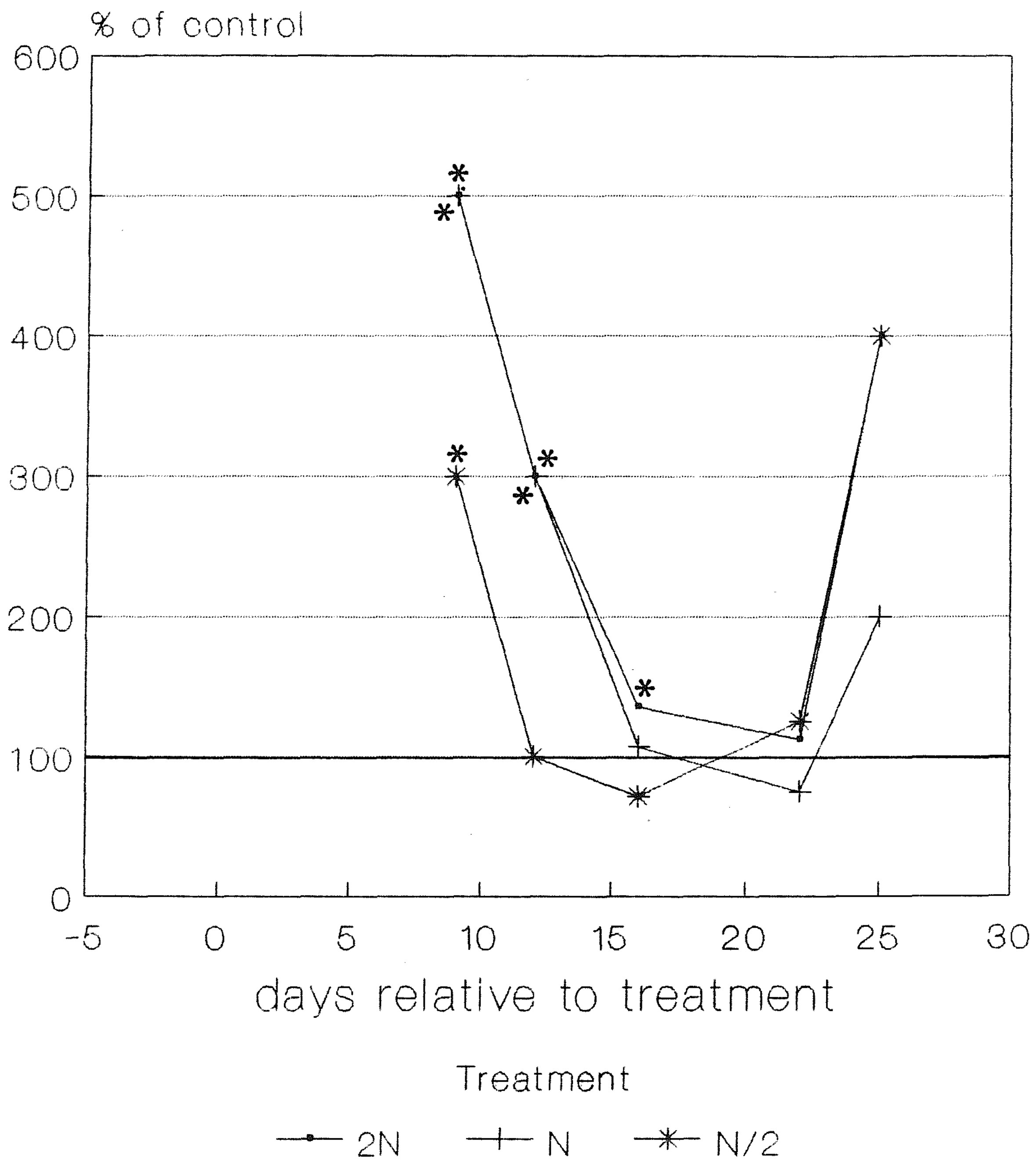


Fig. 3.16 Total Diptera.

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

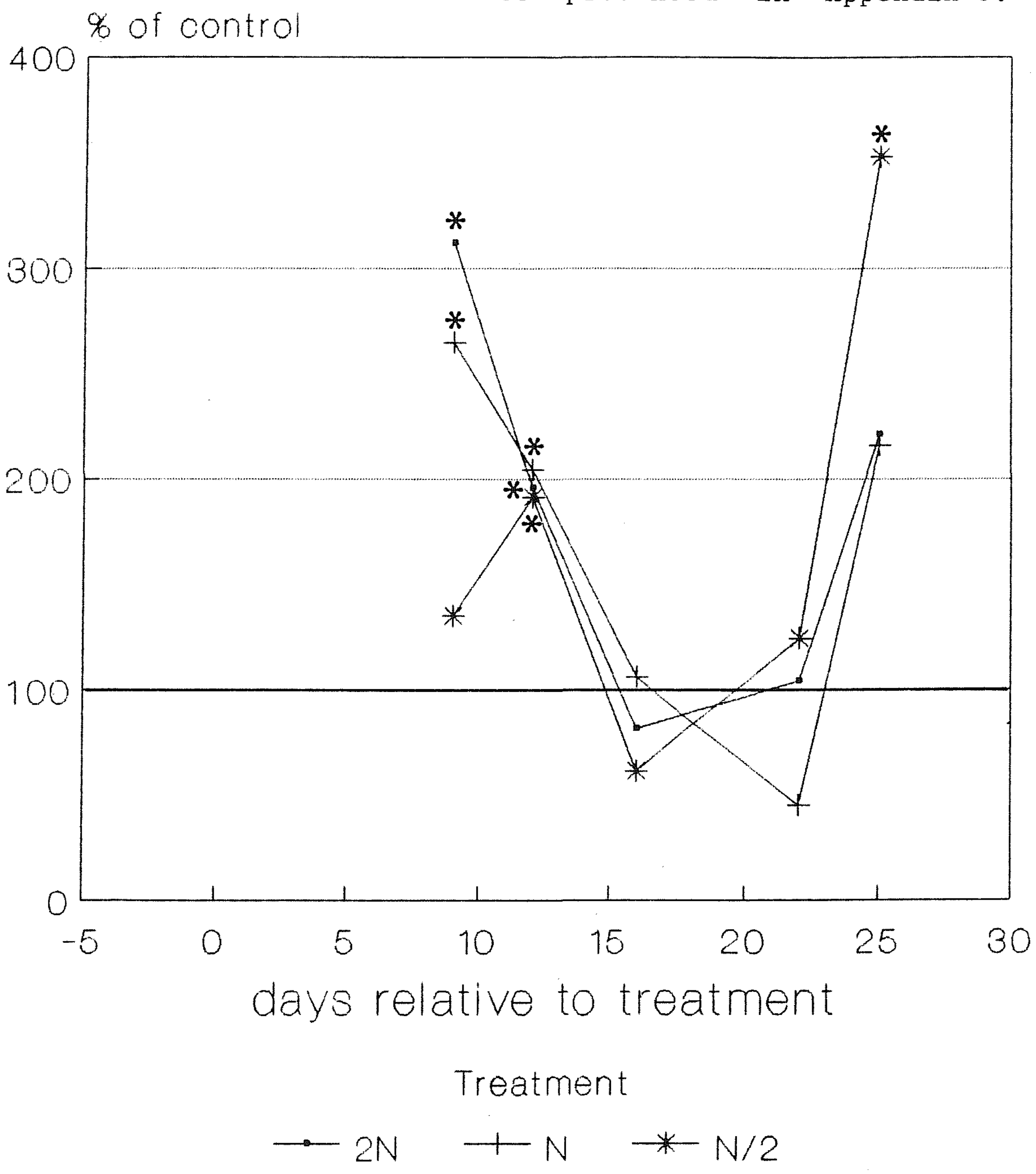


Fig. 3.17 Sitobion avenae (F.).

Pitfall trap catches in treatment plots as a percentage of the effective abundance in control barriers.

N = Normal field rate of 25g a.i./ha.

N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA). Multiple range comparisons indicating concentration related differences in effective abundance are presented in Appendix 3.

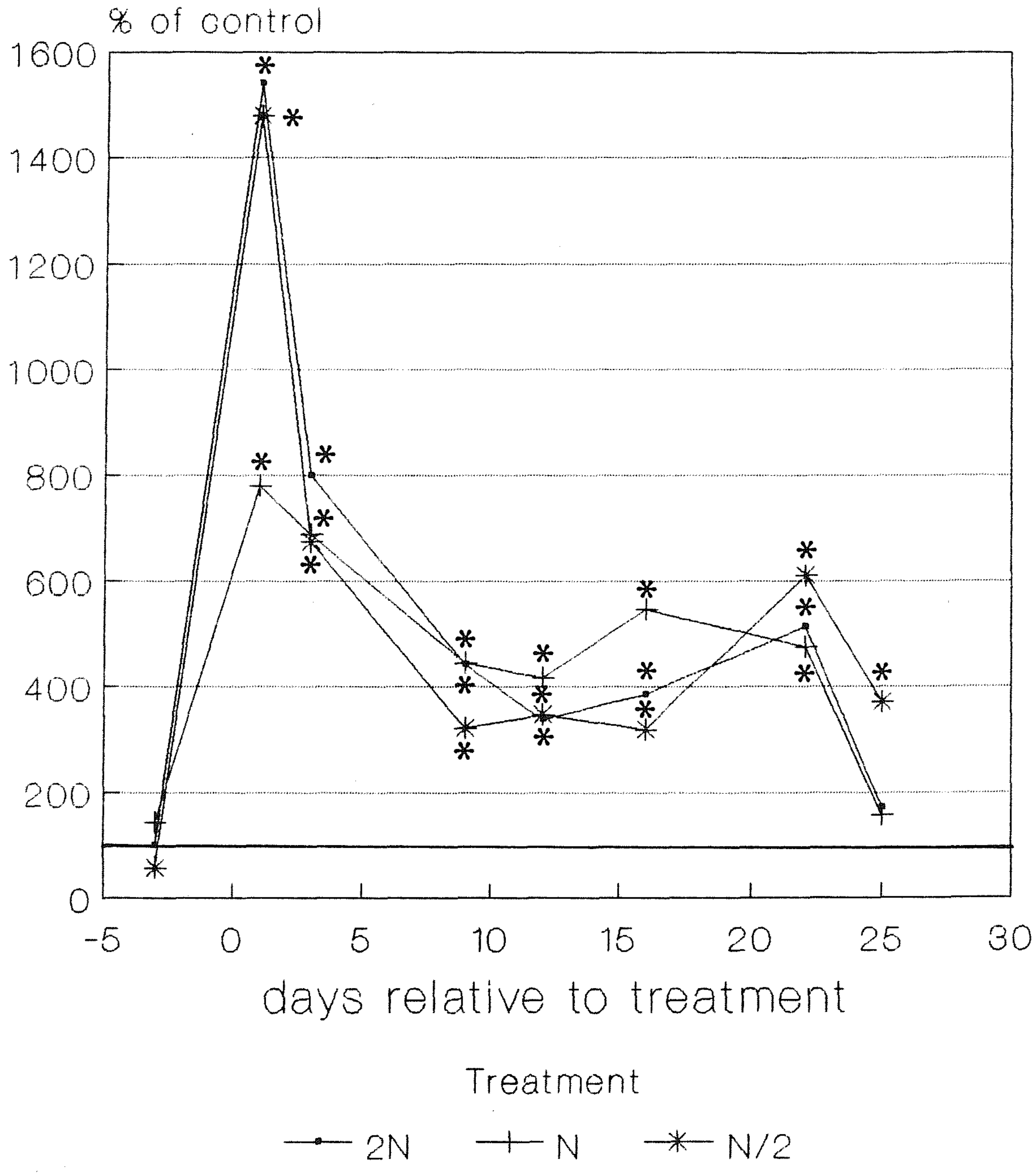


Table 3.1 Data for twice normal rate (2N).
Summary of pitfall trap results for the cypermethrin barrier trial.

Comparison of catches in plots treated with twice the normal field rate (2N) with those in control plots (ANOVA, 95% confidence intervals). Dates on which treatment catches were significantly higher ($p<0.05$) than those in control plots are indicated with + while significantly lower ($p<0.05$) catches are denoted by -.

More comprehensive details of the results of the one-way ANOVAs and multiple range tests are presented in Appendix 3.

The significance level for rejection of the null hypothesis by the sign test (Steel and Torrie, 1987) was set at $p=0.05$ with one degree of freedom.

	DAYS RELATIVE TO TREATMENT									
Species/Group	-03	-01	01	03	09	12	16	22	25	sign test
P.melanarius	+						+	+		
Total Carabidae										
Staphylinidae						-		-		
E.atra					-	-	-			
E.dentipalpis					-	-	-			
O.fuscus										
Total Erigoninae					-	-	-			
M.rurestris										
Total Linyphiinae										
Total Linyphiidae				+	-	-	-			
Male Linyphiidae					-	-	-			
Female Linyphiidae				+						
Syrphidae					+	+		+		+
Total Diptera					+	+				+
S.avenae			+	+	+	+	+	+		+

Table 3.2 Data for normal rate (N).
Summary of pitfall trap results for the cypermethrin barrier trial.

Comparison of catches in plots treated with the normal field rate (N) with those in control plots (ANOVA, 95% confidence intervals). Dates on which treatment catches were significantly higher ($p<0.05$) than those in control plots are indicated with + while significantly lower ($p<0.05$) catches are denoted by -.

More comprehensive details of the results of the one-way ANOVAs and multiple range tests are presented in Appendix 3.

The significance level for rejection of the null hypothesis by the sign test (Steel and Torrie, 1987) was set at p=0.05 with one degree of freedom.

	DAYS RELATIVE TO TREATMENT									
Species/Group	-03	-01	01	03	09	12	16	22	25	sign test
P.melanarius				-						
Total Carabidae										
Staphylinidae						-		-		
E.atra					-	-	-			
E.dentipalpis					-	-				
O.fuscus										
Total Erigoninae					-	-	-			
M.rurestris				+						
Total Linyphiinae				+						
Total Linyphiidae				+	-	-	-	-		
Male Linyphiidae					-	-				
Female Linyphiidae				+						
Syrphidae					+	+		+		+
Total Diptera					+	+				
S.avenae			+	+	+	+	+	+		+

Table 3.3 Data for half normal rate (N/2).
Summary of pitfall trap results for the cypermethrin barrier trial.

Comparison of catches in plots treated with half the normal field rate (N/2) with those in control plots (ANOVA, 95% confidence intervals). Dates on which treatment catches were significantly higher ($p<0.05$) than those in control plots are indicated with + while significantly lower ($p<0.05$) catches are denoted by -.

More comprehensive details of the results of the one-way ANOVAs and multiple range tests are presented in Appendix 3.

The significance level for rejection of the null hypothesis by the sign test (Steel and Torrie, 1987) was set at p=0.05 with one degree of freedom.

	DAYS RELATIVE TO TREATMENT									
Species/Group	-03	-01	01	03	09	12	16	22	25	sign test
P.melanarius				-						
Total Carabidae										
Staphylinidae						-				
E.atra					-					
E.dentipalpis					-	-				-
O.fuscus										
Total Erigoninae					-					
M.rurestris										
Total Linyphiinae										
Total Linyphiidae				+	-	-	-			
Male Linyphiidae					-					
Female Linyphiidae										
Syrphidae										
Total Diptera					+				+	
S.avenae			+	+	+	+	+	+	+	+

3.3 Analysis of the gut contents of Pterostichus melanarius (Illiger).

3.3.1 Materials and methods.

All specimens of the carabid beetle P.melanarius were dissected under binocular microscope and the contents of their digestive tracts were examined.

The beetles were pinned to a plasticine-lined dissecting dish with their dorsal surface uppermost, and immersed in 70% alcohol. The elytra were removed by severing them at the hinge, and the abdominal cavity was opened by cutting around the dorsal surface of the abdominal cuticle. The digestive tract was severed above the crop and beneath the proventriculus. This section of gut was removed and placed in a drop of glycerol on a microscope slide. The specimen was teased out on the slide, the section of gut tissue was removed and a cover slip was placed over the sample of gut contents. The slide was then examined under compound microscope.

The contents of the crop and proventriculus were then identified by comparison with reference slides which had been produced by macerating examples of the organisms trapped within the barriers.

Although a few specimens were found to contain fragments of Coleoptera and Collembola the predominant dietary components were members of the Araneae, Aphididae and Diptera. The remains of spiders were represented by long tubular sections of legs covered in characteristically fine hair-like bristles. Dipteran remains included fragments of wing, leg and compound eye. Bristles from flies were readily distinguished from those of the Araneae as they are generally thicker and darker, and have distinctive forms of basal insertion. Aphid remains were readily discernible by the presence of siphunculae, stylets and sections of leg. These were often complete and/or attached to comparatively large sections of the general exoskeleton.

3.3.2 Results.

Between-treatment comparisons (ANOVA, 95% confidence intervals) of the percentage of beetles containing each dietary component are provided in Table 3.4. None of the groups analysed exhibited pre-treatment differences ($p>0.05$).

There were significant ($p<0.05$) differences in the post-treatment percentages of P.melanarius containing aphid remains but surprisingly this did not appear to be correlated with the rate of aphicide applied. The significant difference ($p<0.05$) was between beetles from the N and N/2 treated plots (Table 3.4.1).

Following the application of cypermethrin the percentage of P.melanarius containing spider remains increased with pesticide concentration. Significantly more of the beetles trapped in the 2N plots contained fragments of spiders than did those from the N/2 and control plots ($p<0.05$) (Table 3.4.2).

The proportion of P.melanarius containing dipteran remains did not exhibit significant treatment-related differences following application of the cypermethrin ($p>0.05$) (Table 3.4.3).

Table 3.4
Gut contents of Pterostichus melanarius (Illiger).
N.B. N = Normal field rate of 25g a.i./ha cypermethrin.

For pre- and post-treatment analyses, values sharing the same letter are not significantly different according to 95% confidence intervals (p>0.05, ANOVA, treatment d.f.=3).

3.4.1 Percentage of dissected P.melanarius containing solid fragments of Aphididae.

Pre/ post spray	detransformed mean % and S.E.				F-ratio	Sig. Level
	2N	N	N/2	C		
Pre.	48.8a ± 07.4 (n= 28)	50.8a ± 13.7 (n= 26)	45.1a ± 06.4 (n= 30)	42.3a ± 05.1 (n= 29)	0.147	0.9301
Post.	46.7ab ± 04.7 (n=140)	68.3b ± 09.3 (n= 82)	41.9a ± 04.7 (n= 92)	51.5ab ± 01.6 (n=108)	4.282	0.0213

3.4.2 Percentage of dissected P.melanarius containing solid fragments of Araneae.

Pre/ post spray	detransformed mean % and S.E.				F-ratio	Sig. Level
	2N	N	N/2	C		
Pre.	18.3a ± 07.6 (n= 28)	10.0a ± 06.7 (n= 26)	14.5a ± 06.7 (n= 30)	12.0a ± 05.1 (n= 29)	0.173	0.9131
Post.	29.1b ± 03.5 (n=140)	12.6ab ± 05.3 (n= 82)	13.9a ± 02.8 (n= 92)	11.9a ± 01.6 (n=108)	5.500	0.0086

3.4.3 Percentage of dissected P.melanarius containing solid fragments of Diptera.

Pre/ post spray	detransformed mean % and S.E.				F-ratio	Sig. Level
	2N	N	N/2	C		
Pre.	72.7a ± 08.3 (n= 28)	82.5a ± 05.7 (n= 26)	59.6a ± 11.6 (n= 30)	64.3a ± 09.4 (n= 29)	1.844	0.1798
Post.	57.0a ± 04.3 (n=140)	76.1a ± 07.9 (n= 82)	54.1a ± 03.6 (n= 92)	58.6a ± 04.4 (n=108)	3.596	0.0370

3.4 Predatory capacity.

3.4.1 Materials and methods.

Consumption rates of artificial prey were used to determine the impact of the pesticide on the overall predatory capacity within the barriers.

Predation rates were periodically measured by placing artificial-prey cards in the barriers overnight. Each card consisted of a 5cm square section of 'wet or dry' paper with twelve fruit-fly (Drosophila melanogaster) pupae attached to the abrasive side by means of flour and water paste. Four cards were placed in each plot (Fig. 3.1) with the pupae on the lower surface, and held in place by 5cm-long steel pins.

All pupae cards were examined twenty-four hours after being placed in the barriers and the numbers of missing and damaged pupae were recorded.

3.4.2 Results.

One-way ANOVAs in conjunction with multiple range comparisons by 95% confidence intervals were applied to square-root transformed values for each of the sample dates. Detransformed values for the mean number of pupae consumed per card per day are plotted against days relative to treatment in Figure 3.18.

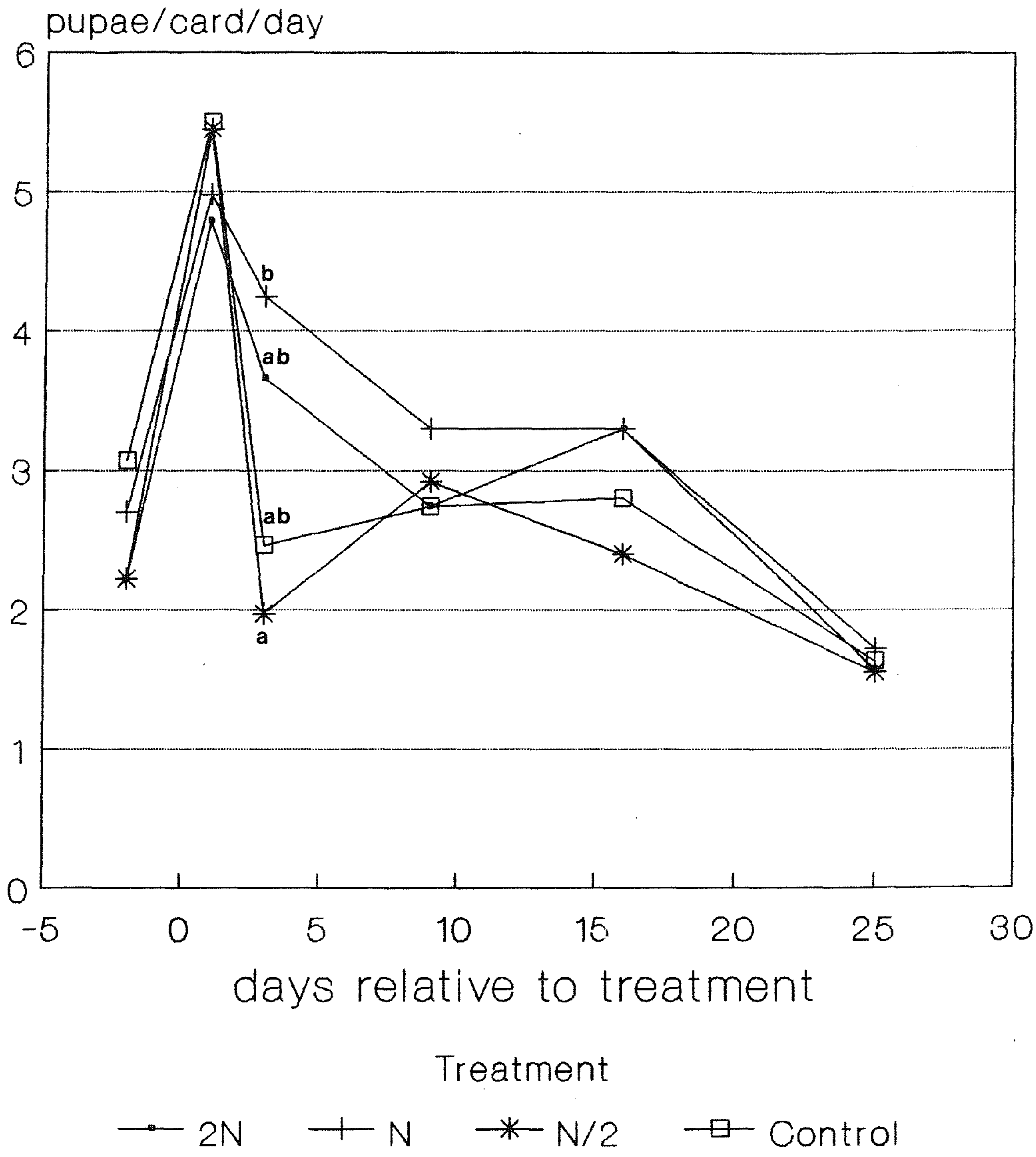
There were no significant differences ($p>0.05$) between the control and treatment values at any stage during the trial. However, on day three the predation rate in the N/2 treated plots was significantly lower ($p<0.05$) than that in the plots to which the normal field rate (N) had been applied.

Fig. 3.18 Predatory capacity

The effects of different rates of cypermethrin on the consumption of artificial prey within barriered plots.

N.B. N = Normal field rate of 25g a.i./ha.

For each sample date points sharing the same letter were not significantly different according to 95% confidence intervals (p>0.05, ANOVA).



3.5 Discussion.

Summer application of cypermethrin at the rate recommended for use on cereals in the autumn still resulted in a considerable disruption of some elements of the epigeal arthropod fauna. This is despite the negative temperature coefficient associated with pyrethroid toxicity (Harris and Kinoshita, 1977) and the potential of the crop canopy to intercept a large proportion of the applied pesticide (Cilgi et al 1988).

The summer application of cypermethrin resulted in a major disruption of the local community of linyphiid spiders, a family which is known to include important predators of cereal aphids (Fraser, 1982; Sunderland et al 1986a, 1986b; Sunderland, 1987). There appears to have been a disproportionate impact on male spiders (Fig. 3.14). This suggests that the timing of treatment relative to the mating period may be an important factor in determining the reproductive success of the local linyphiid population. All three rates of cypermethrin produced reductions in the abundance of linyphiids which were comparable with those observed following summer applications of deltamethrin at 6.25g a.i./ha (Fischer and Chambon, 1987) and 7.5g a.i./ha (Basedow et al 1985), and fenvalerate (Poehling, 1987).

Pitfall trap catches are not simply related to the density of the trapped arthropods but are also dependent upon a number of additional behavioural and environmental factors. Since pitfall traps are fundamentally passive in nature the size of catches will determined by the proportion of the population encountering the trap, which is itself a function of the arthropod's level of activity. Arthropod activity is influenced by several factors including temperature, rainfall and hunger. Behavioural differences between species result in variation in the level of trapping efficiency (Halsall and Wratten, 1989) such that differences in pitfall trap catches should not be used to infer a proportional disparity in the densities of different species. For these reasons the values obtained from pitfall trapping surveys are often referred to as indices of effective abundance, relative abundance or activity abundance.

Despite the problems inherent in the interpretation of pitfall trap data when employed within replicated field trials they remain a valuable tool in determining the impact of pesticides on individual species. In such cases the number of variables is reduced to the extent that for a given species any post-treatment differences will be a consequence of changes in density and/or activity.

Bearing these factors in mind, the impact of cypermethrin on the effective abundance of linyphiids (Appendix 3.10; Figure 3.11) can be interpreted as paralleling the sequential nature of pyrethroid intoxication. The post-treatment increase in the catches of spiders in treated plots is almost certainly due to hyperactivity resulting from the irritation of the peripheral sensory nervous system by cypermethrin. The subsequent depression in catches within the treatment plots results from mortality following the accumulation of a lethal dose of the pesticide.

The apparently disproportionate impact on male spiders (Figure 3.14) may be a consequence either of differences in body size or a difference in the degree of exposure to the pesticide. Male linyphiids are smaller than females (Locket and Millidge, 1951) and are therefore more susceptible to intoxication by a given dose. Males of the predominant species were actively searching for mates at the time of application. The comparatively high level of activity results in a greater degree of contact with contaminated surfaces and consequently an increase in the probability of exposure to a lethal dose of the toxin.

There were significant ($p<0.05$) post-treatment differences in the proportion of P.melanarius containing solid fragments of spider which were correlated with the rate of pesticide applied (Table 3.4.2) and with decreases in the activity abundance of linyphiid spiders (Fig.3.11). This may have been due to increased rates of encounter with prey as a result of the initial post-treatement increase in spider activity (Fig. 3.11) or through the greater abundance of spider corpses available to be scavenged as a consequence of subsequent mortality. Unfortunately the number of P.melanarius available for dissection was not large enough to enable a valid date by date comparison of changes in dietary composition.

Predation rates determined by pupae cards did not show significant differences between control values and those recorded in plots which had been treated with cypermethrin. Pupae cards examined in the field frequently had one or more P.melanarius associated with them. This suggests that measurements of the index of predation may have been biased towards indicating the predatory efficacy of the P.melanarius population rather than that of the predatory community as a whole.

Chiverton (1984) observed that the summer application of fenvalerate (100g a.i./ha) resulted in an initial significant reduction in capture rates of P.melanarius in pitfall traps. It was noted that the subsequent 'recovery' included a period during which pitfall catches in the treatment plots were significantly higher than in the untreated control. Chiverton (1984) suggested that increased catches within the treatment plots were a consequence of raised levels of activity of hungry beetles which were actively searching for food in areas depleted of prey. Three days after the enclosures had been treated with cypermethrin there were significant ($p<0.05$) reductions in the trapping rates of P.melanarius within plots which had been treated with normal and half normal rates of pesticide (Fig. 3.2). Values obtained from plots which had been treated with twice the recommended rate followed a similar course of recovery to that exhibited by P.melanarius following the summer application of fenvalerate (Chiverton, 1984). From day twelve onwards trapping rates within the 2N enclosures were approximately twice those observed in the controls. The difference was statistically significant ($p<0.05$) in samples which were collected sixteen days after treatment. If one accepts Chiverton's assertion that the apparent recovery is partially due to abnormally-active hungry beetles it follows that consumption rates of artificial prey would be higher in the treatment plots. Examination of Fig. 3.18 indicates that this tended to be the case in plots which were treated with the normal and double rates of cypermethrin although individual treatment and control values could not be separated statistically ($p>0.05$).

Effects on catches of S.avenae (Fig. 3.17) and Diptera (including Syrphidae) (Fig. 3.16) indicate that a degree of residual insecticidal activity persisted for the duration of the trial with knockdown resulting in increased collection rates in pitfall traps (Figs. 3.15-3.17). This continued knockdown of potential prey would tend to increase rather than decrease the quantity of food available to scavenging P.melanarius. The significant increases observed in the case of fenvalerate (Chiverton, 1984) occurred 5-6 weeks after treatment by which time there may have been little or no residual activity remaining.

CHAPTER 4 - DELTAMETHRIN / DEMETON-S-METHYL FIELD TRIAL (AUTUMN 1986).

4.1 Introduction.

The two preceding field trials (Chapters 2 and 3) had indicated that both autumn and summer applications of cypermethrin induced significant changes in the effective abundance of several arthropod groups. The impact on linyphiid spiders was particularly marked.

Limitations to the degree of replication in the first autumn field trial placed restrictions on the level of significance which could be attributed to the data and therefore on the probability of separating effects using statistical criteria. During the autumn, comparatively low levels of arthropod activity and abundance provide the field worker with a number of difficulties in experimental design. This is especially true in the case of trials which are monitored through to the following summer. In open field trials there is a requirement for a high degree of replication during the autumn and winter to counteract the high levels of heterogeneity of variance resulting from the small magnitude of samples and thus plot sizes may be reduced in order to accommodate replicates. At the same time however the increase in the area of arthropod home ranges and comparatively high mobility of many cursorial species, especially at higher temperatures (Baars, 1979; Grum, 1983) gives rise to the risk of rapid recolonization in the following spring and summer when plot sizes are small. This indicates the need to use as large a plot size as possible in cases where monitoring is to last for any considerable period of time. In short therefore, trials with large plot size and minimal replication may be best suited to experiments which aim to determine the potential duration of effects, while high replication probably with smaller plots may enable detection of more subtle changes in effective abundance. The latter will however be prone to dilution effects through rapid recolonization (Sotherton et al 1988; Jepson 1989; Thacker and Jepson, 1990).

One aim of the following trial was to attempt to determine whether or not the autumn application of aphicides significantly impaired the ability of the resident predatory arthropod population to limit the subsequent summer aphid infestation. This necessitated the use of as large a plot size as possible in order to minimise dilution effects caused by the reinvasion of treated plots. Thus, the experimental design was effectively a compromise resulting from the requirement for the largest possible plot size, the necessity to meet statistical needs for replication and the limited availability of suitable land.

It was decided to substitute deltamethrin for the cypermethrin used in the earlier autumn trial due to the greater insecticidal efficacy of the former (BCPC, 1979.) and its more widespread local usage. Demeton-S-methyl was included as a toxic standard in order to provide a comparison of a pyrethroid with an alternative group of approved autumn aphicides, the organophosphates.

The autumn application of deltamethrin has been shown to induce a temporary reduction in the activity abundance of the general carabid population to 30% of the control value (Matcham and Hawkes, 1985; Purvis et al 1988). Powell et al (1988) were unable to confirm this apparent effect due to low carabid densities at the time of spray application. Feeney (1982) reported an initial 65% reduction in the effective abundance of Trechus quadristriatus (Schrank) after the autumn application of deltamethrin. This value corresponds well with the 60-70% reduction in overall abundance of carabids recorded by Purvis et al (1988) during a trial in which catches of Carabidae were dominated by Trechus . T.quadristriatus has also been shown to be susceptible to demeton-S-methyl both in semi-field trials

(Vickerman, 1988) and laboratory screening (Sotherton, 1989).

The available evidence suggests that adult staphylinids present at the time of spraying are not particularly susceptible to autumn applications of deltamethrin (Purvis et al 1988). These sprays are reported to produce significant and comparatively long lasting depressions in the effective abundance of linyphiid spiders, however (Powell et al 1988; Purvis et al 1988). Both authors reported decreases in spider abundance which persisted until the following spring/summer.

The field trial outlined below attempted to monitor the impact of the autumn applications of two aphicides on populations of individual predatory species and to determine the consequences for the subsequent summer aphid infestation.

4.2 Estimates of abundance.

4.2.1 Materials and methods.

The trial was carried out in fields 11/12 and 13/14 of Charity Down Farm, Longstock, Hampshire. (see map, Appendix 1.2)

Nine 200m by 200m plots were marked out as indicated in Figure 4.1 . Both fields were sown with seed crops of winter wheat (Field 11/12 cv. Rendezvous and Field 13/14 cv. Moulin). The pesticides were applied on 03-11-86 when the crop was at the three leaf stage (Zadoks 13).

The plots were treated as indicated in Figure 4.1 deltamethrin (2.5% EC) and demeton-S-methyl (58% EC). Control plots were left unsprayed. The pesticides were applied by farm staff using a 'Chafer Pathfinder' hydraulic unit operating an 18m boom at a pressure of 1.6 bar and a tractor speed of 10 km/h. The spray boom was fitted with 'Chafer red-cone' nozzles with a separation of 33cm.

The demeton-S-methyl was applied at a proposed rate of 243.60g a.i./ha and the deltamethrin at 6.25g a.i./ha both in 220 l/ha water. To check on the accuracy of these rates of application the outputs from ten randomly selected nozzles were measured and the actual rates of delivery were determined. The rate of delivery for the demeton-S-methyl was calculated as 228.81 $\pm$ 5.38g a.i./ha and that for the deltamethrin as 5.87 $\pm$ 0.14g a.i./ha. The spray unit was thoroughly washed out three times between each treatment.

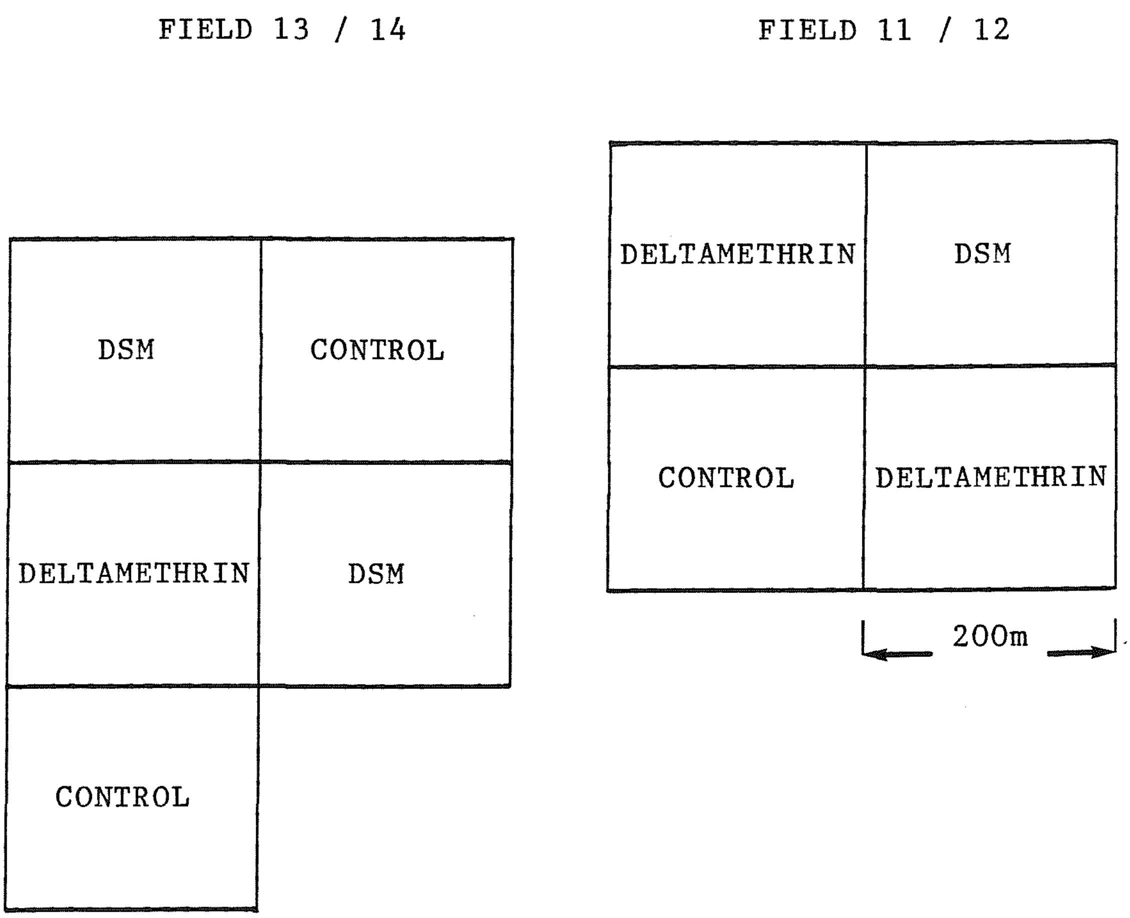
There were three major components to the study:-

1) The monitoring of pre- and post-treatment levels of effective abundance for non-target arthropods between the autumn and harvest in the following year.

2) Individuals of the carabid species T.quadristriatus (Schrank) were retained in alcohol for dissection and determination of:-
   i) Antifeedant effects and an indirect indication of irritant induced hyperactivity.
   ii) Sex related differences in the severity of impact.
   iii) Effects on egg production and deposition.

3) Monitoring the levels of summer aphid infestation and the resultant effects on yield as defined by thousand-grain weight.

Fig. 4.1
Plot arrangement deltamethrin / DSM field trial (Autumn 1986).



Two methods were employed to monitor the abundance of arthropods in the experimental plots. Pitfall traps were used throughout the duration of the trial and samples were taken using a Dietrick vacuum sampler, or D-vac, from 31-05-87 (day 209) onwards.

The effective abundance of the epigeal arthropod fauna was measured both pre- and post-treatment by means of pitfall traps (diameter 7cm). Each plot contained a central arrangement of twenty pitfall traps in a 5x4 grid with traps separated by intervals of 10m. Traps were partially filled with a 5% solution of formalin to which a few drops of detergent had been added. Traps were emptied at approximately fortnightly intervals.

The trapped arthropods were transferred to 70% alcohol for storage prior to sorting and identification under binocular microscope. Wherever possible arthropods were identified to species level. In addition, the larvae of the carabid beetle Nebria brevicollis (F.) were identified to the level of instar in order to monitor any impact on transition between developmental stages. The instar was determined from the width of the larval head capsule using the values obtained by van Emden (1942).

The D-vac samples consisted of five, ten-second sub-samples per plot. The D-vac had a collecting area of 0.092 m^2 giving a total sample area of 0.46 m^2 per plot. Samples were frozen in plastic bags prior to identification under binocular microscope.

4.2.2 Results.

Pitfall trap data were transformed by log(n+1) for the number of individuals per trap per day before analysis by one-way ANOVA and multiple range comparison by 95% confidence intervals using the Statgraphics (vers 2.1) software package. In order to account for pre-treatment differences, analysis of variance was carried out on 'k' values (Sotherton et al 1987) for those arthropods which were numerically dominant at the time of spray application. These were Bembidion obtusum (Serville) (Fig. 4.5), T.quadristriatus (Schrank) (Fig. 4.16) and total adult Carabidae (Fig. 4.18).

'k' is defined as the mean difference between the log(n+1) transformed value obtained immediately prior to treatment and the value obtained on each separate sampling occasion as indicated below.

'k'= pre-treatment value (log(n+1)) - post-treatment value (log(n+1)).

In cases where there is a net increase in effective abundance a negative value is produced for 'k' and a net decrease results in a positive value. For ease of interpretation the signs of the 'k' values in Figures 4.5, 4.16 and 4.18 have been reversed so that points above the 'k'=0 line indicate an increase in activity abundance and points falling below it denote a net decrease in abundance.

In addition, a sign test (Steel and Torrie, 1987) was applied to each set of pitfall trap data in order to detect any significant ($p<0.05$) trends in the size of catches relative to those from the control plots.

Pitfall trap catches in the deltamethrin and DSM treated plots are shown as a percentage of the values obtained in the control areas in Figures 4.2-4.32. More comprehensive information relating to the outcome of the relevant ANOVAs and multiple range comparisons is provided in Appendices 4.1-4.31.

Summaries of the ANOVA and sign test results for pitfall trap data are provided in Tables 4.1 and 4.2.

Data collected by D-vac was transformed by log(n+1) for the number of individuals per $0.46m^2$ sample before analysis by one-way ANOVA and multiple range comparison by 95% confidence intervals (Tables 4.3-4.7).

Carabidae. (Appendices 4.1-4.18; Figures 4.2-4.19; Tables 4.3-4.5).

Pitfall data indicated that immediately after treatment there was a decrease in the relative abundance of total adult Carabidae in the deltamethrin treated plots. This was followed by an apparently total recovery to control values within 50 days of treatment. Deltamethrin catches were significantly lower ($p<0.05$) than either control or DSM values in samples collected on day 8 and were also reduced relative to DSM catches on day 18 ($p<0.05$) (Fig. 4.17). The application of a sign test to 'k' values indicated that the frequency with which the adjusted abundance in deltamethrin plots was lower than that in the control areas was significant at $p=0.05$ (Table 4.1). No such trend was detected in a comparison between control plots and those treated with DSM (Table 4.2).

No significant between-treatment differences were detected in the numbers of total adult Carabidae occurring in D-vac samples collected in the following summer (Table 4.5).

At the time of the autumn spray application the carabid component of the pitfall trap samples was dominated by B.obtusum and T.quadristriatus.

On days 2 and 8 after treatment the effective abundance of B.obtusum was significantly lower ($p<0.05$) in the deltamethrin plots than in those assigned to either of the other treatments. The deltamethrin values were also significantly lower than those from DSM plots alone on day 18 ($p<0.05$). Although no individual sample dates after day 8 produced any significant effects ($p>0.05$). Sign tests indicated that the effective abundance of B.obtusum was consistently higher ($p<0.05$) in control plots than in those treated with either of the two pesticides (Table 4.1 and

4.2). Data transformed to 'k' values to account for pre-treatment differences (Fig. 4.6) indicated that adjusted values from deltamethrin plots were significantly lower ($p<0.05$) than the adjusted DSM and control values obtained two days after treatment. The application of a sign test to 'k' transformed data indicated that the numbers of B.obtusum found in pitfall samples from the deltamethrin plots were consistently smaller than those occurring in the control samples ($p<0.05$). 'k' values for the DSM samples did not exhibit a significant trend ($p>0.05$) when compared with adjusted values obtained from the controls.

Data for the related carabid species Bembidion lampros (Herbst.) (Fig. 4.4) indicated decreases in activity abundance in both the deltamethrin and DSM plots immediately after treatment but this was not to a statistically significant level ($p>0.05$). Analysis of the deltamethrin and control data sets produced a positive result for a sign test ($p<0.05$) indicating that deltamethrin catches were larger than control values for the majority of the sample dates. Data from D-vac samples confirmed that there were no significant treatment-related differences in the abundance of B.lampros during the period corresponding to the summer infestation by cereal aphids (Table 4.3).

Immediately after spray application, the activity abundance of T.quadristriatus in the control and DSM plots increased relative to the pre-treatment level. At the same time the effective abundance in the areas treated with deltamethrin exhibited a decrease relative to the pre-treatment value. This effect can be observed in Figure 4.16 where 'k' values for T.quadristriatus are plotted against days relative to treatment. While analyses of variance (Appendices 4.14 and 4.15) did not reveal significant differences between treatments for either log(n+1) transformed no./trap/day data (Fig. 4.15) or 'k' values (Fig. 4.16), sign tests did indicate significant trends ($p<0.05$) in the relative levels of the 'k' values. When adjusted for pre-treatment differences the values obtained for effective abundance in the deltamethrin plots proved to be consistently reduced relative to the 'corrected' data obtained from either of the other two treatments ($p<0.05$). At the same time, an analysis of 'k' values from the DSM plots demonstrated a significant ($p<0.05$) tendency for the adjusted abundance in these plots to be higher than that observed in either the control or deltamethrin plots. D-vac samples of <u>T.quadristriatus</u> collected during the period of summer aphid infestation (Table 4.4) did not show any significant differences between treatments ($p>0.05$).

In the case of <u>Agonum dorsale</u> (Pont.) (Fig. 4.2), <u>Loricera pilicornis</u> (F.) (Fig. 4.7), <u>Notiophilus biguttatus</u> (F.) (Fig. 4.13) and <u>P.melanarius</u> (Fig. 4.14) there were no apparent differences between treatments on any of the sample dates ($p>0.05$). There were also no significant differences on any of the separate sample dates for members of the genus <u>Amara</u> (Fig. 4.3) but a sign test (Table 4.1) did indicate that catches in the deltamethrin plots tended to be larger than those in the control plots.

Analysis of catches of <u>N.brevicollis</u> (Fig. 4.8) failed to detect any significant differences in the trapping levels for individual dates ($p>0.05$) but a sign test revealed that the DSM induced a significant ($p<0.05$) depression in the abundance of this species over the course of the trial. Between days 18 and 31 after treatment the first instar larvae of <u>N.brevicollis</u> (Fig. 4.9) exhibited a marked increase in activity abundance in both deltamethrin treated areas and in the DSM plots. In the case of the deltamethrin plots the approximately elevenfold increase in relative abundance proved to be significant at $p=0.05$. The fivefold increase in effective abundance in the DSM samples was not statistically significant ($p>0.05$). No treatment related differences were detected during comparisons of rates of capture for second and third instar <u>N.brevicollis</u> larvae on separate sample dates. The application of a sign test to the data set for the DSM treated areas revealed a significant trend ($p<0.05$) towards a reduction in the relative abundance of the third instar larvae of N.brevicollis.

Directly after spray application, both deltamethrin and DSM treated plots exhibited similar sharp but non-significant ($p>0.05$) decreases in the relative abundance of total carabid larvae (Fig. 4.19). There was a rapid rebound in the relative rates of capture and no significant treatment-related differences were detected on any of the sampling dates.

Staphylinidae. (Appendix 4.19; Figure 4.20; Table 4.6).

Immediately following spray application (ie day 2, Fig. 4.20) there was a sharp drop in the relative abundance of adult Staphylinidae in plots treated with deltamethrin. However, this decrease proved not to be statistically significant ($p>0.05$) and was followed by a rapid resurgence so that within 31 days of treatment the levels of effective abundance in pyrethroid plots were higher than those in both the control and DSM treated plots. During this period the staphylinid component of pitfall trap samples was dominated by Xantholinus linearis (Olivier).

Sign tests (Table 4.1 and 4.2) applied to pitfall trap data and ANOVAs applied to D-vac samples collected during the summer (Table 4.6) indicated that neither pesticide induced any longterm disruption of staphylinid populations within the experimental plots.

Linyphiidae. (Appendices 4.20-4.28; Figures 4.21-4.29; Table 4.7).

Both pesticide treatments induced severe and comparatively longterm disruptions in the populations of a number of species of linyphiid spider. Of the two treatments the pyrethroid appeared to have the most extreme effect.

Sign tests (Table 4.1) indicated significant trends towards reduced catches in deltamethrin plots for Erigone atra (Blackwall), Erigone dentipalpis (Wider), Oedothorax spp., total Erigoninae, Lepthyphantes tenuis (Blackwall), Meioneta rurestris (C.L.Koch), total Linyphiinae and total Linyphiidae. Sign tests comparing DSM catches with control values (Table 4.2) indicated persistent reductions in the numbers of E.atra, total Erigoninae, L.tenuis, total Linyphiinae and total Linyphiidae ($p<0.05$).

Throughout the trial the pitfall samples of linyphiid spiders were dominated by E.atra. After treatment, a steady decline was observed in the relative abundance of E.atra in plots treated with DSM (Fig. 4.21). In the areas treated with deltamethrin E.atra exhibited a brief two to threefold increase in relative abundance between days 8 and 18 before falling to approximately a quarter of control values by 31 days after treatment. Despite the fact that pre-treatment catches of E.atra had been higher in the DSM and deltamethrin plots, the post-treatment levels remained reduced relative to control values until June of the following year. For a major part of the trial the relative abundance of E.atra , in plots treated with deltamethrin, remained depressed to well below 50% of the control values. Catches in the plots treated with demeton-s-methyl were reduced to approximately 70% of the control levels in a similar manner.

At the time of treatment, the numbers of E.dentipalpis obtained from pitfall samples were extremely small. As general levels of activity abundance increased with warmer weather it became apparent that there was a marked difference in the duration of impact of the two pesticides (Fig. 4.22). At the end of February '87 the numbers obtained for both of the pesticides were significantly lower than the control values ie 12.5% ($p<0.05$). While catches of E.dentipalpis in the deltamethrin plots continued to be reduced until the following June, the relative abundance in the DSM areas exhibited a rapid recovery as early as March. In fact, at the end of March '87 (day 143) the effective abundance of E.dentipalpis in the DSM plots was significantly higher ($p<0.05$) than that in the plots which had been treated with deltamethrin. These factors are reflected in the difference in results obtained from sign tests (Tables 4.2 and 4.3). The deltamethrin values proved to be consistently lower than control levels while the relative abundance in the DSM treatments did not exhibit a significant trend ($p<0.05$, sign test).

It was necessary to pool the data for members of the genus Oedothorax due to the comparatively low numbers obtained for the individual species. Samples were mainly composed of O.fuscus , but both O.retusus and O.apicatus were also in evidence. Catches of Oedothorax spp. in the deltamethrin plots were only significantly lower than those in the control areas on one of the sampling occasions (day 115, $p<0.05$). On one sample date (day 168) the abundance in the DSM plots was significantly higher ($p<0.05$) than that in either the control areas or those treated with deltamethrin. A sign test indicated that there was an overall tendency towards a depression of the relative abundance of Oedothorax spp. in the deltamethrin plots (Table 4.1) but not in the DSM plots (Table 4.2).

Perhaps not surprisingly the curves obtained for catches of total Erigoninae (Fig 4.24) closely parallel those for E.atra (Fig 4.21). The main difference is that in the case of the summed values the decrease within the deltamethrin plots was not statistically significant on day 31 ($p>0.05$).

Analyses of variance (Appendix 4.24) indicated that the relative abundance of B.gracilis in the deltamethrin plots was significantly lower ($p<0.05$) than the control values on days 129 and 185 after treatment (Fig 4.25). A sign test revealed a significant trend for the post-treatment abundance of B.gracilis in the deltamethrin plots to be reduced relative to that in the control plots. Data obtained from the demeton-S-methyl plots did not exhibit any significant trend but the pitfall samples from 07-05-87 (day 185) were significantly lower than control values ($p<0.05$).

In the case of L.tenuis (Fig. 4.26) no significant differences were found on any of the individual sample dates ($p>0.05$) but sign tests indicated that both of the pesticides induced persistent reductions in the relative abundance of this species.

Pitfall catches of M.rurestris (Fig. 4.27) in the plots treated with deltamethrin were significantly higher ($p<0.05$) than in the control plots on day 18 after treatment (Appendix 4.27). This is not apparent from Fig. 4.27 since the graph does not include any points for this sample date. This is due to the fact that no M.rurestris were recovered from the control catches collected on this date. The apparent transient increase within the deltamethrin plots was subsequently followed by a sustained decrease in the relative abundance of M.rurestris. The decrease relative to the control values was significantly different ($p<0.05$) on days 108 and 168 after treatment. The application of a sign test indicated that there was a significant ($p<0.05$) trend towards a reduction in the population of M.rurestris within the areas treated with deltamethrin. Samples collected from the deltamethrin plots were also significantly smaller ($p<0.05$) than those from DSM plots on days 129 and 168. Pitfall samples from DSM treated plots were significantly lower ($p<0.05$) than control values on only one of the individual sample dates (day 129). The application of a sign test to the data set from the DSM plots failed to reveal any significant trend in its effect on the relative abundance of M.rurestris ($p>0.05$).

M.rurestris and L.tenuis were the two most frequently recorded members of the sub-family Linyphiinae. Pitfall data for total adult Linyphiinae (Fig. 4.28) indicated that the application of deltamethrin resulted in a brief increase in the relative abundance of members of this sub-family. This apparent peak was then followed by a sustained decrease in relative abundance which lasted until the following June. The statistical significance of this trend was confirmed by means of a sign test ($p<0.05$) (Table 4.1). A series of one-way ANOVAs (Appendix 4.27) indicated that catches of Linyphiinae were significantly lower ($p<0.05$) in deltamethrin plots than in the controls on days 108, 115 and 129. Levels of Linyphiinae in areas treated with deltamethrin were significantly lower ($p<0.05$) than DSM values on days 108 and 168. The DSM trap values were significantly lower than the control values on only one of the individual sample dates, day 129. A sign test indicated that pitfall catches in the plots treated with DSM were consistently lower than those in the control replicates ($p<0.05$) (Table 4.2).

Following the application of the pyrethroid, the comparative levels of activity abundance for total adult Linyphiidae exhibited a brief but marked increase (Fig. 4.29). The linyphiid population within the deltamethrin plots subsequently appeared to decrease relative to the level in the controls with the disparity persisting until June of the following summer. The statistical significance of the trend ($p<0.05$) was confirmed by means of a sign test (Table 4.1). The catches of Linyphiidae in the replicates treated with deltamethrin were significantly reduced ($p<0.05$) on two specific sample dates, namely days 115 and 129. Values for the pyrethroid treated plots were also reduced relative to those in the areas treated with DSM on day 115. The demeton-S-methyl values proved to be significantly lower ($p<0.05$) than the control levels on days 47 and 115 after treatment. A sign test (Table 4.2) confirmed a significant trend ($p<0.05$) towards a reduction in the relative abundance of Linyphiidae within the replicates treated with DSM. D-vac samples collected during June confirmed that populations of linyphiid spiders in the treatment plots had recovered to control levels before the onset of the growth phase of the aphid infestation (Table 4.7).

Acari. (Appendix 4.29; Figure 4.30).

Pitfall trap data for separate sample dates did not show any significant differences between treatments ($p>0.05$) but a sign test (Table 4.1) indicated a tendency for catches in plots treated with deltamethrin to be higher than those in the control plots ($p<0.05$). No such trend was detected when comparing catches of mites in control plots with those in plots treated with DSM ($p>0.05$) (Table 4.2).

Collembola. (Appendix 4.30; Figure 4.31).

The pitfall samples collected from the deltamethrin and DSM plots two days after spray application produced values which were significantly lower than those in control plots ($p<0.05$) (Fig. 4.31). This was the only sample date for Collembola on which there were significant differences between treatments. A sign test indicated that there was a significant trend ($p<0.05$) for reduced catches in deltamethrin plots (Table 4.1) but a similar tendency in the areas treated with DSM proved not to be statistically significant ($P>0.05$) (Table 4.2).

It should be pointed out that the relative abundance of Collembola in the control plots was already higher than that in plots designated as treatment areas even before the application of the pesticides. However, the disparity was not statistically significant ($p>0.05$).

Diptera. (Appendix 4.31; Figure 4.32).

Pitfall catches for Diptera in the deltamethrin plots exhibited a short term but significant decrease ($p<0.05$) relative to those in both control and DSM treated areas (Fig. 4.32). The apparent recovery in the relative abundance of Diptera was rapid with deltamethrin plots producing higher catches than either DSM or control samples within eighteen days of treatment.

Fig. 4.2 Agonum dorsale (Pont.).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

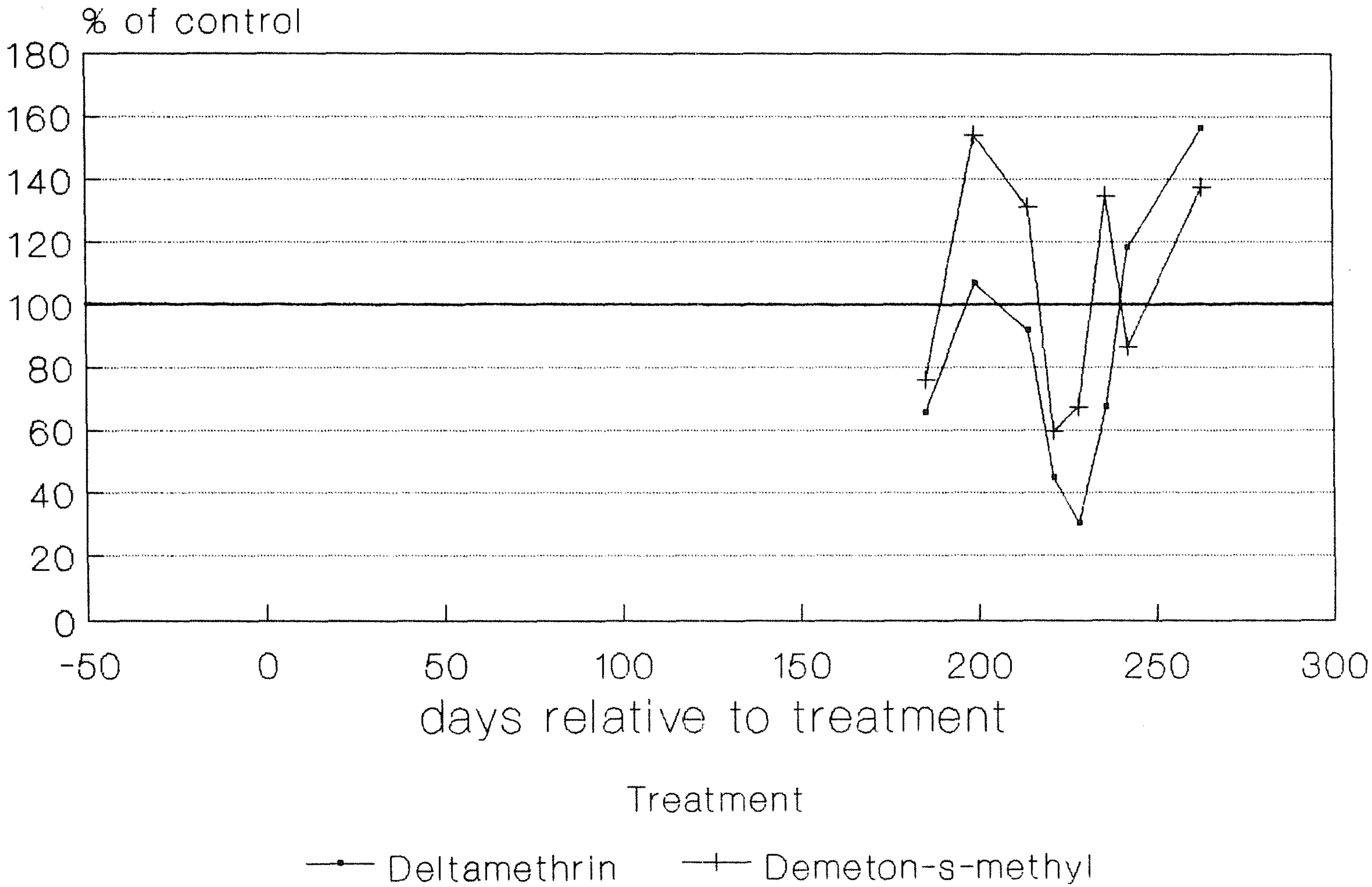


Fig. 4.3 Amara spp.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

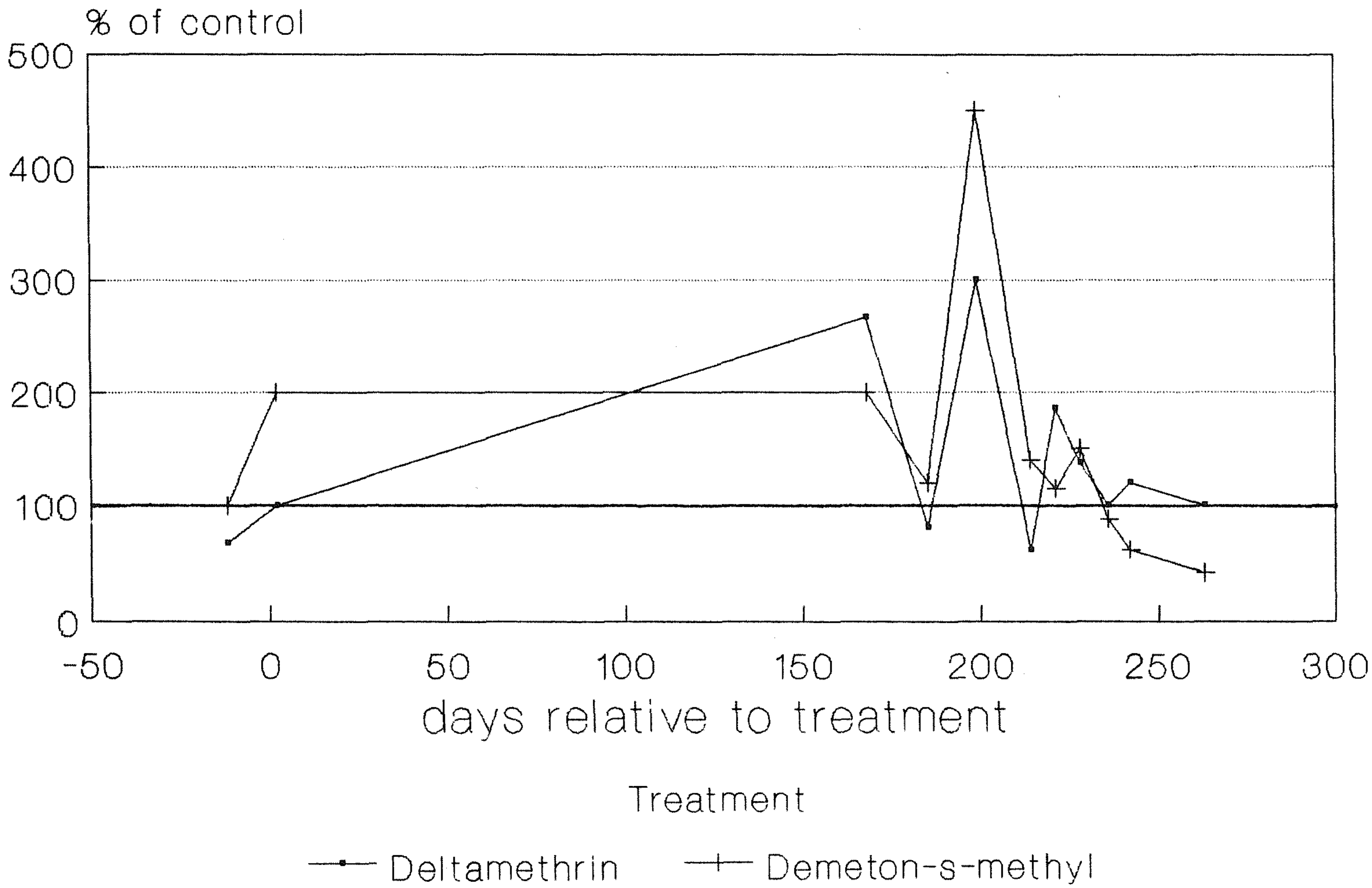


Fig. 4.4 Bembidion lampros (Herbst.).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

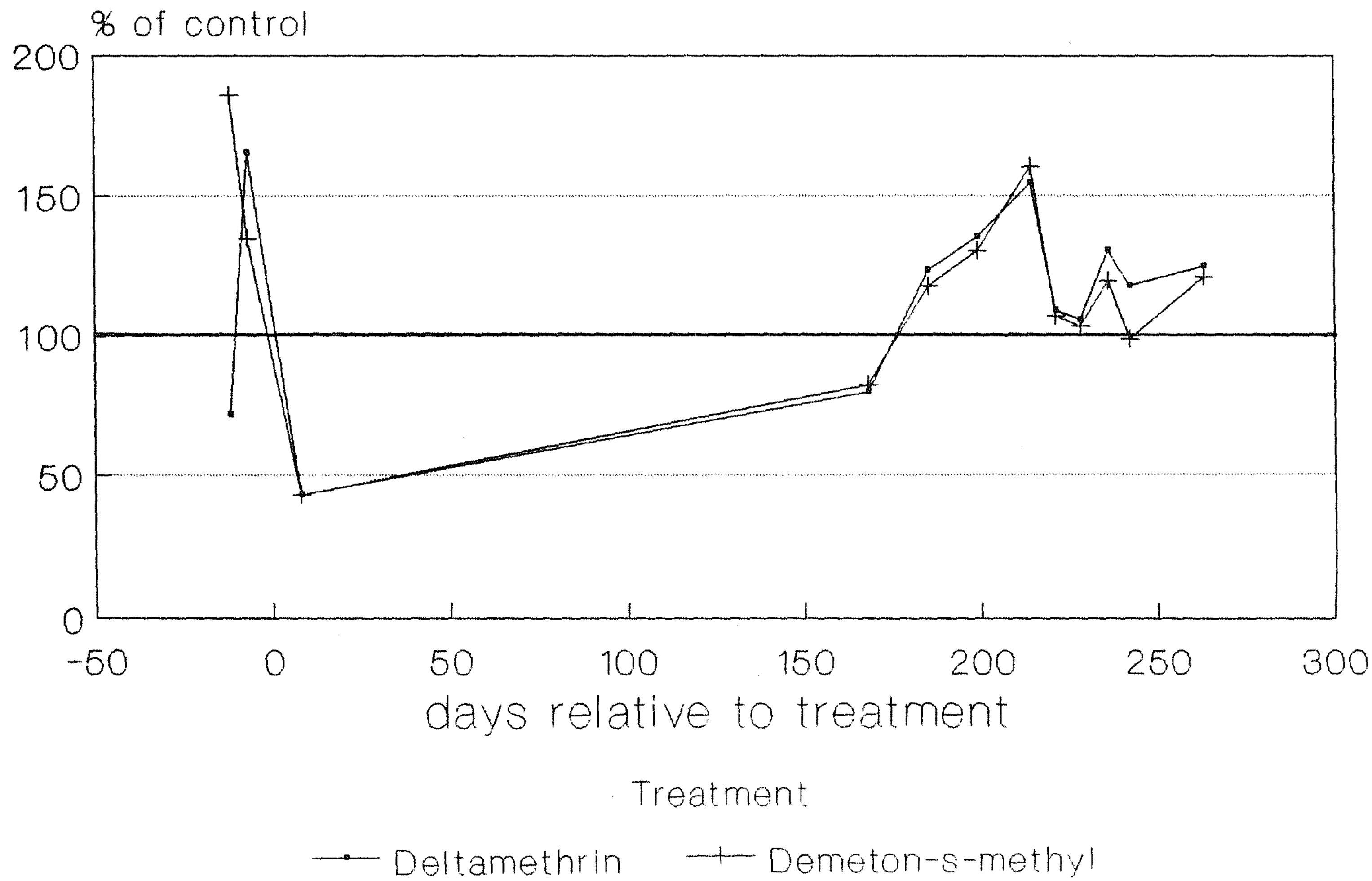


Fig. 4.5 Bembidion obtusum (Serville).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

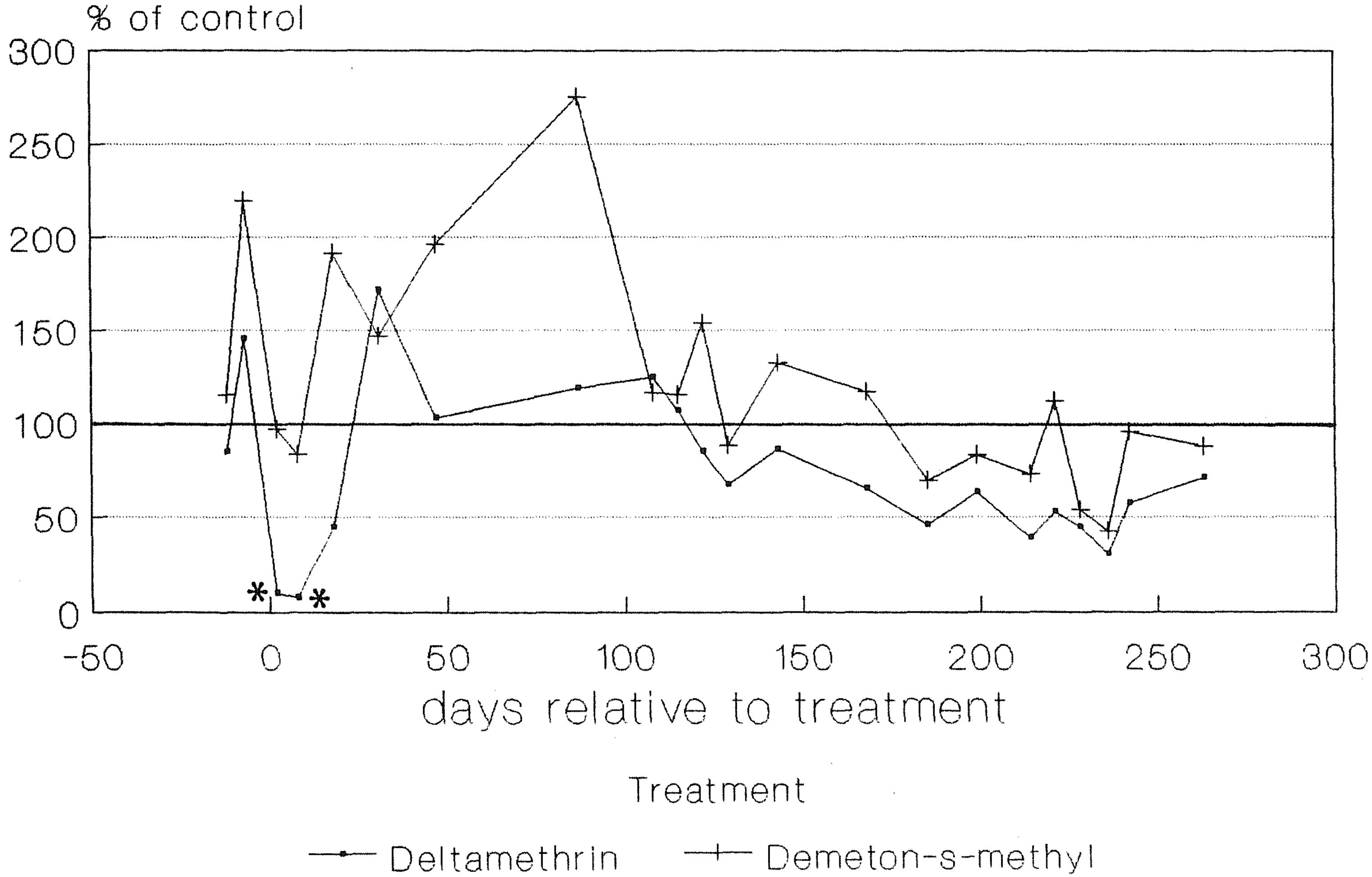


Fig. 4.6 Bembidion obtusum (Serville) 'k' values.
Comparison of 'k' values for plots treated with deltamethrin, DSM and unsprayed control plots.
N.B. For each sample date, points sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

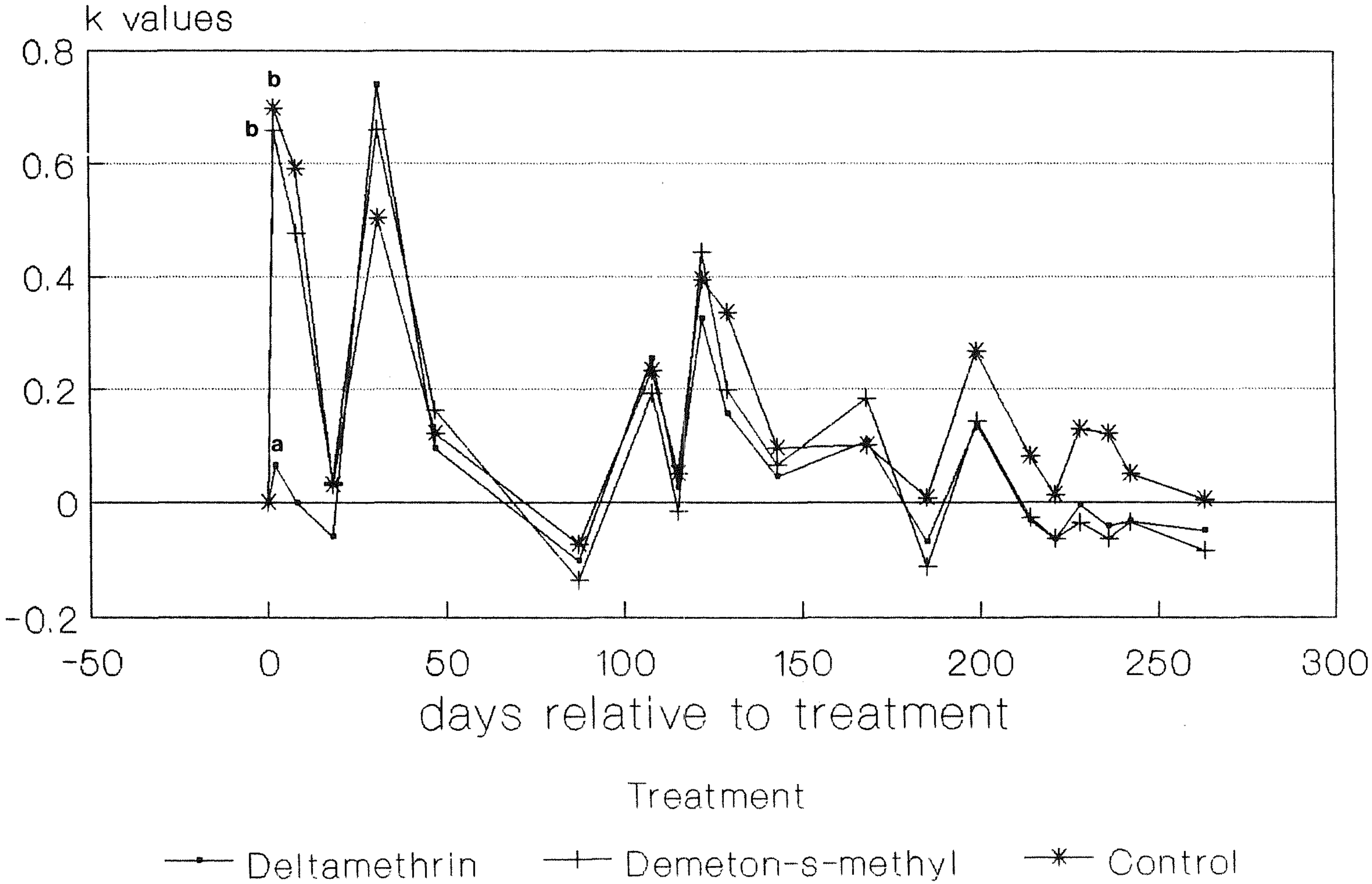


Fig. 4.7 Loricera pilicornis (F.).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

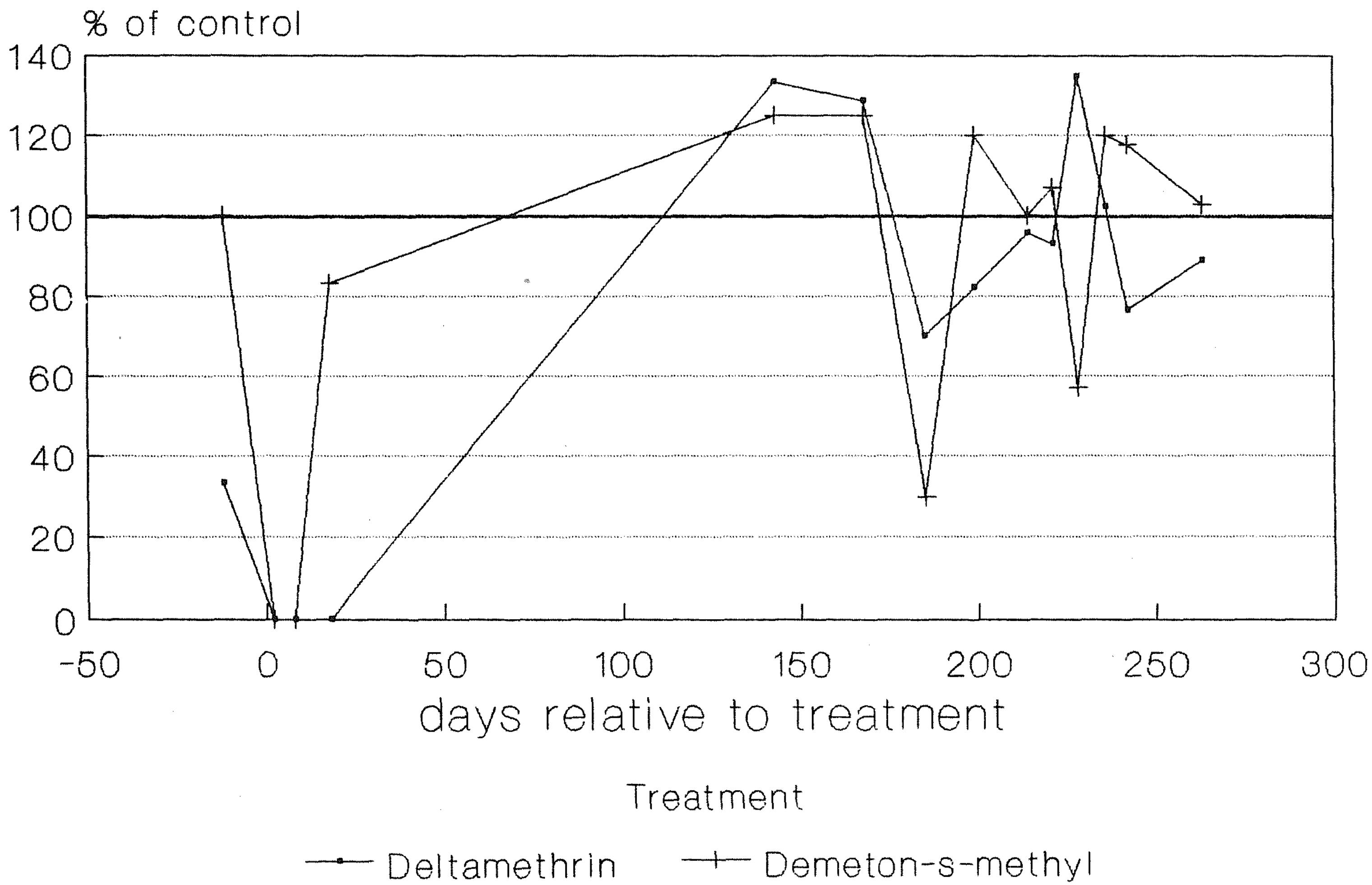


Fig. 4.8 Nebria brevicollis (F.).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA).

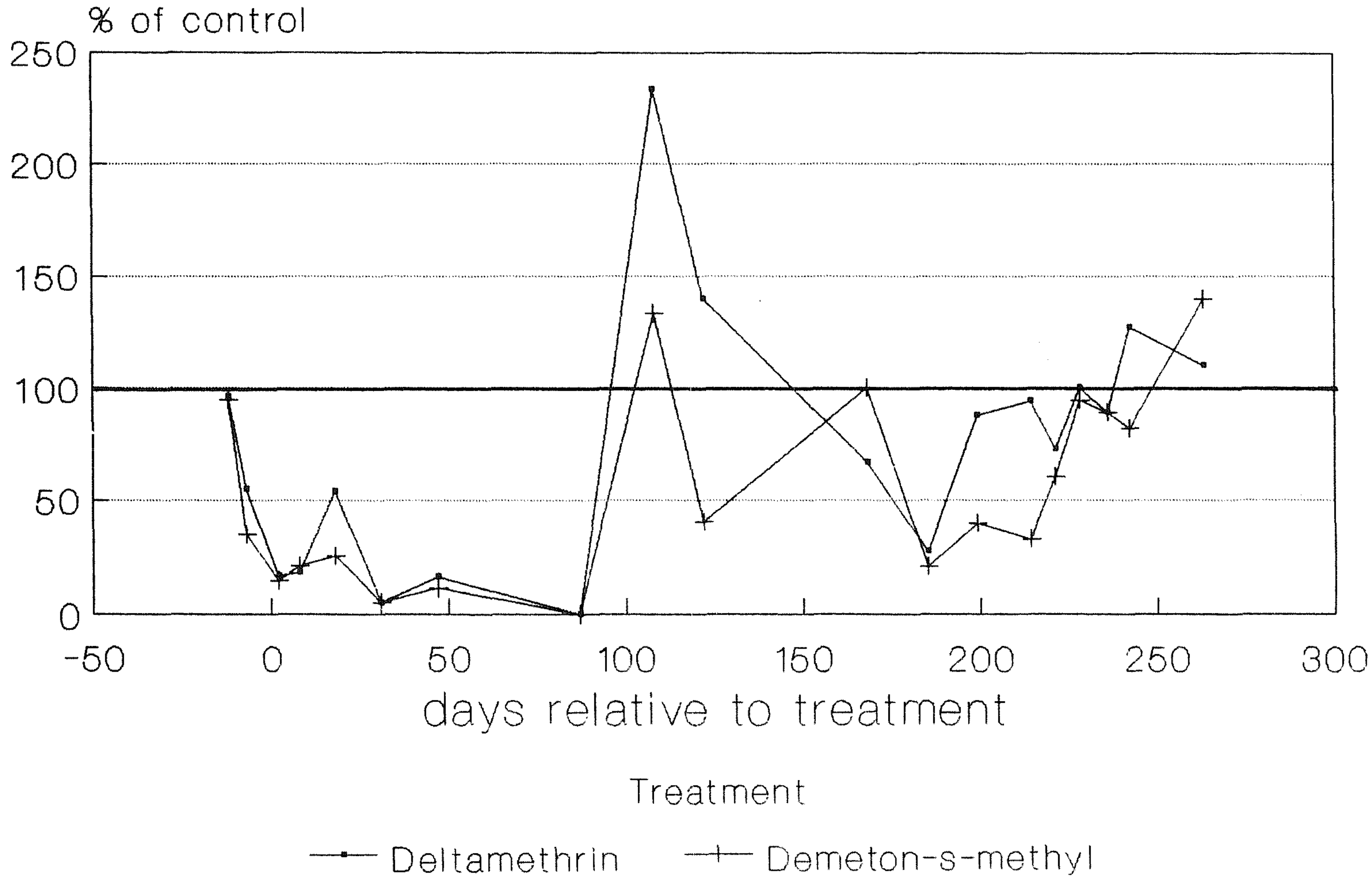


Fig. 4.9 Nebria brevicollis (F.) larvae (instar I).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

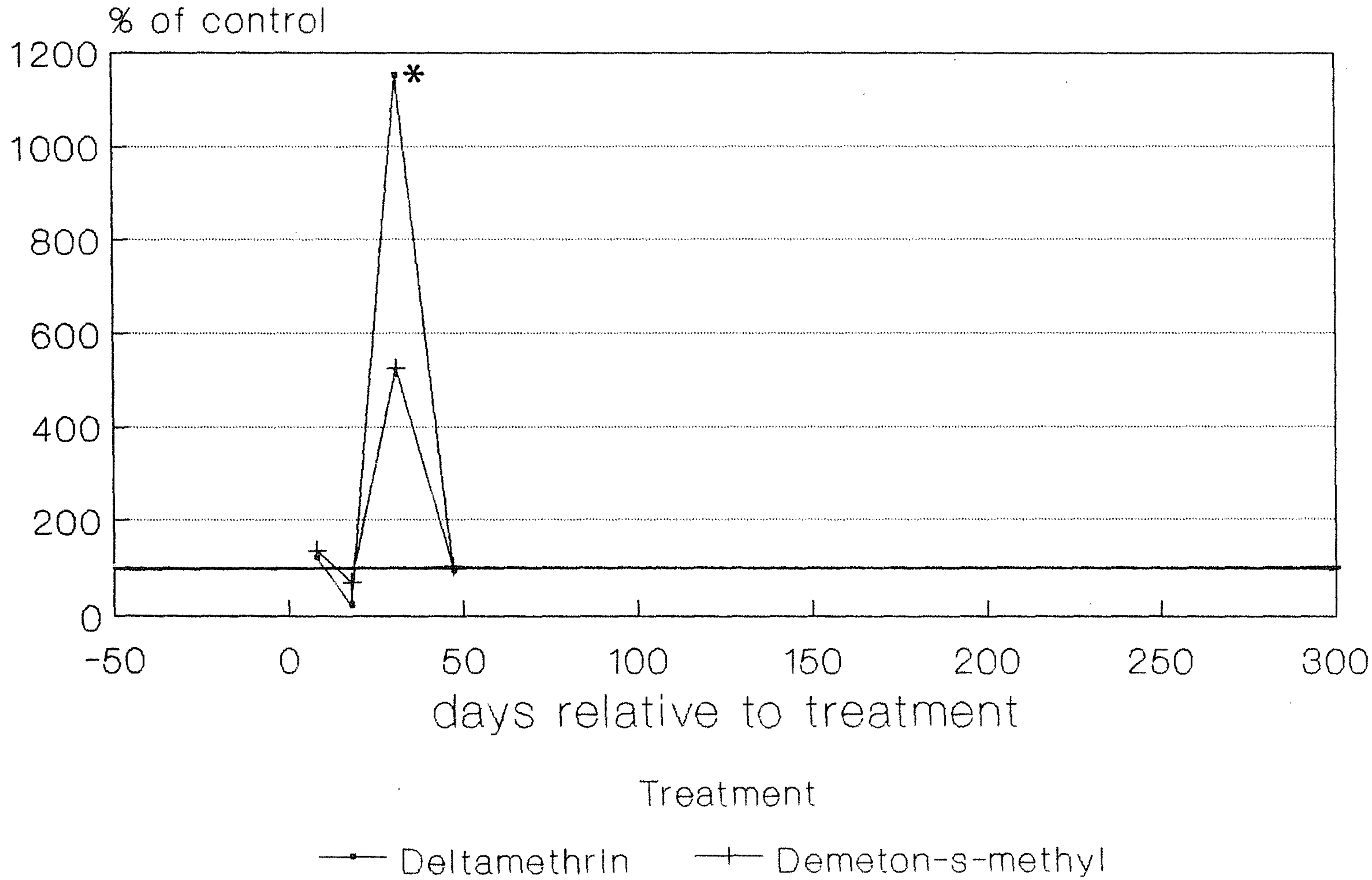


Fig. 4.10 <u>Nebria</u> <u>brevicollis</u> (F.) larvae (instar II).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA).

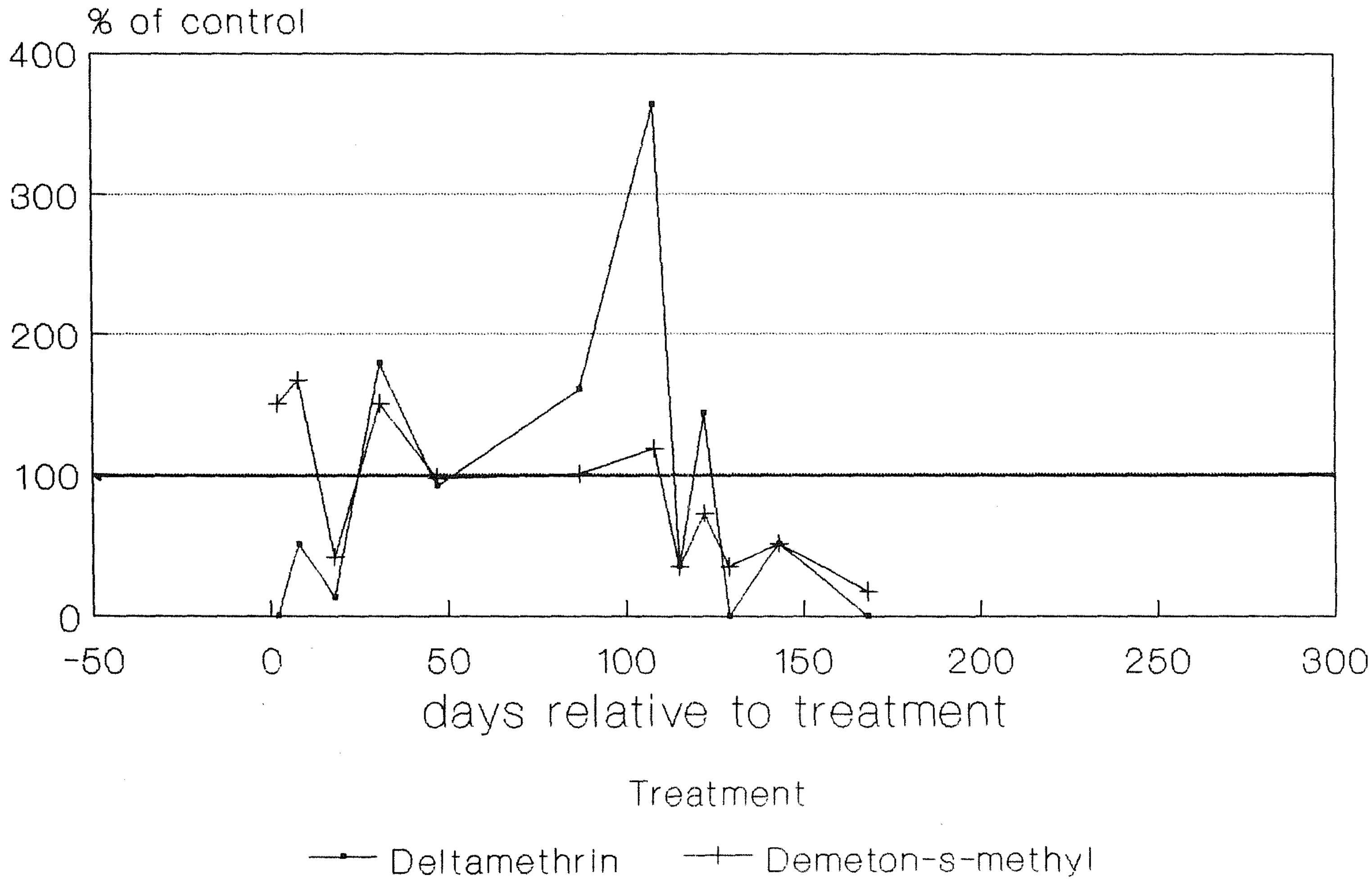


Fig. 4.11 Nebria brevicollis (F.) larvae (instar III).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA).

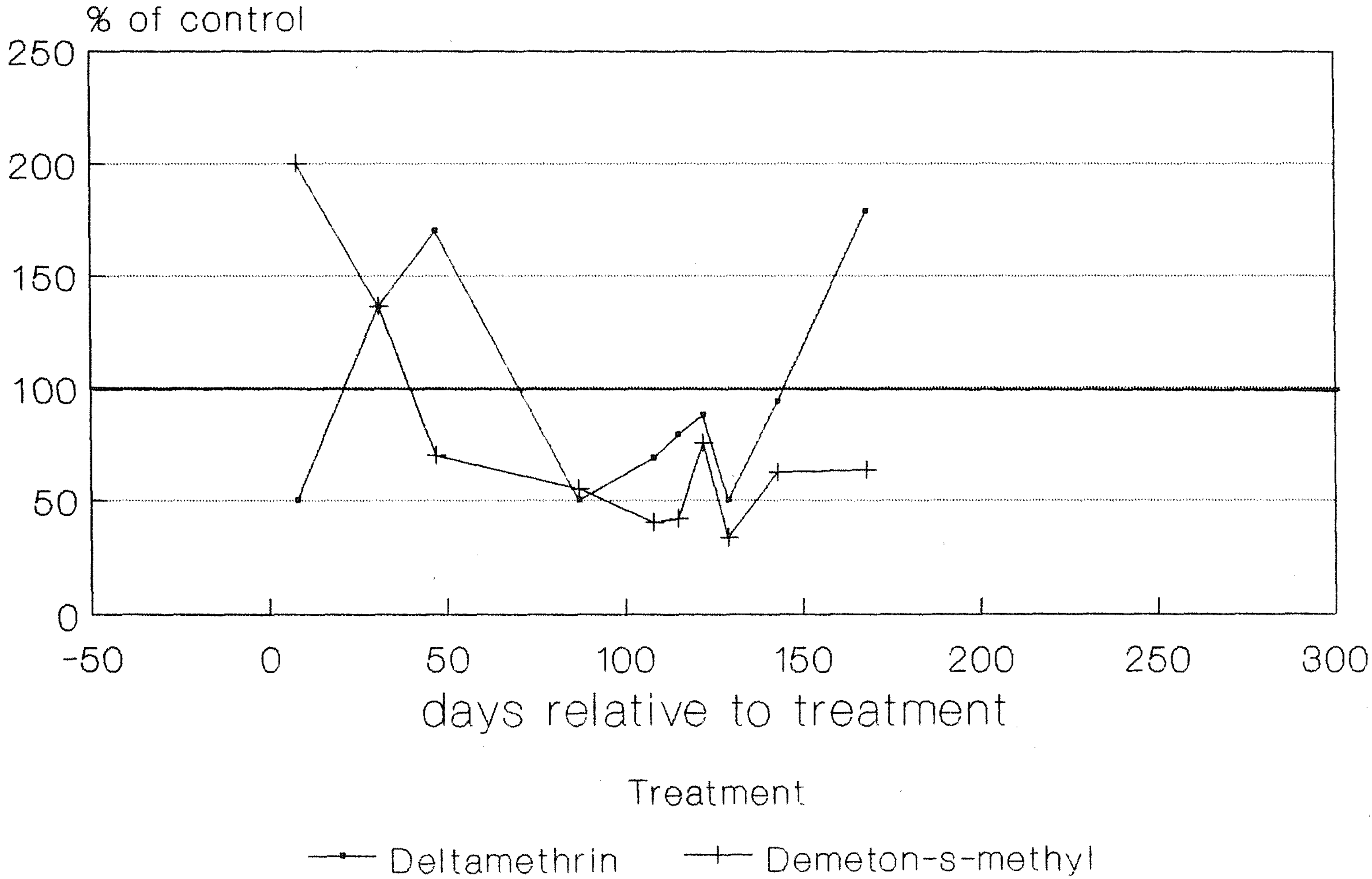


Fig. 4.12 <u>Nebria brevicollis</u> larvae (F.) (instars I-III).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA).

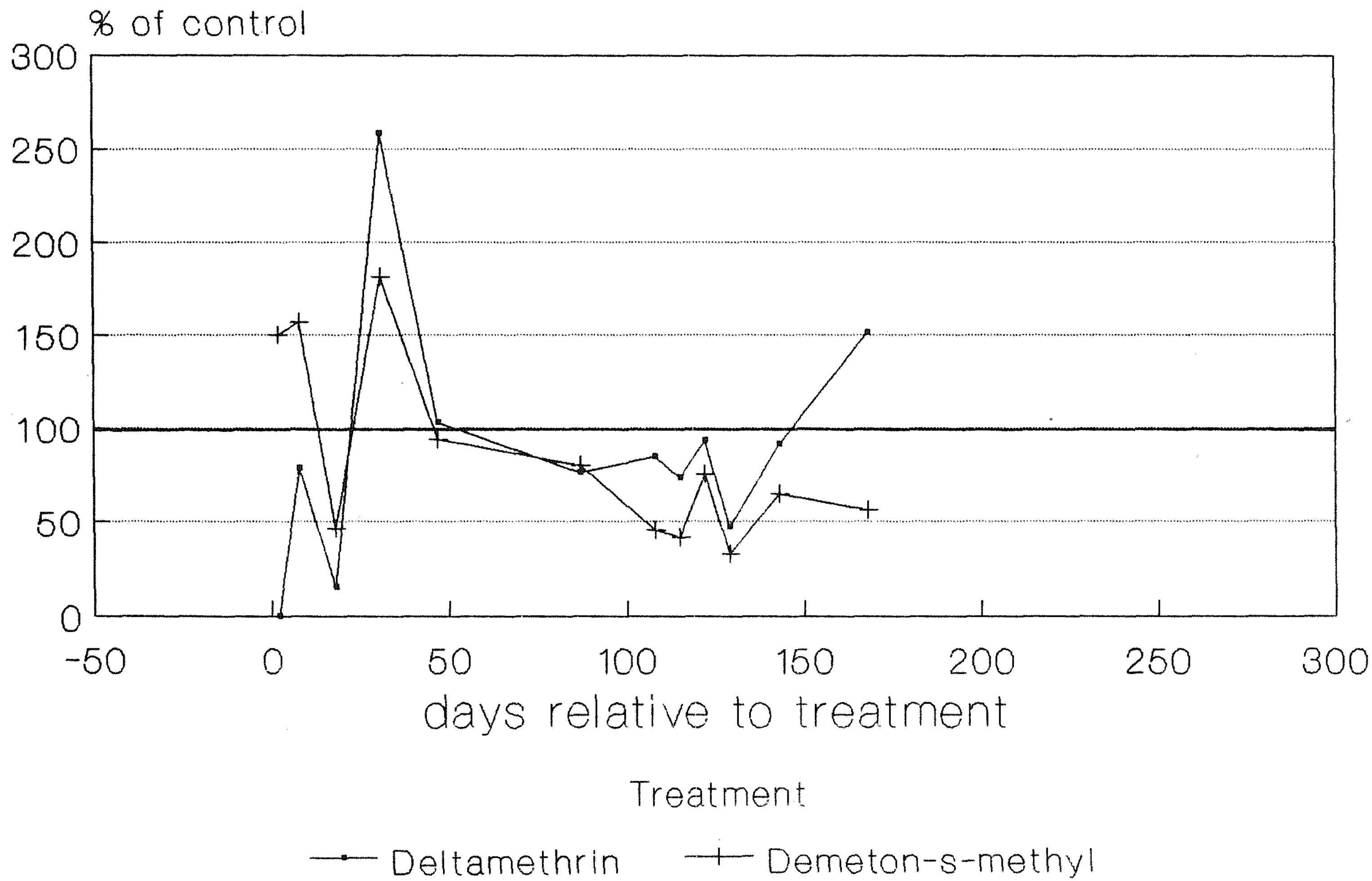


Fig. 4.13 <u>Notiophilus biguttatus</u> (F.).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA).

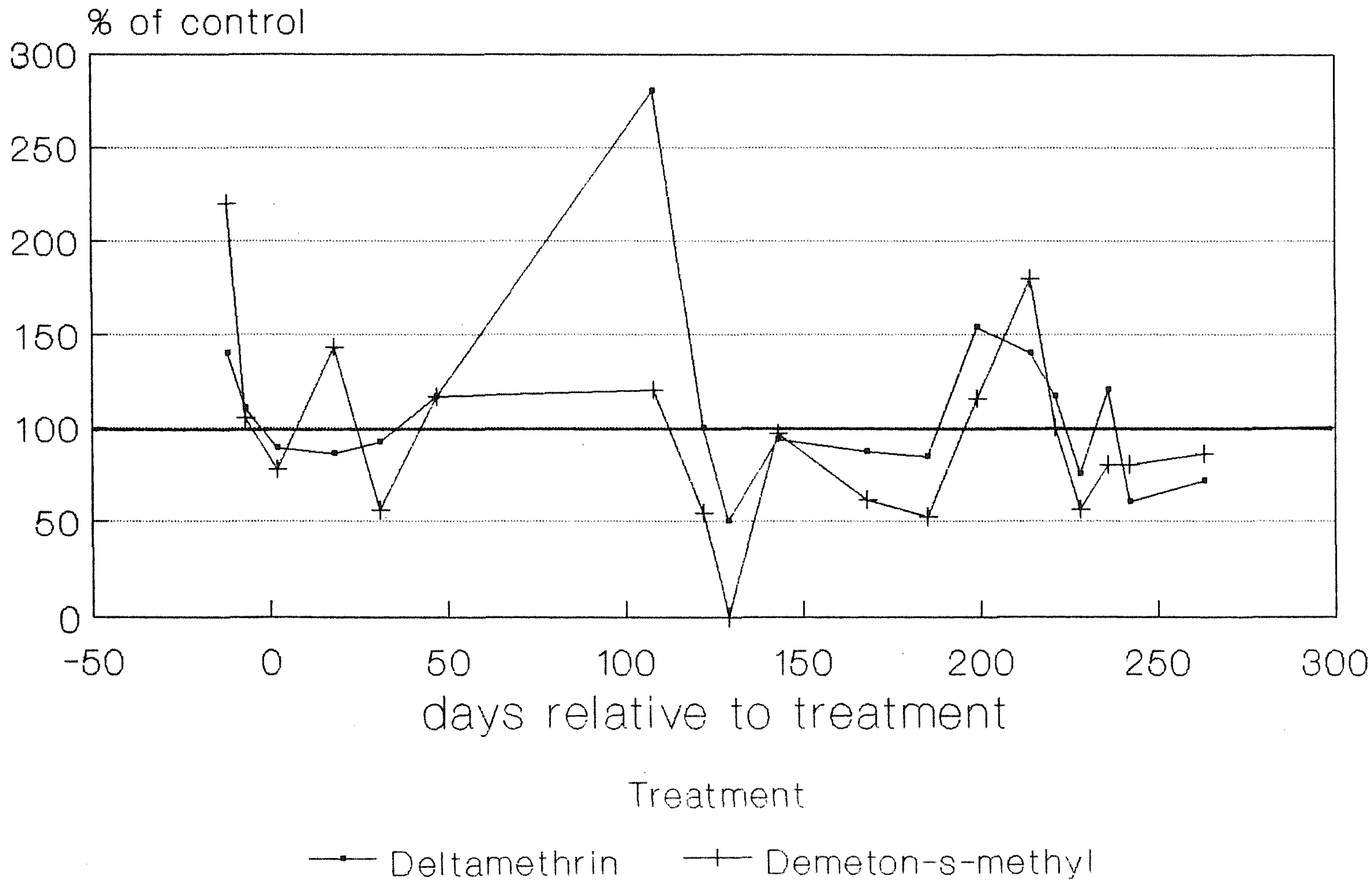


Fig. 4.14 <u>Pterostichus melanarius</u> (Illiger).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA).

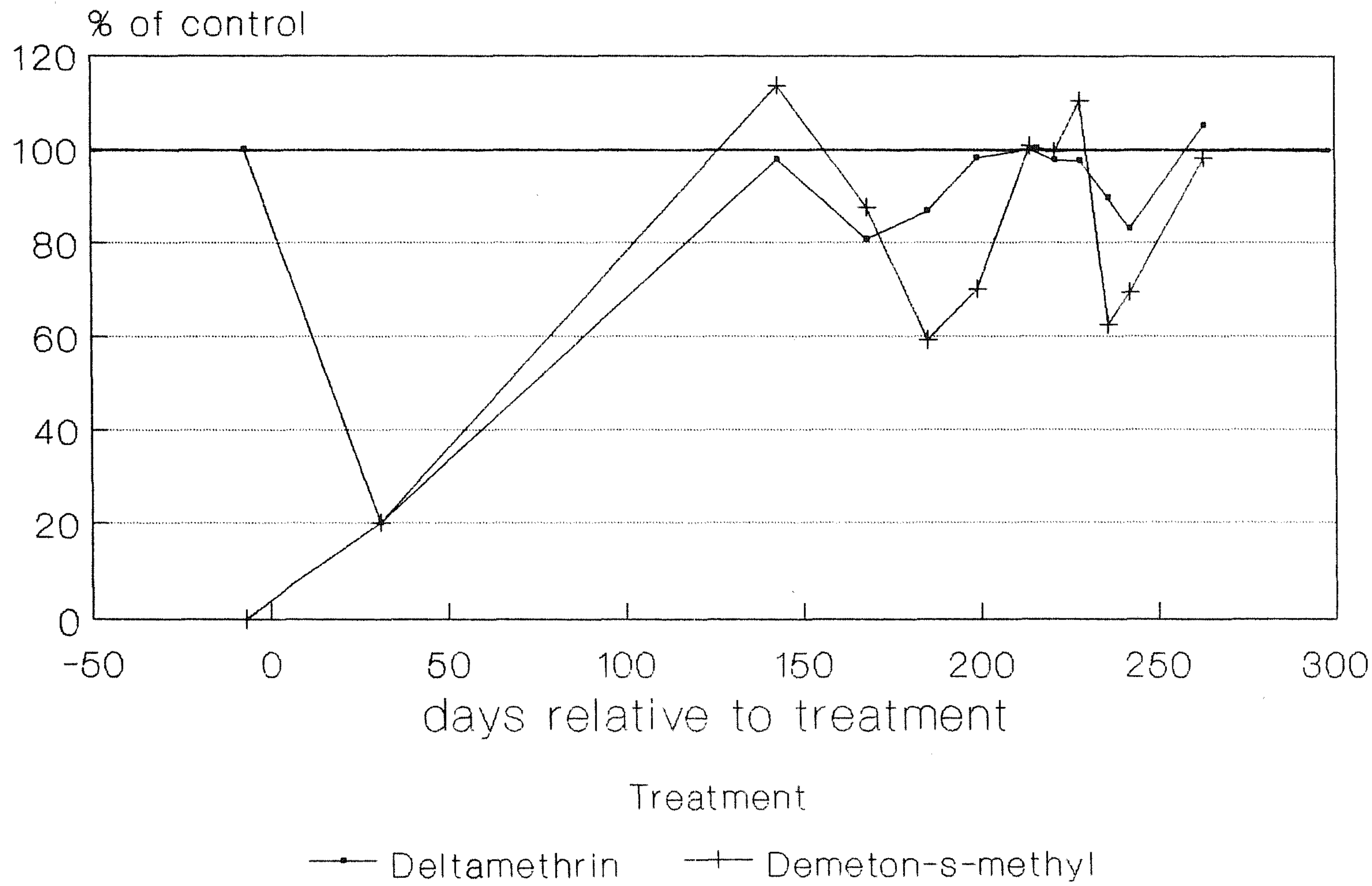


Fig. 4.15 <u>Trechus quadristriatus</u> (Schrank).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA).

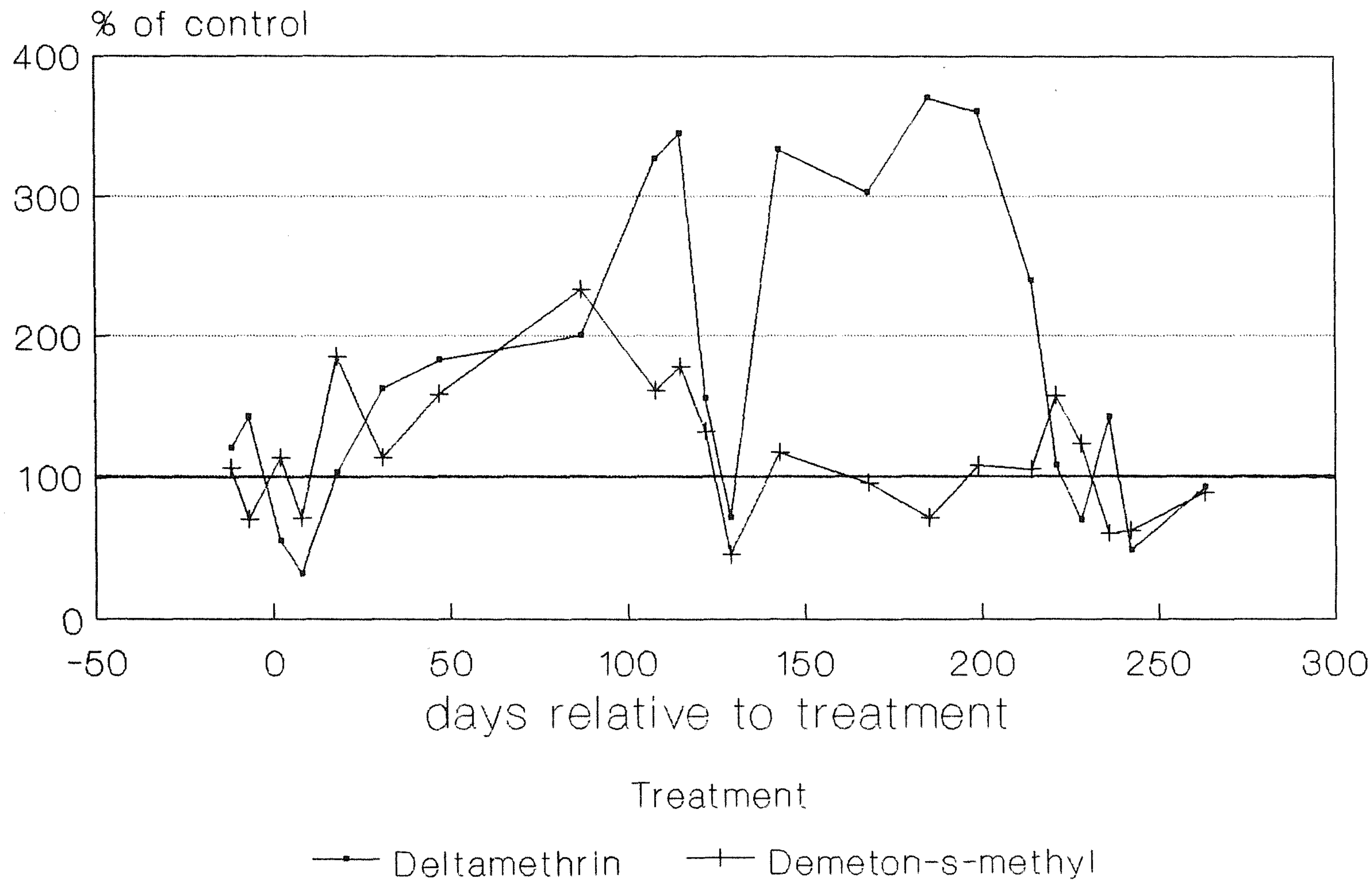


Fig. 4.16 <u>Trechus</u> <u>quadristriatus</u> (Schrank) 'k' values.
Comparison of 'k' values for plots treated with deltamethrin, DSM and unsprayed control plots.
N.B. For each sample date, points sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

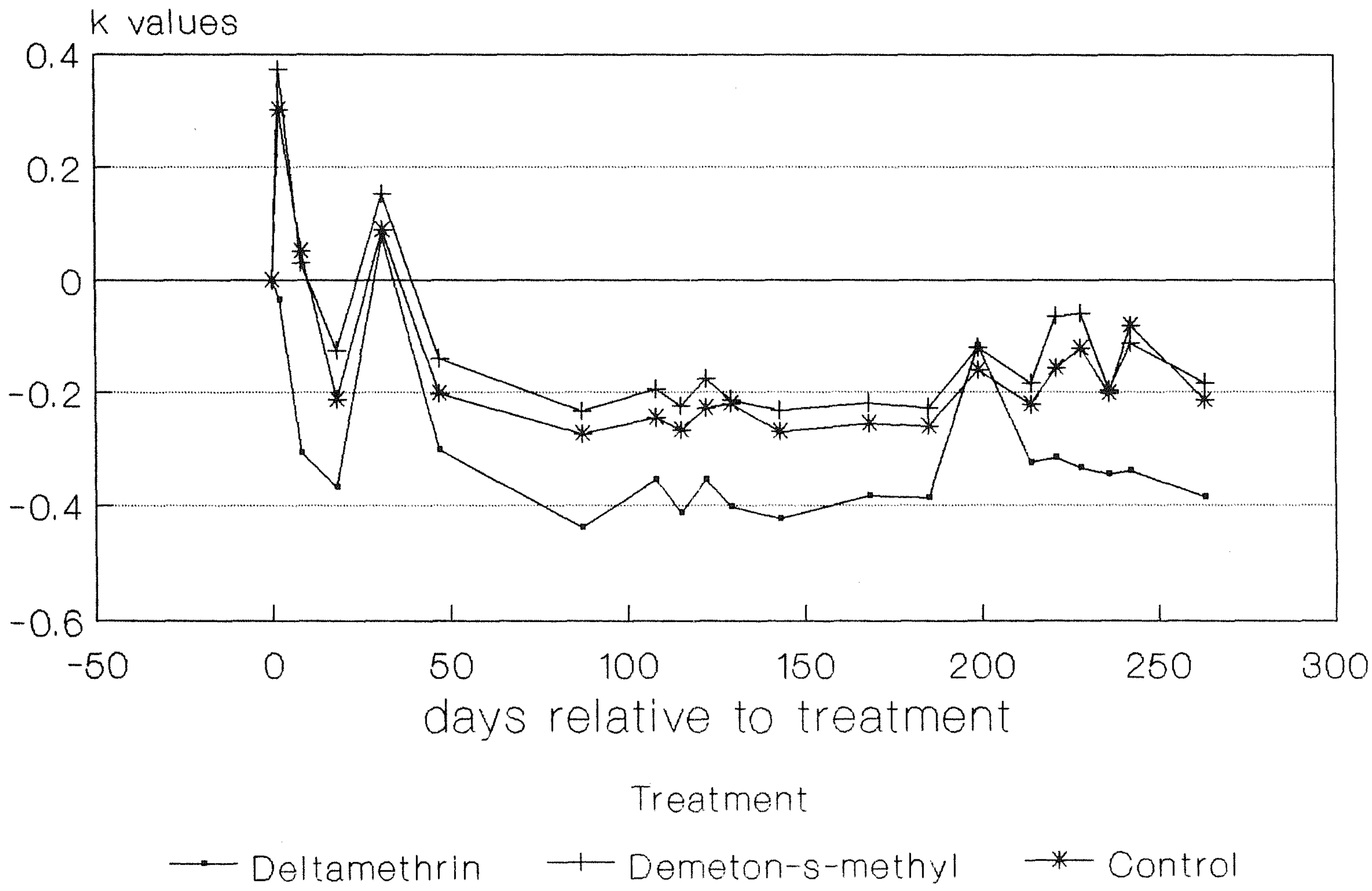


Fig. 4.17 Total adult Carabidae.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA).

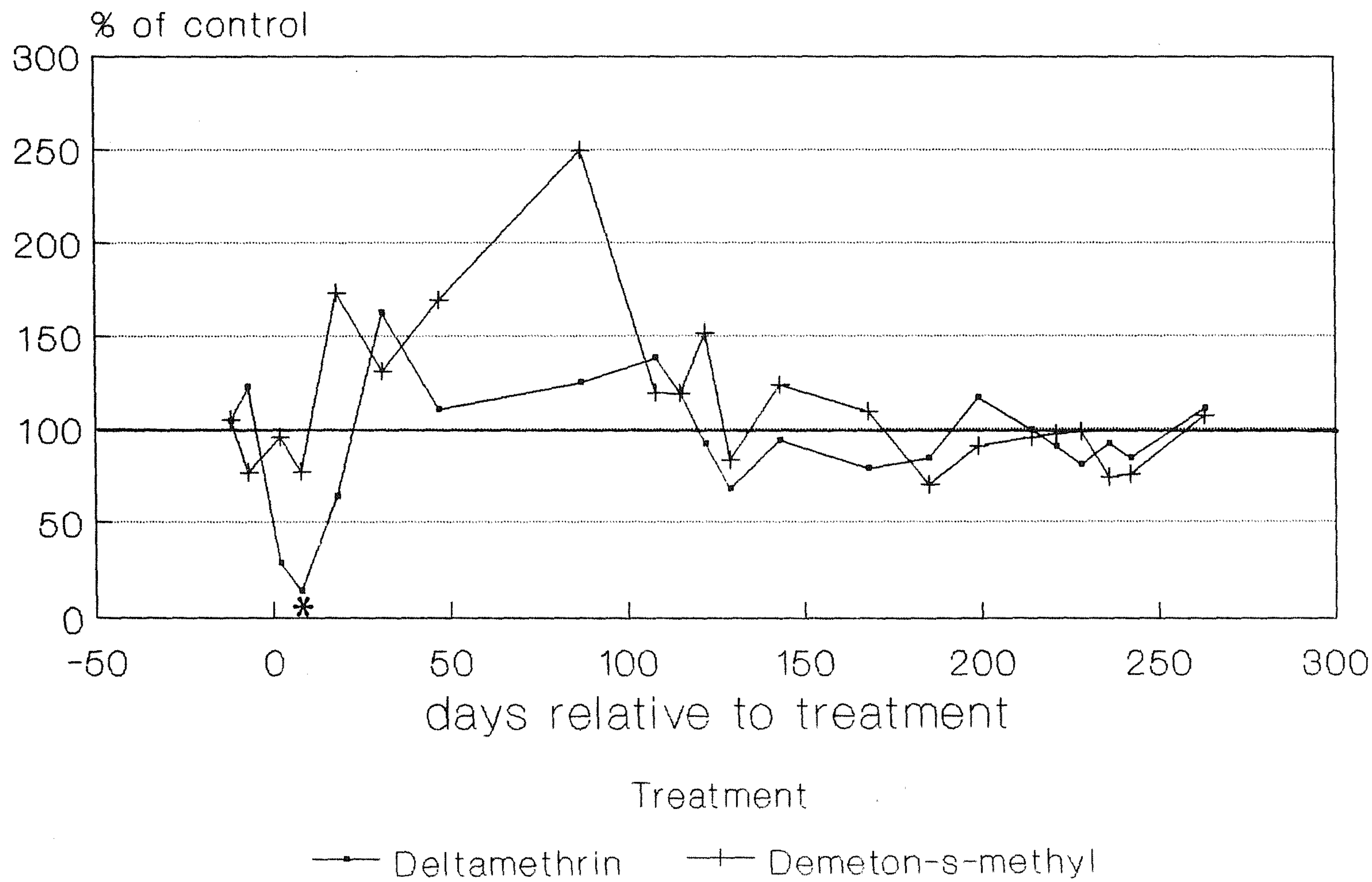


Fig. 4.18 Total adult Carabidae 'k' values.
Comparison of 'k' values for plots treated with deltamethrin, DSM and unsprayed control plots.
N.B. For each sample date, points sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

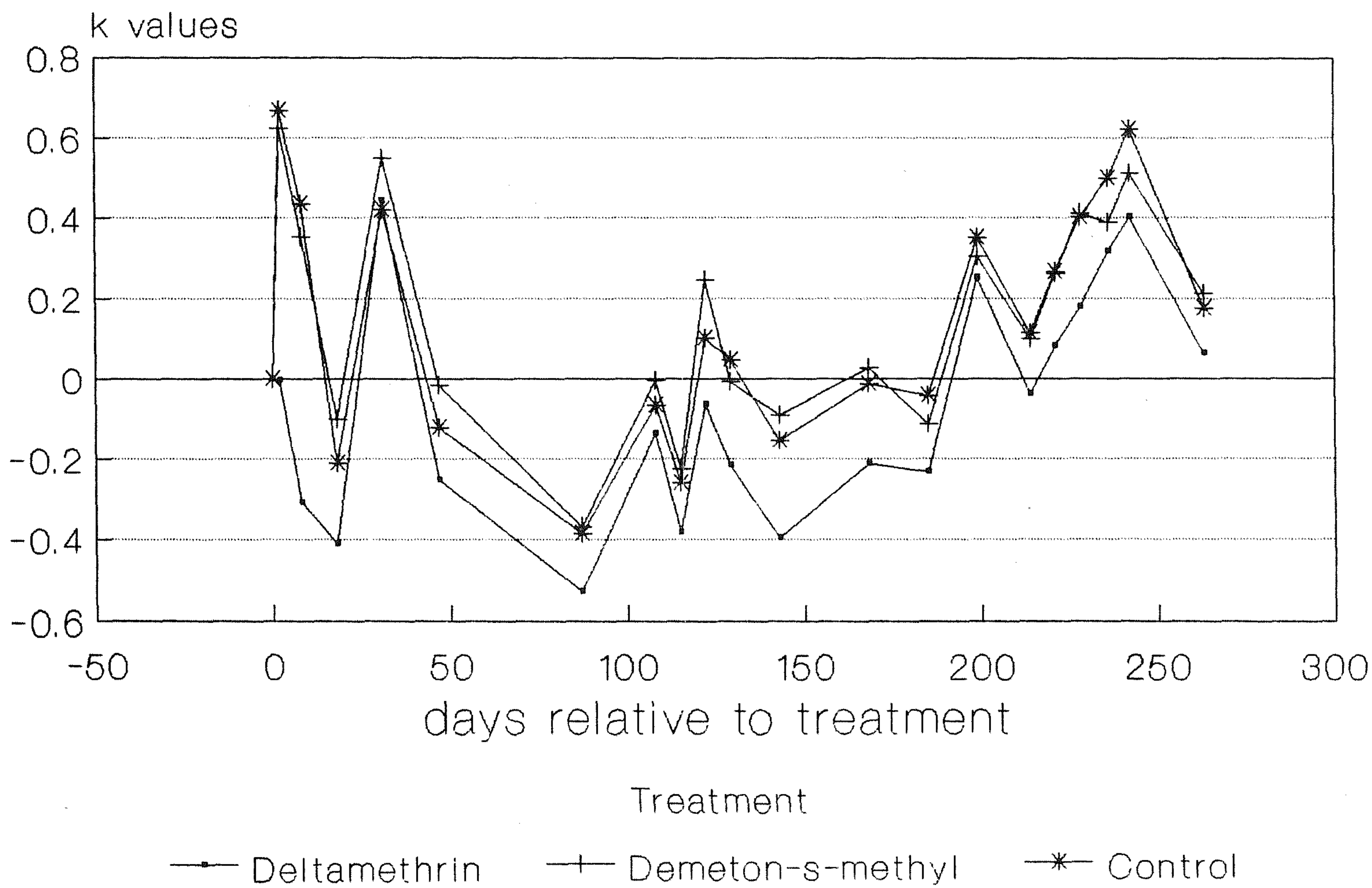


Fig. 4.19 Total carabid larvae.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

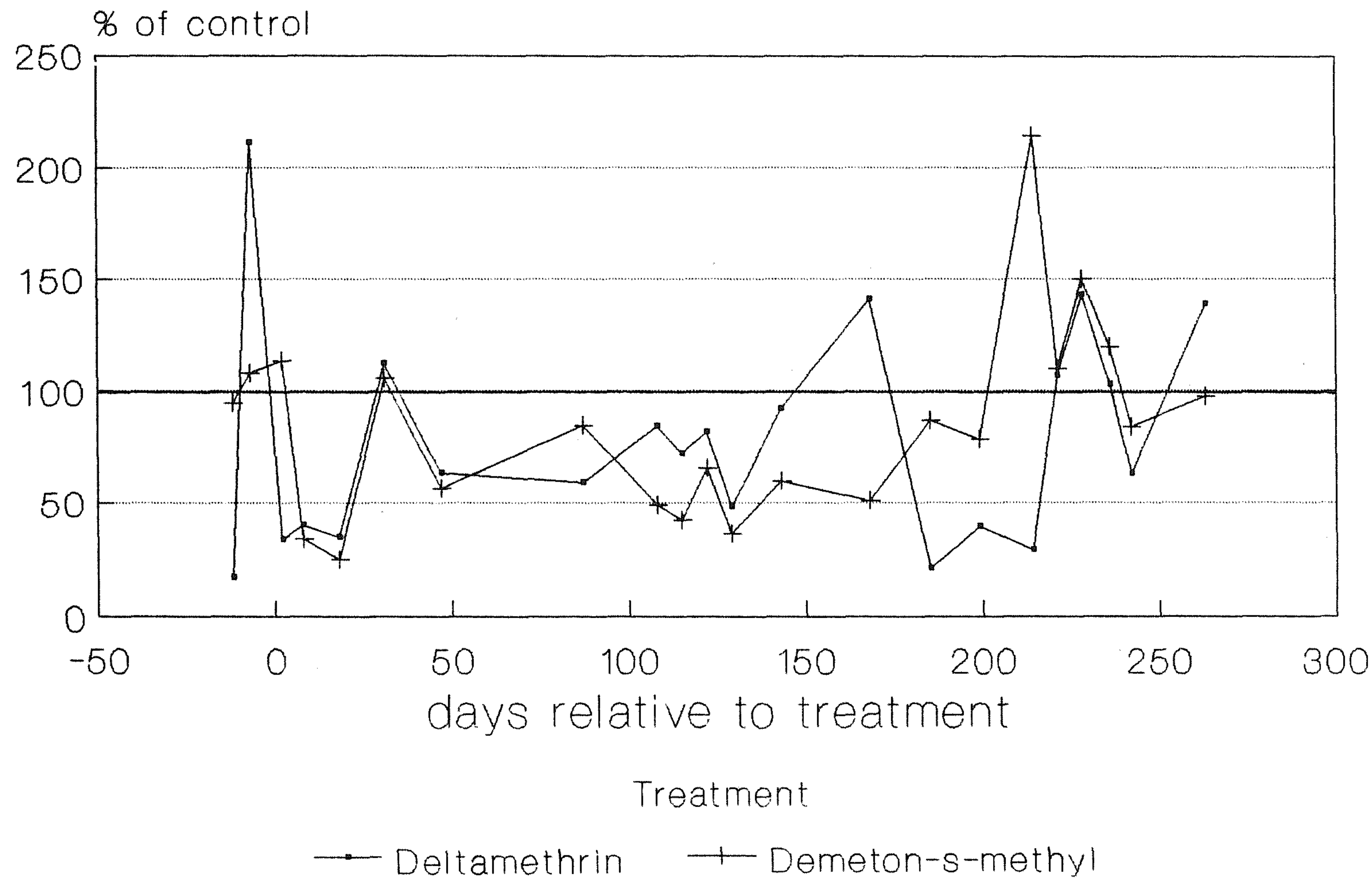


Fig. 4.20 Total adult Staphylinidae.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA).

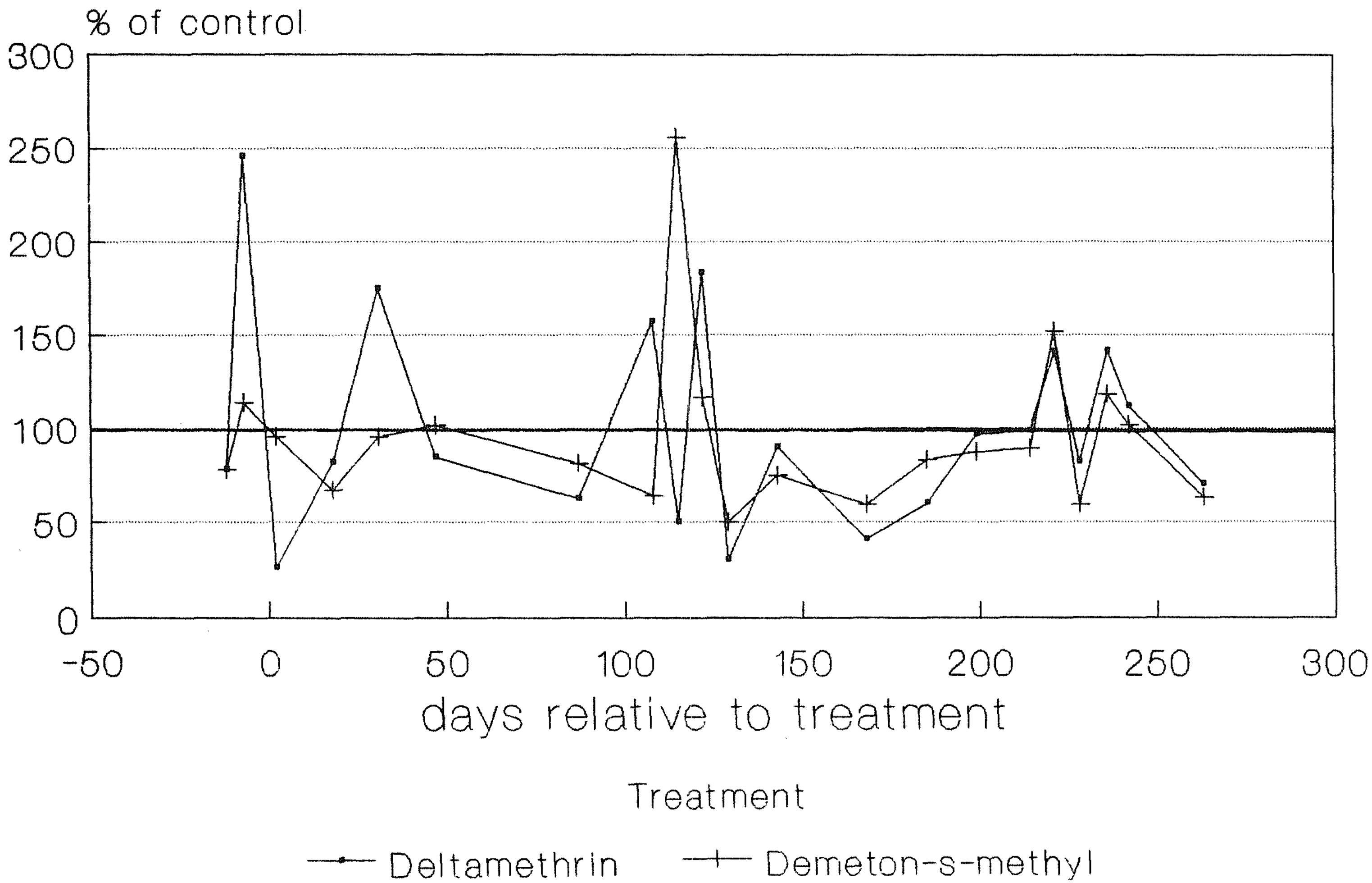


Fig. 4.21 Erigone atra (Blackwall).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

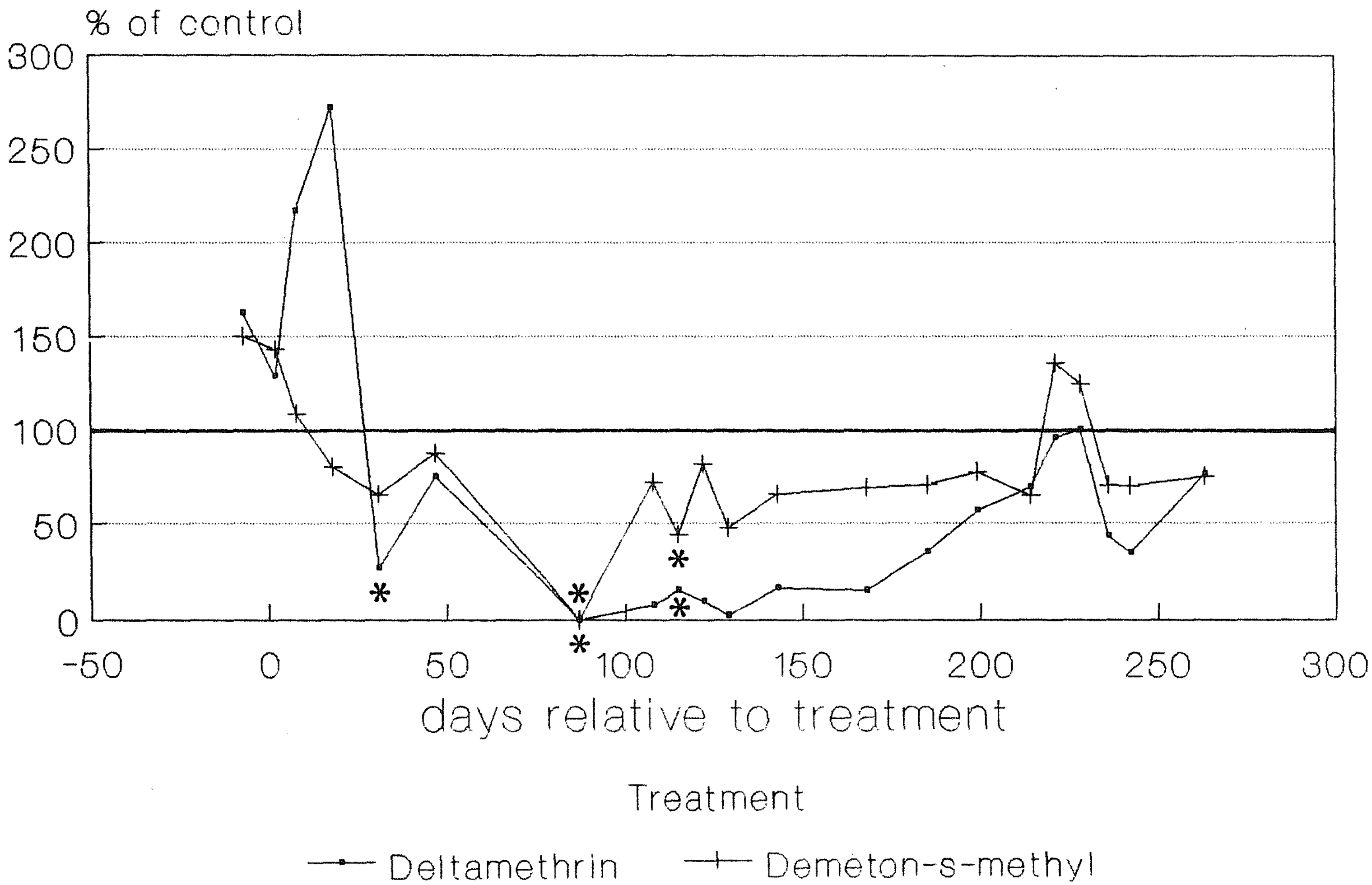


Fig. 4.22 Erigone dentipalpis (Wider).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA).

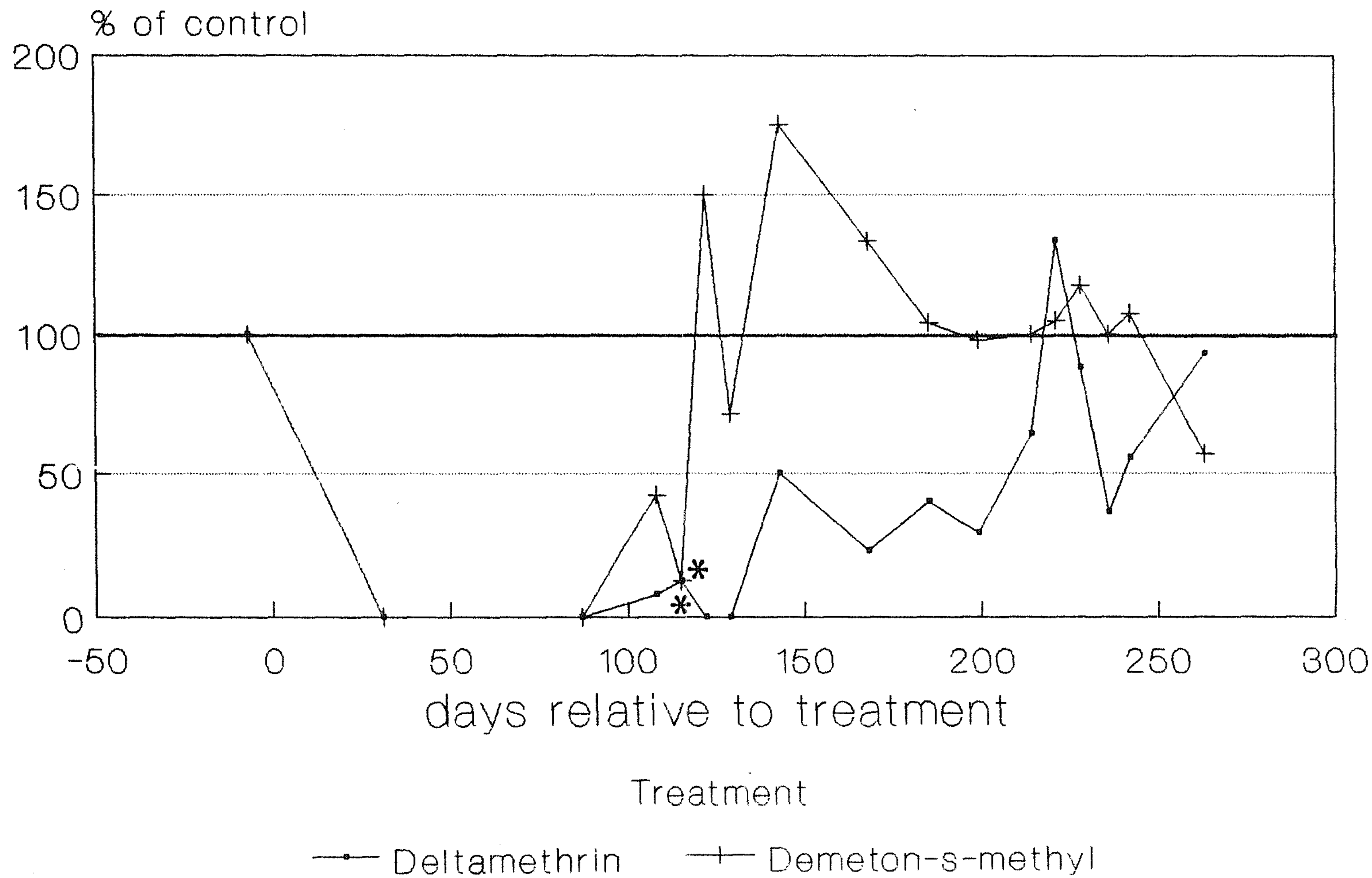


Fig. 4.23 Oedothorax spp.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

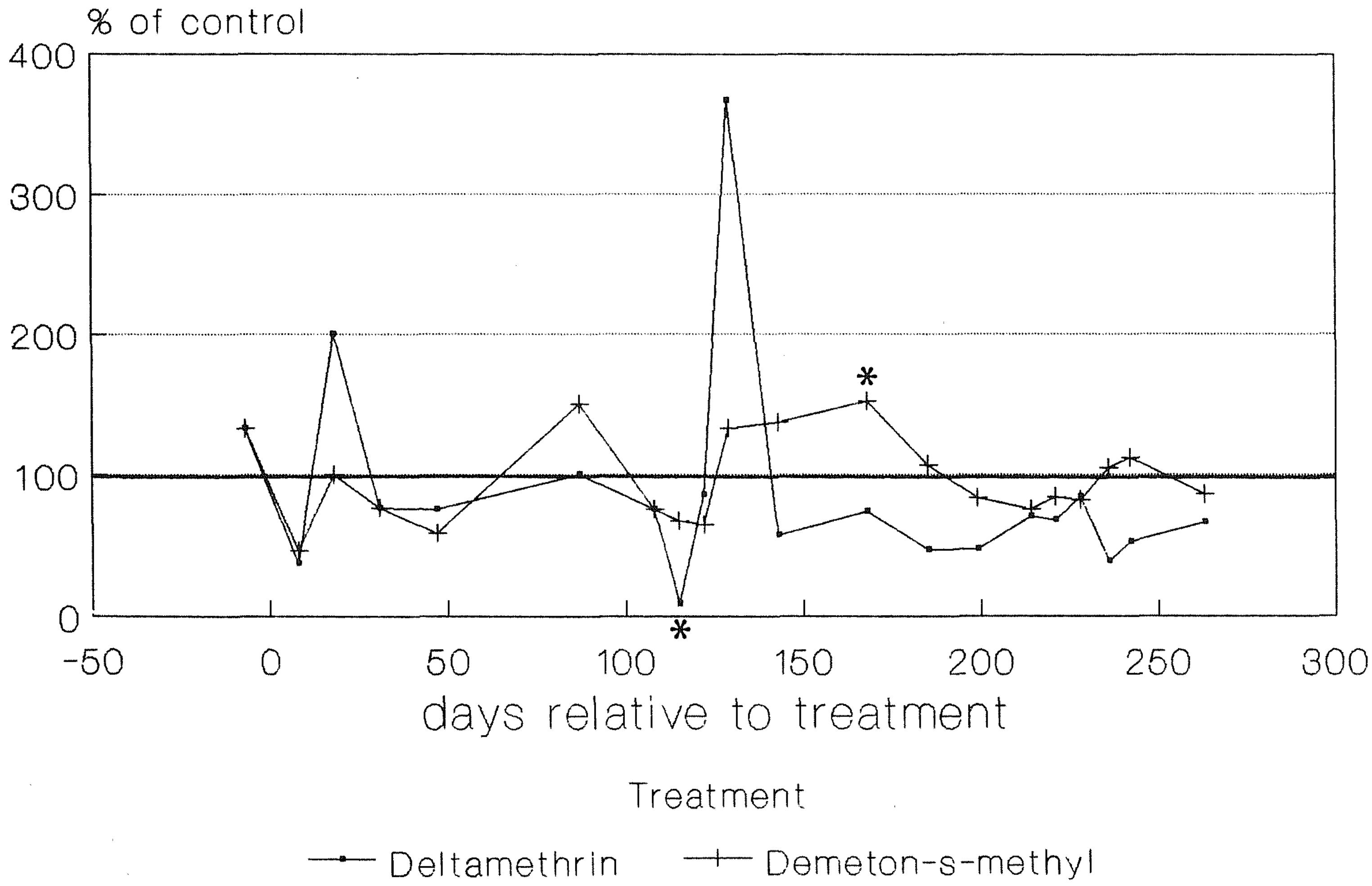


Fig. 4.24 Total Erigoninae.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA).

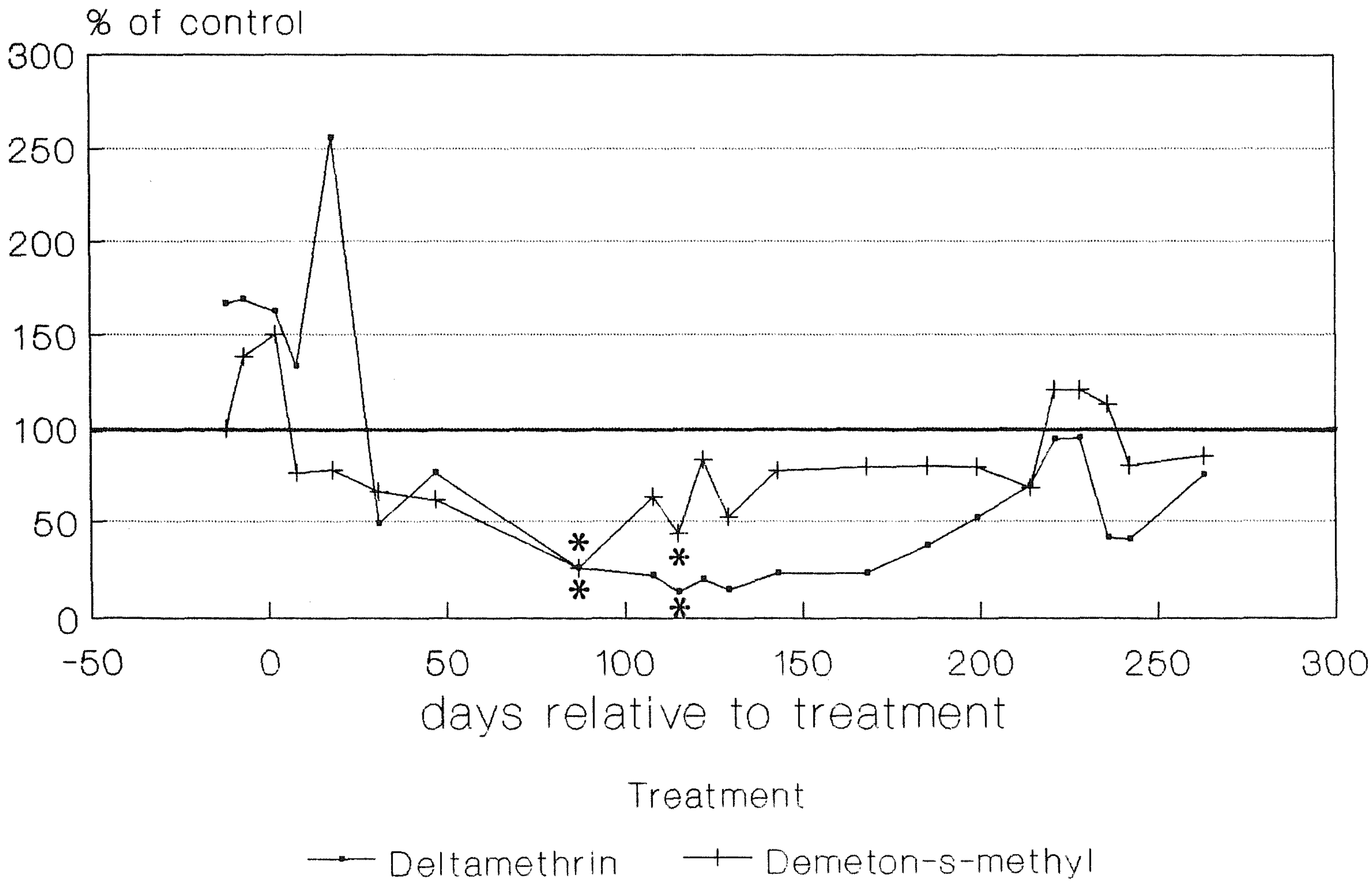


Fig. 4.25 Bathyphantes gracilis (Blackwall).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA).

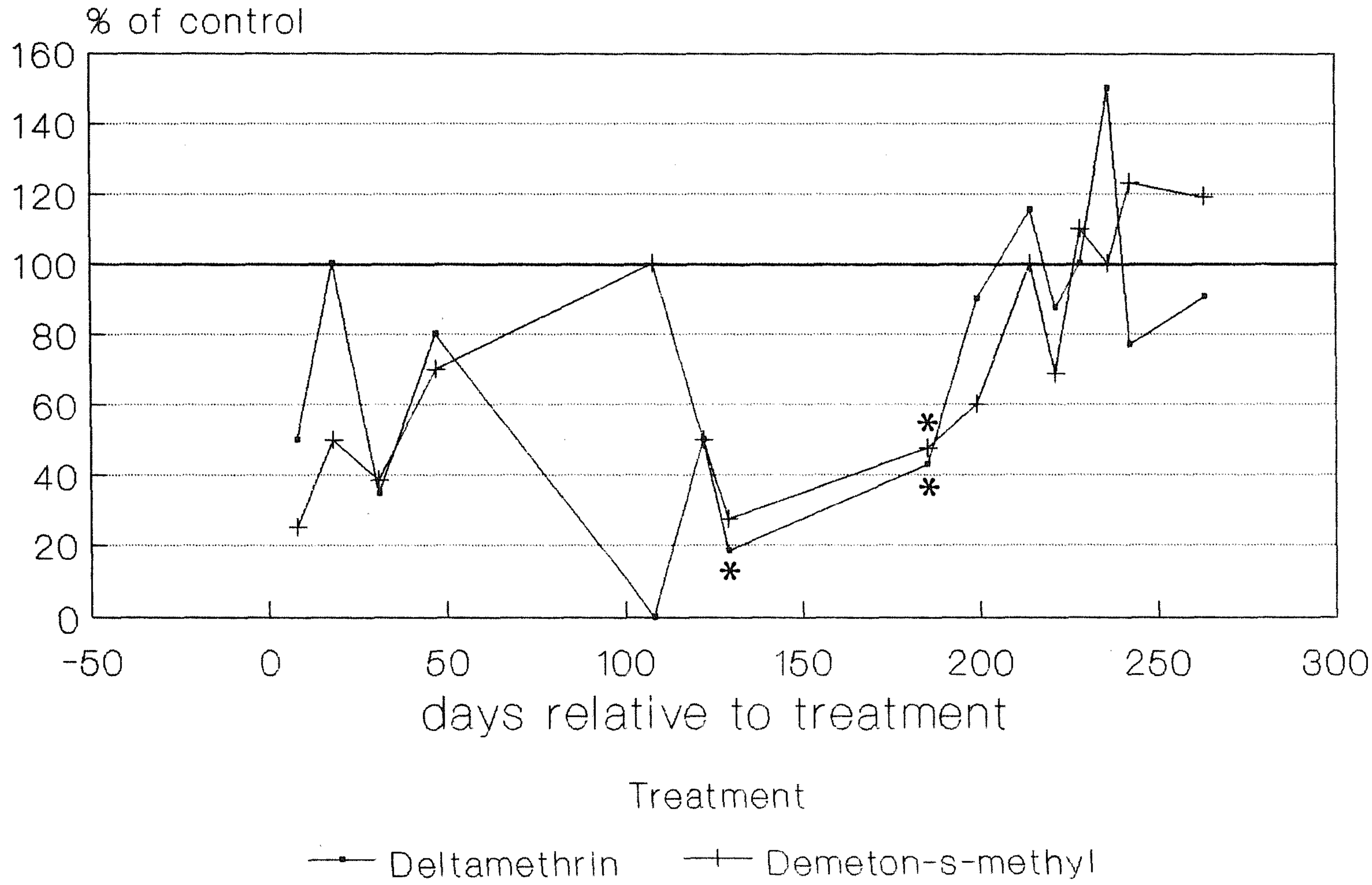


Fig. 4.26 <u>Lepthyphantes tenuis</u> (Blackwall).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

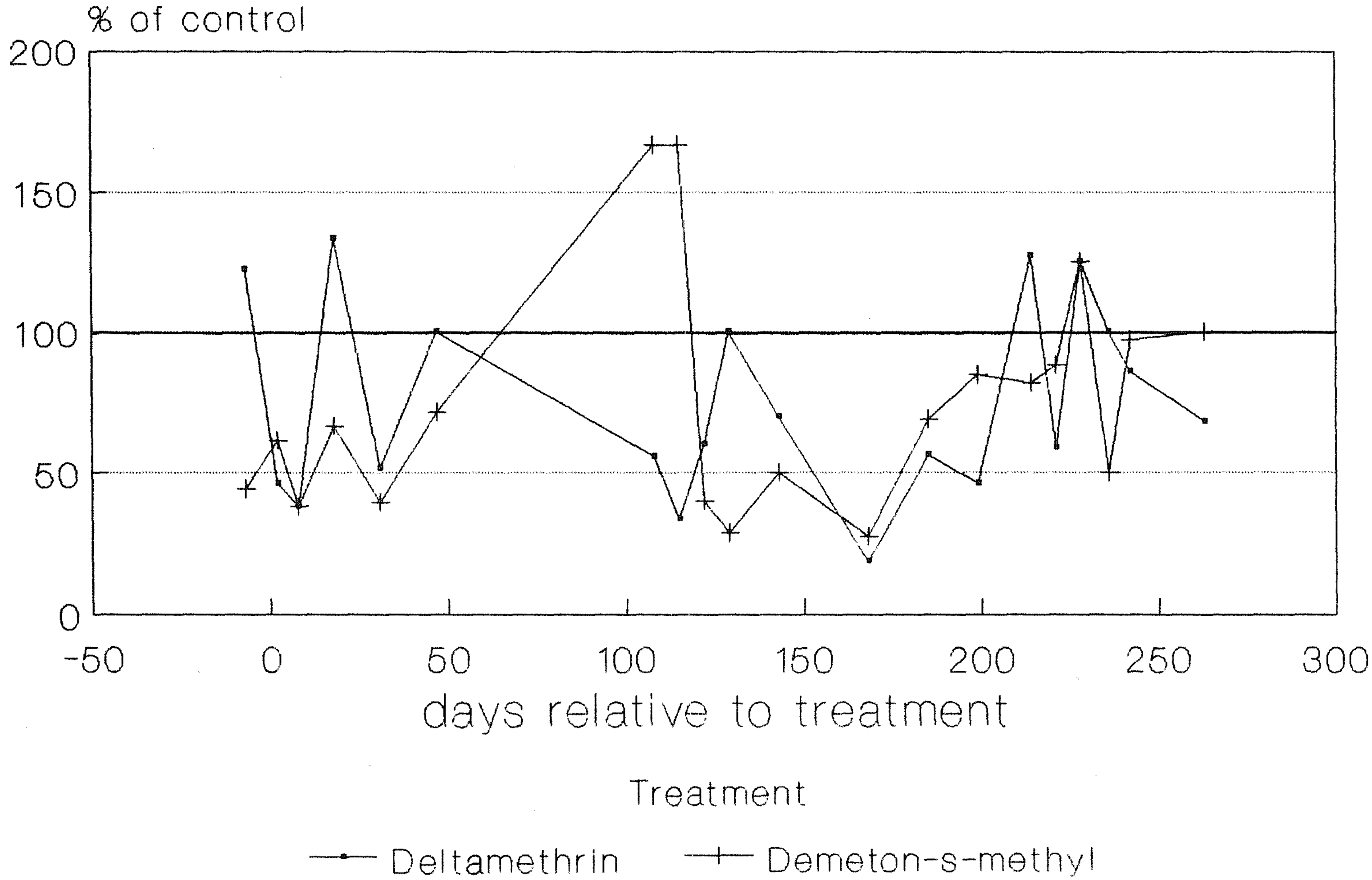


Fig. 4.27 *Meioneta rurestris* (C.L.Koch).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

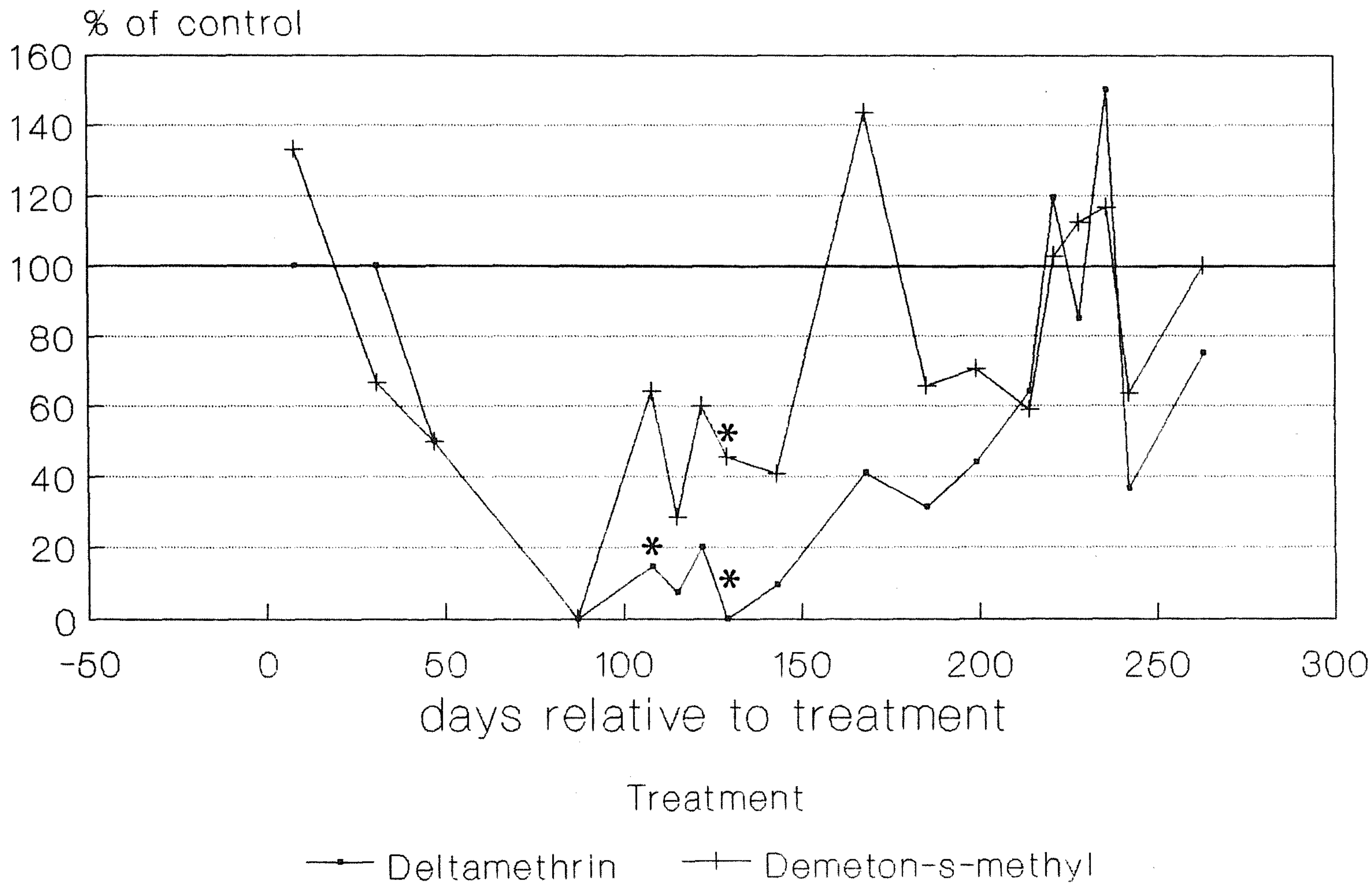


Fig. 4.28 Total Linyphiinae.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

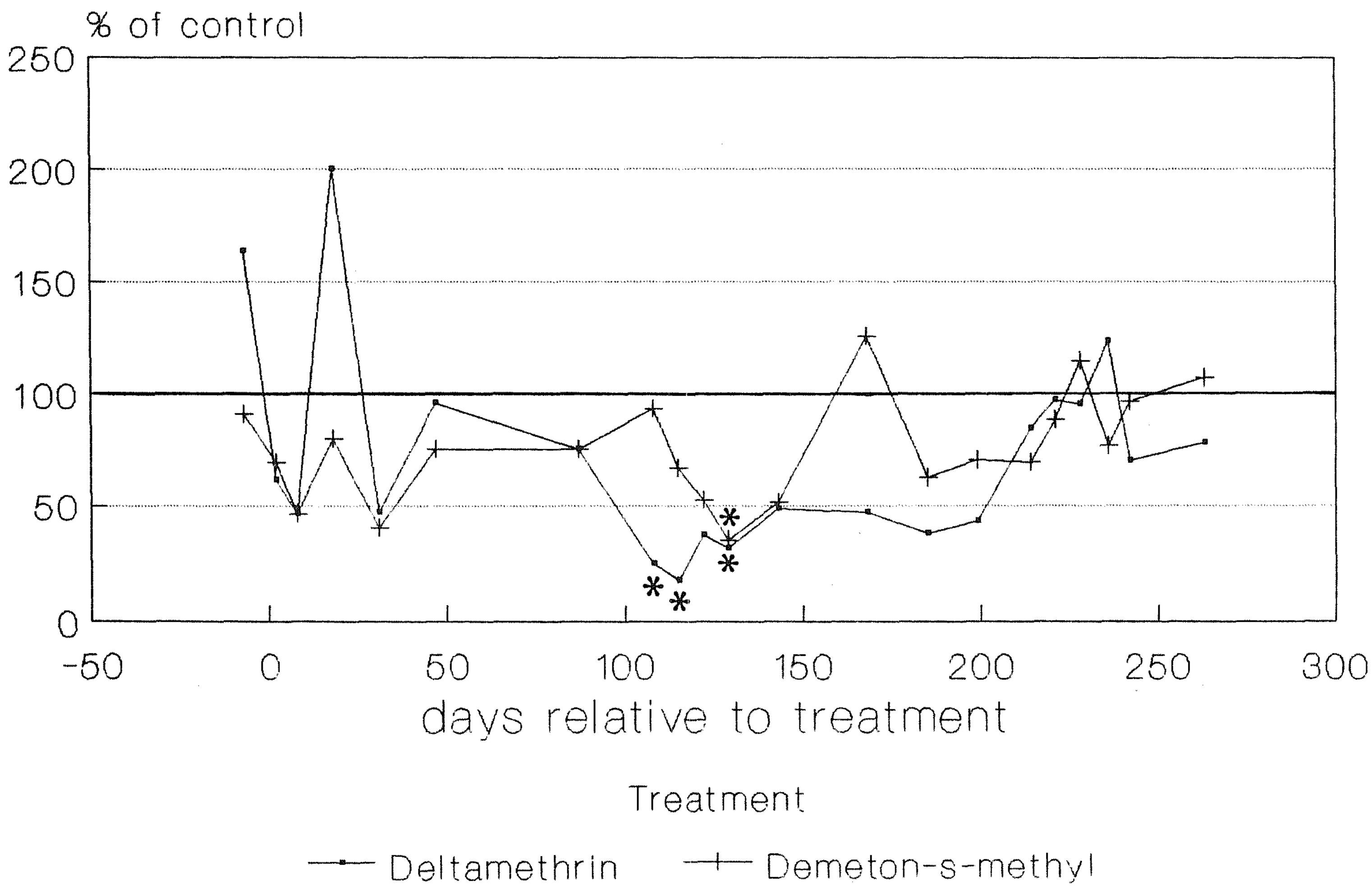


Fig. 4.29 Total Linyphiidae.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

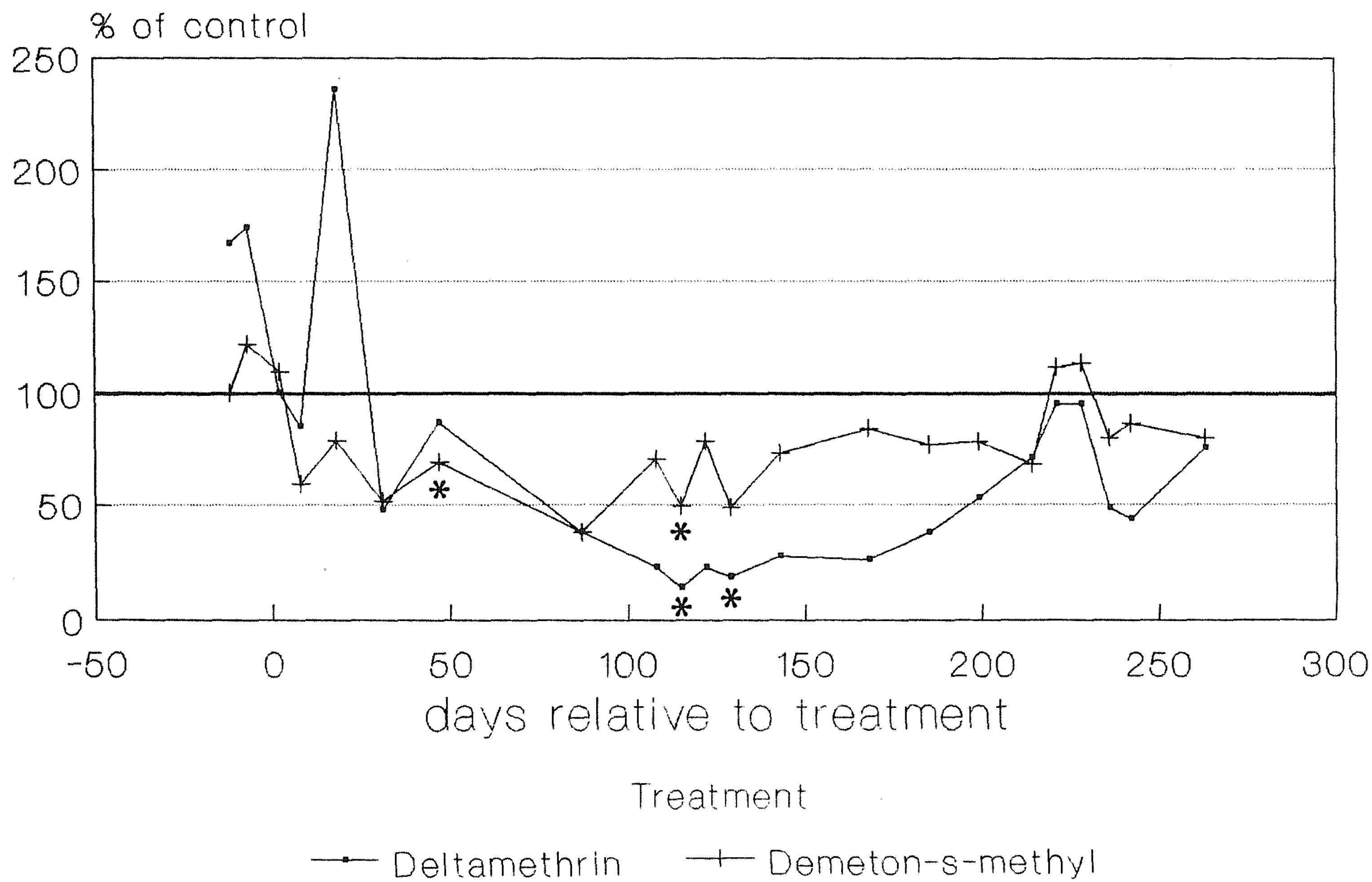


Fig. 4.30 Acari.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

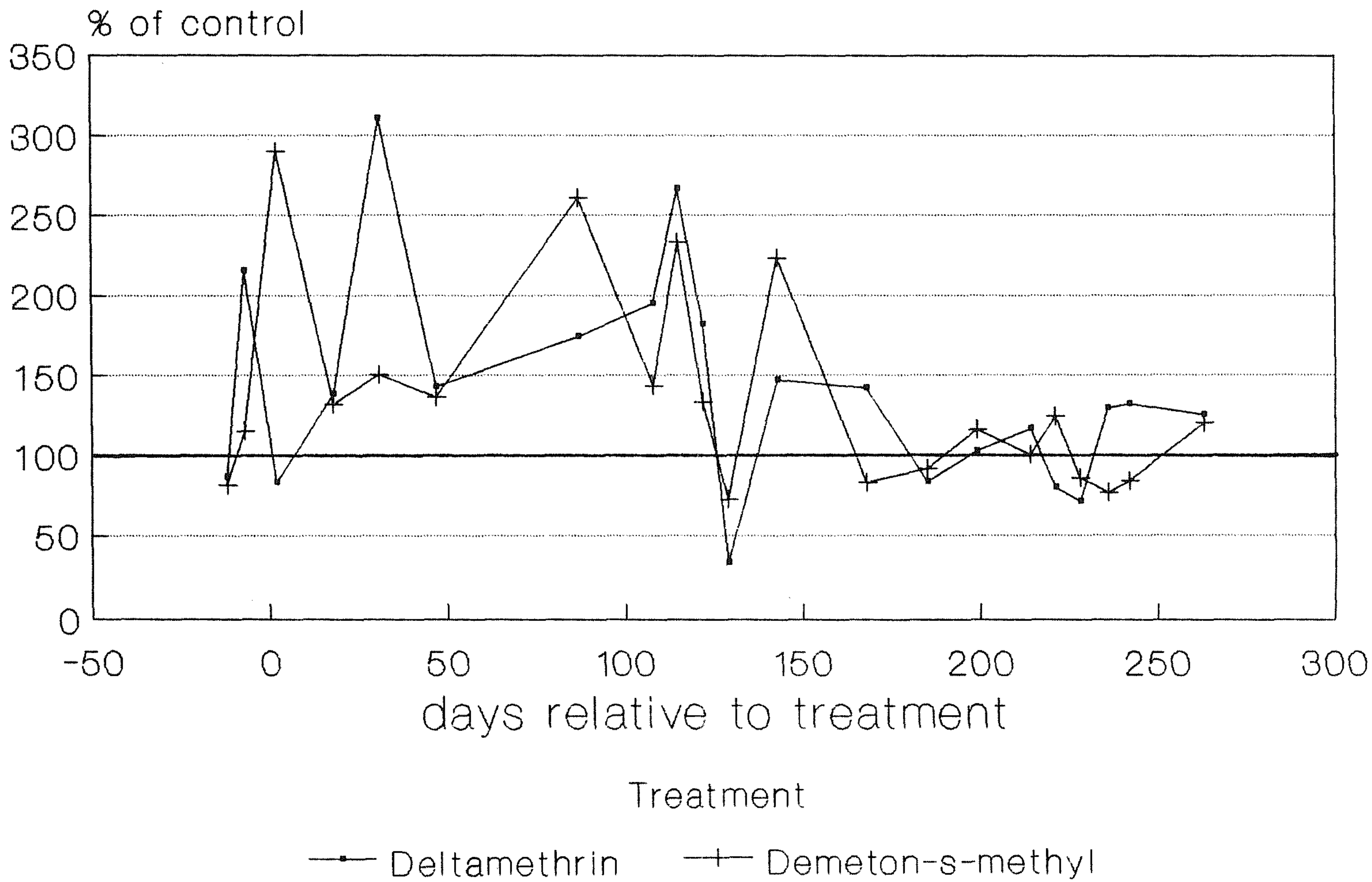


Fig. 4.31 Collembola.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals (p<0.05, ANOVA).

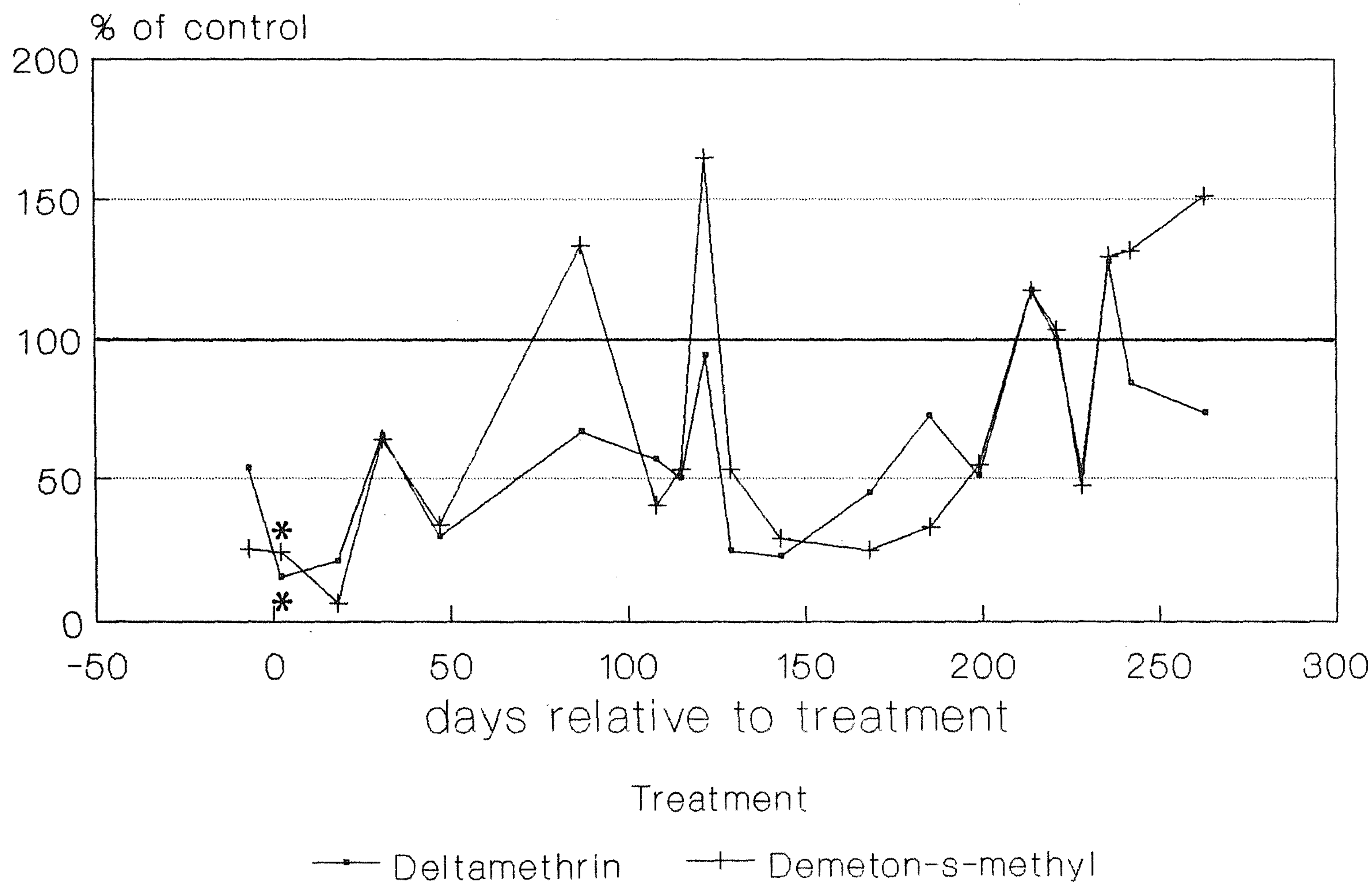


Fig. 4.32 Diptera.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. Points labelled * are significantly different from control values according to 95% confidence intervals ($p<0.05$, ANOVA).

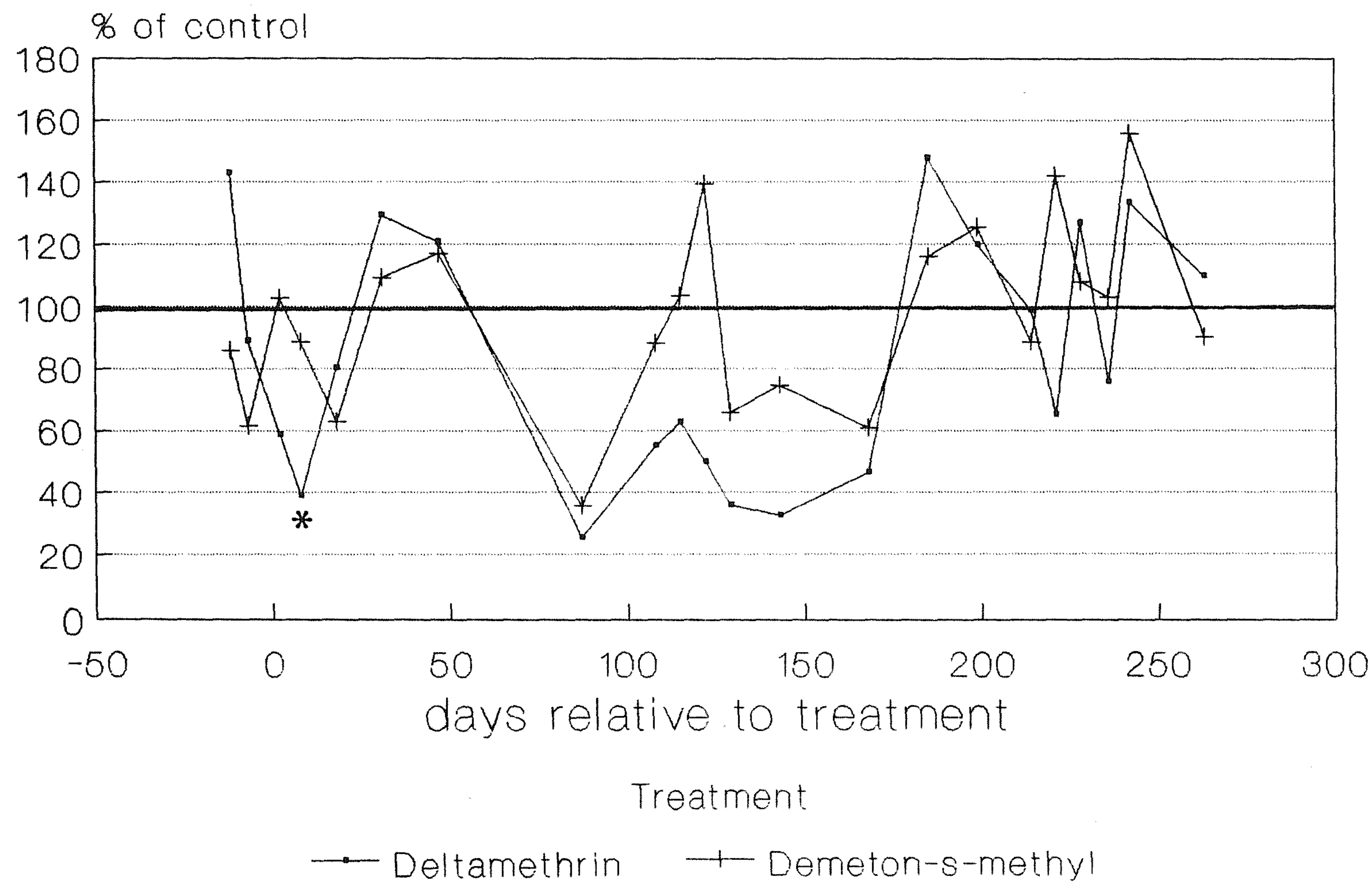


Table 4.1
Summary of pitfall trap results for the deltamethrin / DSM field trial (Deltamethrin data).

Dates on which treatment catches were significantly higher than those in control plots ($p<0.05$, ANOVA, 95% confidence intervals) are indicated with + while significantly lower catches are depicted by a - symbol. More detailed information on the relevant F-ratios and significance levels can be found in Appendix 4.

Results for sign tests were deemed to be significant where $p<0.05$.

	DAYS RELATIVE TO TREATMENT (DELTAMETHRIN)								
Species/Group	-12	-07	02	08	18	31	47	87	108
A.dorsale									
Total *Amara* spp.									
B.lampros									
B.obtusum			-	-					
B.obtusum 'k' values			-						
L.pilicornis									
N.brevicollis									
N.brev. larvae I						+			
N.brev. larvae II									
N.brev. larvae III									
N.brev. larvae I-III									
N.biguttatus									
P.melanarius									
T.quadristriatus									
T.quad 'k' values									
Total Carabidae				-					
Total Carabidae 'k'									
Total carabid larvae									
Total Staphylinidae									
E.atra						-		-	
E.dentipalpis									
Oedothorax spp.									
Total Erigoninae								-	
B.gracilis									
L.tenuis									
M.rurestris					+				-
Total Linyphiinae									-
Total Linyphiidae									
Acari									
Collembola			-						
Diptera			-						

Table 4.1 (continued).
Summary of pitfall trap results for the deltamethrin / DSM field trial (Deltamethrin data).

Dates on which treatment catches were significantly higher than those in control plots ($p<0.05$, ANOVA, 95% confidence intervals) are indicated with + while significantly lower catches are depicted by a - symbol. More detailed information on the relevant F-ratios and significance levels can be found in Appendix 4.

Results for sign tests were deemed to be significant where $p<0.05$.

	DAYS RELATIVE TO TREATMENT (DELTAMETHRIN)								
Species/Group	115	122	129	143	168	185	199	214	221
A.dorsale									
Total Amara spp.									
B.lampros									
B.obtusum									
B.obtusum 'k' values									
L.pilicornis									
N.brevicollis									
N.brev. larvae I									
N.brev. larvae II									
N.brev. larvae III									
N.brev. larvae I-III									
N.biguttatus									
P.melanarius									
T.quadristriatus									
T.quad 'k' values									
Total Carabidae									
Total Carabidae 'k'									
Total carabid larvae									
Total Staphylinidae									
E.atra	-								
E.dentipalpis	-								
Oedothorax spp.	-								
Total Erigoninae	-								
B.gracilis						-			
L.tenuis									
M.rurestris			-						
Total Linyphiinae	-								
Total Linyphiidae	-		-						
Acari									
Collembola									
Diptera									

Table 4.1 (continued).
Summary of pitfall trap results for the deltamethrin / DSM field trial (Deltamethrin data).

Dates on which treatment catches were significantly higher than those in control plots (p<0.05, ANOVA, 95% confidence intervals) are indicated with + while significantly lower catches are depicted by a - symbol. More detailed information on the relevant F-ratios and significance levels can be found in Appendix 4.

Results for sign tests were deemed to be significant where p<0.05.

	DAYS RELATIVE TO TREATMENT (DELTAMETHRIN)				
Species/Group	228	236	242	263	Sign test
A.dorsale					
Total *Amara* spp.					+
B.lampros					+
B.obtusum					-
B.obtusum 'k' values					-
L.pilicornis					
N.brevicollis					
N.brev. larvae I					
N.brev. larvae II					
N.brev. larvae III					
N.brev. larvae I-III					
N.biguttatus					
P.melanarius					
T.quadristriatus					
T.quad 'k' values					-
Total Carabidae					
Total Carabidae 'k'					-
Total carabid larvae					
Total Staphylinidae					
E.atra					-
E.dentipalpis					-
Oedothorax spp.					-
Total Erigoninae					-
B.gracilis					
L.tenuis					-
M.rurestris					-
Total Linyphiinae					-
Total Linyphiidae					-
Acari					+
Collembola					-
Diptera					

Table 4.2
Summary of pitfall trap results for the deltamethrin / DSM field trial (DSM data).

Dates on which treatment catches were significantly higher than those in control plots ($p<0.05$, ANOVA, 95% confidence intervals) are indicated with + while significantly lower catches are depicted by a - symbol. More detailed information on the relevant F-ratios and significance levels can be found in Appendix 4.

Results for sign tests were deemed to be significant where $p<0.05$.

	DAYS RELATIVE TO TREATMENT (DSM)								
Species/Group	-12	-07	02	08	18	31	47	87	108
A.dorsale									
Total *Amara* spp.									
B.lampros									
B.obtusum									
B.obtusum 'k' values									
L.pilicornis									
N.brevicollis									
N.brev. larvae I									
N.brev. larvae II									
N.brev. larvae III									
N.brev. larvae I-III									
N.biguttatus									
P.melanarius									
T.quadristriatus									
T.quad 'k' values									
Total Carabidae									
Total Carabidae 'k'									
Total carabid larvae									
Total Staphylinidae									
E.atra								-	
E.dentipalpis									
Oedothorax spp.									
Total Erigoninae								-	
B.gracilis									
L.tenuis									
M.rurestris									
Total Linyphiinae									
Total Linyphiidae							-		
Acari									
Collembola			-						
Diptera									

Table 4.2 (continued).
Summary of pitfall trap results for the deltamethrin / DSM field trial (DSM data).

Dates on which treatment catches were significantly higher than those in control plots ($p<0.05$, ANOVA, 95% confidence intervals) are indicated with + while significantly lower catches are depicted by a - symbol. More detailed information on the relevant F-ratios and significance levels can be found in Appendix 4.

Results for sign tests were deemed to be significant where $p<0.05$.

	DAYS RELATIVE TO TREATMENT (DSM)								
Species/Group	115	122	129	143	168	185	199	214	221
A.dorsale									
Total *Amara* spp.									
B.lampros									
B.obtusum									
B.obtusum 'k' values									
L.pilicornis									
N.brevicollis									
N.brev. larvae I									
N.brev. larvae II									
N.brev. larvae III									
N.brev. larvae I-III									
N.biguttatus									
P.melanarius									
T.quadristriatus									
T.quad 'k' values									
Total Carabidae									
Total Carabidae 'k'									
Total carabid larvae									
Total Staphylinidae									
E.atra	-								
E.dentipalpis	-								
Oedothorax spp.					+				
Total Erigoninae	-								
B.gracilis						-			
L.tenuis									
M.rurestris			-						
Total Linyphiinae			-						
Total Linyphiidae	-								
Acari									
Collembola									
Diptera									

Table 4.2 (continued).
Summary of pitfall trap results for the deltamethrin / DSM field trial (DSM data).

Dates on which treatment catches were significantly higher than those in control plots ($p<0.05$, ANOVA, 95% confidence intervals) are indicated with + while significantly lower catches are depicted by a - symbol. More detailed information on the relevant F-ratios and significance levels can be found in Appendix 4.

Results for sign tests were deemed to be significant where $p<0.05$.

	DAYS RELATIVE TO TREATMENT (DSM)				
Species/Group	228	236	242	263	Sign test
A.dorsale					
Total *Amara* spp.					
B.lampros					
B.obtusum					-
B.obtusum 'k' values					
L.pilicornis					
N.brevicollis					-
N.brev. larvae I					
N.brev. larvae II					
N.brev. larvae III					-
N.brev. larvae I-III					
N.biguttatus					
P.melanarius					
T.quadristriatus					
T.quad 'k' values					+
Total Carabidae					
Total Carabidae 'k'					
Total carabid larvae					
Total Staphylinidae					
E.atra					-
E.dentipalpis					
Oedothorax spp.					
Total Erigoninae					-
B.gracilis					
L.tenuis					-
M.rurestris					
Total Linyphiinae					-
Total Linyphiidae					-
Acari					
Collembola					
Diptera					

Table 4.3
D-vac data for Bembidion lampros (Herbst.).
Comparison of, log(n+1) transformed, mean number per $0.46m^2$ sample for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots (ANOVA, 95% CL).

Days +or-	Mean no. per sample, log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
209	0.3544a ± 0.0424	0.4315a ± 0.0375	0.4580a ± 0.0473	1.595	0.2089
220	0.3719a ± 0.0435	0.4128a ± 0.0386	0.4005a ± 0.0372	0.277	0.7585
227	0.5659a ± 0.0420	0.5306a ± 0.0480	0.5301a ± 0.0515	0.189	0.8284
234	0.4825a ± 0.0330	0.4646a ± 0.0393	0.4660a ± 0.0389	0.072	0.9306
241	0.4561a ± 0.0486	0.4975a ± 0.0375	0.5352a ± 0.0363	0.922	0.4016

Table 4.4
D-vac data for Trechus quadristriatus (Schrank).
Comparison of, log(n+1) transformed, mean number per $0.46m^2$ sample for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots (ANOVA, 95% CL).

Days +or-	Mean no. per sample, log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
209	0.8990a ± 0.0549	0.8358a ± 0.0405	0.8087a ± 0.0427	0.995	0.3740
220	0.8603a ± 0.0393	0.9362a ± 0.0323	0.9394a ± 0.0491	1.203	0.3053
227	0.8931a ± 0.0501	0.8081a ± 0.0550	0.9152a ± 0.0475	1.232	0.2968
234	0.8006a ± 0.0394	0.7084a ± 0.0480	0.7108a ± 0.0423	1.470	0.2356
241	0.7953a ± 0.0000	0.8437a ± 0.0000	0.9474a ± 0.0000	3.535	0.0334

N.B. For each sample date values sharing the same letter are not significantly different ($p>0.05$) according to 95% confidence intervals (ANOVA).

Table 4.5
D-vac data for total adult Carabidae.
Comparison of, log(n+1) transformed, mean number per $0.46m^2$ sample for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots (ANOVA, 95% CL).

Days +or-	Mean no. per sample, log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
209	1.1346a ± 0.0354	1.0832a ± 0.0290	1.0991a ± 0.0253	0.758	0.4715
220	1.0624a ± 0.0333	1.1528a ± 0.0216	1.1680a ± 0.0286	4.093	0.0200
227	1.1615a ± 0.0348	1.1282a ± 0.0333	1.1911a ± 0.0245	1.020	0.3650
234	1.0845a ± 0.0205	1.0480a ± 0.0290	1.0315a ± 0.0310	0.993	0.3746
241	1.0959a ± 0.0349	1.1034a ± 0.0292	1.1809a ± 0.0247	2.483	0.0894

Table 4.6
D-vac data for total adult Staphylinidae.
Comparison of, log(n+1) transformed, mean number per $0.46m^2$ sample for plots treated with deltamethrin, demeton-s-methyl (DSM) and unsprayed control plots (ANOVA, 95% CL).

Days +or-	Mean no. per sample, log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
209	0.5966a ± 0.0293	0.5766a ± 0.0352	0.6330a ± 0.0188	1.001	0.3715
220	0.6698a ± 0.0161	0.6621a ± 0.0178	0.6236a ± 0.0141	2.367	0.0998
227	0.6782a ± 0.0299	0.5993a ± 0.0347	0.6497a ± 0.0327	1.512	0.2263
234	0.6371a ± 0.0534	0.6747a ± 0.0596	0.5651a ± 0.0550	0.989	0.3763
241	0.8254a ± 0.0458	0.7381a ± 0.0439	0.8109a ± 0.0500	1.006	0.3697

N.B. For each sample date values sharing the same letter are not significantly different ($p>0.05$) according to 95% confidence intervals (ANOVA).

Table 4.7
D-vac data for total adult Linyphiidae.
Comparison of, log(n+1) transformed, mean number per $0.46m^2$ sample for plots treated with deltamethrin, demeton-s-methyl (DSM) and unsprayed control plots (ANOVA, 95% CL).

Days +or-	Mean no. per sample, log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
209	0.9044a ± 0.0226	0.7975a ± 0.0503	0.8905a ± 0.0310	2.532	0.0854
220	0.7489a ± 0.0469	0.6246a ± 0.0545	0.6858a ± 0.0665	1.208	0.3037
227	0.7738a ± 0.0532	0.7478a ± 0.0407	0.6750a ± 0.0536	1.067	0.3484
234	0.8690a ± 0.0425	0.9182a ± 0.0274	0.9753a ± 0.0420	1.966	0.1462
241	0.6670a ± 0.0228	0.7245a ± 0.0444	0.6967a ± 0.0410	0.595	0.5540

N.B. For each sample date values sharing the same letter are not significantly different (p>0.05) according to 95% confidence intervals (ANOVA).

4.3 Dissections of Trechus quadristriatus (Schrank).

4.3.1 Materials and methods.

Specimens of T.quadristriatus obtained in pitfall trap samples were stored in a 70% solution of alcohol (ethanol) for dissection at a later date. For each sample date thirty Trechus were selected at random from each plot to provide a total of ninety insects per treatment for dissection. On some occasions fewer than thirty beetles were collected from some plots and in such cases all available insects were dissected.

Beetles were pinned to a plasticine-lined petri dish, dorsal surface uppermost, and immersed in a 70% solution of alcohol. The elytra were severed at the the hinge and removed. The dorsal section of the abdominal integument was then cut away to expose the alimentary canal and reproductive organs.

Where contents were present crops examined invariably contained an orange-brown flocculant liquid with no solid fragments thus preventing the identification of prey by microscopic examination. In all of the specimens which were examined the crop was either totally devoid of contents or occupied approximately 25% of the total volume of the abdominal cavity. For the purposes of this study the condition of the crop was simply classed as being either empty or full depending on which of the two conditions described above was applicable. Values were determined for the percentage of Trechus in each plot which possessed full crops.

The sex of specimens was readily determined by the presence of a pair of ovaries in females or of a prominent sickle-shaped intromittant organ in the case of the male. In T.quadristriatus each ovary consists of eight polytrophic ovarioles. A record was made of the gender of each dissected beetle in order that the proportions of males and females could be determined on each of the sample dates.

Three distinct stages of ovarian development could be detected in the dissected females. These were similar to the categories described by Gilbert (1956) for members of the genus Calathus. The three stages were as described below:-

I - Immature ovaries - In this condition the ovarioles appear as thread-like opaque white structures with no apparent internal differentiation and no follicular relics.

II - Mature ovaries - Ovarioles and/or oviducts contain mature oval cream-coloured eggs approximately 0.6mm in length. In some case the presence of follicular relics or corpora lutea indicated that the female had already deposited eggs.

III - Spent ovaries - Some females possessed ovaries in which the ovarioles had degenerated following the completion of egg production. In such cases the ovarioles appeared as withered translucent grey structures with well defined follicular relics at the base. It was noticeable that the fat bodies in such individuals were invariably reduced in volume and frequently discoloured by the presence of accumulated urates. Such deposits often occur in older insects and may be used as an indication of relative age (Richards and Davies, 1977).

4.3.2 Results.

For each sample date, data relating to the percentage of T.quadristriatus with full crops was transformed to $(n+0.5)^{\frac{1}{2}}$ prior to the application of a series of one-way analyses of variance and multiple range tests by 95% confidence intervals. The values obtained for the percentage of Trechus with full crops are plotted against days relative to treatment in Fig. 4.33.

The values indicating the percentage of *Trechus* which were female were arc-sine transformed prior to the application of a series of one-way ANOVAs and multiple range tests by 95% confidence intervals. Data for female *T.quadristriatus* as a percentage of the population is shown plotted against days relative to treatment in Fig. 4.34.

Data on the percentage of females with mature eggs were subjected to an arc-sine transformation prior to the application of analyses of variance and multiple range tests by 95% confidence intervals. The detransformed percentage values are shown plotted against days relative to treatment in Fig. 4.35.

Values for the number of mature eggs per female were transformed to $(n+0.5)^{\frac{1}{2}}$ before the application of a separate analysis of variance and multiple range tests by 95% confidence intervals for each sample date. The data obtained for the mean number of eggs per female are plotted against the number of days relative to treatment in Fig. 4.36.

On the first two collection dates after spray application, both insecticide treatments resulted in samples of *Trechus* in which a higher proportion of dissected insects possessed full crops (Fig. 4.33). In both cases the difference in values on day 2 was approximately 4% while on day 8 it was about 7% in the case of the deltamethrin plots and the region of 3% for specimens collected in the areas which had been treated with demeton-S-methyl. The limited degree of replication within the experimental design again meant that these values could not be separated statistically ($p>0.05$). After day 8 no consistent, treatment related, trends could be detected in the proportion of *T.quadristriatus* with full crops.

In the period immediately after spray application there were no obvious differences in the sex ratios of *T.quadristriatus* within the different treatment blocks. In samples collected during the winter there appeared to be a higher proportion of females in the plots which had been treated with deltamethrin than in those belonging to either of the other two treatments. The proportion of females in samples collected from the deltamethrin treated plots on 04-12-86 (day 31) was approximately 11% higher than in the control plots. On 19-02-87 (day 108) the difference was approaching 30% and on day 122 it was approximately 8%. Given the passive nature of pitfall sampling this tends to suggest that females in the deltamethrin plots were exhibiting higher than normal levels of activity during the winter months. However, the limited degree of replication available meant that this apparent effect could not be confirmed statistically ($P>0.05$).

As with the dissection data obtained by Mitchell (1963), mature eggs were found to be present in the ovaries of T.quadristriatus from the autumn through to the following spring. It is widely acknowledged that T.quadristriatus is primarily an autumn breeder with an overwintering larval stage. However, the resurgence both in the proportion of females with mature eggs and in the mean number of eggs per female, observed during March, confirms Mitchell's assertion that some overwintered adults also breed during the spring.

Very few of the dissected beetles fell within category III for ovarian state. The sample size for females with spent ovaries was too small to permit statistical analysis. However, it was noticeable that while no such females were observed in post-treatment samples from deltamethrin plots they continued to be periodically detected in the DSM and control areas.

Females collected from control plots on day 2 exhibited an increase in the proportion with mature eggs relative to the values observed on 27-10-86 (day -7). During the same period decrease were detected in the values obtained for insects from the areas treated with deltamethrin and DSM.

In the deltamethrin plots the mean value for the percentage of females with mature eggs decreased from approximately 49% to 31% while a net increase was observed in the control samples from 54% to almost 69%. The values could not be distinguished statistically ($p>0.05$) but it is important to note that this was the only occasion on which the values from all three treatments did not either increase or decrease in unison.

Simultaneously there was an abrupt decrease in the mean number of eggs per female within the plots treated with deltamethrin (Fig. 4.36). As with the data relating to changes in the percentage of females with mature ovaries it was not possible to separate the points statistically ($p>0.05$).

Fig. 4.33 % of <u>Trechus quadristriatus</u> (Schrank) with full crops.
N.B. For individual sample dates, points labelled with different letters are significantly different ($p<0.05$). No letters have been assigned on occasions when values could not be separated by statistical means (ANOVA).

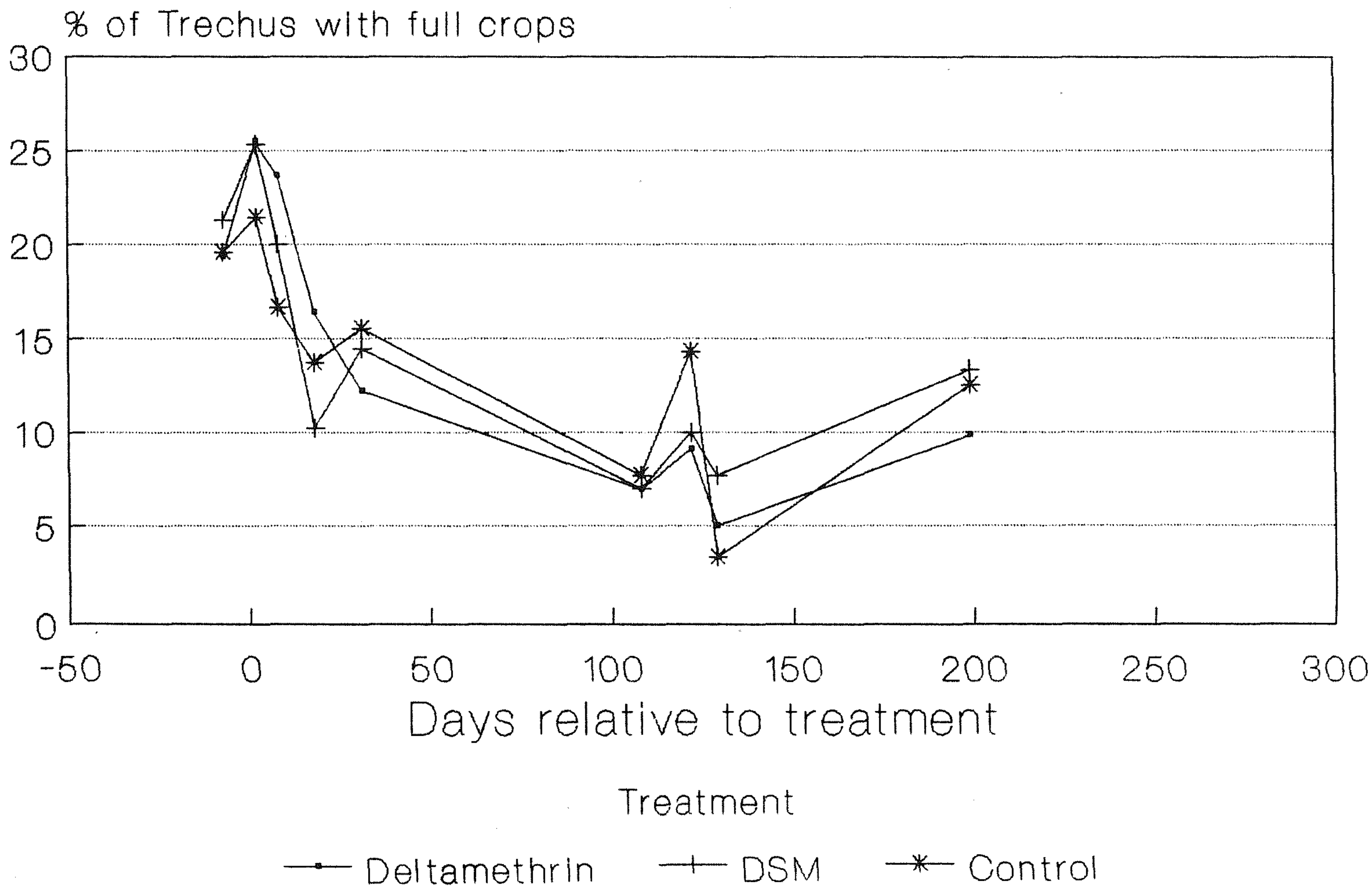


Fig. 4.34 Females as a % of total Trechus quadristriatus (Schrank).
N.B. For individual sample dates, points labelled with different letters are significantly different ($p<0.05$). No letters have been assigned on occasions when values could not be separated by statistical means (ANOVA).

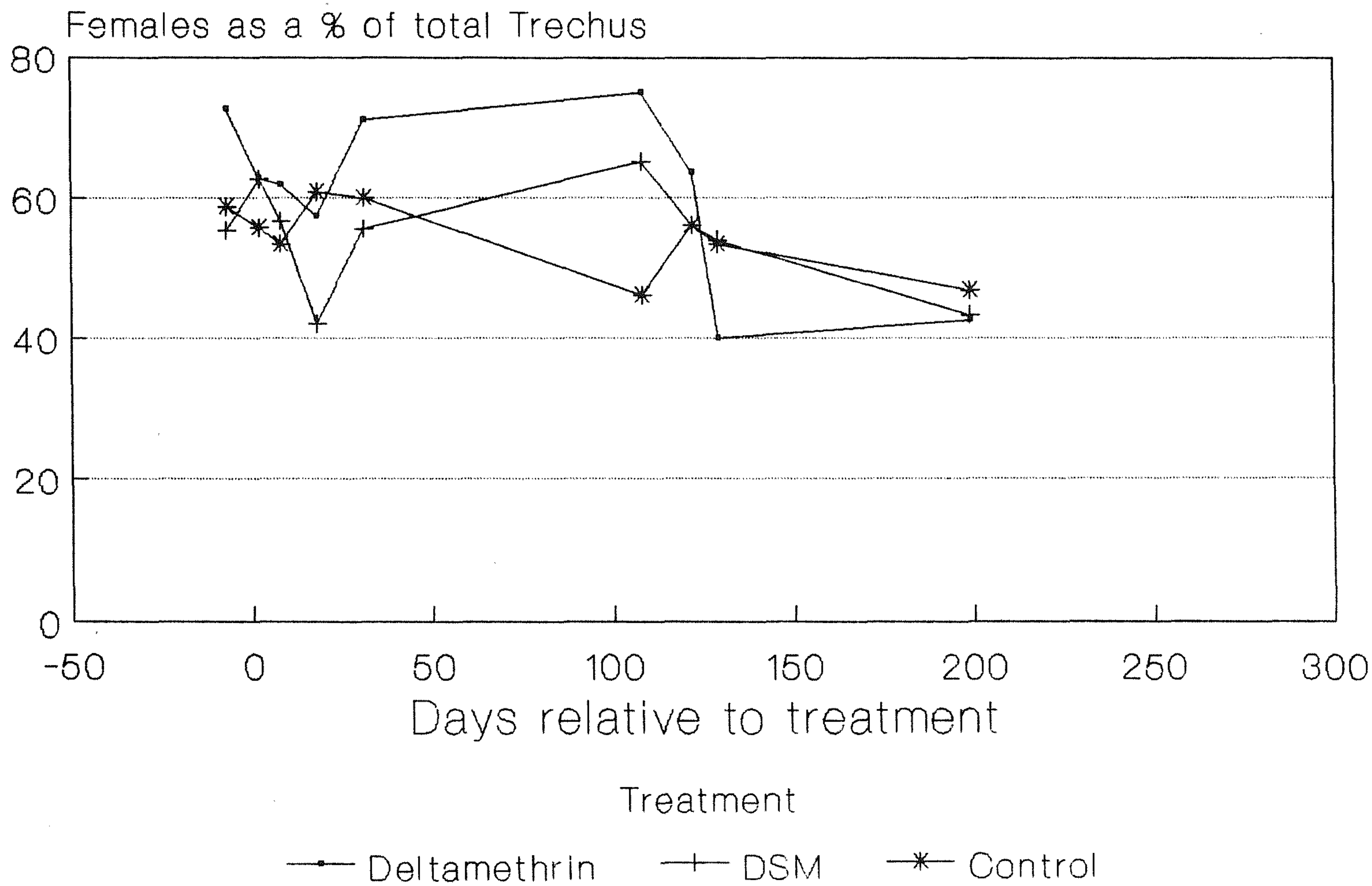


Fig. 4.35 % of female Trechus quadristriatus (Schr.) with mature eggs. N.B. For individual sample dates, points labelled with different letters are significantly different (P<0.05). No letters have been assigned on occasions when values could not be separated by statistical means (ANOVA).

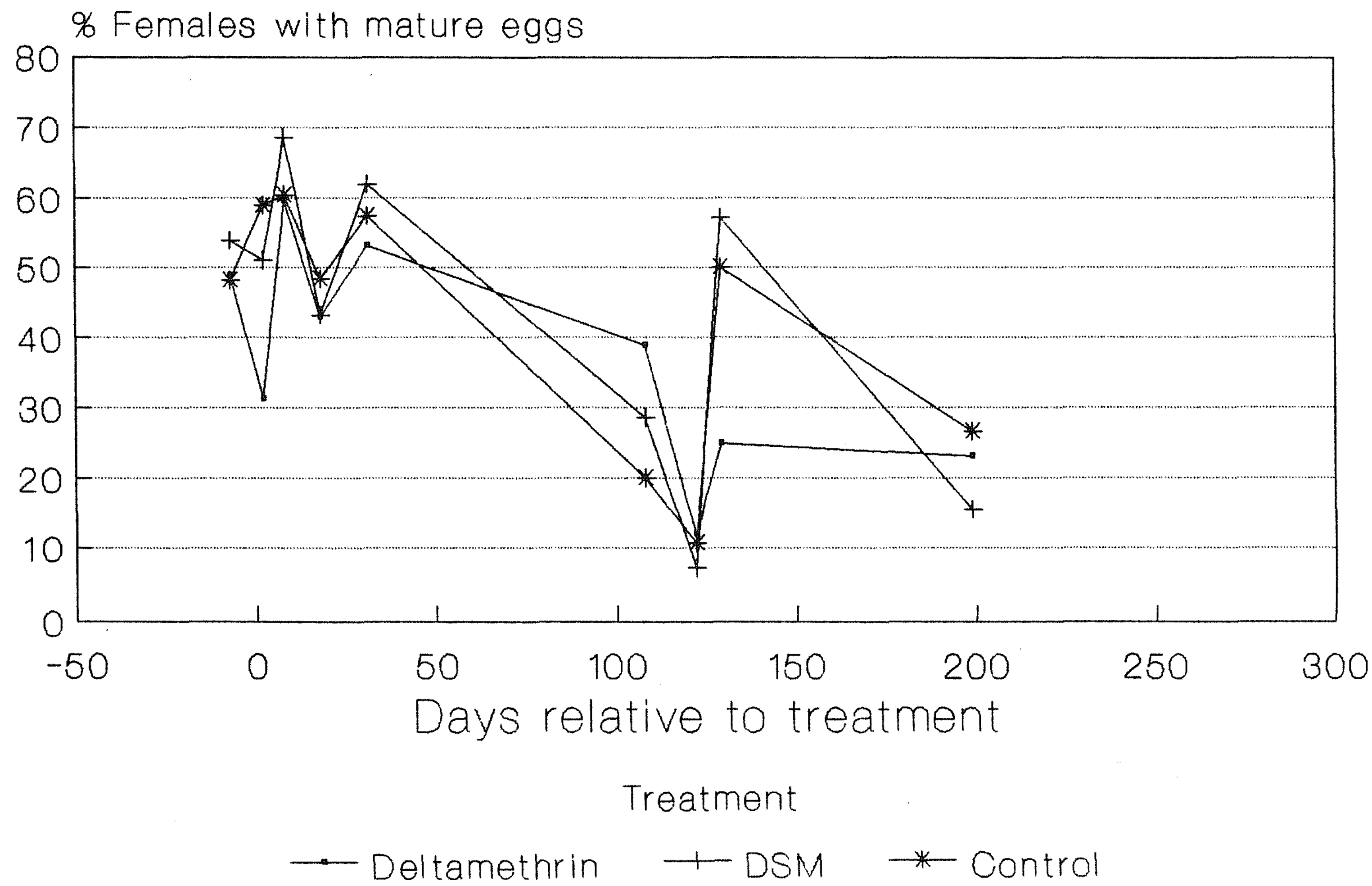
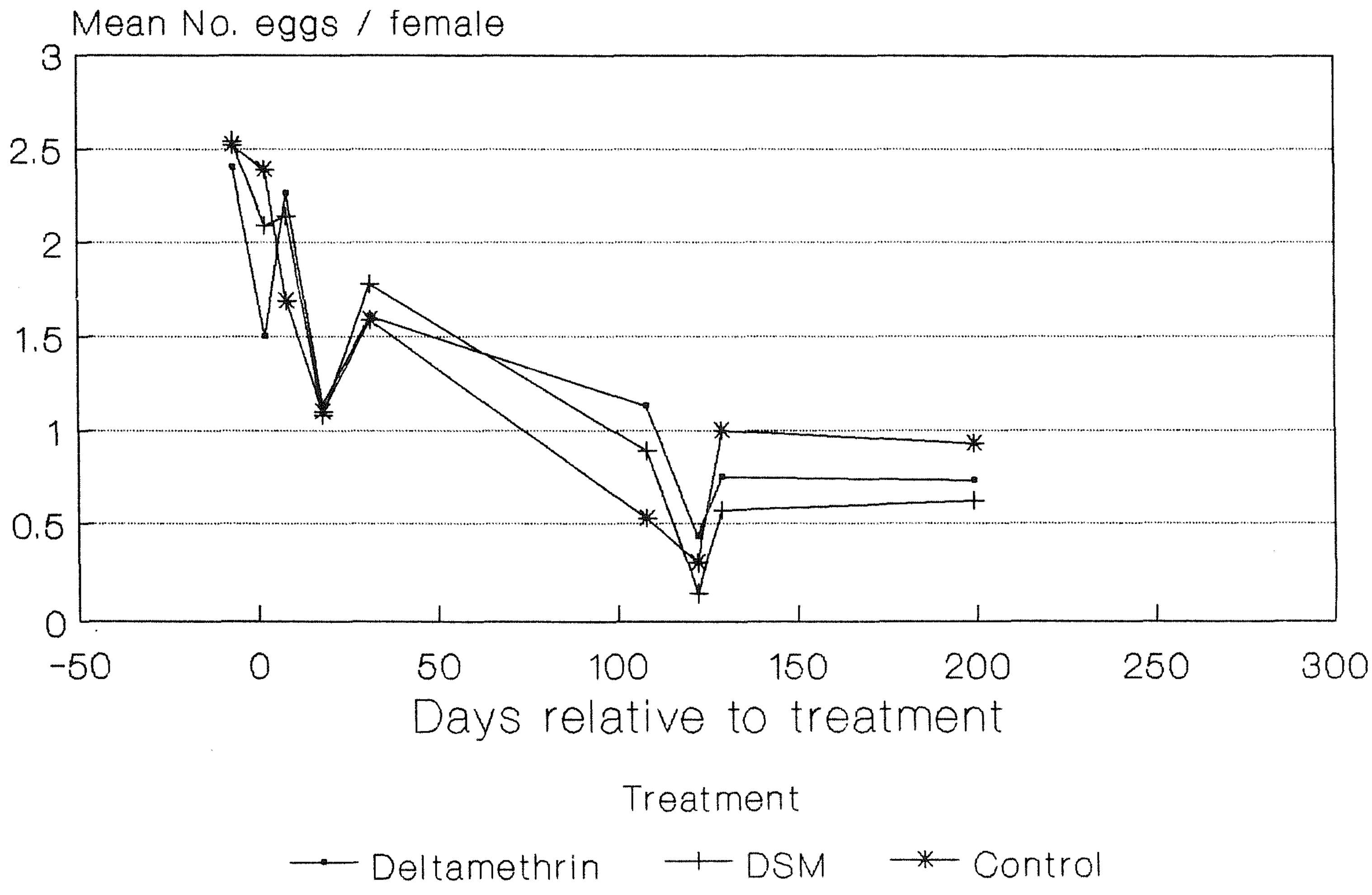


Fig. 4.36 Mean no./eggs/female Trechus quadristriatus (Schrank).
N.B. For individual sample dates, points labelled with different letters are significantly different ($p<0.05$). No letters have been assigned on occasions when values could not be separated by statistical means (ANOVA).



4.4 Aphid counts.

4.4.1 Materials and methods.

The development of the summer infestation on the crop by Sitobion avenae (F.) was monitored in each of the experimental plots. Commencing on 30-05-87 and terminating on 08-08-87 the level of infestation was periodically assessed through the examination of twenty randomly selected stems per plot.

The instars of S.avenae were identified according to the key produced by Lykouressis (1983). For the purposes of this study, specimens of S.avenae were grouped as follows; i) instars I and II, ii) Instars III and IV, iii) apterous adults, iv) alates, v) total S.avenae and vi) aphid mummies. In addition, a record was made of the percentage of stems in each plot which was infested with aphids.

4.4.2 Results.

Statistical analysis of the data was by means of a series of one-way ANOVAs and multiple range comparisons by 95% confidence intervals for log(n+1) transformed numbers per stem and for arc-sine transformed data in the case of the percentage of stems infested.

A statistically significant ($p<0.05$), treatment-related, difference was observed in the density of instars I and II on 27-06-87 (day 237) (Fig. 4.37). On this date the numbers of first and second instar S.avenae observed in the deltamethrin plots were significantly lower ($p<0.05$) than those in either the DSM treated or control areas. Throughout the assessment the numbers of first and second instar cereal aphids recorded in the areas treated with deltamethrin were consistently lower than the control values. These developmental stages also tended to be less abundant in the areas treated with demeton-S-methyl than in the untreated controls.

No statistically significant differences were recorded in the relative densities of third and fourth instar S.avenae ($p>0.05$) but the level observed within the deltamethrin treated plots was consistently the lowest (Fig. 4.38).

The abundance of apterous adult S.avenae was also consistently lower in the deltamethrin plots than in the controls (Fig. 4.39). Statistically significant differences ($p<0.05$) were recorded between the deltamethrin and control values on three of the assessment dates; days 222 (12-06-87), 237 (27-06-87) and 264 (24-07-87).

Significant differences ($p<0.05$) in the abundance of alate S.avenae were recorded during the final stages of the infestation (Fig. 4.40). Counts of alates in the DSM plots were significantly reduced on days 255 and 264 after treatment. The deltamethrin values were significantly reduced on only one of the assessment dates, day 264 ($p<0.05$).

Data relating to the total number of S.avenae per stem (Fig. 4.41) indicated that the level of infestation was consistently lower in the deltamethrin treated plots than in the untreated controls. The reduction was particularly marked during the establishment phase with the difference being statistically significant on day 237 ($p<0.05$). On the same assessment date the density within the deltamethrin plots was also significantly reduced ($p<0.05$) when compared with that in the areas treated with demeton-S-methyl. Autumn applications of both pesticides resulted in peak aphid densities in the summer which were lower than those in the control areas. The maximum density of S.avenae in the deltamethrin plots was approximately one third of the peak value which was attained within the untreated areas.

The percentage of tillers infested was recorded as an indication of differences in the potential spread of aphid-borne disease within the crop. During the aphid establishment phase statistically significant differences ($p<0.05$) were detected in the percentage of wheat stems which were infested with S.avenae (Fig. 4.42). The assessment carried out two hundred and twenty-two days after treatment indicated that the proportion of stems infested in the deltamethrin plots was significantly lower ($p<0.05$) than in either the control plots or in those treated with demeton-S-methyl. On day 241 (01-07-87) there was a significant ($p<0.05$) reduction in the percentage of stems infested in the DSM plots relative to the level observed in the controls.

There were no apparent between-treatment differences in levels of parasitism as indicated by the presence of aphid mummies (Fig. 4.43).

Fig. 4.37 S.avenae (instars I and II).

Graph showing the numbers of first and second instar S.avenae per stem against days after treatment. Means based on random samples of 20 stems per plot.

N.B. For each sample date, points sharing the same letter are not significantly different according to 95% confidence intervals (p>0.05, ANOVA). Letters have not been assigned on dates on when there were no significant differences between treatments.

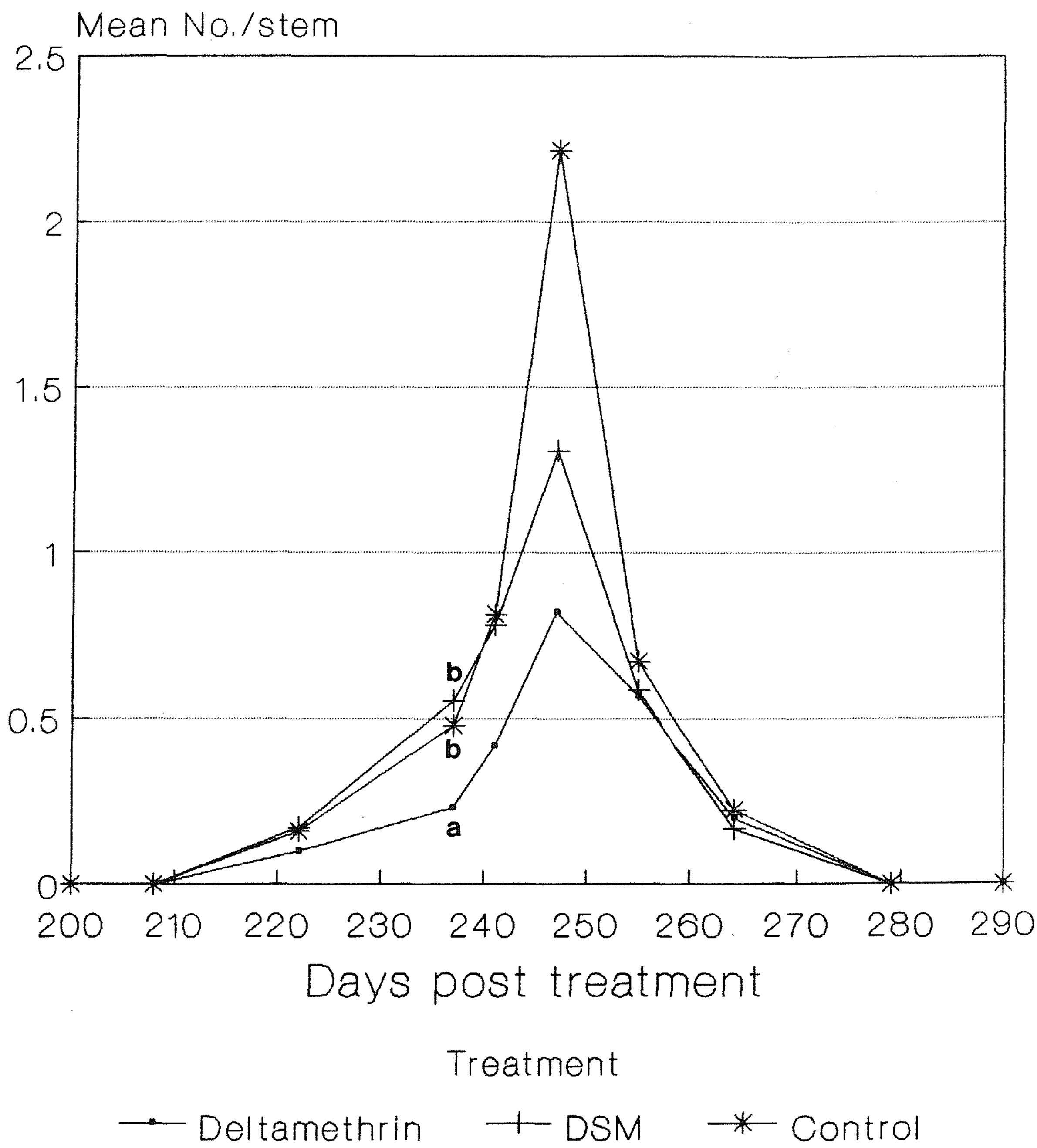


Fig. 4.38 S.avenae (instars III and IV).

Graph showing the numbers of third and fourth instar S.avenae per stem against days after treatment. Means based on random samples of 20 stems per plot.

N.B. For each sample date, points sharing the same letter are not significantly different according to 95% confidence intervals (p>0.05, ANOVA). Letters have not been assigned on dates on when there were no significant differences between treatments.

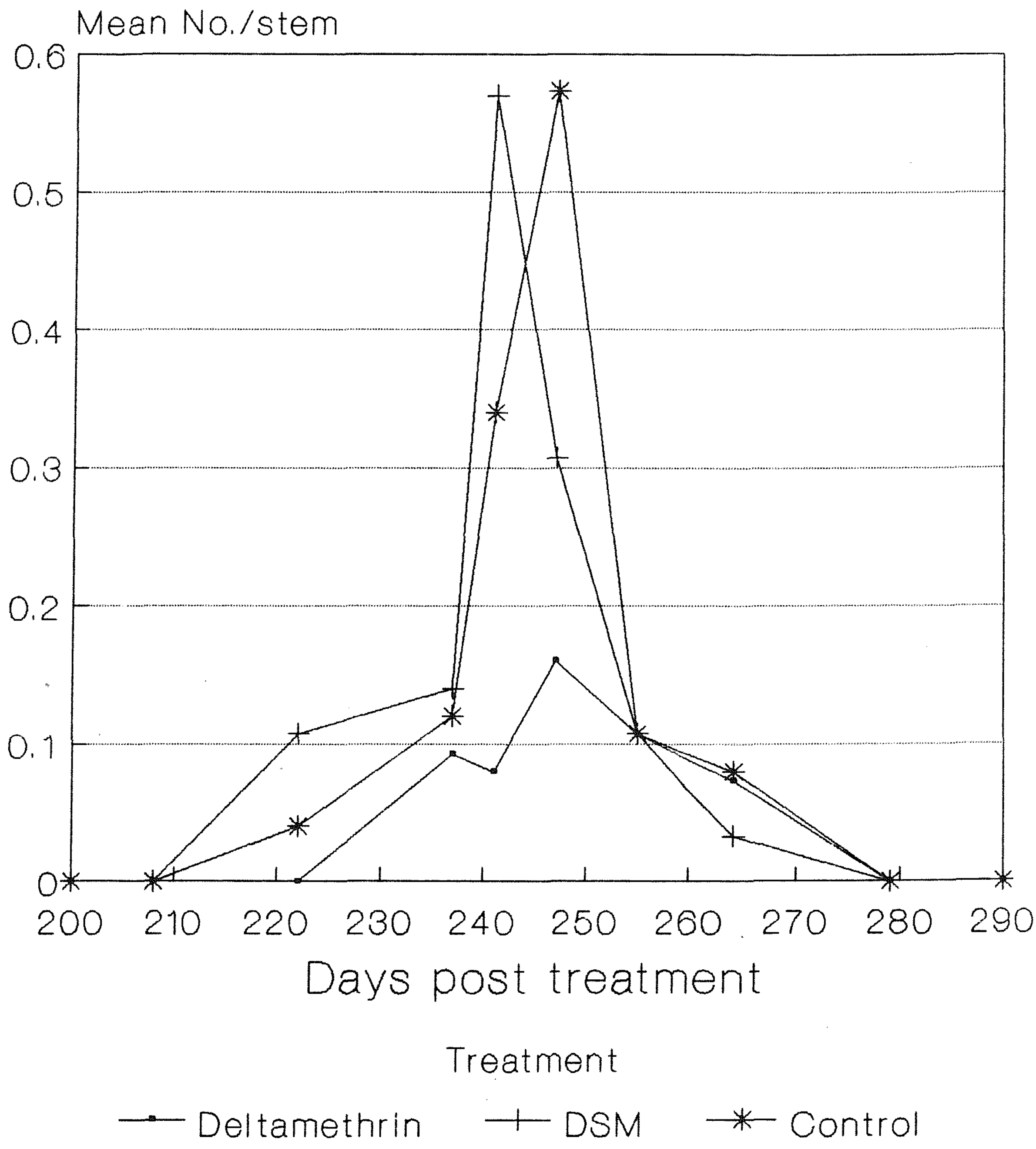


Fig. 4.39 S.avenae (Apterous adults).

Graph showing the numbers of apterous adult S.avenae per stem against days after treatment. Means based on random samples of 20 stems per plot.

N.B. For each sample date, points sharing the same letter are not significantly different according to 95% confidence intervals ($p>0.05$, ANOVA). Letters have not been assigned on dates on when there were no significant differences between treatments.

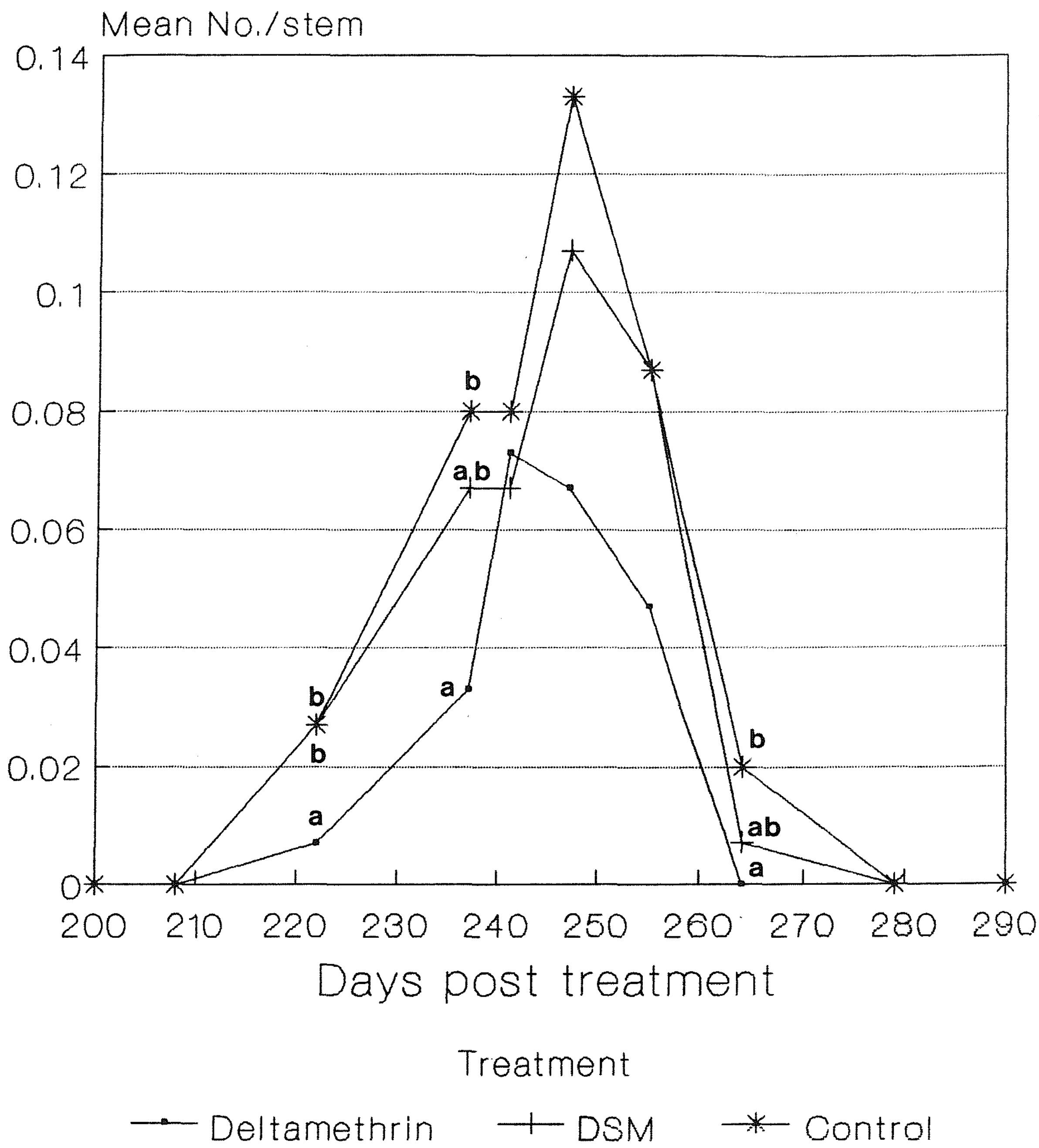


Fig. 4.40 S.avenae (Alates).

Graph showing the numbers of alate S.avenae per stem against days after treatment. Means based on random samples of 20 stems per plot.

N.B. For each sample date, points sharing the same letter are not significantly different according to 95% confidence intervals (p>0.05, ANOVA). Letters have not been assigned on dates on when there were no significant differences between treatments.

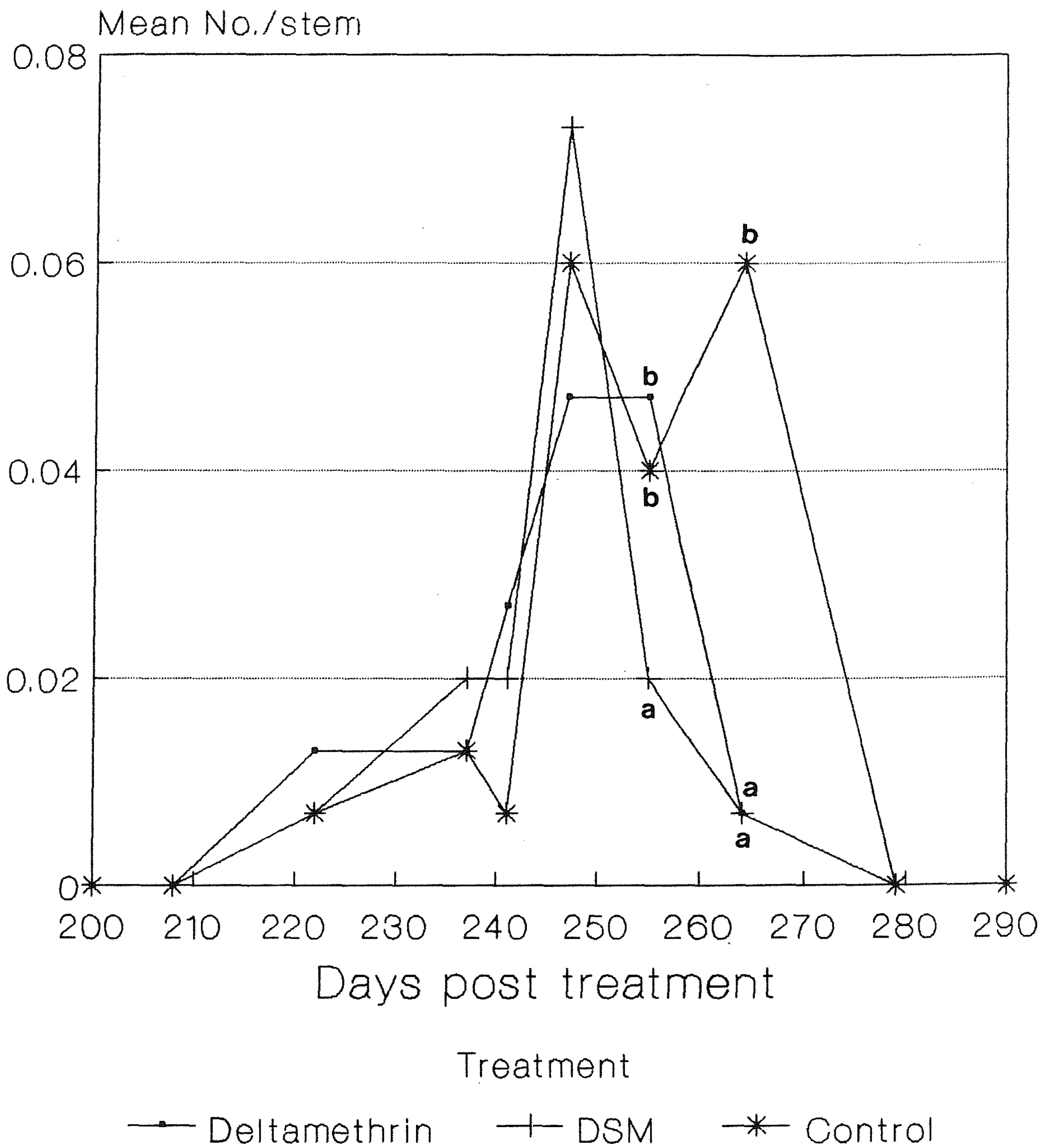


Fig. 4.41 Total S.avenae.

Graph showing the total numbers of S.avenae per stem against days after treatment. Means based on random samples of 20 stems per plot.

N.B. For each sample date, points sharing the same letter are not significantly different according to 95% confidence intervals (p>0.05, ANOVA). Letters have not been assigned on dates on when there were no significant differences between treatments.

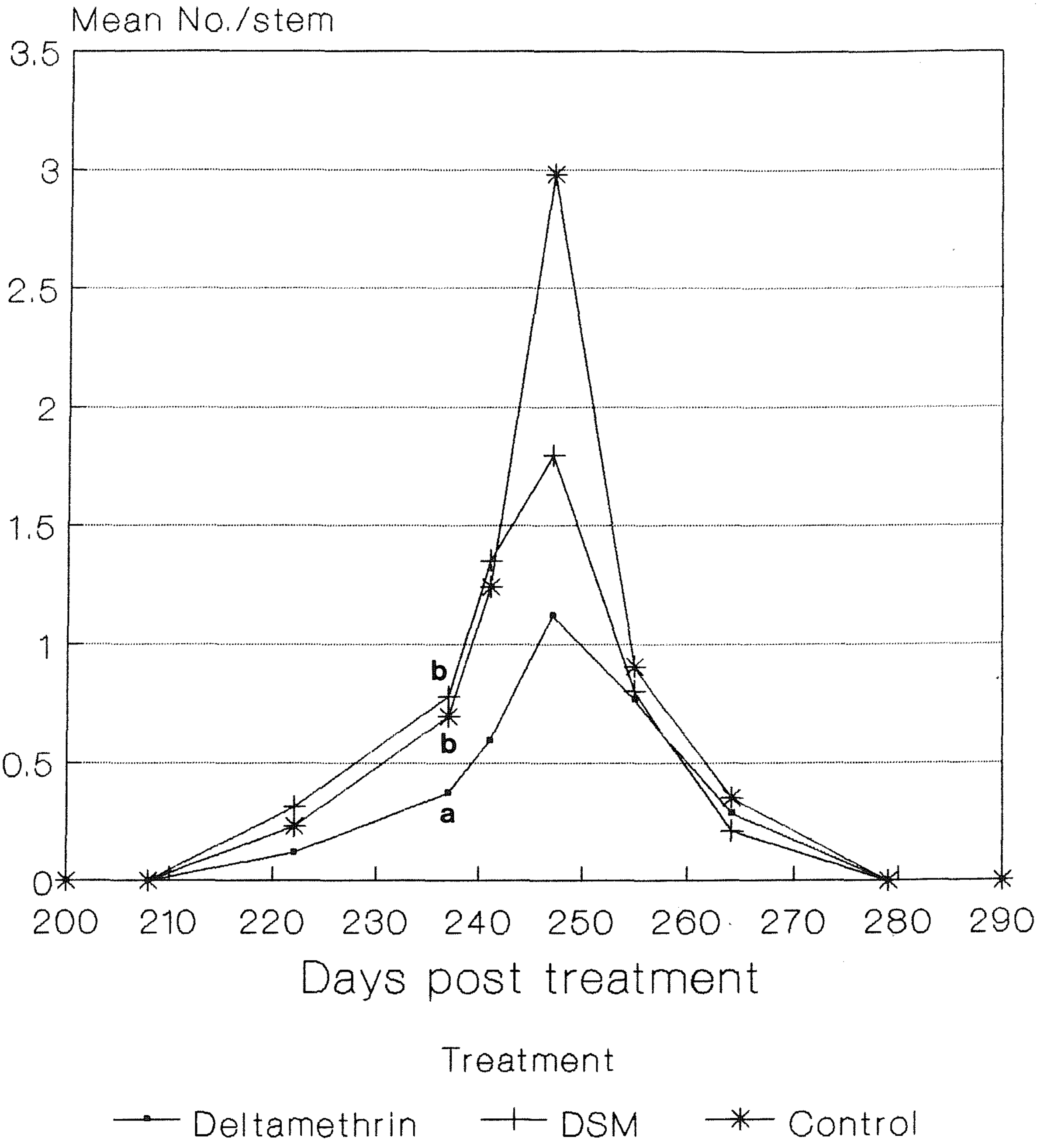


Fig. 4.42 % of stems infested with <u>S.avenae</u>.

Graph showing the percentage of stems infested with *S.avenae* against days after treatment. Means based on random samples of 20 stems per plot.

N.B. For each sample date, points sharing the same letter are not significantly different according to 95% confidence intervals (p>0.05, ANOVA). Letters have not been assigned on dates on when there were no significant differences between treatments.

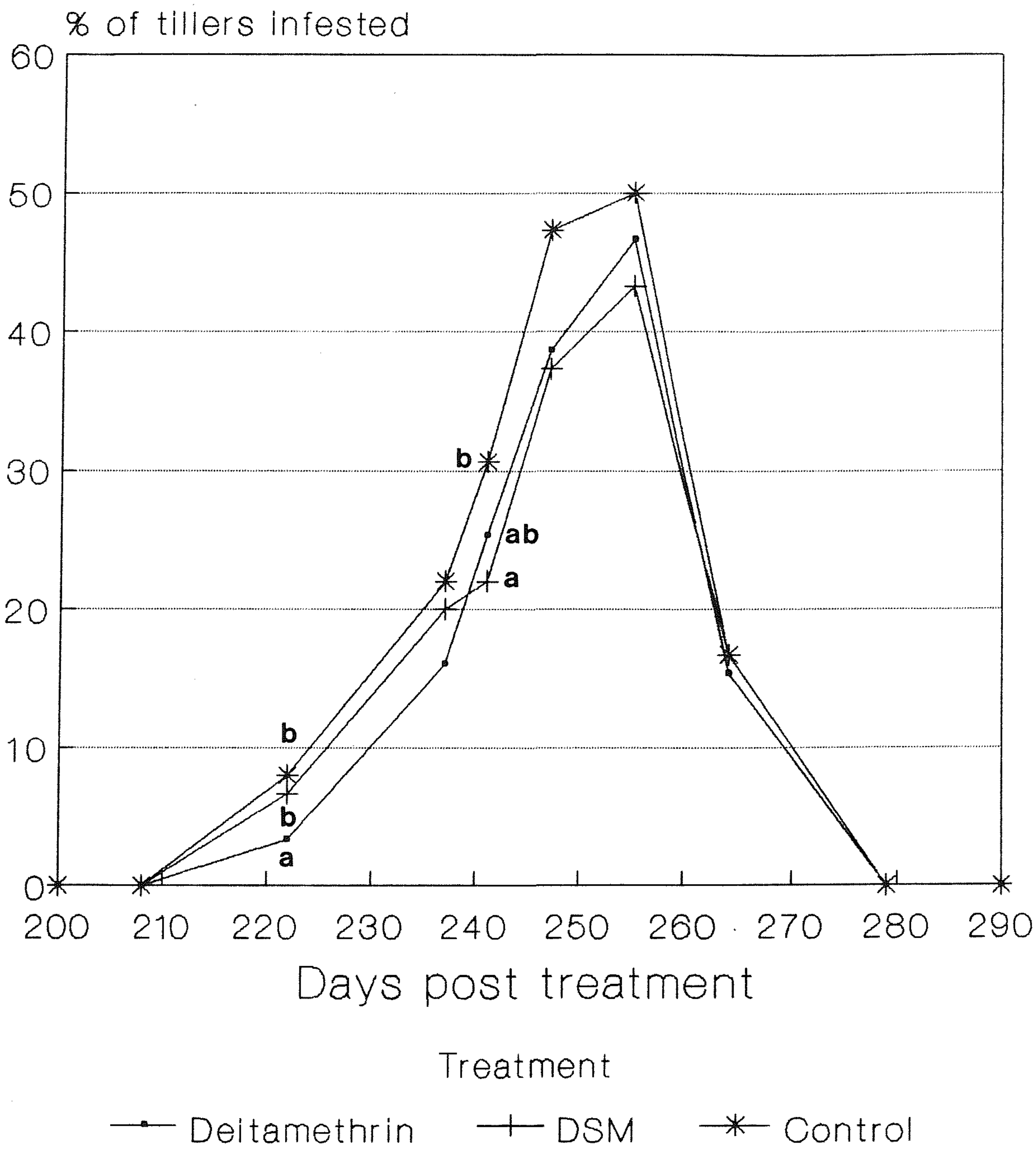
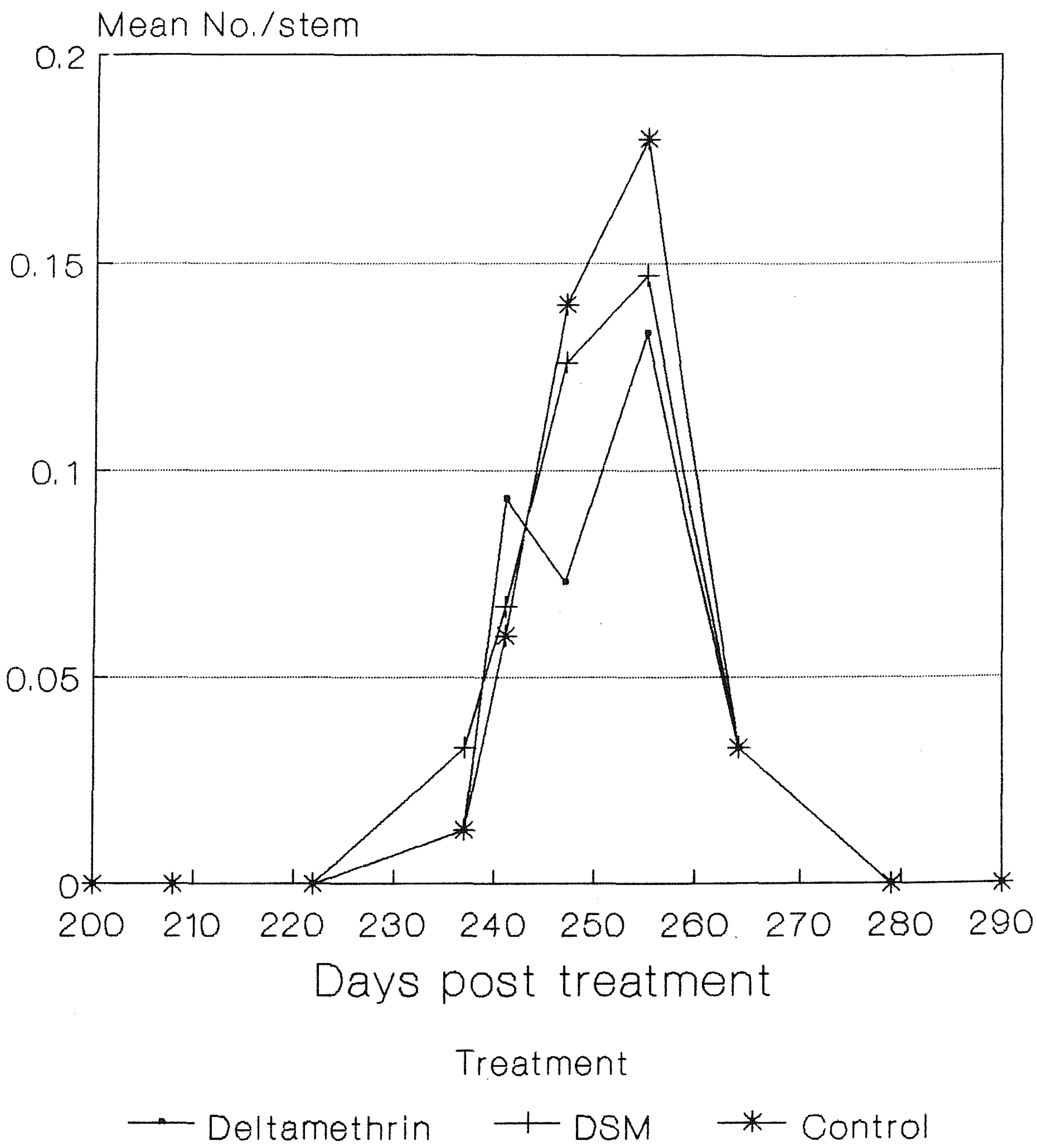


Fig. 4.43 Aphid mummies.

Graph showing the numbers of aphid mummies per stem against days after treatment. Means based on random samples of 20 stems per plot.

N.B. For each sample date, points sharing the same letter are not significantly different according to 95% confidence intervals (p>0.05, ANOVA). Letters have not been assigned on dates on when there were no significant differences between treatments.



4.5 Comparisons of yield.

4.5.1 Materials and methods.

The impact of the pesticide treatments on crop yield was assessed through a comparison of thousand-grain weights. During August samples of grain were collected from the experimental plots immediately prior to harvest. Husks were removed by hand and five samples of a thousand grains of wheat were sorted for each plot. The samples were placed in small dishes of aluminium foil and heated in an electric oven until constant weights were achieved.

4.5.2 Results.

The mean values obtained for each plot were entered into a one-way analysis of variance combined with a multiple range analysis by 95% confidence intervals (Table 4.8).

Mean values for thousand-grain weights were significantly higher ($p<0.05$) in the areas which had been treated with deltamethrin than in those which had been left untreated as controls. The average weight of samples collected from the DSM plots was intermediate and could not be statistically separated from the values obtained for either of the other two treatments ($p>0.05$).

Table 4.8
Table giving multiple range analysis of 1000-grain weight samples by 95% confidence intervals (ANOVA).

Treatment	Reps.	Mean weight ± S.E. (grams)		F-Ratio	Sig. Level
Deltamethrin	3	53.51 ± 1.35	*	3.892	0.0825
DSM	3	51.58 ± 0.45	**		
Control	3	50.27 ± 0.17	*		

N.B. Treatments having an asterisk in the same column are not significantly different ($p>0.05$).

4.6 Discussion.

If the autumn application of either aphicide had resulted in a prolonged disruption of the predator complex one would have expected a reduction in its ability to inhibit the development of the summer aphid infestation. Such a reduction in predatory capacity would be manifested in the form of higher pest densities within the treated areas. Within the constraints of scale applicable to this field trial this was not the case.
Monitoring the levels of aphid infestation indicated that populations of Sitobion avenae (F.) became more rapidly established in the plots which had remained untreated during the autumn. The consequences of this were higher peak densities of aphids in the unsprayed plots and a significant decrease in grain size when comparing control samples with those from plots which had been treated with deltamethrin.

The higher numbers of apterae observed in untreated areas during the establishment phase are an indication of increased levels of overwintering within the control plots. This is supported by the fact that a greater proportion of the plants in the untreated plots were shown to be infested with S.avenae during the early stages of the aphids establishment phase. A statistically significant ($p<0.05$) 1% reduction in grain weight was recorded in samples from the untreated controls. Linear regression analysis failed to detect a significant correlation between thousand-grain weight and either maximum aphid density (correlation coefficient = 0.591) or the maximum number of tillers infested (correlation coefficient = 0.311). The lack of a direct correlation suggests that other factors were contributing to the variation in grain weight. During the spring and summer there were noticeably higher incidences of fungal plant pathogens within the untreated areas and this may explain the inability to detect a direct correlation between grain weight and measurements of the extent of aphid infestation. Vereijken (1979) concluded that at least 50% of the yield loss within his experiments could be attributed to fungi feeding on aphid honeydew. There was no evidence of BYDV in any of the experimental plots so that this could not be cited as a possible contributory factor.

Whilst the effective abundance of total Carabidae exhibited a significant ($p<0.05$) if temporary decrease within the deltamethrin plots, an immediate critical impact could only be proven for one individual carabid species namely Bembidion obtusum (Serville) (Figs. 4.5, 4.6). During the first week after application of the pyrethroid the depression in the effective abundance of B.obtusum was in excess of 90%. Populations in the deltamethrin plots appeared to recover to control levels within thirty-one days of treatment. The results of sign tests indicated a persistent tendency for reductions in the comparative levels of log(n+1) and 'k' transformed pitfall data from the deltamethrin plots ($p<0.05$). This suggests that the adverse impact of deltamethrin on B.obtusum is more prolonged than that which is apparent from the analyses of variance for individual sample dates. B.obtusum has also been shown to be susceptible to autumn applications of lambdacyhalothrin with a mean depression of 63% lasting for more than eighty days in plots of 7ha (Brown et al 1988).

Examination of the gut contents of B.obtusum by both microscopic analysis (Feeney, 1982) and ELISA (Sopp and Chiverton, 1987) indicates that the aphids R.padi and S.avenae form a significant component of the autumn and winter diet of this carabid. Combined with the species' comparatively high abundance during the autumn and winter this suggests that B.obtusum is potentially an important natural control agent for aphid populations which overwinter in cereal fields.

The autumn breeding species N.brevicollis and T.quadristriatus were amongst the most abundant carabids at the time of spray application. Immediately after treatment with deltamethrin both species exhibited marked, but not statistically significant ($p>0.05$), decreases in effective abundance. The initial depression in the apparent abundance of N.brevicollis was in the region of 80% which is similar to the mean decrease of 76% observed after the autumn application of lambdacyhalothrin (Brown et al 1988).

The fluid nature of the crop contents of T.quadristriatus prevented the identification of dietary components by microscopic analysis but the use of ELISA has indicated that the aphids S.avenae and R.padi are important sources of food for Trechus during the autumn (Sopp and Chiverton, 1987). Approximately 75% of the T.quadristriatus tested by Sopp and Chiverton (1987) had been feeding on R.padi while 59% had consumed S.avenae. The same study also indicated that the larvae of Nebria brevicollis (F.) frequently contained evidence of aphid remains during the autumn.

The larvae of N.brevicollis were recorded to the level of instar in order to determine if there were any treatment related differences in the scale and timing of peak activity for the three stages. Such differences could be used to infer modified rates of larval development resulting from either a physiologically based insectistatic effect or from nutritional deficiencies caused by reduced availability of prey. However, the only significant ($p<0.05$) treatment-related difference observed was a brief increase in the relative abundance of first instar larvae in the deltamethrin plots on day 31 (Fig. 4.9). Prior to this the application of the pyrethroid had resulted in immediate decreases in the estimated abundance of all three instars although not to a statistically significant degree ($p>0.05$) (Figs. 4.9-4.12).

The maximum depression in the activity abundance of T.quadristriatus in the deltamethrin plots was approximately 70%. This value is similar in magnitude to the 60-70% decrease observed by Purvis et al (1988) and the

65% depression recorded by Feeney (1982). It is also close to the mean depression of 59% which was observed in populations of *T.quadristriatus* after the autumn application of lambdacyhalothrin (Brown *et al* 1988). The absence of mortality in *Trechus* enclosed in areas treated with lambdacyhalothrin led Brown *et al* (1988) to suggest that the apparent decrease in the open field resulted from either a temporary emigration from the treatment area or from a period of inactivity.

The level of activity of individual carabid beetles is determined by the degree of hunger which they are experiencing with motivational status being indicated by the proportion of the available gut volume which is filled (Mols, 1979, 1984). In turn, the magnitude of pitfall trap samples has been shown to be related to the level of arthropod activity which determines the probability of an encounter with a pitfall trap in a given time interval (eg Adis, 1979). If the above assumptions are accepted it should follow that a comparative increase in the proportion of beetles with full crops in pitfall samples will be the result of an increase in carabid activity which is not related to prey availability. Under laboratory conditions increased irritability and hyperactivity are classic symptoms of the low level intoxication of invertebrates by pyrethroids (Ruigt, 1985). Dissections of *T.quadristriatus* which had been trapped immediately after spray application provided weak evidence of an increase in the proportion of beetles with full crops in the plots which had been treated with pesticide (Fig. 4.33). The limited degree of replication meant that the points could not be separated statistically ($p>0.05$) but the results do suggest that elements of the *Trechus* population surviving spray application underwent a slight transient increase in activity probably as the result of the irritant effects of the two pesticides.

Demeton-S-methyl has been observed to have an overall adverse effect on *T.quadristriatus* both in the field

(Vickerman, 1988) and in the laboratory (Sotherton, 1989). In one field study the autumn application of DSM appeared to induce hyperactivity in T.quadristriatus although the author failed to provide any information on pre-treatment differences (Feeney, 1982). In the case of the data presented here the application of a sign test to 'k' transformed values indicated a significant tendency ($p<0.05$) for the 'corrected' abundance of T.quadristriatus to be highest in the plots which had been treated with DSM (Table 4.2).

Comparison of treatment related differences in the sex ratio of T.quadristriatus suggests that overwintering females were more active in the deltamethrin plots than elsewhere (Fig 4.34).

Sub-lethal doses of pyrethroid have previously been shown to influence ovarian development and egg production in members of the Coleoptera (Samsoe-Petersen, 1985; Raghunatha Rao et al 1986). Immediately after spray application the proportion of females with mature eggs continued to increase in the control plots while the proportion in the areas treated with deltamethrin and DSM exhibited a marked decrease (Fig. 4.35). The values could not be separated statistically ($p>0.05$) but it is significant that this was the only occasion on which the proportion observed in all three treatments did not either increase or decrease in unison. This apparent depression coincided with a decrease in the mean number of eggs per female which was more pronounced in specimens obtained from the deltamethrin and DSM plots (Fig. 4.36). The limited degree of replication prevented statistical confirmation of this observation but it appears that the stress of exposure to the pesticides may have induced fecund females to prematurely discharge eggs which were either mature or near to maturity. If this did prove to be the case then the viability of such eggs would need to be examined in the laboratory prior to inferring a possible impact on the subsequent generation.

The results of dissections published both here and by other authors (Mitchell, 1963; Desender and Pollet, 1987) indicate that while T.quadristriatus is primarily an autumn breeder a component of the overwintered population also engages in a secondary breeding season during the early spring (Figs 4.35, 4.36). Carabids which are predominantly autumn breeding may adopt either of two strategies during years when prey availability is restricted. The available nutrients may be utilised for egg production at the cost of reduced overwintering success or alternatively the deposition of fat deposits may take priority to permit spring breeding by overwintered adults (Murdoch, 1966; Baars and van Dijk, 1984). If the autumn application of either pesticide had resulted in a prolonged and critical reduction in the availability of the prey of Trechus one would have expected either; i) A significantly higher rate of egg production in the autumn with a reduced adult population in treated plots in the spring or conversely ii) Reduced egg production in the autumn with a larger population of fecund females in the early spring. The results obtained indicate that there was no prolonged treatment-related effect on egg production in the autumn or any significant differences in the level of supplementary breeding during the spring (Figs. 4.35, 4.36). These factors indicate that the degree of disruption of the alternative prey community was not severe enough to significantly disturb the breeding pattern of T.quadristriatus.

With the exception of a transient 75% decrease in the effective abundance of staphylinids in the deltamethrin plots neither of the two pesticides appeared to produce a significantly adverse impact on this group. Purvis et al (1988) also reported observing little immediate impact of deltamethrin on adult Staphylinidae.

The most prolonged significant depressions in abundance were observed in members of the Linyphiidae (Figs. 4.21-4.29). Of the two pesticides tested deltamethrin appears to have been the most damaging both with respect to the degree of severity and apparent duration of the effect. Whilst the effective abundances of E.dentipalpis and M.rurestris in the DSM plots had returned to control levels by April, complete recovery within the areas treated with deltamethrin did not occur until the beginning of June. For the major part of the field trial the rate of capture of total Linyphiidae in the deltamethrin plots was between 20-50% of that in the untreated areas. In the plots which had been sprayed with demeton-S-methyl the trapping levels for linyphiids tended to be reduced to between 50-80% of control values. Similar sustained depressions in the effective abundance of linyphiid spiders have been reported elsewhere (Powell et al 1988; Purvis et al 1988). Both here and in the trials carried out by the above authors the adverse effect on the spider population persisted until the late spring of the following year. A comparison of the numbers of spiders in D-vac samples confirmed that there were no significant treatment-related differences in the abundance of linyphiids during the period of summer aphid infestation ($p>0.05$) (Table 4.7). Linyphiid spiders have the ability to migrate over considerable distances by means of aerial 'ballooning' on silk threads (Duffey, 1956). The apparent recovery in the linyphiid population coincides with the onset of a period of increased aeronautic activity (Sunderland, 1987) so that it is uncertain whether the recovery is due to a cursorial redistribution or an aerial immigration of spiders.

The sharp increase in the activity abundance of Erigone atra (Blackwall) which is observed immediately after the application of deltamethrin (Fig. 4.21) is similar to that detected during both the summer and autumn cypermethrin trials. In all cases the effect can be attributed to pyrethroid induced irritability as described in section 1.4.2 of the introductory chapter.

CHAPTER 5 - DELTAMETHRIN FIELD TRIAL (AUTUMN 1987).

5.1 Introduction.

The limited degree of replication in the previous field trial meant that marked reductions in the apparent abundance of several species in the deltamethrin plots could not be statistically confirmed. Such non-target invertebrates included Trechus quadristriatus (Schrank), adult and larval Nebria brevicollis (F.), the linyphiid spider Lepthyphantes tenuis (Blackwall), and adult Staphylinidae. It was hoped that by increasing the level of replication it would be possible to obtain statistical confirmation of adverse effects on these and other beneficial arthropods. Due to limitations on the availability of land the increase in replication could only be achieved at the cost of decreased plot size and the absence of a toxic standard.

5.2 Estimates of abundance.

5.2.1 Materials and methods.

The experiment was carried out in Field 11/12 of Charity Down Farm, Longstock, Hampshire (see map, Appendix 1.2).

Ten, 100m by 100m plots were marked out in a field of winter wheat (cv. Rendezvous) as indicated in Figure 5.1. Five of the plots were treated with deltamethrin with alternate plots being left untreated to act as controls as indicated in the figure. The deltamethrin was applied when the wheat seedlings were at the two leaf stage (Zadoks 12).

The pesticide was applied with a 'Chafer Pathfinder' hydraulic spray unit with an 18m boom operating at a pressure of 1.6 bar and a tractor speed of 10 km/h. The formulation was applied at the rate of 250ml in 220 l/ha water giving a predicted rate of application of 6.25g a.i./ha. In order to determine the actual rate of delivery the outputs from ten randomly selected spray nozzles were recorded. This indicated that the actual rate of delivery was 5.96 $\pm$ 0.13g a.i./ha

In order to measure the effective abundance of the epigeal arthropod fauna a central grid of ten pitfall traps (diameter 7cm) was sunk in each plot with five traps on either side of the central tram-line. Traps were separated by a distance of 5m. A 5% solution of formalin with a small quantity of detergent was employed as the trapping fluid. Traps were emptied periodically between 22-10-86 (day -12) and 08-08-87 (day 279) with the interval between samples being determined by the levels of arthropod activity. Catches were transferred to 70% alcohol for storage before examination under binocular microscope.

Prior to treatment, a barrier had been erected around a small (7m x 7m) sub-plot near the centre of each main plot in an attempt to overcome the problem of reinvasion and permit the sampling of isolated overwintering populations during the following spring. The barrier walls consisted of a 20cm wide strip of corregated lawn edging material buried to a depth of approximately 10cm. In the following spring five pitfall traps were sunk inside each barriered area, one in the centre and one halfway along the inner edge of each plot. Samples were collected at approximately five-day intervals between 13-04-88 and 28-04-88.

One of the limitations of the pitfall trap as a measure of abundance is the fact that the majority of the linyphiid spiders collected are male. This is due to the fact that the females tend to be generally less active than the males and are more closely associated with webs (Locket and Millidge, 1951; Sunderland et al 1986a). In order to overcome this problem, webs were 'visualised' with water droplets from a hand operated 'Spray-mist' aerosol and the numbers of webs in ten random 0.5m^2 quadrats were recorded for each plot. Estimates of web density were carried out on the same dates as collection of pitfall trap samples.

The reinvasion of treated plots by aeronautic spiders was monitored by means of sticky traps. Each sticky trap was composed of a 20.5cm by 9.5cm rectangle of heavy gauge card which had been coated with a thin layer of 'Tanglefoot' adhesive. Only spiders found in the central 19cm by 7.5cm area were recorded as having been potential aeronauts. Three cards were placed in each of the ten plots and these were examined in conjunction with the pitfall traps and replaced as proved necessary.

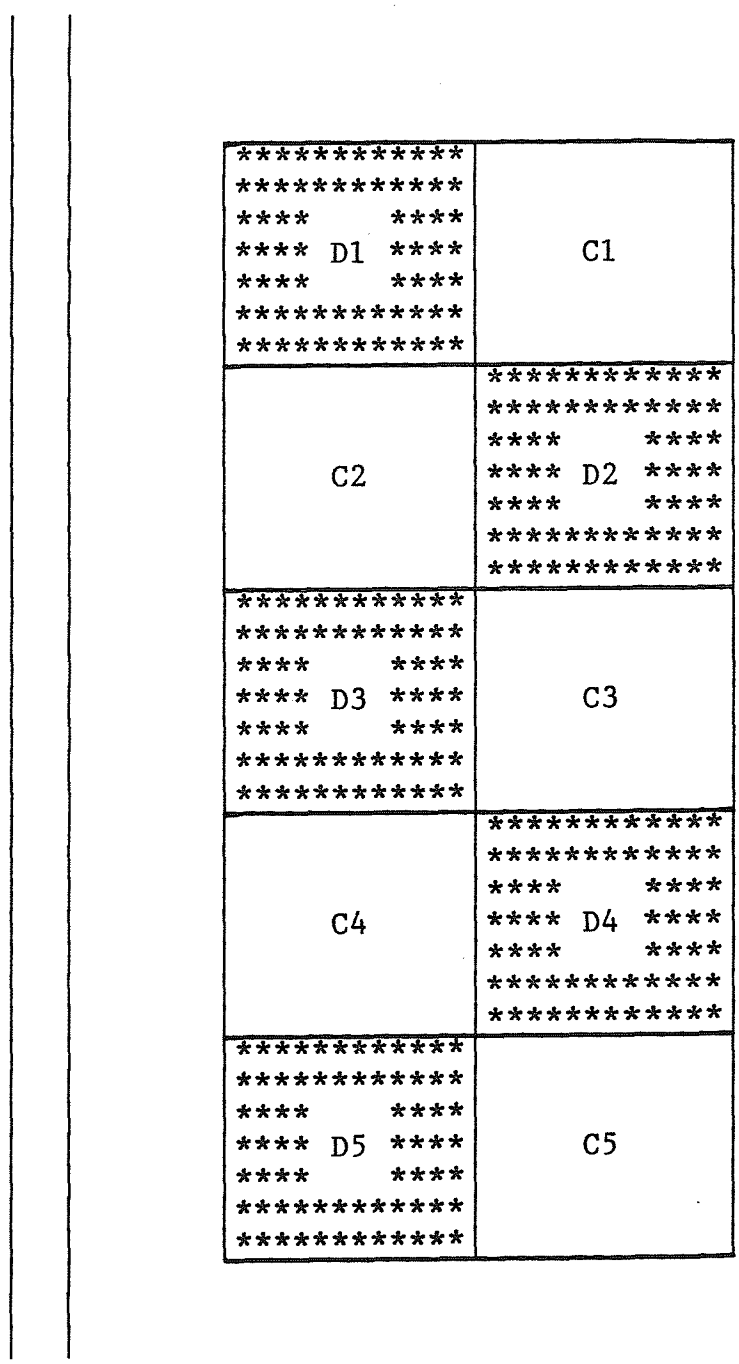
The specific dates associated with the values for days relative to treatment which are used throughout this chapter are provided in Appendix 5.27.

Fig. 5.1 Plot layout for the deltamethrin trial 1987/8.

Each replicate consisted of a square plot approximately 1ha in area.

N.B. D = Plot treated with deltamethrin (6.25g a.i./ha).
C = Unsprayed control plot.

FIELD 11 / 12, LONGSTOCK.



'GREEN WAY' BRIDLE PATH.

5.2.2 Results.

Analysis of data was by means of Student's t-test using the Statgraphics (vers. 2.1) package. Data were transformed to log(n+1) no./trap/day prior to analysis. In order to account for pre-treatment differences, analysis was carried out on 'k' values for those arthropods which were numerically dominant at the time of spray application. These were Bembidion obtusum (Serville) (Fig. 5.4), Trechus quadristriatus (Schrank) (Fig. 5.11) and total adult Carabidae (Fig. 5.13). Comprehensive lists of the means, t-statistics and significance levels relating to the main-plot pitfall trap data are provided in Appendix 5. Values relating to the enclosed sub-plots appear in Tables 5.2-5.19.

In addition, a sign test was applied to each set of pitfall trap data in order to detect any significant trends in the size of catches relative to those from the control plots. The results of the sign tests are presented in Table 5.1. along with summaries of the pitfall trapping results.

A comparison of spider web densities in the treated and control plots is presented in Fig. 5.25.

Carabidae (Appendices 5.1-5.13; Figures 5.2-5.14; Tables 5.2-5.7).

As in both of the two previous autumn field trials the samples of Carabidae collected at the time of spray application were dominated by B.obtusum and T.quadristriatus.

Application of the deltamethrin resulted in an immediate and dramatic decrease in the activity abundance of B.obtusum (Fig. 5.3). Rates of capture in the treatment plots were temporarily depressed to less than 20% of those in the controls. Highly significant differences were observed on three separate sample dates, day 2 ($p<0.0001$), day 6 ($p<0.001$) and day 11 ($p<0.0001$). Based only on log(n+1) transformed values the impact of deltamethrin on

B.obtusum appears to have been transient. The application of a sign test to the relevant 'k' values (Table 5.4) indicated that values adjusted for pre-treatment differences were consistently lower in the replicates which had been treated with the pyrethroid ($p<0.05$). 'k' values for this species (Fig. 5.4) exhibited statistically significant differences ($p<0.05$) on the same three sampling occasions as the data transformed to log(n+1). On all five spring sampling dates pitfall catches in the barriered sub-plots were lowest in those which had been treated with deltamethrin in the previous autumn (Table 5.3). On one of the sample dates (day 160) the difference in the rate of capture of B.obtusum was highly significant ($p<0.001$). For four of the five occasions on which catches were smallest in the deltamethrin sub-plots the reverse was true for samples collected from the main open-field plots.

Immediately after the application of the pesticide, the estimated abundance of T.quadristriatus in the deltamethrin replicates exhibited an abrupt decrease relative to control levels (Fig. 5.10). For the first three sample dates after treatment the deltamethrin catches were reduced to less than 50% of the control values. However, within 21 days of treatment the rate of capture in the deltamethrin plots was in excess of that in the areas which had been left untreated. Prior to spraying, the relative abundance of T.quadristriatus had been highest in the areas which had been allocated for treatment with deltamethrin. Following transformation of data to 'k' values (Fig 5.11) statistically significant differences were indicated for a further two separate sample dates, day 74 ($p<0.05$) and day 135 ($p<0.05$). Critical values for probability were only narrowly avoided for 'k' values on several other sample dates (Appendix 5.9). A sign test indicated that there was a significant tendency for the adjusted values to be reduced in the deltamethrin plots ($p<0.05$). Rates of capture of T.quadristriatus in the barriered sub-plots were comparatively low and no critical differences could be detected (Table 5.6).

B.lampros was poorly represented in the early samples collected during the autumn but exhibited a peak in activity in all plots from the end of March onwards (Fig. 5.2). A sign test (Table 5.1) failed to indicate any trend in the relative abundance of B.lampros in the open field sites which had been treated with deltamethrin ($p>0.05$). There were no significant between-treatment differences in the samples collected from the barriered sub-plots ($p>0.05$) (Table 5.2) but catches in the deltamethrin barriers were consistently lower than those in the untreated controls.

Loricera pilicornis (F.) did not appear in samples until after the middle of March (Fig. 5.5). There was no apparent treatment-related trend in the relative abundance of L.pilicornis in either the open field sites or the barriered areas. There was however a marked increase in the comparative abundance of the species in samples collected from the main deltamethrin plots on day 160 ($p<0.01$)).

No critical differences or trends were detected for the comparative abundances of adult N.brevicollis (Fig. 5.6). The relative abundance of N.brevicollis larvae (Fig. 5.7) exhibited a significant but transient decrease following the application of the pesticide. On day 2 there was a critical difference between the numbers of larvae obtained from the two treatments ($p<0.05$). There was an apparent recovery of the larval population within twentyone days of treatment.

Data for Notiophilus biguttatus (F.) also showed a significant decline in the deltamethrin plots on day 2 ($p<0.05$). On the date in question there were no specimens of N.biguttatus recorded in any of the areas which had been treated with pesticide. Again the population appeared to rebound quite rapidly so that in samples collected on day 40 the number of N.biguttatus obtained from treated plots was more than double that in the controls.

The population of the large carabid Pterostichus melanarius (Illiger) did not appear to be significantly disrupted by the autumn application of deltamethrin (Fig. 5.9). No critical differences in abundance could be detected in samples from either the main plots or the barriered sub-plots ($p>0.05$).

Both log(n+1) transformed pitfall trap data and 'k' values for total adult Carabidae exhibited statistically significant ($p<0.05$), treatment related, differences on days 2, 6 and 11 (Figs. 5.12 and 5.13). 'k' values for catches obtained in the plots treated with the pyrethroid proved to be consistently lower than those from the controls (Table 5.1). In the latter stages of the trial, traps in the main open field plots generally yielded higher total catches of Carabidae in those areas which had been treated with deltamethrin. In contrast to this, the trapping rates in the sub-plots remained consistently higher within the untreated barriers (Table 5.7). On one of the sample dates (day 160) the difference proved to be highly significant ($p<0.01$).

Carabid larvae collected in the autumn were predominantly those of N.brevicollis and a number of members of the Harpalinae. Summer samples were largely dominated by the larvae of P.melanarius. There was an apparent decline in the post-treatment abundance of total carabid larvae (Fig. 5.14) but this proved not to be statistically significant ($p>0.05$) and was only a transient effect.

Staphylinidae (Appendix 5.14; Figure 5.15; Table 5.8).

The estimated abundance of total adult Staphylinidae was significantly lower in the plots treated with deltamethrin on two separate occasions, day 2 ($p<0.05$) and day 125 after treatment ($p<0.05$). In the barriered plots the catches of total Staphylinidae were significantly lower in those plots treated with deltamethrin on day 160 ($p<0.05$). For most of the trial there appears to have been comparatively little variation between catches of staphylinids associated with the two treatments. However, on the final three sampling dates the catches in the deltamethrin plots varied between two and five times the magnitude of the trapping levels in the control plots. These differences were statistically significant at the critical level of p=0.05.

Linyphiidae (Appendices 5.15-5.23; Figures 5.16-5.25; Tables 5.9-5.16).

The autumn application of deltamethrin resulted in a marked disruption of the local population of linyphiid spiders. A series of sign tests (Table 5.1) indicated significant trends ($p<0.05$) towards persistent post-treatment reductions in the relative abundances of Erigone dentipalpis (Wider), total Erigoninae, Meioneta rurestris (Blackwall), and total Linyphiinae.

No such trend could be statistically proven for the main plot data for E.atra ($p>0.05$) although values obtained on a number of the individual sample dates were confirmed as exhibiting significant ($p<0.05$) treatment-related differences (Fig. 5.16). The effective abundance of E.atra was significantly lower than the control value on days 21 ($p<0.01$), 74 ($p<0.05$), 89 ($p<0.01$), 125 ($p<0.05$) and 135 ($p<0.05$). None of the five sets of samples collected from the barriered sub-plots exhibited a critical difference in the comparative abundance of E.atra ($p>0.05$) although the samples collected on day 175 came close at ($p<0.06$). The control values for the effective abundance of E.atra were consistently higher than those obtained from the sub-plots which had been treated with deltamethrin.

Pitfall catches for E.dentipalpis remained reduced in the deltamethrin plots until the middle of March in the following year (Fig. 5.17). The population of E.dentipalpis exhibited a higher relative abundance in the deltamethrin treated replicates on days 145 and 160 but these apparent differences were not statistically significant ($p>0.05$). The population in the deltamethrin plots then appeared to undergo a progressive decline such that a highly significant difference was detected in the samples collected from the main plots on day 180 ($p<0.01$). A sign test indicated that the general trend towards a reduction in the population in the deltamethrin plots was significant ($p<0.05$). The trapping rates in the barriered areas were also consistently lower in the sub-plots which had been treated with deltamethrin (Table 5.10). None of the separate sets of samples collected from the barriers produced statistically significant differences although the critical probability value of $p=0.05$ was almost achieved on two out of the five dates; days 175 ($p=0.0642$) and 180 ($p=0.0551$).

In the case of O.fuscus a critical difference was observed on only one sample date (Fig. 5.18). On day 47 the effective abundance of O.fuscus in the deltamethrin plots was significantly higher than that in the controls ($p<0.05$). No general trends could be detected in samples collected from either the main plots or from the barriered sub-plots. There also appear to have been no significant differences in the comparative abundance of O.fuscus within the barriers on any of the separate sample dates (Table 5.11).

The combined data for all species of Erigoninae (Fig. 5.19) indicated that trapping levels were consistently lower in the areas treated with deltamethrin than in the open field and barriered plots which were left untreated. Shortly after treatment the population of total Erigoninae in the deltamethrin plots exhibited a brief increase in relative abundance prior to undergoing a sustained depression until the following April. The individual sample dates on which the deltamethrin catches proved to be significantly reduced were days 21 ($p<0.05$), 64 ($p<0.05$), 89 ($p<0.01$) and 125 ($p<0.05$). In the barriered plots treated with deltamethrin the rate of capture of total Erigoninae was significantly reduced to 58.5% of the control value in samples collected on day 175 after treatment ($p<0.05$).

No treatment related differences or trends could be detected in the numbers of Bathyphantes gracilis (Blackwall) trapped in either the open plots (Fig. 5.20) or the enclosures (Table 5.13) ($p>0.05$).

The population of Lepthyphantes tenuis (Blackwall) (Fig. 5.21) did not exhibit any detectable trends in the relative abundance observed in either of the treatments but values in the main deltamethrin plots were significantly reduced on days 21 ($p<0.0001$), 74 ($p<0.05$) and 89 ($p<0.05$).

Meioneta rurestris (C.L.Koch) was the most frequently observed member of the sub-family Linyphiinae and appeared to be relatively active throughout the trial. Immediately after application of the pyrethroid the effective abundance of M.rurestris exhibited a sharp decrease to less than 20% of that in the untreated plots (Fig. 5.22). The application of a sign test indicated that the overall trend towards a reduction in the activity density of M.rurestris in the deltamethrin plots was significant ($p<0.05$). Statistically significant decreases were determined for four of the individual sample dates; days 2 ($p<0.001$), 21 ($p<0.001$), 166 ($p<0.05$) and 175 ($p<0.05$). Rates of capture of M.rurestris were also consistently lower in the enclosures treated with deltamethrin than in the untreated sub-plots (Table 5.14).

Combined data for all members of the sub-family Linyphiinae (Fig. 5.23) were analysed by means of a simple sign test. The result indicated that there had been a significant tendency ($p<0.05$) towards a post-treatment reduction in the relative abundance of Linyphiinae within the replicates sprayed with the pyrethroid. Significant treatment-related differences were observed on four separate sample dates; days 2 ($p<0.05$), 21 ($p<0.001$), 89 ($p<0.05$) and 175 ($p<0.01$). In the case of the barriered sub-plots none of the individual sampling occasions revealed significant ($p<0.05$) variations in the rates of capture although the levels observed in the barriers treated with deltamethrin were consistently lower than the control values.

In addition to those species already mentioned the data for total Linyphiidae includes representatives from a large number of species which were trapped relatively infrequently. Such species include Oedothorax retusus (Westring), Oedothorax apicatus (Blackwall), Savignia frontata (Blackwall), Macrargus rufus (Wider), Scotargus innerans (O.P.-Cambridge), Bathyphantes parvalus (Westring) and Ostearius melanopygius (O.P.-Cambridge). Two specimens of the comparatively rare Lepthyphantes insignis (O.P.-Cambridge) were also obtained. Application of the pyrethroid resulted in an immediate and significant ($p<0.05$) decrease in the general linyphiid population to less than 20% of the control value. This apparent decline within the treatment plots was swiftly followed by a marked but not statistically significant increase in the activity abundance of the Linyphiidae to more than twice the control value. This peak was in turn subsequently followed by a second highly significant decrease ($p<0.001$) to approximately one third of the apparent activity-density in the untreated replicates. The relative abundance of the total Linyphiidae in the deltamethrin plots was significantly reduced on a further three occasions; days 64 ($p<0.05$), 74 ($p<0.05$) and 89 ($p<0.001$). Samples collected from the deltamethrin treated enclosures on day 175 indicated a critical reduction in the comparative abundance of total Linyphiidae to approximately 63% of the control values ($p<0.05$). Trapping rates in the barriered areas were also consistently lower in those sub-plots which had been treated with deltamethrin (Table 5.16).

Sampling in random quadrats revealed reductions of 20% and 38% in the relative density of spider webs in deltamethrin plots on days 21 and 40 respectively (Fig.

5.25). Neither of these apparent deviations proved to be statistically significant ($p>0.05$).

The sticky traps intended to monitor the local activity of aeronautic spiders collected a total of nine individuals suggesting that no major aerial migrations occurred during the period over which the cards were employed.

Acari (Appendix 5.24; Figure 5.26; Table 5.17).

No treatment related differences could be detected in the effective abundance of the general mite population in either the main plots (Fig. 5.26) or the barriered sub-plots (Table 5.17). A sign test also confirmed that there were no trends present in the estimated abundances as determined by pitfall traps ($p>0.05$).

Collembola (Appendix 5.25; Figure 5.27; Table 5.18).

Despite the total absence of specimens in samples collected from the deltamethrin plots on day 6, no statistically significant differences were detected in the populations of Collembola during the course of the trial. There were also no apparent trends or differences in samples collected from the enclosures ($p<0.05$, sign test and t-tests).

Diptera (Appendix 5.26; Figure 5.28; Table 5.19).

Treating areas with deltamethrin resulted in an immediate and highly significant reduction in the the rate of capture of Diptera in the pitfall traps ($p<0.01$). The effect was transient and was followed by an apparently steady recovery to the trapping rates observed in the untreated areas. No differences were detected in samples collected from the sub-plots in the spring (Table 5.19) and no significant trends ($p>0.05$) were observed in data obtained from either the open plots or from the enclosures.

Fig. 5.2 <u>Bembidion lampros</u> (Herbst.).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

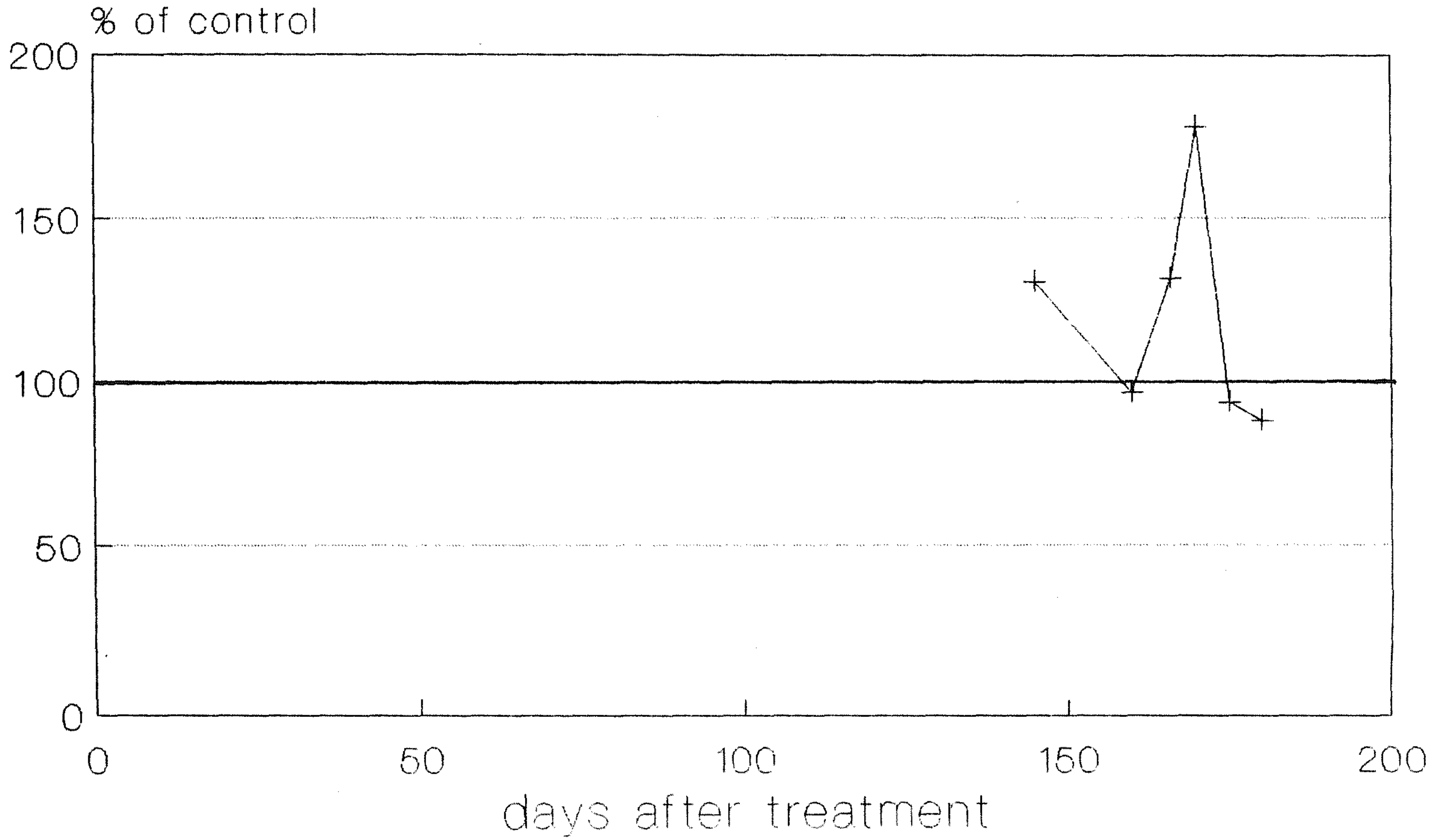


Fig. 5.3 Bembidion obtusum (Serville).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at p<0.05 and p<0.01 respectively (t-test).

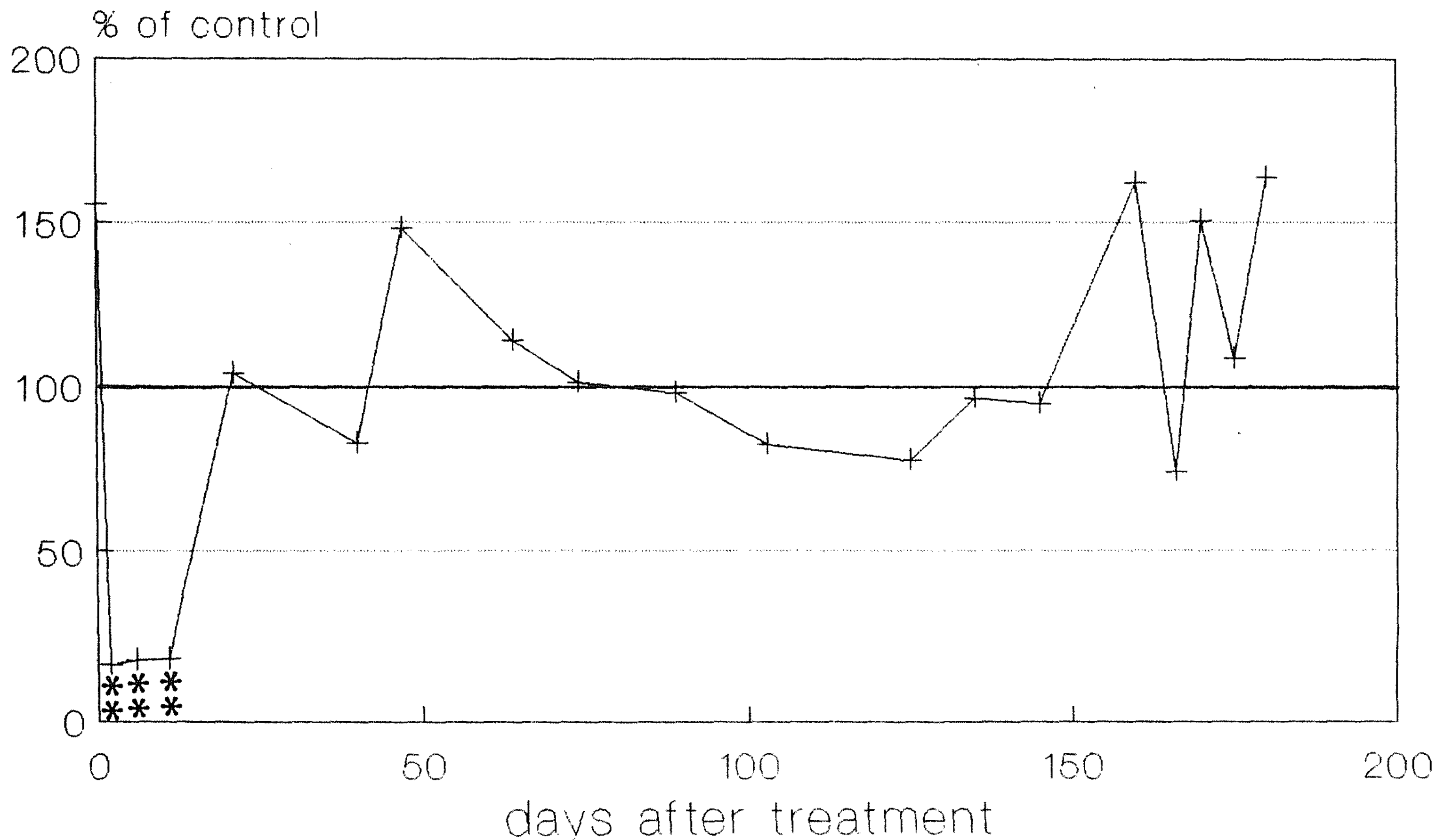


Fig. 5.4 Bembidion obtusum (Serville) 'k' values.
Comparison of 'k' values for plots treated with deltamethrin and unsprayed control plots.
N.B. For each sample date, points labelled with different letters are significantly different p<0.05 (t-test).

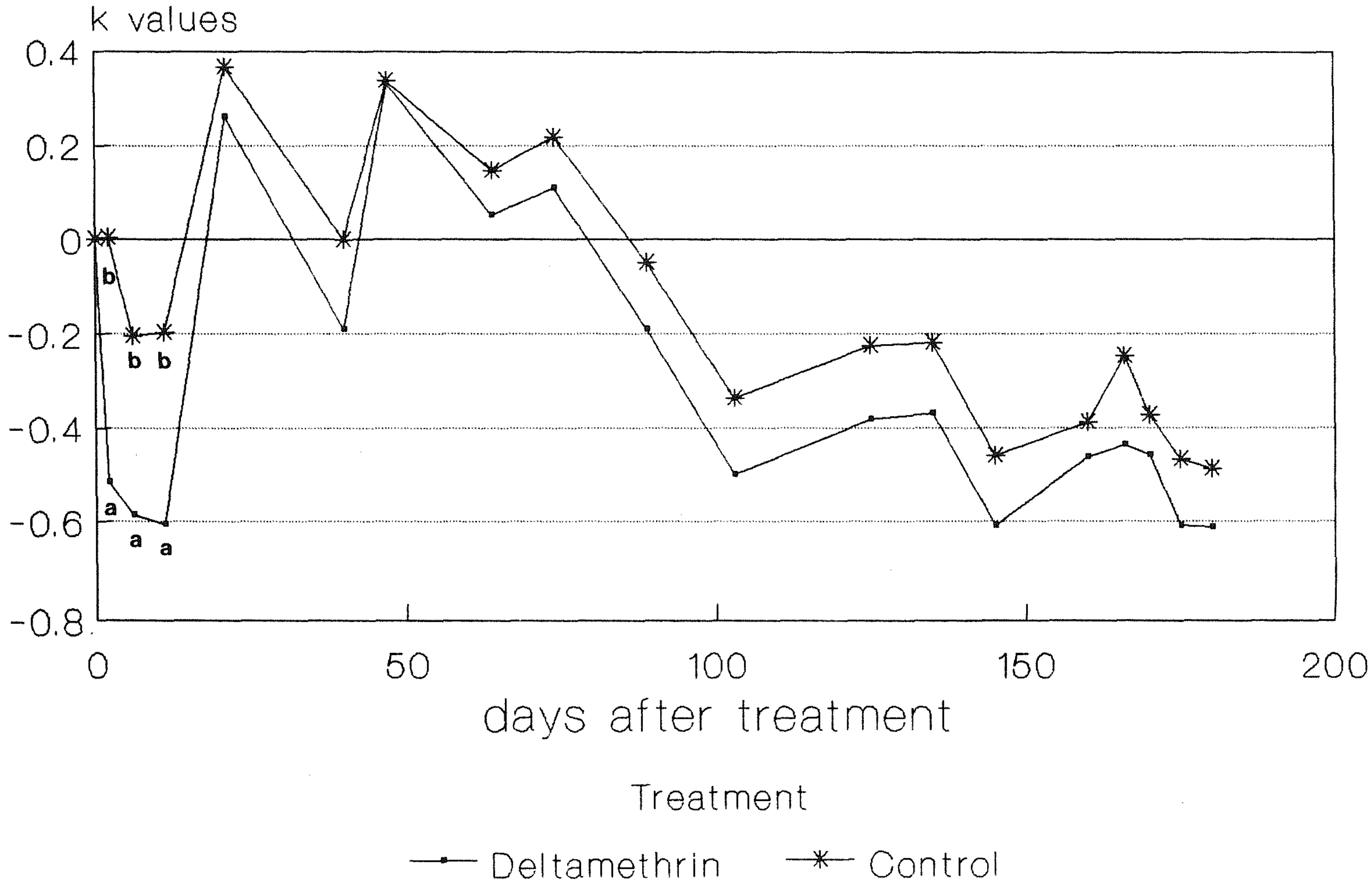


Fig. 5.5 Loricera pilicornis (F.).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

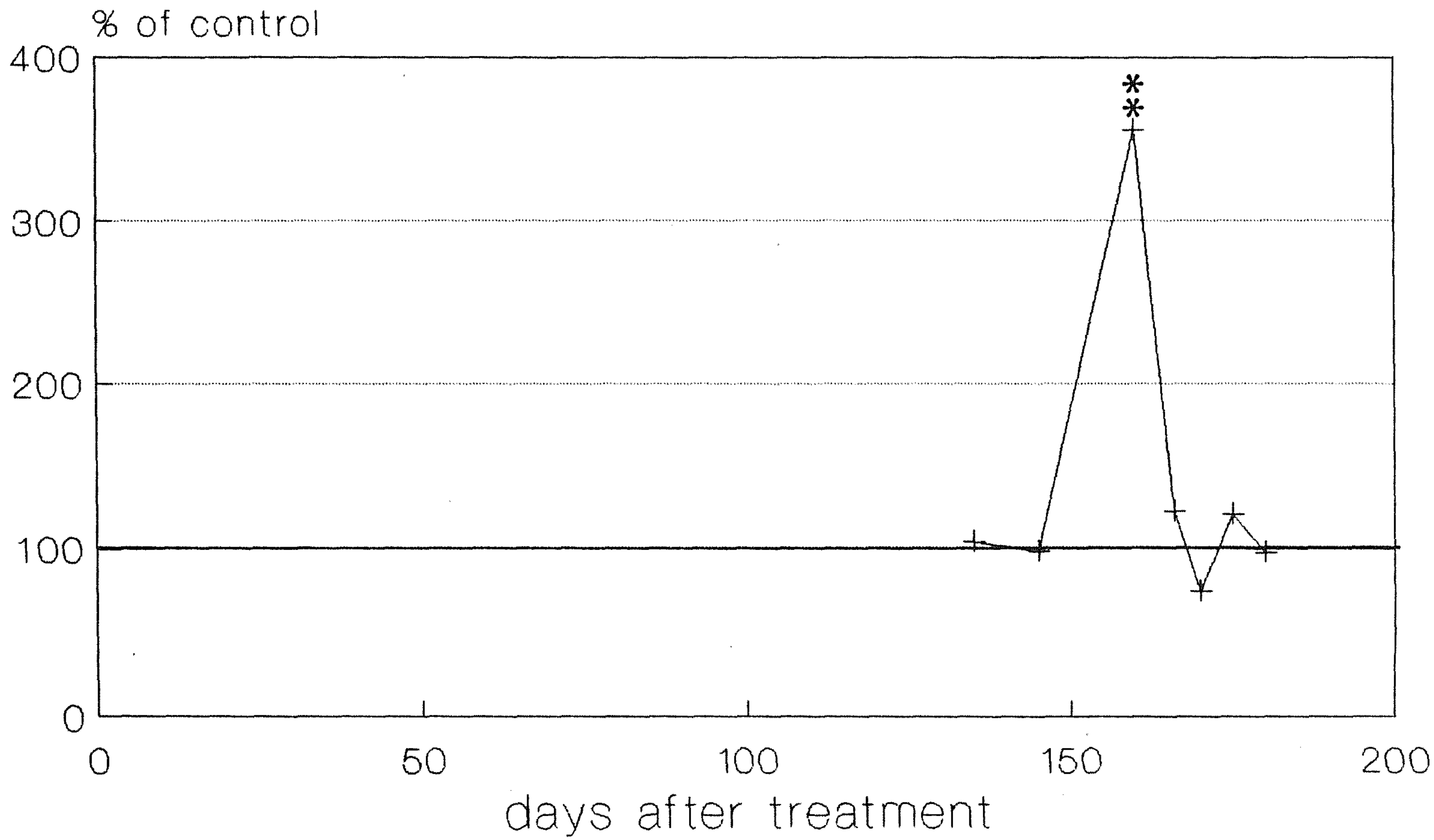


Fig. 5.6 Nebria brevicollis (F.).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

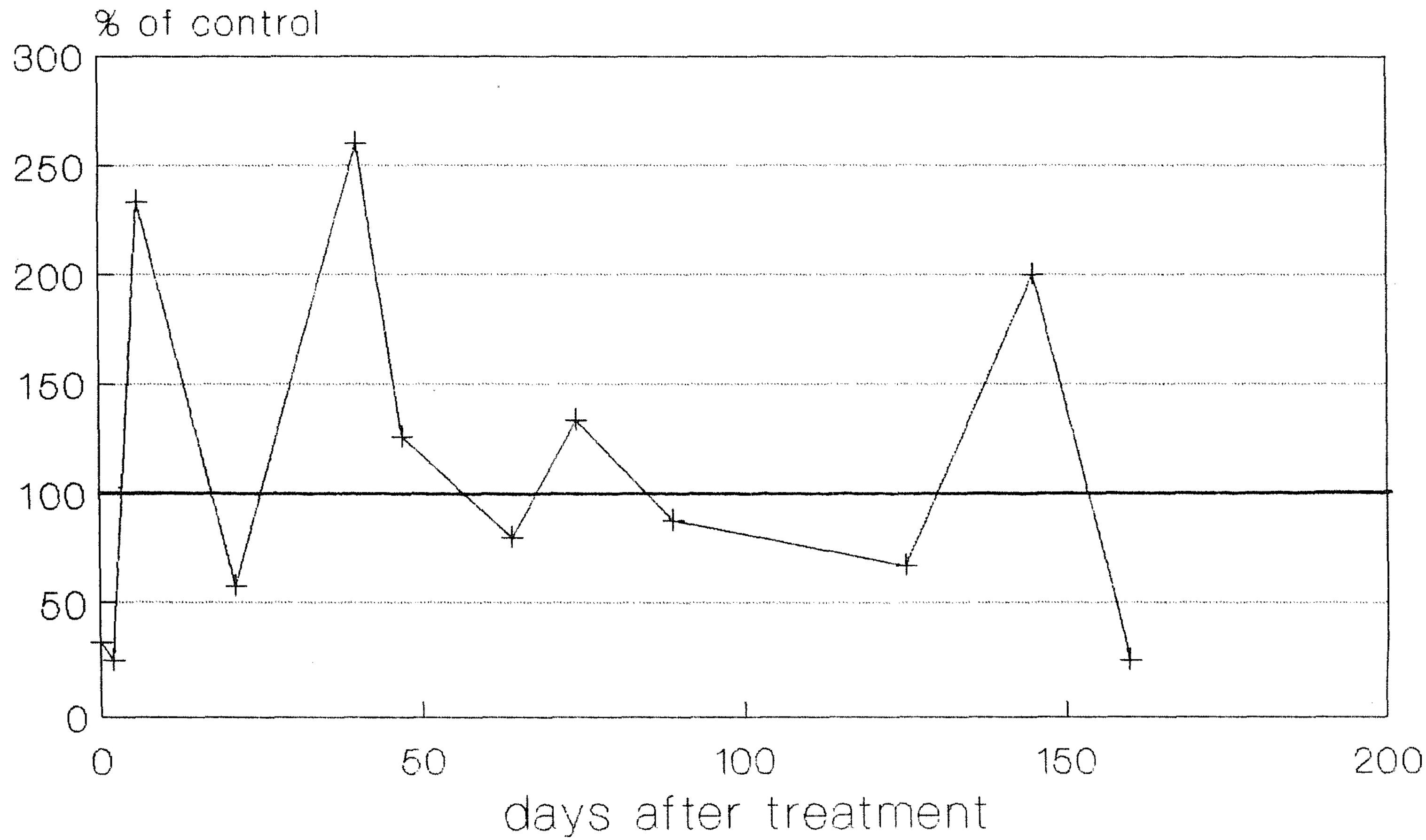


Fig. 5.7 N.brevicollis (F.) larvae.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

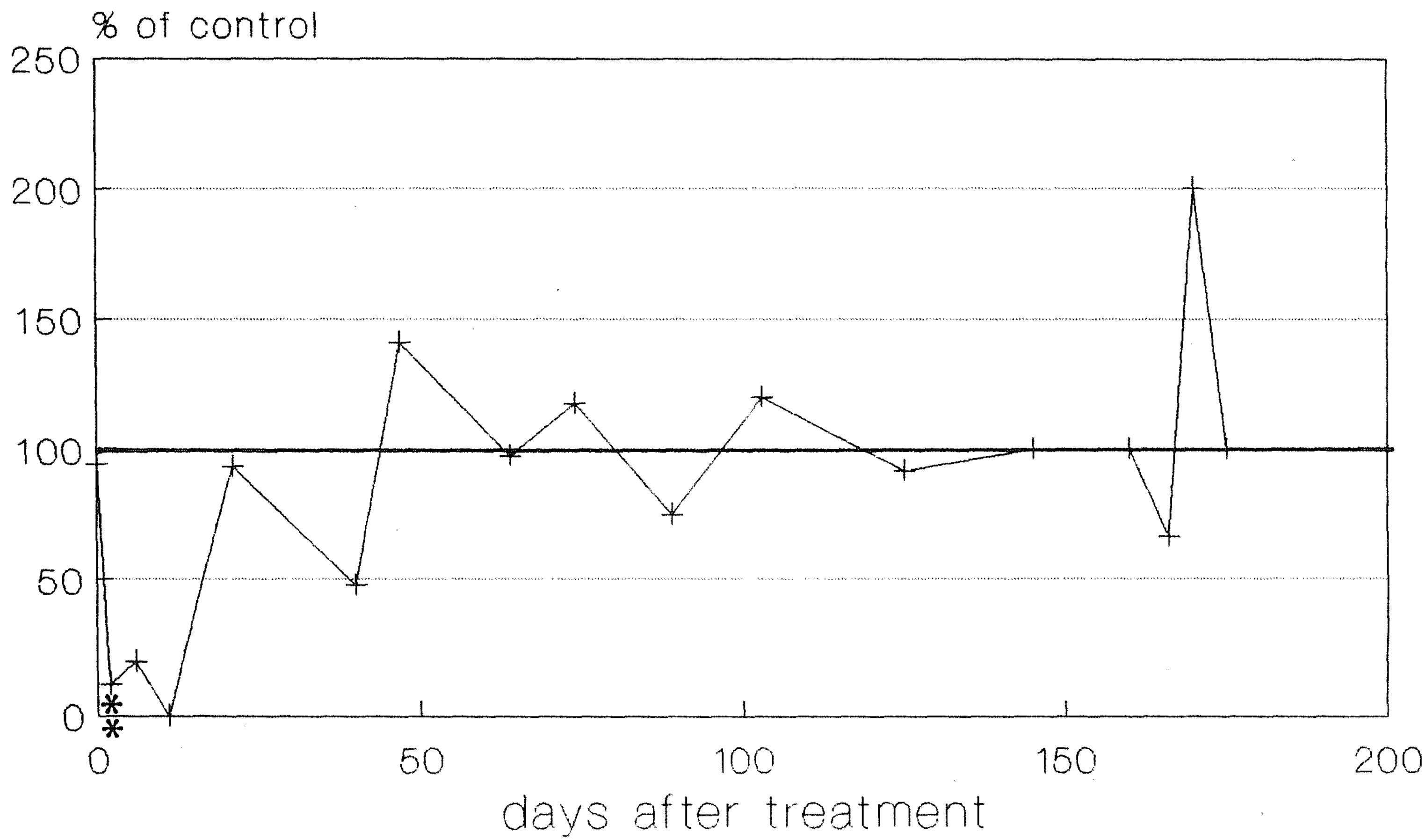


Fig. 5.8 Notiophilus biguttatus (F.).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

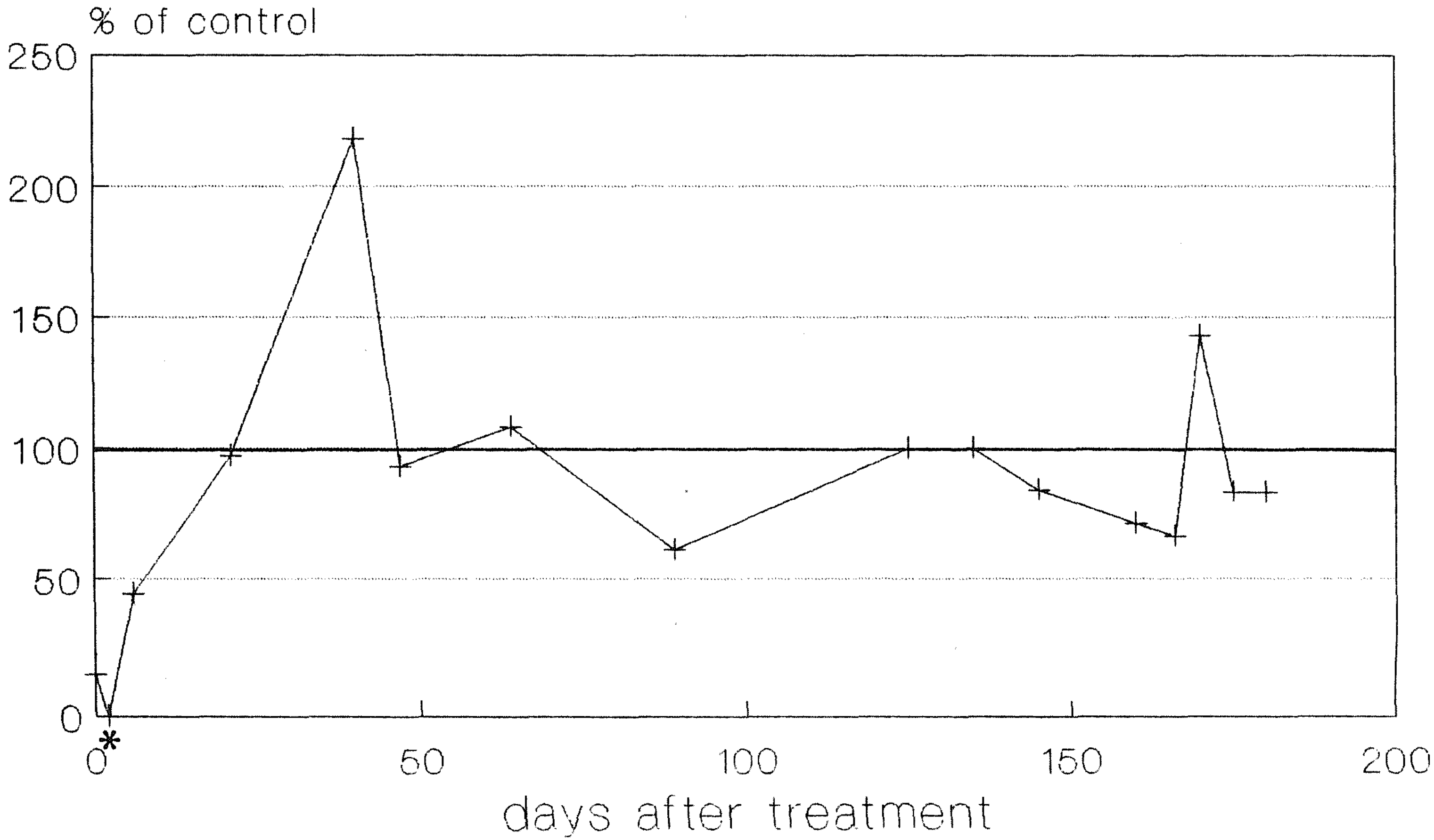


Fig. 5.9 Pterostichus melanarius (Illiger).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at p<0.05 and p<0.01 respectively (t-test).

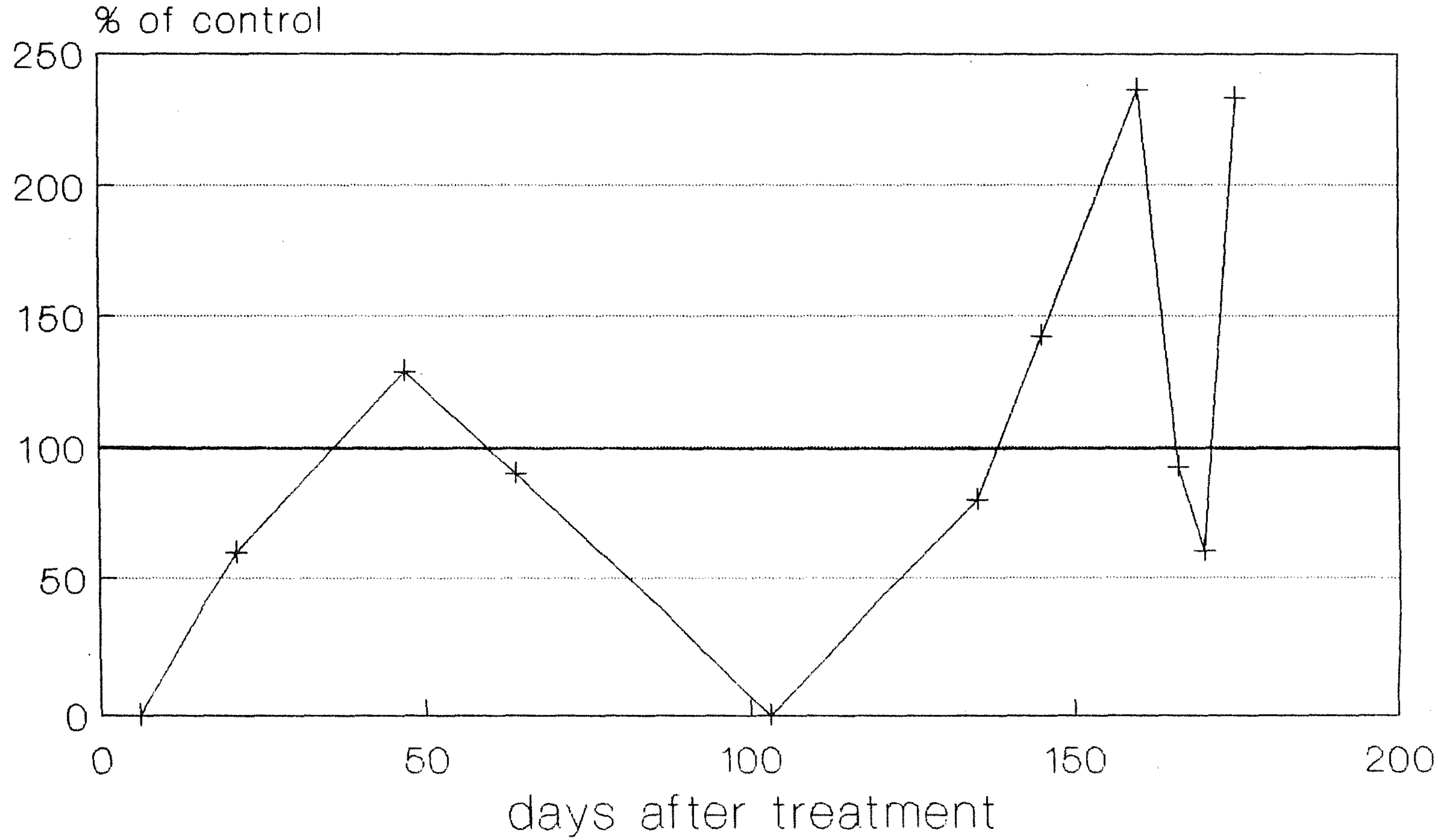


Fig. 5.10 <u>Trechus quadristriatus</u> (Schrank).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at p<0.05 and p<0.01 respectively (t-test).

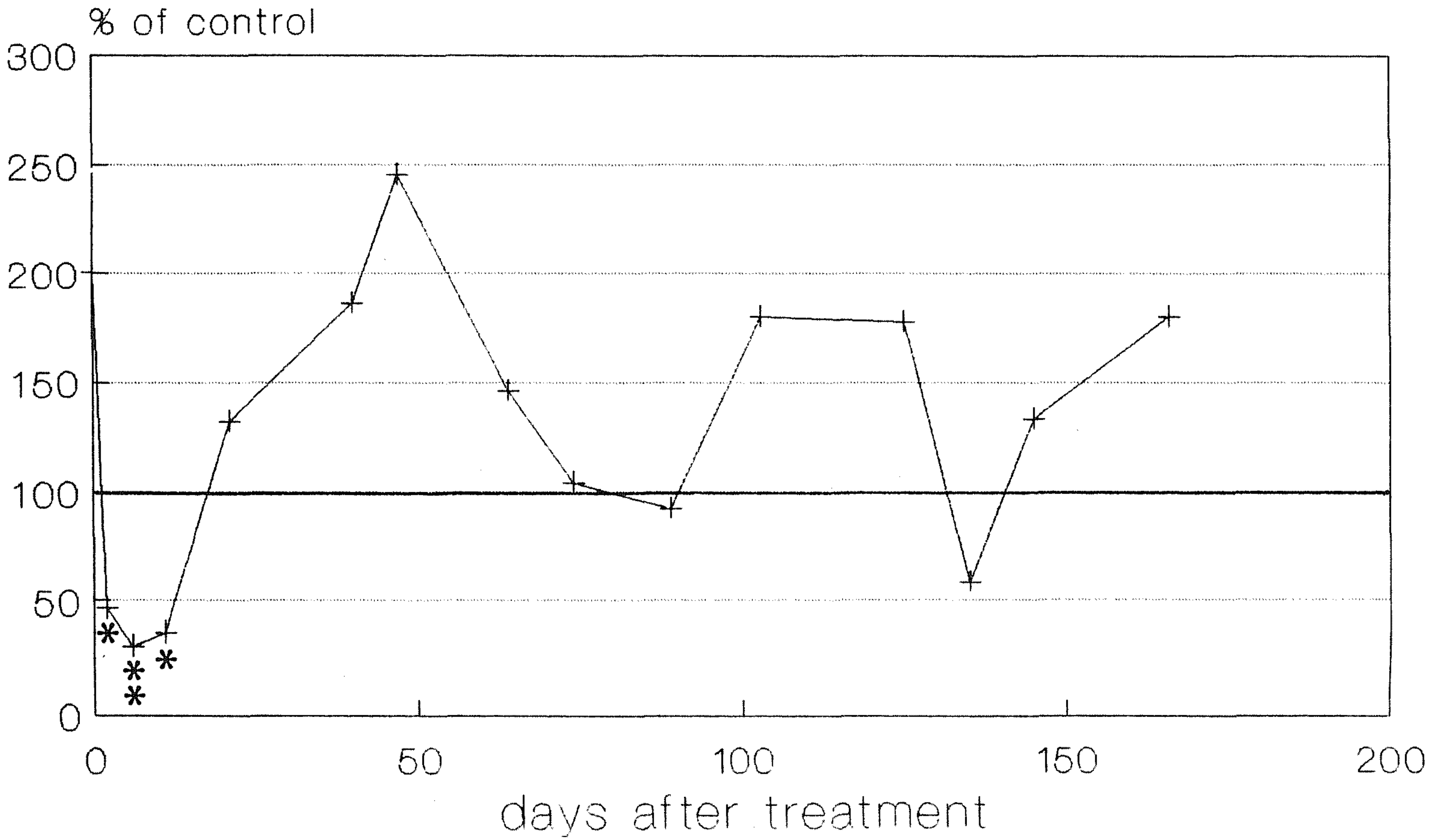


Fig. 5.11 Trechus quadristriatus (Schrank) 'k' values.
Comparison of 'k' values for plots treated with deltamethrin and unsprayed control plots.
N.B. For each sample date, points labelled with different letters are significantly different $p<0.05$ (t-test).

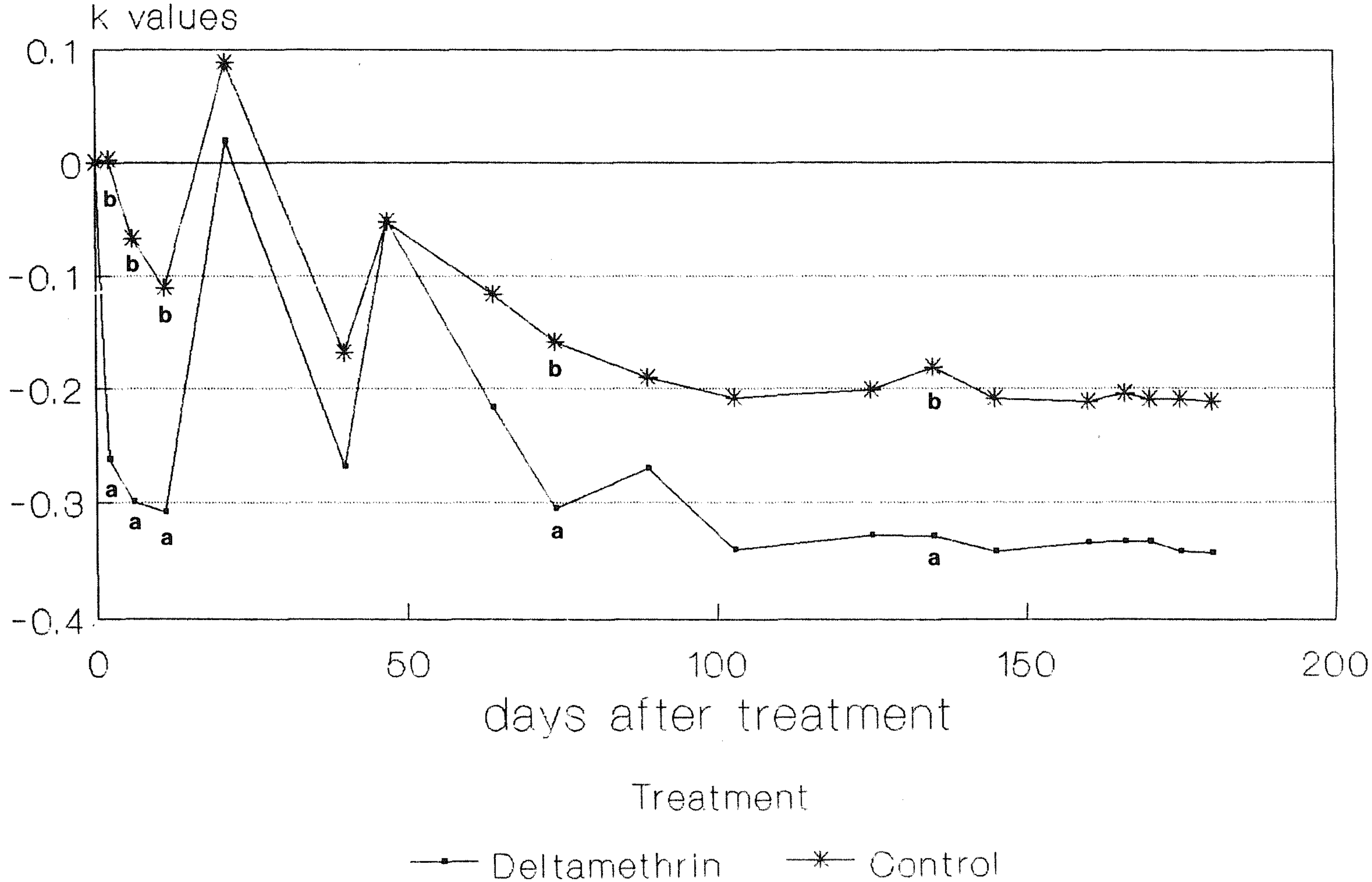


Fig. 5.12 Total adult Carabidae.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at p<0.05 and p<0.01 respectively (t-test).

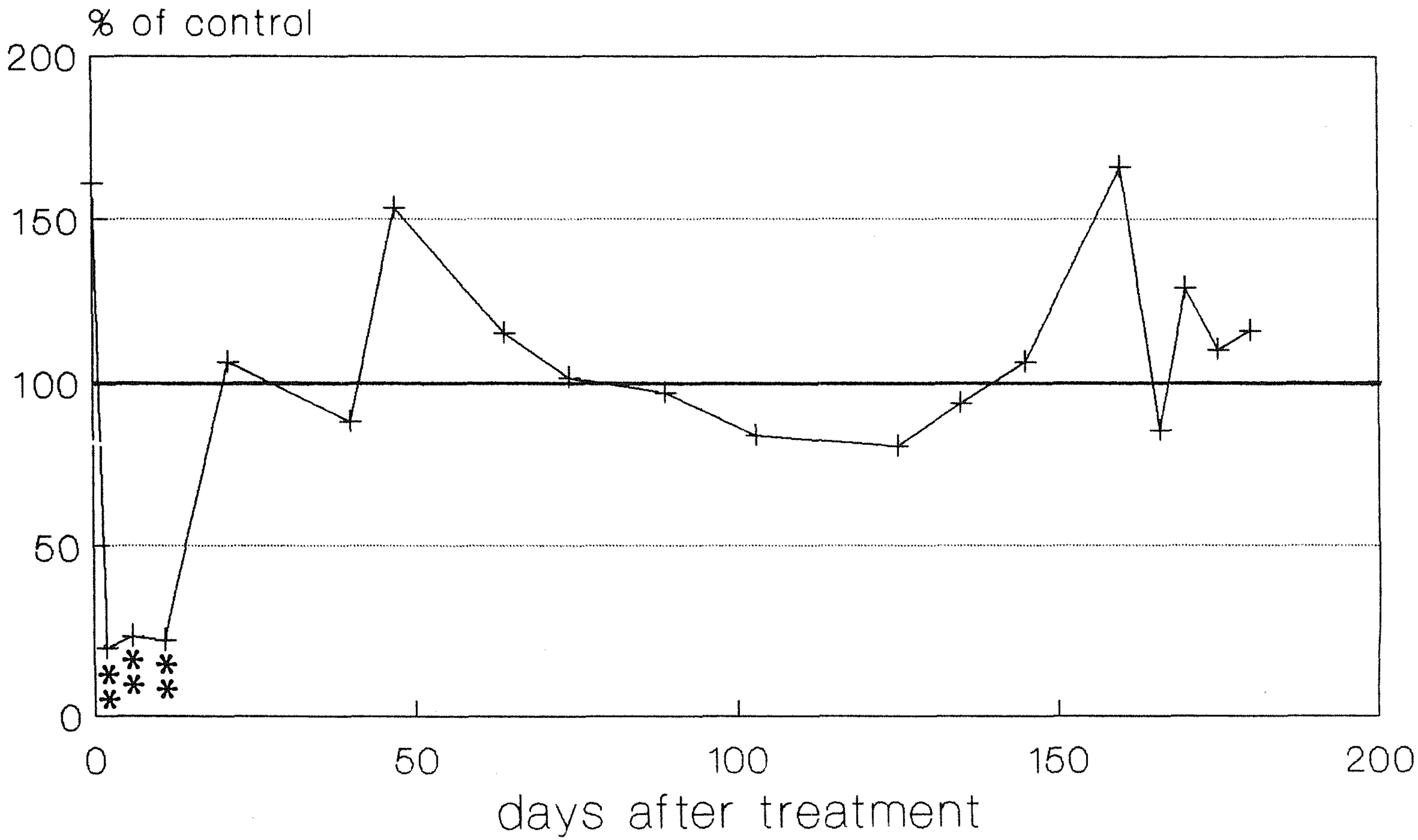


Fig. 5.13 Total adult Carabidae 'k' values.
Comparison of 'k' values for plots treated with deltamethrin and unsprayed control plots.
N.B. For each sample date, points labelled with different letters are significantly different $p<0.05$ (t-test).

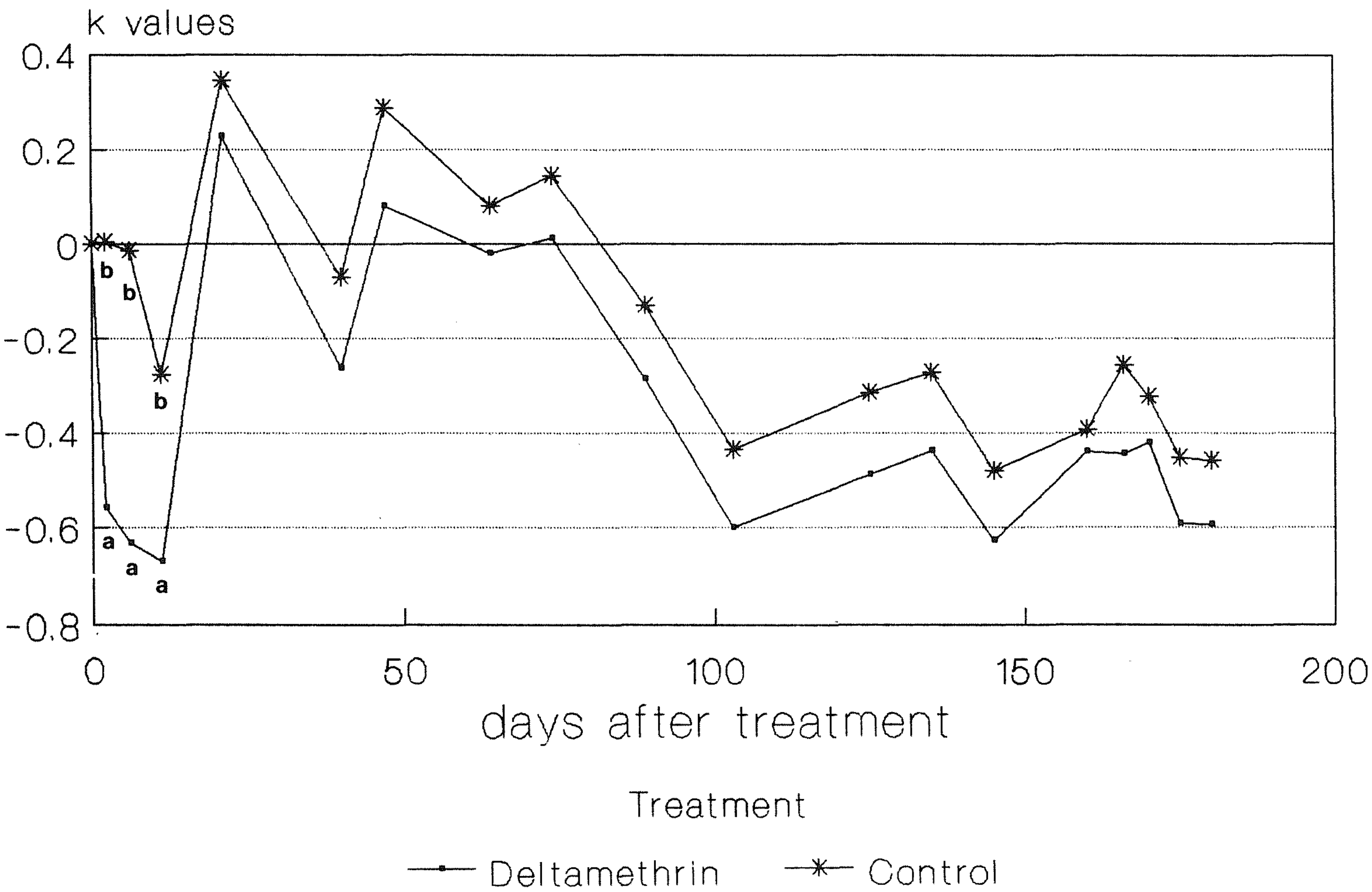


Fig. 5.14 Total carabid larvae.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at p<0.05 and p<0.01 respectively (t-test).

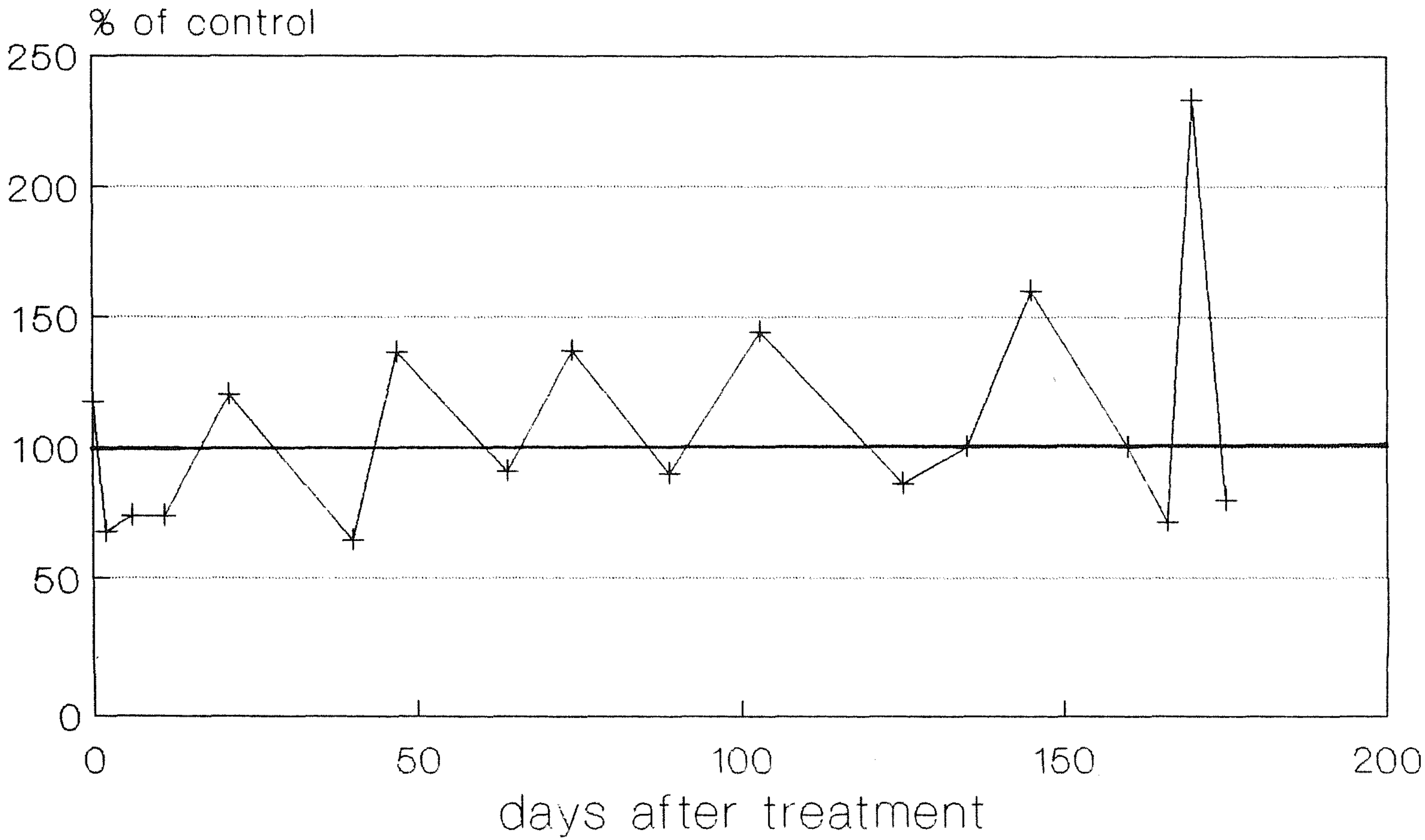


Fig. 5.15 Total adult Staphylinidae.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

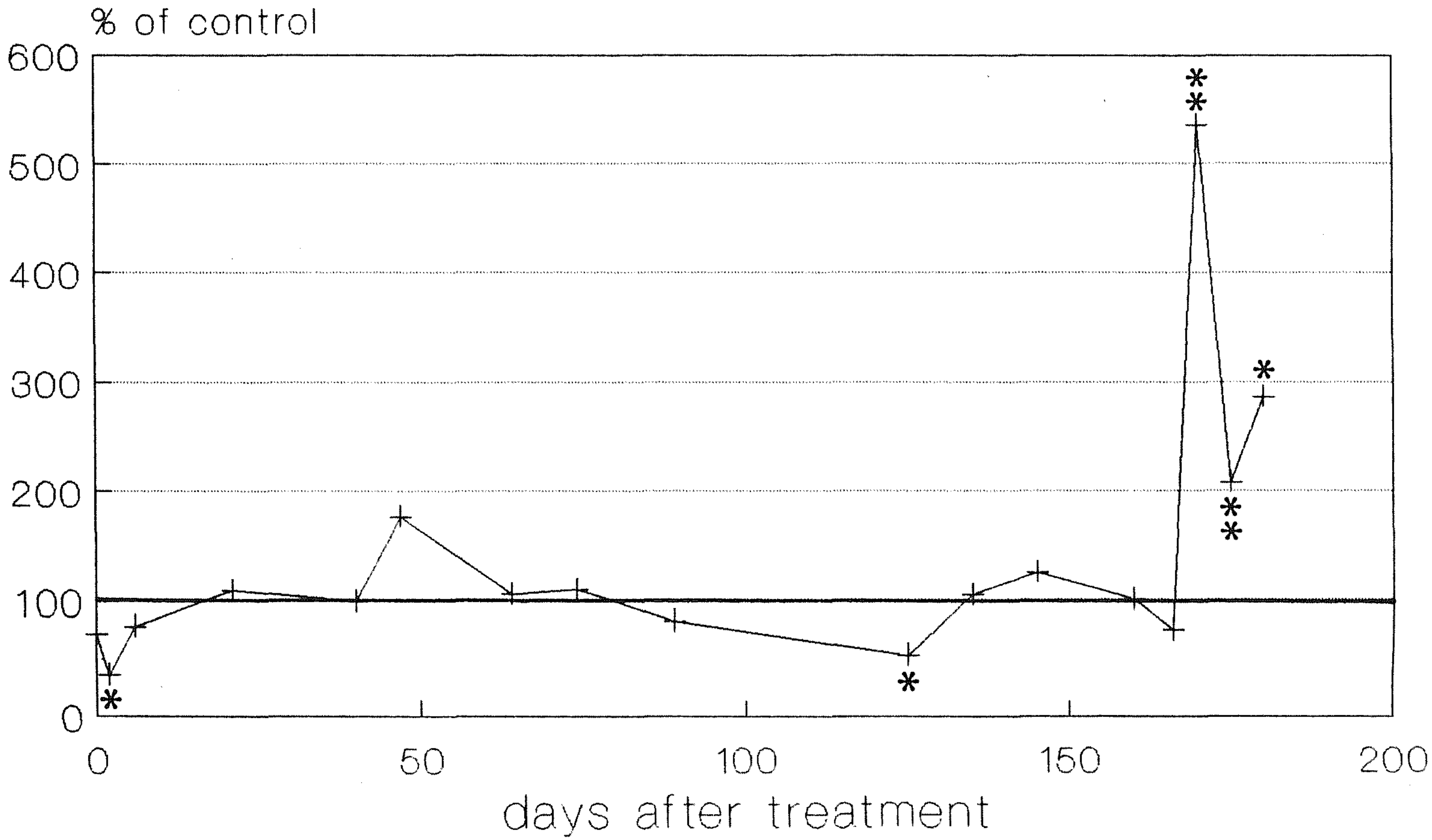


Fig. 5.16 Erigone atra (Blackwall).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at p<0.05 and p<0.01 respectively (t-test).

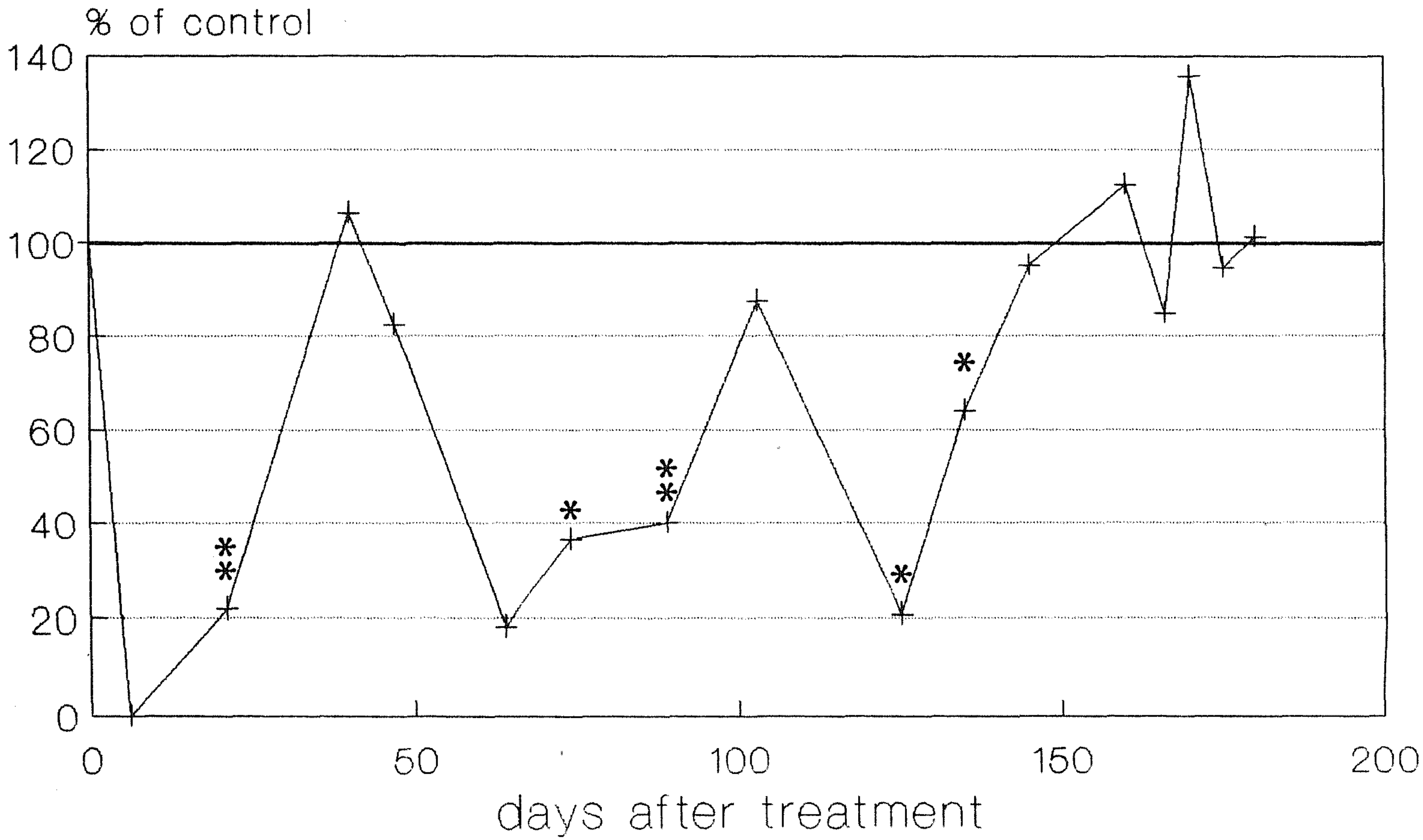


Fig. 5.17 Erigone dentipalpis (Wider).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

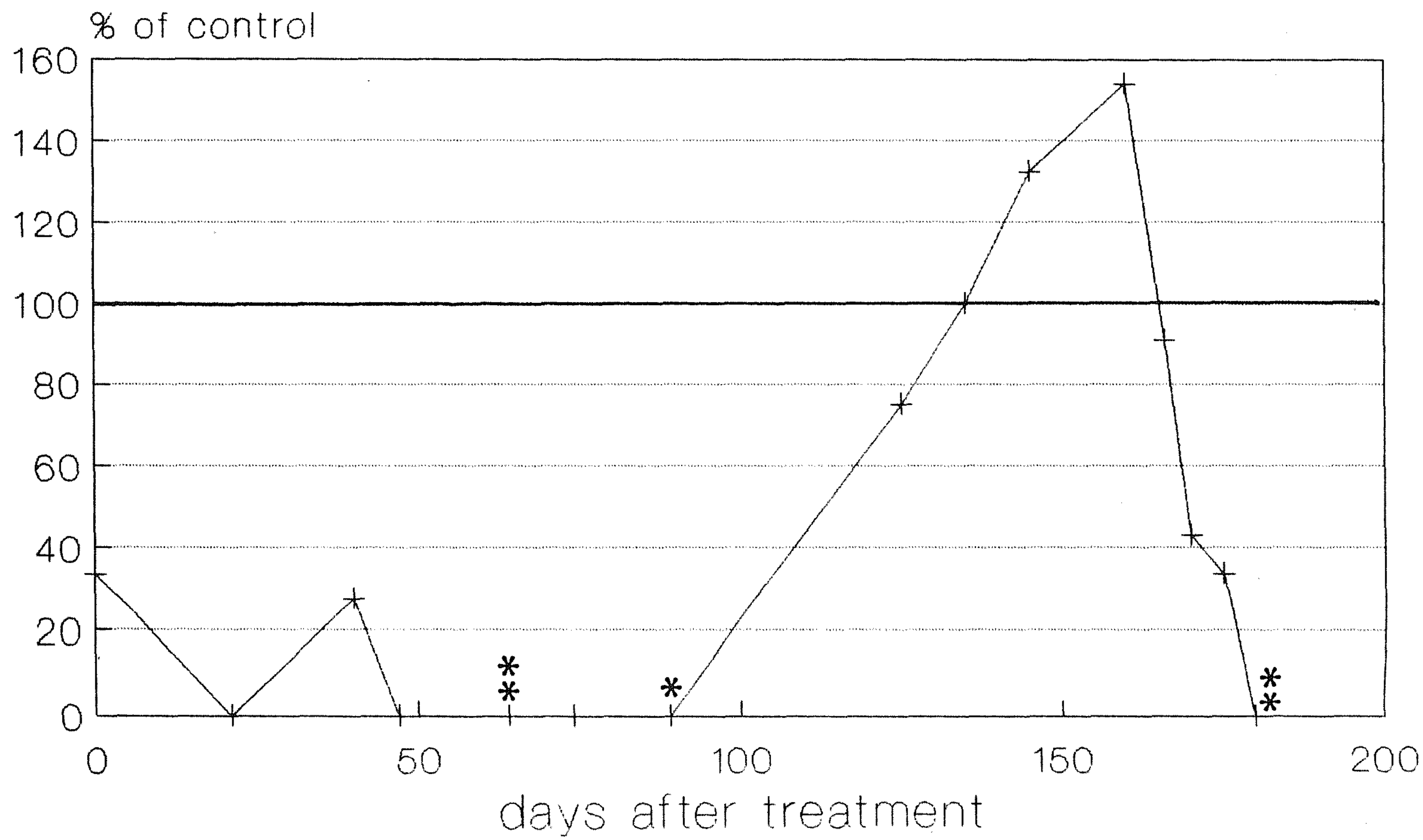


Fig. 5.18 Oedothorax fuscus (Blackwall).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

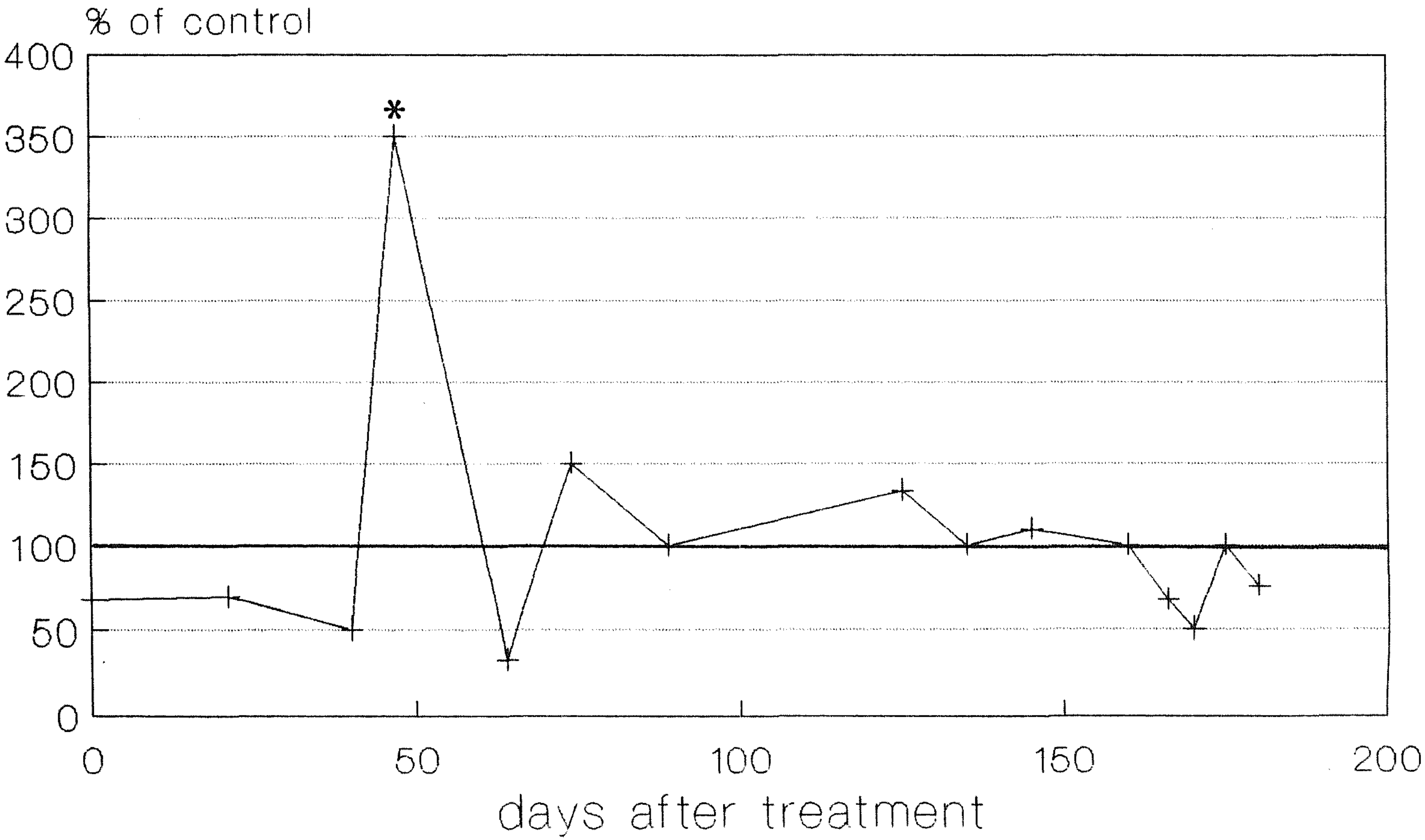


Fig. 5.19 Total Erigoninae.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at p<0.05 and p<0.01 respectively (t-test).

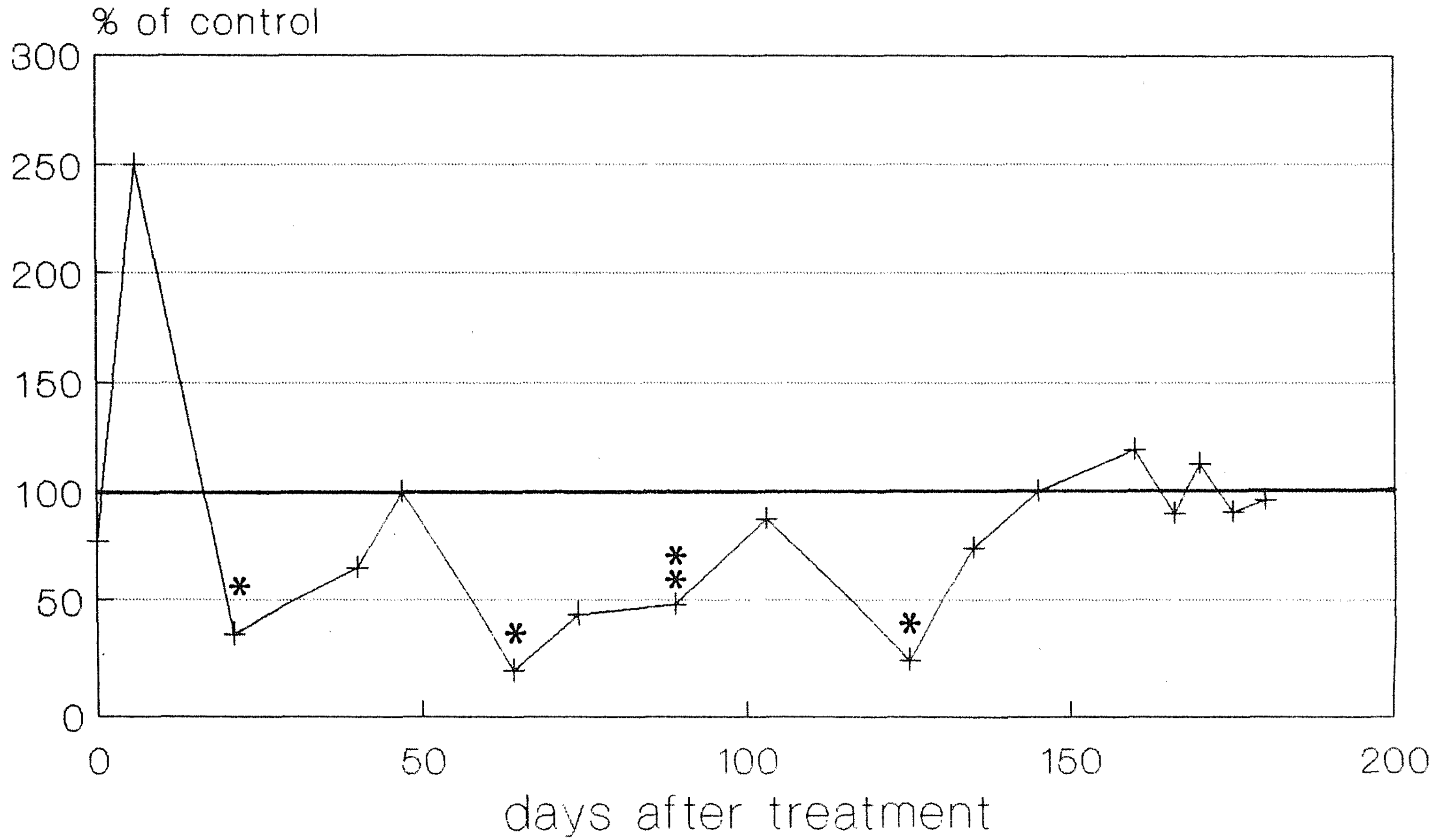


Fig. 5.20 Bathyphantes gracilis (Blackwall).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

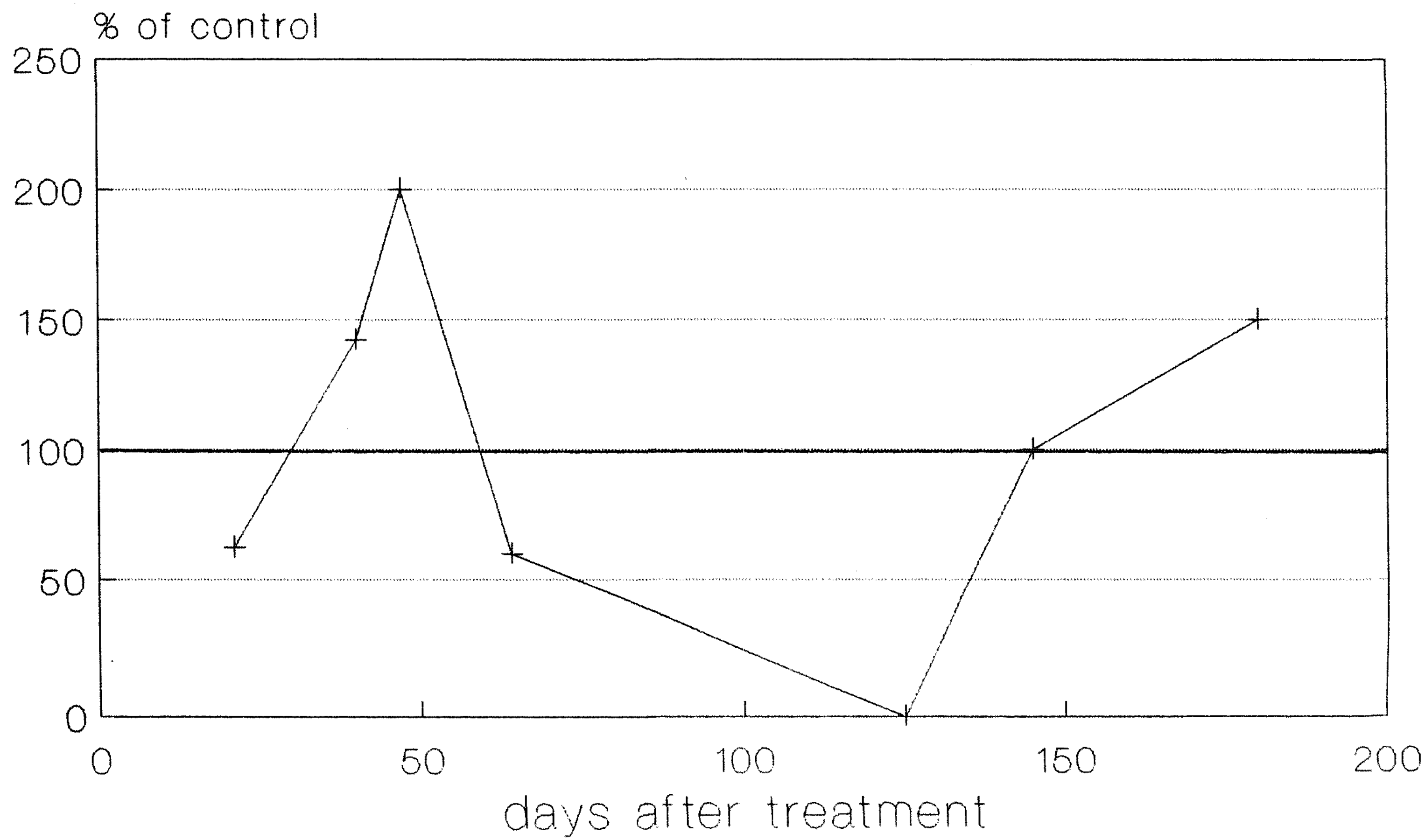


Fig. 5.21 Lepthyphantes tenuis (Blackwall).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

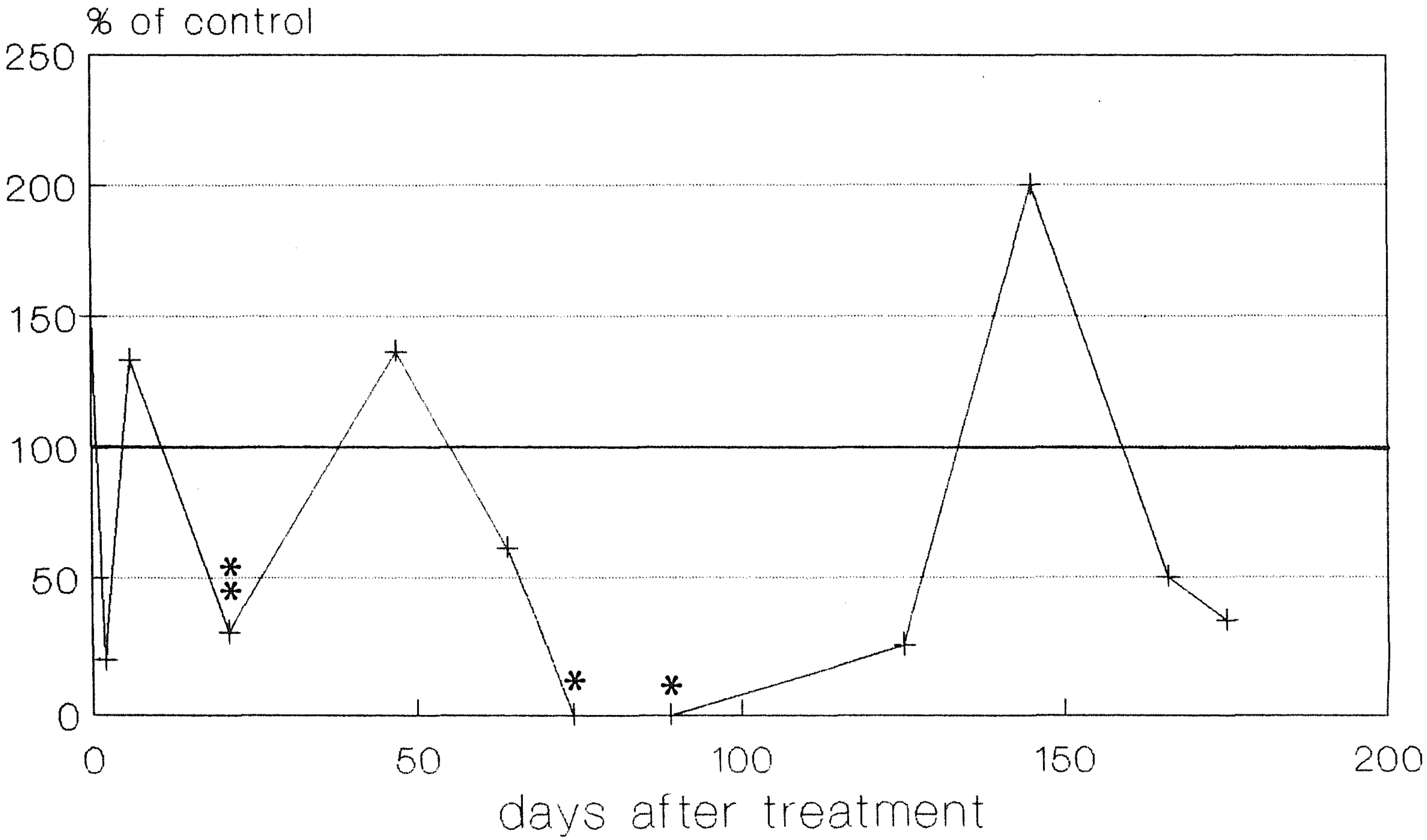


Fig. 5.22 Meioneta rurestris (C.L.Koch).
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at p<0.05 and p<0.01 respectively (t-test).

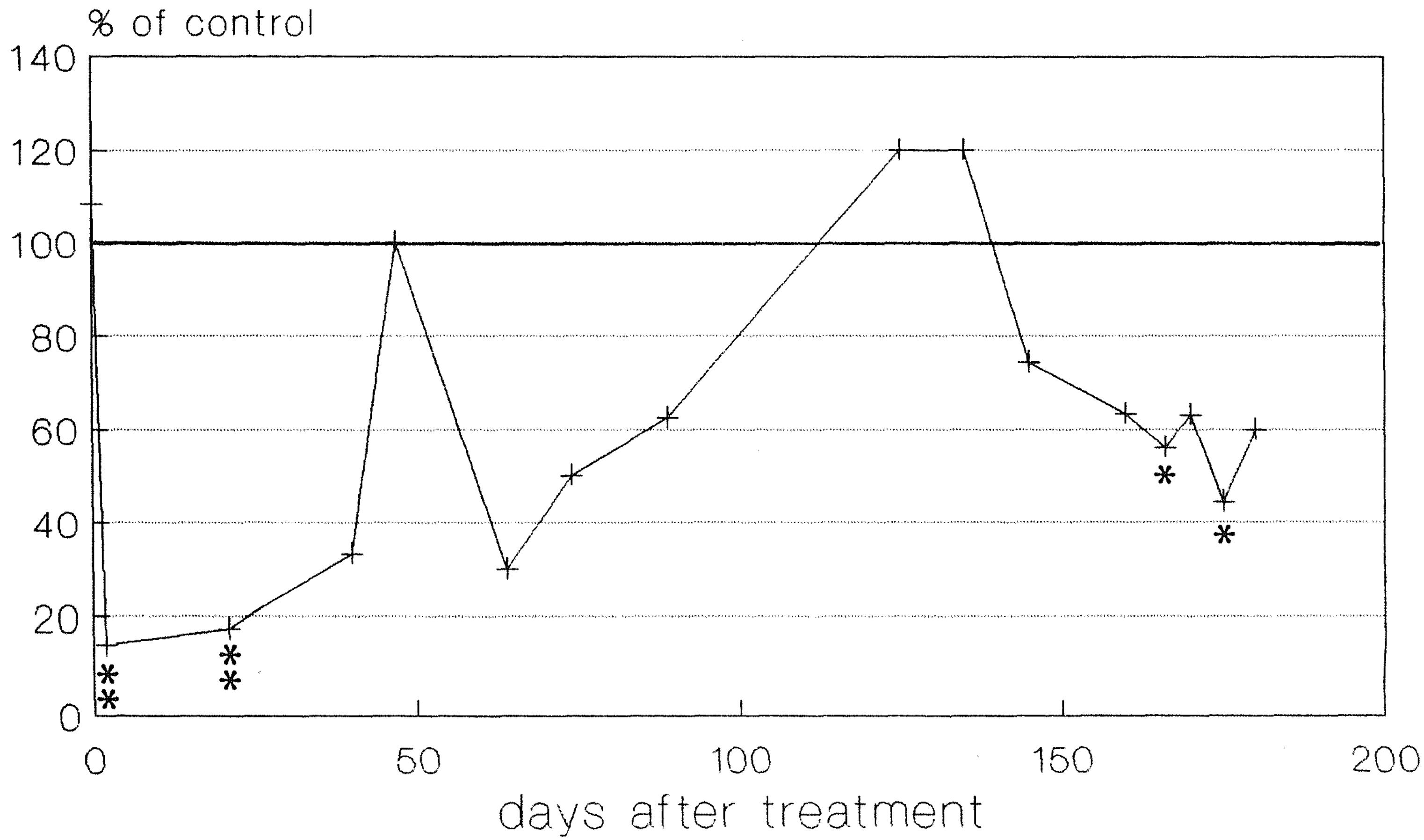


Fig. 5.23 Total Linyphiinae.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

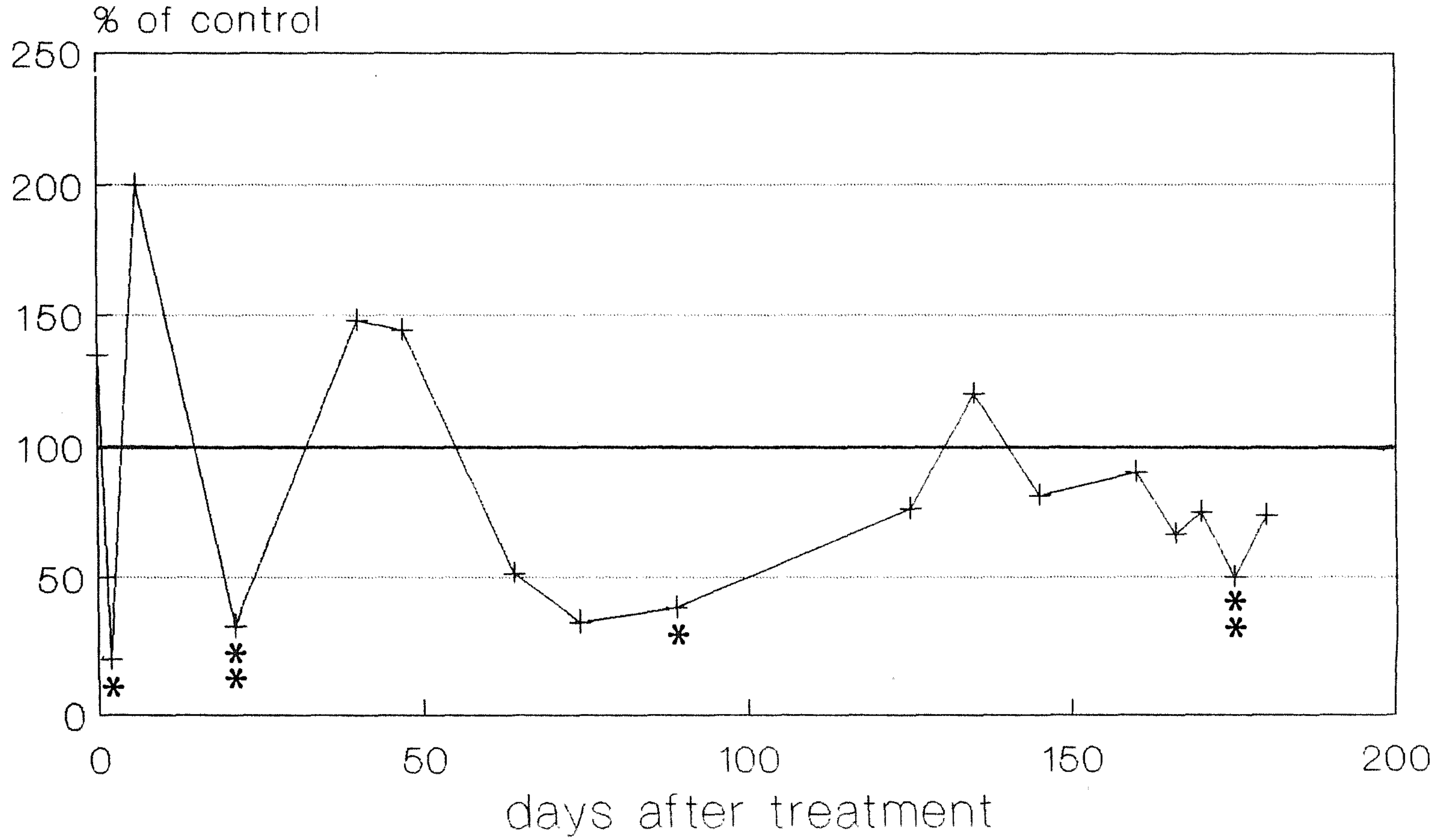


Fig. 5.24 Total Linyphiidae.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

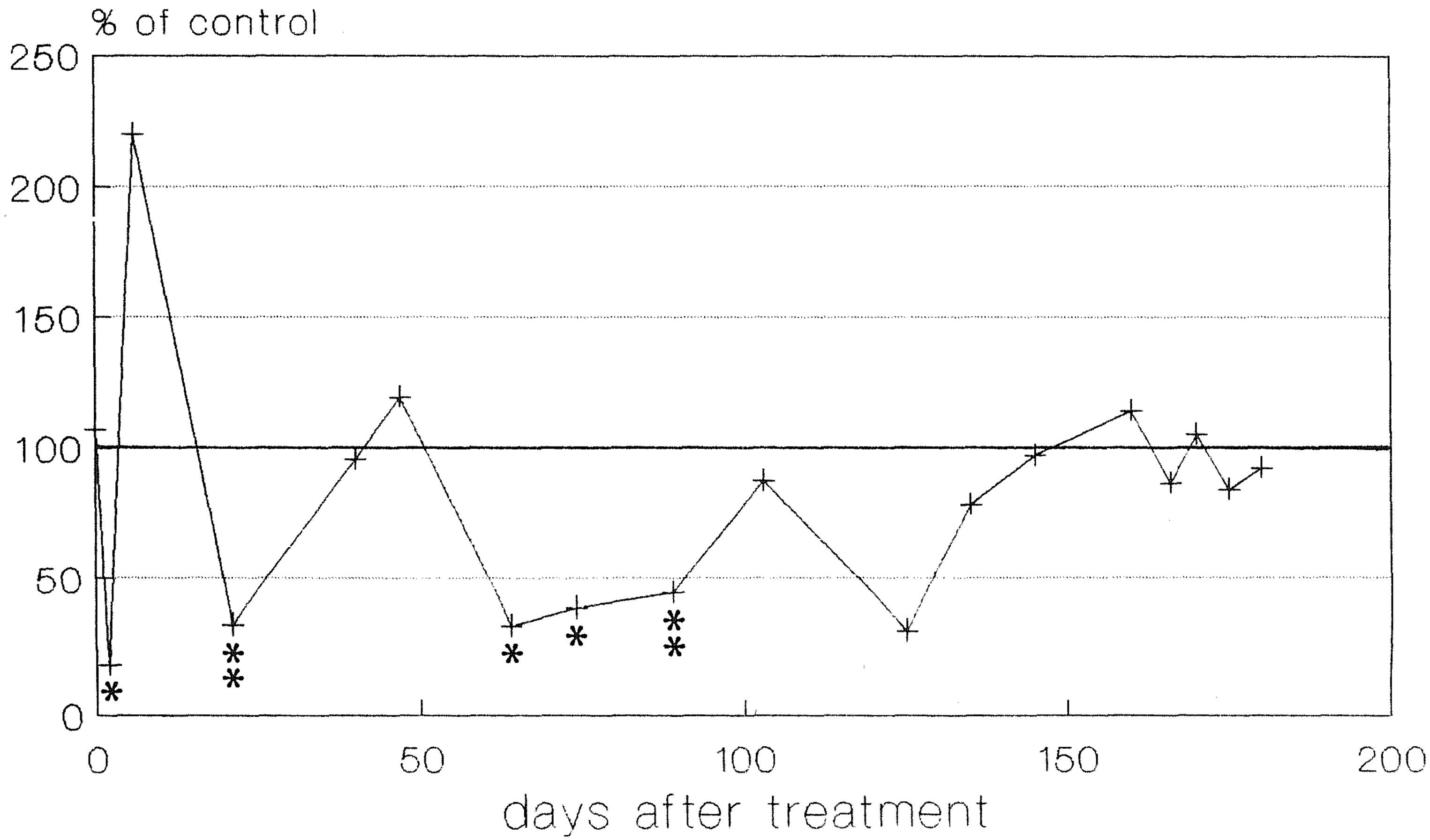


Fig. 5.25 Comparison of spider web densities.
N.B. For individual sample dates, points labelled with different letters are significantly different p<0.05 (t-test). No letters have been assigned on occasions when values could not be separated by statistical means.

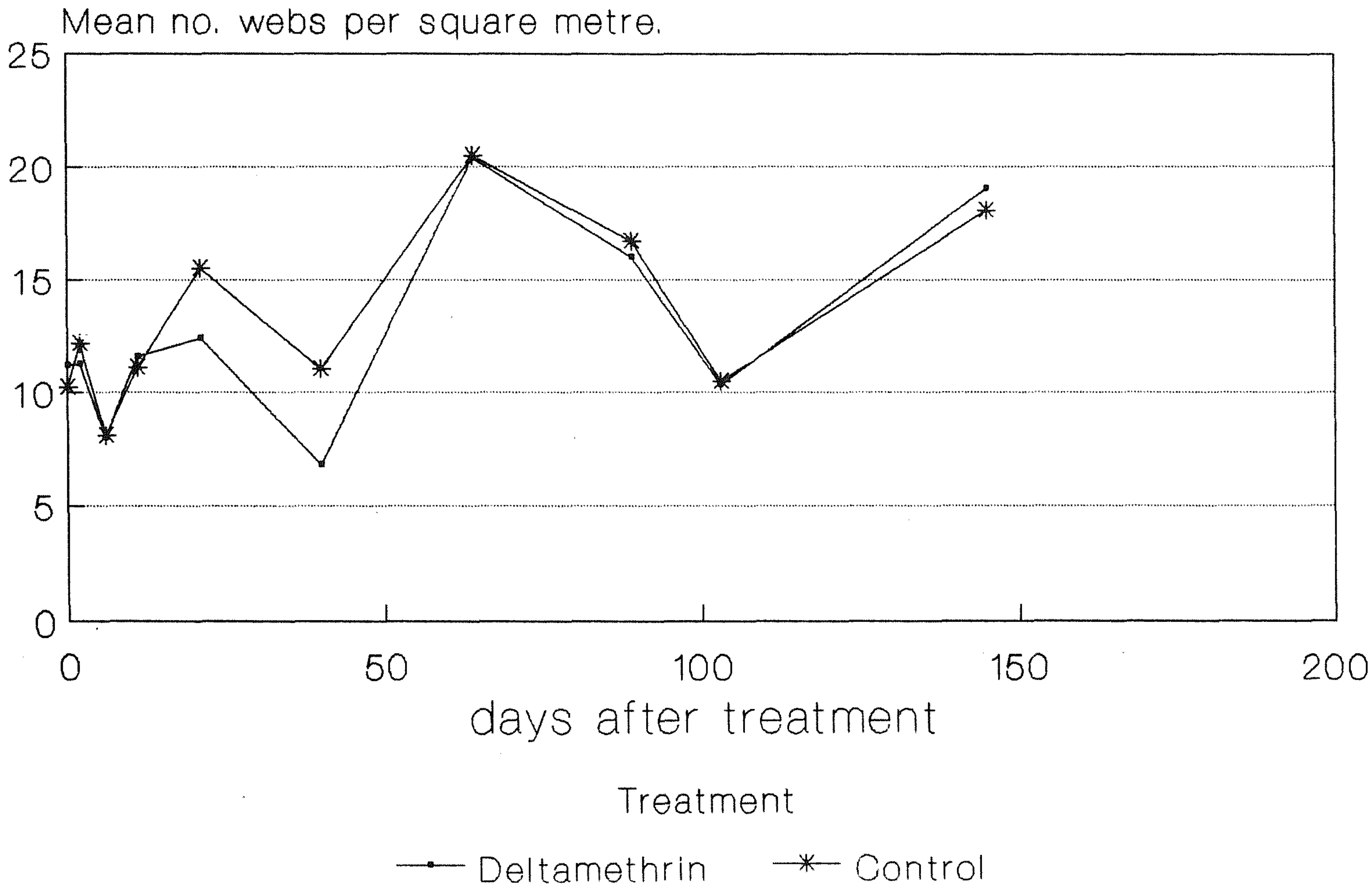


Fig. 5.26 Acari.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

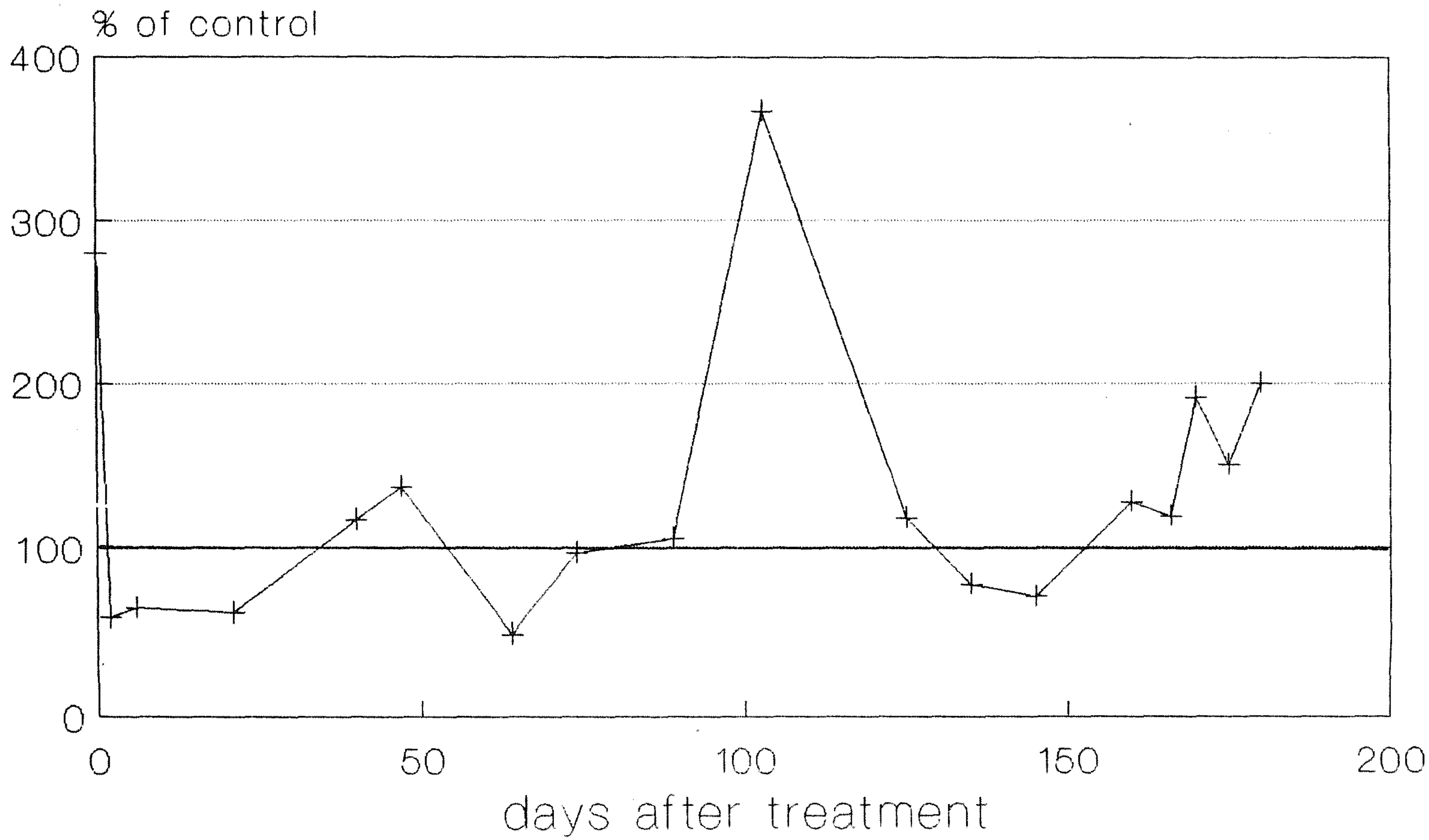


Fig. 5.27 Collembola.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

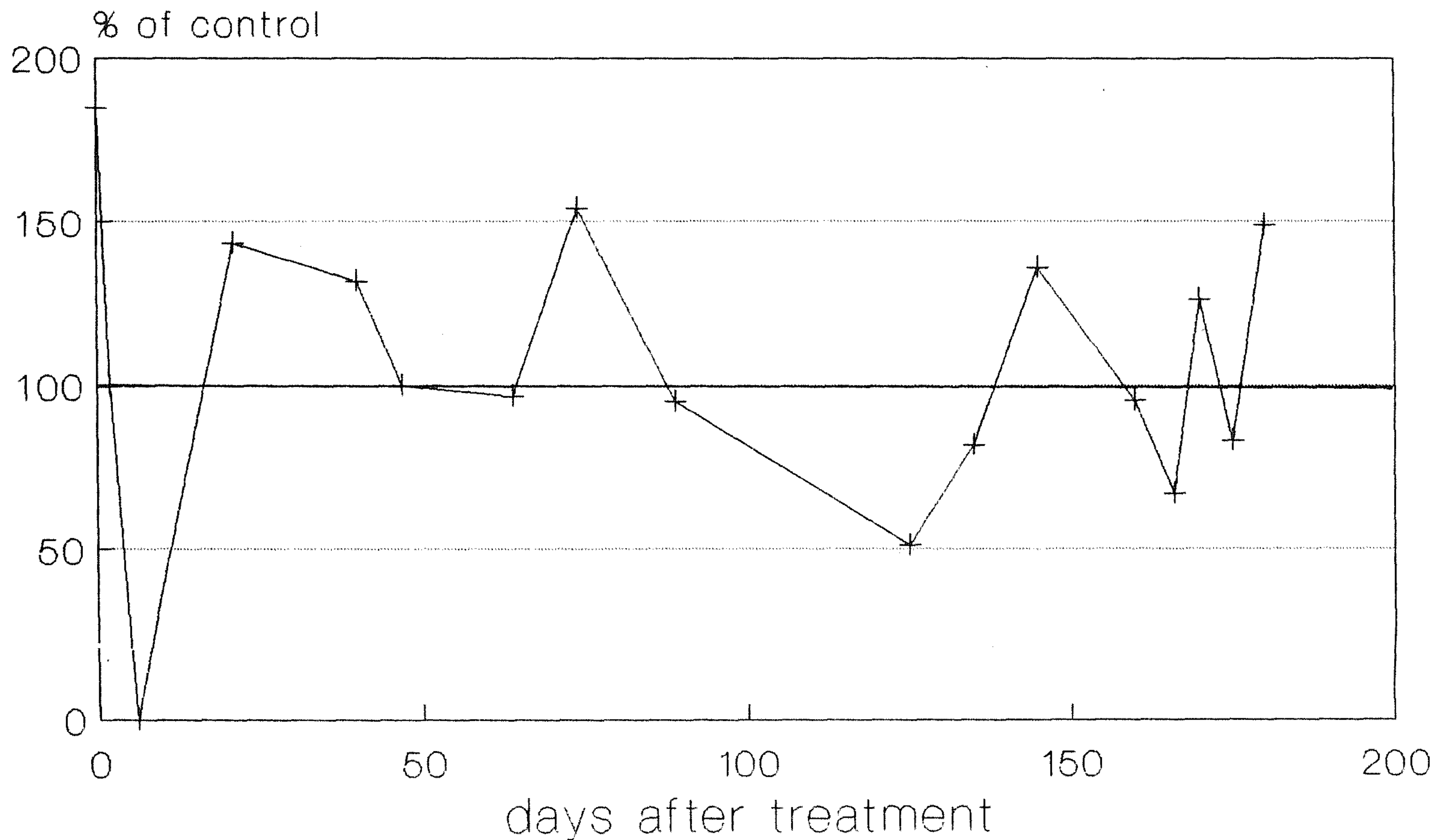


Fig. 5.28 Diptera.
Pitfall trap catches in treated areas as a percentage of those in control plots.
N.B. * and * * indicate that points are significantly different from control values at p<0.05 and p<0.01 respectively (t-test).

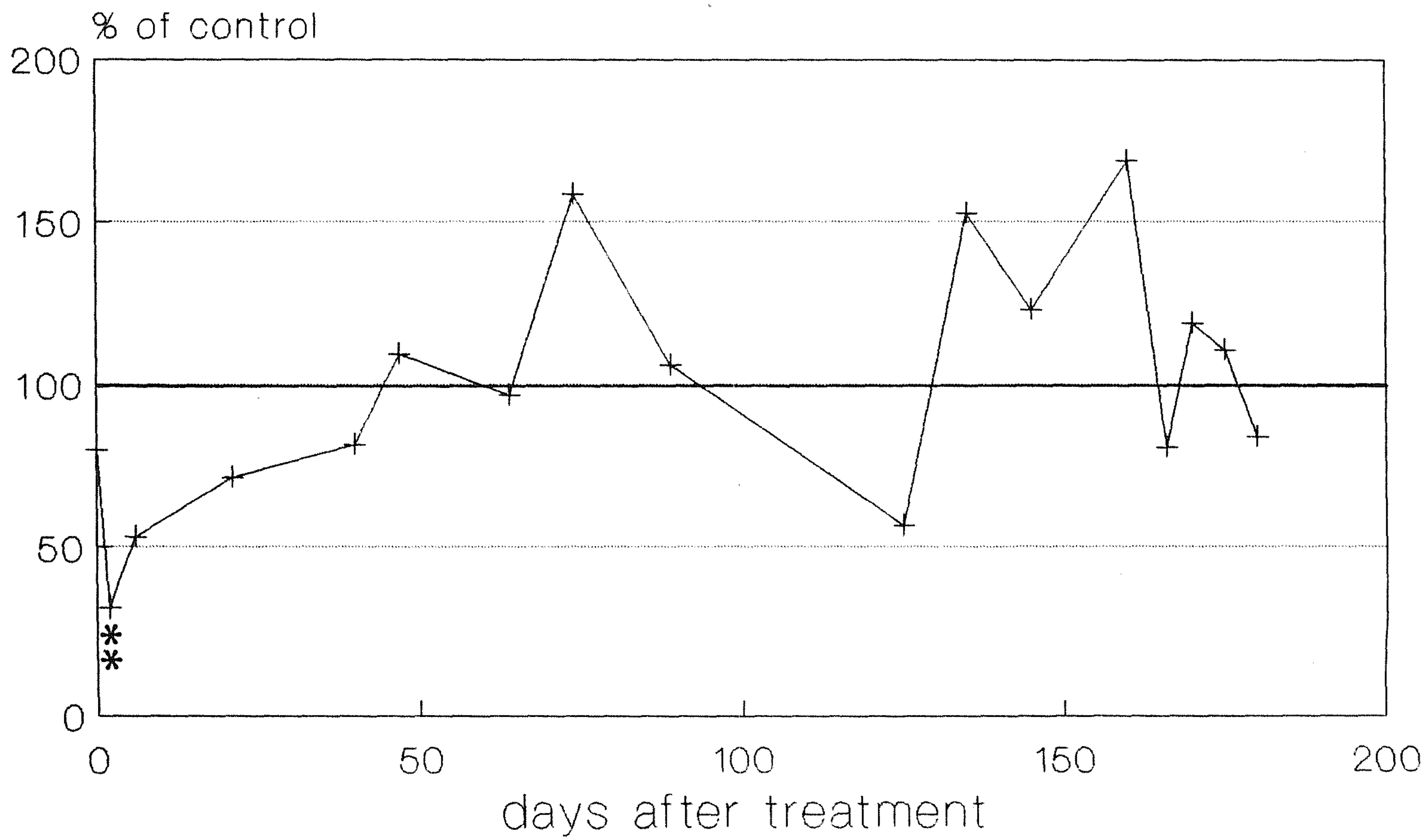


Table 5.1
Summary of pitfall trap results for deltamethrin field trial.
Dates on which treatment catches were significantly higher than those in control plots ($p<0.05$, t-test) are indicated with + while significantly lower catches are depicted by a - symbol. Precise values for the relevant t-statistics and significance levels are presented in Appendix 5.

N.B. Significance for sign tests was set at $p<0.05$.

	DAYS RELATIVE TO TREATMENT (DELTAMETHRIN)									
Species/Group	00	02	06	11	21	40	47	64	74	89
B.lampros										
B.obtusum		-	-	-						
B.obtusum 'k'		-	-	-						
L.pilicornis										
N.brevicollis										
N.brev. larvae		-								
N.biguttatus		-								
P.melanarius										
T.quadristriatus		-	-	-						
T.quad 'k' value		-	-	-					-	
Total Carabidae		-	-	-						
Carabidae 'k'		-	-	-						
Carabid larvae										
Staphylinidae		-								
E.atra					-				-	-
E.dentipalpis								-		-
O.fuscus							+			
Total Erigoninae					-			-		-
B.gracilis										
L.tenuis					-				-	-
M.rurestris		-			-					
Total Linyphiinae		-			-					-
Total Linyphiidae		-			-			-	-	-
Acari										
Collembola										
Diptera		-								

Table 5.1 (continued).
Summary of pitfall trap results for deltamethrin field trial.
Dates on which treatment catches were significantly higher than those in control plots ($p<0.05$, t-test) are indicated with + while significantly lower catches are depicted by a - symbol. Precise values for the relevant t-statistics and significance levels are presented in Appendix 5.

N.B. Significance for sign tests was set at $p<0.05$.

	DAYS RELATIVE TO TREATMENT (DELTAMETHRIN)									
Species/Group	103	125	135	145	160	166	170	175	180	sign test
B.lampros										
B.obtusum										
B.obtusum 'k'										-
L.pilicornis					+					
N.brevicollis										
N.brev. larvae										
N.biguttatus										
P.melanarius										
T.quadristriatus										
T.quad 'k' values			-							-
Total Carabidae										
Carabidae 'k'										-
Carabid larvae										
Staphylinidae		-					+	+	+	
E.atra		-	-							
E.dentipalpis									-	-
O.fuscus										
Total Erigoninae		-								-
B.gracilis										
L.tenuis										
M.rurestris						-		-		-
Total Linyphiinae								-		-
Total Linyphiidae										
Acari										
Collembola										
Diptera										

Table 5.2
Pitfall trap data for Bembidion lampros (Herbst.).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
160	0.0197 ± 0.0270	0.0275 ± 0.0028	-0.2968	0.7742
166	0.0377 ± 0.0335	0.1011 ± 0.0940	-1.4200	0.1934
170	0.1100 ± 0.0274	0.1886 ± 0.0894	-1.8811	0.0968
175	0.0487 ± 0.0246	0.0663 ± 0.0151	-0.9307	0.3793
180	0.0507 ± 0.0413	0.0688 ± 0.0413	-0.6925	0.5083

Table 5.3
Pitfall trap data for Bembidion obtusum (Serville).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
160	0.0834 ± 0.0406	0.2148 ± 0.0310	-5.7166	0.0005**
166	0.2795 ± 0.0993	0.3332 ± 0.0859	-0.9752	0.3580
170	0.1288 ± 0.0915	0.2225 ± 0.0764	-1.7581	0.1168
175	0.0397 ± 0.0087	0.0773 ± 0.0444	-1.8600	0.0999
180	0.0426 ± 0.0211	0.0913 ± 0.0471	-2.1114	0.0677

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Table 5.4
Pitfall trap data for <u>Loricera pilicornis</u> (F.).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
160	0.0135 ± 0.0140	0.0068 ± 0.0093	0.8880	0.4005
166	0.0140 ± 0.0169	0.0113 ± 0.0118	0.2912	0.7783
170	0.0409 ± 0.0237	0.0580 ± 0.0542	-0.6461	0.5363
175	0.0169 ± 0.0118	0.0068 ± 0.0093	1.4988	0.1723
180	0.0134 ± 0.0183	0.0000 ± 0.0000	1.6330	0.1411

Table 5.5
Pitfall trap data for <u>Pterostichus melanarius</u> (Illiger).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
160	0.0067 ± 0.0149	0.0168 ± 0.0168	-1.0060	0.3439
166	0.0641 ± 0.0211	0.0709 ± 0.0770	-0.1923	0.8523
170	0.0249 ± 0.0220	0.0345 ± 0.0546	-0.3678	0.7226
175	0.0034 ± 0.0076	0.0034 ± 0.0076	0.0000	1.0000
180	0.0000 ± 0.0000	0.0068 ± 0.0093	-1.6330	0.1411

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Table 5.6
Pitfall trap data for *Trechus quadristriatus* (Schrank).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD		t-stat	Sig.Level
	Treatment	Control		
160	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
166	0.0158 ± 0.0354	0.0214 ± 0.0345	-0.2533	0.8064
170	0.0042 ± 0.0095	0.0000 ± 0.0000	-1.0000	0.3466
175	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
180	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466

Table 5.7
Pitfall trap data for total adult Carabidae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD		t-stat	Sig.Level
	Treatment	Control		
160	0.1213 ± 0.0456	0.2465 ± 0.0553	-3.9043	0.0045**
166	0.3492 ± 0.1052	0.4275 ± 0.1290	-1.0532	0.3230
170	0.2899 ± 0.0500	0.3978 ± 0.1358	-1.6666	0.1342
175	0.1097 ± 0.0146	0.1475 ± 0.0352	-2.2174	0.0574
180	0.1084 ± 0.0405	0.1610 ± 0.0482	-1.0986	0.0986

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Table 5.8
Pitfall trap data for total adult Staphylinidae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD		t-stat	Sig.Level
	Treatment	Control		
160	0.0522 ± 0.0130	0.0981 ± 0.0312	-3.0381	0.0161 *
166	0.0354 ± 0.0278	0.0490 ± 0.0148	-0.9670	0.3619
170	0.0781 ± 0.1081	0.0608 ± 0.0380	0.3384	0.7438
175	0.0233 ± 0.0187	0.0202 ± 0.0139	0.3032	0.7695
180	0.0388 ± 0.0328	0.0234 ± 0.0149	0.9547	0.3677

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Table 5.9
Pitfall trap data for Erigone atra (Blackwall).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD		t-stat	Sig.Level
	Treatment	Control		
160	0.1029 ± 0.0420	0.1125 ± 0.0121	-0.4903	0.6371
166	0.0986 ± 0.0442	0.1090 ± 0.0220	-0.4712	0.6501
170	0.1388 ± 0.0339	0.1890 ± 0.0835	-1.2468	0.2477
175	0.0609 ± 0.0246	0.1033 ± 0.0356	-2.1918	0.0598
180	0.0639 ± 0.0237	0.1022 ± 0.0497	-1.5553	0.1585

Table 5.10
Pitfall trap data for Erigone dentipalpis (Wider).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD		t-stat	Sig.Level
	Treatment	Control		
160	0.0168 ± 0.0167	0.0166 ± 0.0201	0.0103	0.9921
166	0.0248 ± 0.0223	0.0298 ± 0.0314	-0.2878	0.7808
170	0.0820 ± 0.0229	0.1032 ± 0.0644	-0.6677	0.5231
175	0.0034 ± 0.0076	0.0169 ± 0.0118	-2.1461	0.0642
180	0.0000 ± 0.0000	0.0168 ± 0.0167	-2.2440	0.0551

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Table 5.11
Pitfall trap data for *Oedothorax fuscus* (Blackwall).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD		t-stat	Sig.Level
	Treatment	Control		
160	0.0101 ± 0.0150	0.0233 ± 0.0187	-1.2369	0.2512
166	0.0113 ± 0.0117	0.0251 ± 0.0152	-1.6086	0.1464
170	0.0449 ± 0.0211	0.0286 ± 0.0298	1.0033	0.3451
175	0.0068 ± 0.0093	0.0068 ± 0.0093	0.0000	1.0000
180	0.0102 ± 0.0093	0.0034 ± 0.0076	1.2649	0.2415

Table 5.12
Pitfall trap data for total Erigoninae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD		t-stat	Sig.Level
	Treatment	Control		
160	0.1290 ± 0.0458	0.1458 ± 0.0197	-0.7514	0.4739
166	0.1292 ± 0.0489	0.1600 ± 0.0207	-1.2945	0.2316
170	0.2370 ± 0.0330	0.2820 ± 0.1021	-0.9368	0.3763
175	0.0759 ± 0.0192	0.1225 ± 0.0281	-3.0585	0.0156 *
180	0.0812 ± 0.0309	0.1171 ± 0.0615	-1.1661	0.2772

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Table 5.13
Pitfall trap data for Bathyphantes gracilis (Blackwall). Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
160	0.0034 ± 0.0076	0.0067 ± 0.0149	-0.4376	0.6733
166	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
170	0.0042 ± 0.0095	0.0042 ± 0.0095	0.0000	1.0000
175	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
180	0.0000 ± 0.0000	0.0034 ± 0.0076	-1.0000	0.3466

Table 5.14
Pitfall trap data for Meioneta rurestris (C.L.Koch). Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
160	0.0363 ± 0.0176	0.0608 ± 0.0277	-1.6643	0.1346
166	0.0382 ± 0.0242	0.0726 ± 0.0433	-1.5493	0.1599
170	0.0869 ± 0.0573	0.1043 ± 0.0551	-0.4919	0.6360
175	0.0202 ± 0.0140	0.0268 ± 0.0090	-0.9008	0.3940
180	0.0196 ± 0.0290	0.0332 ± 0.0161	-0.9160	0.3865

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Table 5.15
Pitfall trap data for total Linyphiinae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
160	0.0396 ± 0.0144	0.0664 ± 0.0344	-1.6058	0.1470
166	0.0408 ± 0.0269	0.0726 ± 0.0433	-1.3983	0.1996
170	0.0900 ± 0.0606	0.1071 ± 0.0605	-0.4459	0.6675
175	0.0236 ± 0.0090	0.0268 ± 0.0090	-0.5774	0.5796
180	0.0196 ± 0.0290	0.0363 ± 0.0176	-1.1034	0.3019

Table 5.16
Pitfall trap data for total Linyphiidae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
160	0.1587 ± 0.0474	0.1948 ± 0.0244	-1.5130	0.1687
166	0.1598 ± 0.0530	0.2120 ± 0.0345	-1.8424	0.1027
170	0.2934 ± 0.0350	0.3377 ± 0.1206	-0.7905	0.4520
175	0.0959 ± 0.0180	0.1427 ± 0.0321	-2.8390	0.0219 *
180	0.0986 ± 0.0213	0.1456 ± 0.0567	-1.7370	0.1206

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Table 5.17
Pitfall trap data for total Acari.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
160	0.0000 ± 0.0000	0.0034 ± 0.0076	-1.0000	0.3466
166	0.0679 ± 0.0405	0.0899 ± 0.0772	-0.5649	0.5878
170	0.0614 ± 0.0567	0.0768 ± 0.0498	-0.4555	0.6609
175	0.0000 ± 0.0000	0.0034 ± 0.0076	-1.0000	0.3466
180	0.0000 ± 0.0000	0.0017 ± 0.0039	-1.0000	0.3466

Table 5.18
Pitfall trap data for total Collembola.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
160	0.1714 ± 0.0607	0.2079 ± 0.0538	-1.0056	0.3441
166	0.2983 ± 0.0859	0.2193 ± 0.0671	1.6220	0.1435
170	0.2910 ± 0.1040	0.3083 ± 0.1312	-0.2303	0.8237
175	0.3527 ± 0.1202	0.3347 ± 0.0909	0.2677	0.7957
180	0.4043 ± 0.1338	0.3003 ± 0.0779	1.5025	0.1714

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Table 5.19
Pitfall trap data for total Diptera.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated barriered plots (t-test).

Days +or-	Mean no./trap/day log(n+1) with SD		t-stat	Sig.Level
	Treatment	Control		
160	0.1219 ± 0.0373	0.1162 ± 0.0437	0.2228	0.8293
166	0.1002 ± 0.0516	0.1021 ± 0.0725	-0.0462	0.9643
170	0.2490 ± 0.0812	0.2908 ± 0.0403	-1.0311	0.3327
175	0.1334 ± 0.0128	0.1256 ± 0.0148	0.8920	0.3984
180	0.1357 ± 0.0207	0.1295 ± 0.0413	0.3030	0.7696

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

5.3 Discussion.

Analysis of pitfall data from the main plots indicated statistically significant reductions in post-treatment trapping levels for total Carabidae and adults of the carabid species B.obtusum , N.biguttatus and T.quadristriatus. Adults of all three species have been shown to consume cereal aphids during the autumn (Feeney, 1982; Sopp and Chiverton, 1987) and are therefore potentially important factors in the natural control of aphids overwintering in cereal fields. In addition, a significant depression in effective abundance was recorded for the winter-active larvae of N.brevicollis which have also been demonstrated to feed on both R.padi and S.avenae during the autumn (Sopp and Chiverton, 1987). The apparent reductions in the effective abundances of P.melanarius and total carabid larvae proved not to be statistically significant ($p>0.05$). Comparisons of log(n+1) transformed data from the main plots indicated that both the magnitude and duration of reductions in all carabid species were similar to those observed in the larger 4ha plots of the earlier deltamethrin / demeton-S-methyl trial (Chapter 4). Increasing the degree of replication had made it possible to confirm the susceptibility of T.quadristriatus to the autumn application of deltamethrin (6.25g a.i./ha). In all of the carabid species recorded, the log(n+1) transformed pitfall values obtained in the main deltamethrin plots had recovered to control values within twentyone days of treatment. In the case of T.quadristriatus data transformed to 'k' to account for pre-treatment plot differences revealed statistically significant reductions in apparent abundance on days 74 ($p<0.05$) and 135 ($p<0.05$) after treatment (Fig. 5.11). Sign tests applied to 'k' transformed data for both B.obtusum and T.quadristriatus indicated that treatment related reductions in the 'corrected' values persisted for the duration of the field trial. Pitfall samples of B.obtusum collected from the deltamethrin sub-plots during April revealed that statistically significant reductions still remained in populations which had overwintered in isolation from the effects of plot reinvasion (Table 5.3). No corresponding decrease in log(n+1) transformed values was observed in the main plots which had been treated with deltamethrin during the previous autumn. This indicates that the apparently rapid recovery in the abundance of B.obtusum in the open areas was the result of a redistribution across the field rather than a lack of insecticidal action by deltamethrin. Although B.lampros primarily overwinters in field boundaries (Sotherton, 1984, 1985; Coombes and Sotherton, 1986) sufficient numbers were present within the barriered sub-plots to permit statistical comparisons of treatment and control enclosures. While there were no statistically significant differences on individual sample dates the effective abundance of B.lampros was consistently lower in those enclosures which had been treated with deltamethrin during the previous autumn (Table 5.2). Rates of capture for P.melanarius were also consistently lower in the deltamethrin treated sub-plots although not to a statistically significant degree ($p>0.05$). Loricera pilicornis was unusual in that trapping levels during the spring tended to be highest in the areas to which deltamethrin had been applied. This was true from samples from both the main plots and the barriered sub-plots. On one of the collection dates (13-04-88) the difference in main plot samples was statistically significant ($p<0.01$). As indicated in Table 5.6 the trapping rates for T.quadristriatus within the enclosures was too low to permit a valid statistical comparison.

The initial impact on the staphylinid population was less extreme than the approximately 75% reduction observed during the deltamethrin/DSM trial but the increased degree of replication permitted statistical confirmation of the adverse effect which had not been possible during the earlier trial. During the latter stages of the field trial highly significant increases were observed in the apparent abundance of staphylinids in treatment plots. These differences were the result of extremely high densities of small Aleocharinae within the areas which had been treated with deltamethrin. The reason for this is unclear.

The effects of deltamethrin on the linyphiid community were consistent with those observed in the earlier deltamethrin/DSM field trial (Chapter 4) and in experiments carried out by other workers (Powell et al 1988; Purvis et al 1988). With the noticeable exception of O.fuscus, the majority of linyphiid species sustained highly significant reductions in effective abundance which persisted well into the following spring. Capture rates for linyphiids in the main deltamethrin plots had recovered to control levels by the middle of April (Fig. 5.24). Throughout the whole of April trapping rates for linyphiids in the deltamethrin sub-plots consistently failed to exceed 80% of the control values (Fig. 5.16). The apparent depression was statistically significant in samples which were collected on day 175 after treatment ($p<0.05$). The disparity between the rate of recovery in the barriered enclosures and that in the open field suggests that it was the result of a cursorial redistribution rather than an aeronautic immigration. This was confirmed by the extremely low numbers of potential aeronauts which were collected by sticky traps. The number of spider webs per m^2 has been shown to be significantly correlated with the density of female linyphiids in cereal crops (Sunderland et al 1986a). Between 80 and 90% of the linyphiids trapped by pitfalls were male. Taking these two factors into consideration the slight decrease observed in web density in the treatment plots contrasted with the prolonged and significant depression in pitfall samples suggests that deltamethrin had a disproportionately adverse impact on male linyphiids.

Acari, Collembola and Diptera all act as sources of alternative prey for polyphagous predators. For this reason any adverse effects of pesticide application is potentially damaging to the stability of the predator complex. Immediately after spray application transient reductions were observed in the effective abundance of all three groups. However, the apparent decrease was only statistically significant in the case of total Diptera ($p<0.01$). Trapping rates for total Diptera also exhibited the most prolonged reduction of the three with treatment values not reaching control levels until 47 days after treatment. Sign tests confirmed that there had been no longterm disruptions in the major groups of alternative prey.

CHAPTER 6 - SUMMARY AND DISCUSSION.

The failure of the autumn application of deltamethrin (6.25g a.i./ha) to induce an increase in the summer density of cereal aphids (Chapter 4), supports the results of studies examining the effects of alternative pyrethroids. When applied in the autumn, neither cypermethrin (25g a.i./ha) (Cole et al 1986) nor lambdacyhalothrin (5g a.i./ha) (Brown et al 1988) were found to significantly impair the capacity of the predator complex to restrict the development of summer infestations of cereal aphids.

The omission of an autumn applied aphicide exposes the cereal farmer to an increased risk of reduction in grain quality and crop yield, even in the absence of BYDV. Observations on the development of summer infestations of cereal aphids (Chapter 4) indicated that the higher densities of S.avenae overwintering in untreated areas resulted in earlier establishment within the control plots with subsequently higher peak aphid populations and a significant reduction in yield. The pyrethroid insecticide deltamethrin appeared to provide better control of S.avenae, overwintering in winter wheat, than did the organophosphate demeton-S-methyl.

Autumn applications of both cypermethrin (25g a.i./ha) and deltamethrin (6.25g a.i./ha) induced post-treatment reductions in all three of the major polyphagous predatory arthropod groups; the Carabidae, Staphylinidae and Linyphiidae. Both the severity and duration of the adverse impact varied between the groups. Demeton-S-methyl (243.6g a.i./ha) produced significant reductions in the apparent abundance of a number of species of linyphiid spider but not in members of the Carabidae or Staphylinidae.

A number of studies have indicated that both autumn and summer applications of pyrethroids to cereals are followed by a transient decrease in the effective abundance of carabid beetles (eg. Feeney, 1982; Cole and Wilkinson, 1984; Shires, 1985; Fischer and Chambon, 1987; Brown _et al_ 1988; Purvis _et al_ 1988). However, several other field trials failed to confirm a significantly adverse impact on members of the Carabidae (eg. von Rzehak and Basedow, 1982; Inglesfield, 1984; 1985; Basedow, 1985; Basedow _et al_ 1985; Powell _et al_ 1988). In the latter instance, as in the autumn cypermethrin trial (Chapter 2), it is probable that a combination of limited replication and low carabid density resulted in an underestimate of the pyrethroid's immediate impact.

At 70-80%, the maximum reductions in carabid numbers induced by autumn applications of deltamethrin (Chapters 4 and 5) were comparable with post-treatment depressions of approximately 60-70% observed by Cole and Wilkinson - cypermethrin - (1984) and Purvis _et al_ - cypermethrin / deltamethrin - (1988). Following the summer application of WL-85871, Inglesfield (1984) observed a decrease in carabid numbers to approximately 60% of pre-treatment values but this could not be confirmed as being statistically significant.

Pyrethroid-induced reductions in carabid abundance were comparatively short lived. In the initial cypermethrin field trial (Chapter 2) catches of carabids in the treatment areas recovered to control values within 1-2 weeks of spray application. In both of the deltamethrin trials (Chapters 4 and 5) the apparent depressions within the treated areas continued for approximately 3-5 weeks. Significant decreases in effective abundance persisted for considerably longer when the carabid populations were isolated within barriered sub-plots. Where areas were protected from the effects of reinvasion the apparent decrease in carabid abundance continued well into the following spring (Fig. 6.1).

In all three autumn field trials samples of carabids collected at the time of spray application were dominated by _B.obtusum_ and _T.quadristriatus_. Both species continued to constitute a major proportion of the pitfall catches of carabid beetles throughout the year. Winder (1990) reported summer densities of $77/m^2$ for T.quadristriatus in winter wheat. Adults of these two species have previously been shown to consume cereal aphids during the autumn (Feeney, 1982; Sopp and Chiverton, 1987) and summer (Sunderland et al 1987). The combination of these two factors suggest that B.obtusum and T.quadristriatus are potentially important in the natural control of both overwintering vectors of BYDV and of summer infestations of cereal aphids. In the latter instance their potential results from both species being present in considerable numbers during the critical aphid establishment phase, before the arrival of aphid-specific predators. Helenius (1990) determined that manipulation of polyphagous predator densities during the exponential growth phase of R.padi failed to produce any significant effect on maximum aphid density while predation during the establishment phase did contribute to lowered peak densities.

The application of deltamethrin during the 1986/7 deltamethrin / DSM trial (Chapter 4) resulted in a maximum decrease in the effective abundance of B.obtusum to approximately 10% of control values. According to separate ANOVAs for the individual sample dates recovery to control levels occurred within thirty-one days of treatment. However, the application of sign tests to log(n+1) and 'k' transformed pitfall data suggested that disruptions which were too subtle to be detected by ANOVA continued for some time after this point. The subsequent 1987/8 deltamethrin trial (Chapter 5) confirmed an immediate and highly significant post-treatment reduction in the effective abundance of B.obtusum. On this second occasion the maximum depression was to approximately 17% of control values. Total recovery appeared to occur within three weeks of treatment although a sign test again indicated that 'k' values in the deltamethrin plots tended to be depressed for the greater proportion of the field trial. Following the autumn application of deltamethrin, rates of capture for

B.obtusum recovered more rapidly in 1ha open plots than in the corresponding barriered sub-plots (Chapter 5). Populations of B.obtusum which had overwintered within the enclosures remained significantly depressed five months after the pyrethroid had been applied (Fig. 6.2). This indicates that the apparently rapid recovery observed within both the 1ha and 4ha treatment plots was the result of reinvasion by beetles from the surrounding unsprayed areas.

Autumn applications of deltamethrin (6.25g a.i./ha) to winter wheat resulted in immediate 50-70% reductions in the effective abundance of T.quadristriatus. In both years the resultant decrease in relative abundance was temporary with apparent recovery occurring within three weeks of treatment. Similar transient depressions in activity abundance have been reported by Feeney (1982) - cypermethrin 69% and deltamethrin 65%, and Brown et al (1988) - lambdacyhalothrin 59%. Purvis et al (1988) reported a pyrethroid-induced reduction in carabid activity of 60-70% during a multiple site study in which samples were dominated by T.quadristriatus. Analysis of 'k' transformed pitfall data suggested that more subtle disruptions in the activity density of T.quadristriatus persisted beyond the period indicated from the results of the one-way ANOVAs of log(n+1) transformed data. The results obtained by Brown et al (1988) indicated that the reduction produced by lambdacyhalothrin was the result of either a temporary emigration or a reduction in activity rather than a reflection of mortality. Given the capacity of many pyrethroids to induce a knockdown effect in arthropods it is possible that some of the transient reductions observed during pyrethroid field trials are a consequence of incapacitation followed by recovery.

Dissections of T.quadristriatus (Chapter 4) failed to reveal any sex related differences in the impact of either deltamethrin or demeton-S-methyl. In addition, neither aphicide appeared to significantly disrupt either the primary autumn or subsidiary spring reproductive phases of T.quadristriatus. There was weak evidence that exposure to deltamethrin induced the premature discharge of eggs by fecund females but this could not be statistically confirmed.

In deltamethrin and DSM treated plots of 1-4ha, populations of B.obtusum and T.quadristriatus recovered to control levels prior to the establishment and exponential growth phases of summer infestations of cereal aphids.

No significant post-treatment reductions were recorded for adult N.brevicollis but a temporary reduction in the activity abundance of the winter-active larvae was detected during the 1987/8 deltamethrin trial (Chapter 5). The reduction in larval abundance of approximately 80% was transient with recovery occurring within three weeks of treatment. In the earlier deltamethrin / demeton-S-methyl trial (Chapter 4) a significant increase was recorded in the effective abundance of first instar larvae collected thirty-one days after treatment. Neither deltamethrin nor DSM appeared to induce disruptions in the rate of progression between the larval instars of N.brevicollis (Chapter 4). The results obtained for N.brevicollis in this study contrast with the findings of Brown et al (1988) who determined that adults were susceptible to the pyrethroid lambdacyhalothrin while the larvae did not appear to be adversely affected.

The large carabid P.melanarius exhibited a significantly negative response to the summer application of cypermethrin (Chapter 3) but autumn treatments with deltamethrin failed to produce a statistically significant decrease in effective abundance (Chapters 4 and 5). Small scale and extremely transient reductions in the abundance of P.melanarius have also been observed following summer applications of fenvalerate (Chiverton, 1984) and deltamethrin (Fischer and Chambon, 1987). Autumn applications of pyrethroids do not appear to have a significant impact on populations of *P.melanarius* in cereal fields (eg. Brown *et al* 1988; Purvis *et al* 1988).

An increase in carabid diversity was observed during the spring as additional species dispersed into the crop from their overwintering refugia in the adjacent field boundaries (Sotherton, 1984; 1985; Coombes and Sotherton, 1986). Carabid species falling into this category included *A.dorsale* , *B.lampros* and *L.pilicornis*. No significant reductions were recorded in the spring and summer levels of effective abundance for those species which were not directly exposed to the aphicides during the autumn.

Xantholinus linearis (Olivier) dominated pitfall samples of staphylinids collected at the time of spray application. Staphylinids appeared to exhibit only limited susceptibility to autumn applications of cypermethrin, deltamethrin and demeton-S-methyl. The immediate post-treatment reduction in the effective abundance of staphylinids was confirmed as being statistically significant only in the 1987/8 deltamethrin trial (Chapter 5). A highly significant and unexplained increase in staphylinid abundance occurred in the main plots during the summer when samples were dominated by small non-predatory Aleocharinae. This effect was not paralleled in samples which were collected simultaneously from the barriered sub-plots (Fig. 6.3).

Autumn applications of cypermethrin, deltamethrin and demeton-S-methyl resulted in significant disruptions of the linyphiid community associated with the cereal ecosystem.

Throughout the growing season linyphiid spiders have considerable potential as natural control agents of cereal aphids. Many species are physiologically adapted to permit low temperature activity and feeding during the winter (Duman, 1974; Aitchison, 1984). In addition, when food availability is limited spiders are able to survive *in situ* by reducing their metabolic rate (Anderson, 1970). This means that a pesticide-induced reduction in the availability of alternative prey need not necessarily result in a local decrease in the abundance of linyphiids. However, both the fecundity and developmental rate of spiders are adversely affected by reduced food intake (Anderson, 1974; Wise, 1974). Consumption of R.padi and S.avenae during the autumn has previously been demonstrated for all of the linyphiid species which were found to be abundant at the Hampshire site (Sopp and Chiverton, 1987). These species including E.atra , O.fuscus and M.rurestris have also been demonstrated to feed on cereal aphids during the spring and summer (eg. Sunderland et al 1986a; 1986b).

The autumn applied aphicides cypermethrin, deltamethrin and DSM typically produced significant decreases in the effective abundance of linyphiids which persisted until late in the spring of the following year. A comparison of the effects of deltamethrin and DSM (Chapter 4) indicated that the pyrethroid had a more severe impact on the spider population than did the organophosphate. Prolonged reductions in the abundance of linyphiid spiders have also been observed in other studies examining the the effects of autumn applications of pyrethroids (Brown et al 1988; Powell et al 1988; Purvis et al 1988). Both pitfall trap data and D-vac samples collected from areas treated with deltamethrin indicated that the relative abundance of linyphiids in open plots had recovered to control levels before the establishment of summer aphid infestations (Chapter 4). The treatment-induced depression in the abundance of linyphiids persisted within barriered plots for some time after recovery appeared to have occurred within the conventional plots (Fig. 6.4). This indicated that the apparent recovery within the main, open field plots was the result of a redistribution of spiders across the field surface rather than the consequence of aeronautic immigration into the treatment areas. The use of sticky traps confirmed the absence of ballooning activity during the course of the 1987/8 deltamethrin trial (Chapter 5). Thomas et al (1990) describe a 'wavefront' of spiders moving across the treatment / control interface to reinvade areas of field which had been sprayed with deltamethrin (10g a.i/ha) during the summer. The rates of diffusion determined for E.atra by Thomas et al (1990) indicated that the population 75m from the treatment boundary had recovered to control levels within eight weeks of spray application. In all of the autumn field trials described here, pitfall trap samples were dominated by E.atra and yet depressions in the abundance of spiders persisted for considerably longer than eight weeks in plots where the trapping grids were 100m (Chapter 4) and 50m (Chapter 5) from the nearest untreated areas. This contrast, combined with the timing of recovery of the spider population during the spring / summer suggests a seasonal switching in dispersal behaviour. This may simply be related to an increase in temperature or may reflect changes in surface activity during reproductive phases. Sunderland (1987) has also demonstrated comparatively high levels of activity on the soil surface for a number of species of linyphiid spider during the summer.

The summer application of cypermethrin (Chapter 3) also resulted in significant reductions in the effective abundance of linyphiid spiders. The resultant general depression in the abundance of spiders was frequently preceded by a brief period of heightened activity. This was probably the result of an irritant effect caused by the stimulation of the spiders' peripheral sensory nervous system during the initial stages of pyrethroid intoxication. Similar bouts of apparent hyperactivity were also observed in a number of linyphiid species following the autumn application of deltamethrin (Chapters 4 and 5).

Comparisons of treatment related changes in sex ratios during the summer cypermethrin trial (Chapter 3) suggested that male spiders were more susceptible to intoxication by pyrethroids than were the females. The comparatively short lived reduction in web densities following the autumn application of deltamethrin (Chapter 5) contrasted with the prolonged depression in pitfall catches of linyphiids. Given the bias of pitfall sampling to the collection of male spiders and the correlation between web density and the abundance of spiders, the effects observed during the 1987/8 deltamethrin trial (Chapter 5) tend to support the hypothesis of a disproportionate impact on males. This contrasts with the findings of Thomas _et al_ (1990) who determined that the summer application of deltamethrin (10g a.i./ha) had a more severe impact on female _O.apicatus_ than it did on males of the same species. These factors emphasise the need to examine the effects of agricultural practices on arthropods at the level of gender in addition to those of species and guild.

The relative abundances of the alternative prey groups Acari, Collembola and Diptera exhibited only slight and extremely transient reductions following autumn applications of deltamethrin and DSM (Chapters 4 and 5). Following the autumn application of cypermethrin (Chapter 2) there was a sustained increase in the effective abundance of Collembola which may have been correlated with a persistent reduction in the density of linyphiids which are important predators of the group.

Figures 6.5, 6.6 and 6.7 show the effects of varying plot size and replication on the respective rates of population recovery for Carabidae, Staphylinidae and Linyphiidae in field trials where deltamethrin was applied in the autumn. In the case of the Staphylinidae (Fig. 6.5) the increased plot replication in the 1987/8 deltamethrin trial allowed statistical confirmation of a transient adverse effect and weak evidence that recovery in the smaller 1ha plots occurred more rapidly than in the larger 4ha plots of the 1986/7 deltamethrin/DSM field trial. Differences in the rate of recovery for members of the Carabidae (Fig. 6.5) could not be resolved until the data were adjusted for pre-treatment plot differences as indicated in Sotherton _et al_ (1988) when recovery again appeared to be more rapid in the smaller 1ha plots. In both trials involving the autumn application of deltamethrin, the local population of linyphiid spiders remained depressed for several months after spray application but appeared to recover earlier in the smaller plots (Fig. 6.7). The need to obtain a balance between plot size and replication during ecotoxicology field trials is described elsewhere in more detail together with a discussion of further considerations for experimental design (Sotherton et al 1988)

The significance of dispersal capacity in determining the duration of pesticide induced depletions in invertebrate populations has been discussed by Jepson (1989) and Jepson and Thacker (1990) and is reflected in the differences which were observed in the relative rates of population recovery for carabids (Fig. 6.5), staphylinids (Fig. 6.6) and linyphiids (Fig. 6.7). Based on the values for mean daily displacement obtained by Grum (1983) for a number of carabid species, members of such highly dispersive groups could theoretically recolonize plots of the scale employed here within a matter of days. In the case of within-field studies the areas of treatment plots may be misleading figures to quote as the distance to the nearest source of reinvasion, possibly a neighbouring control plot (Thacker and Jepson, 1990), is probably more relevant to the interpretation of data.

In retrospect, whole-field experiments may have been preferable for studying some aspects of the effects of autumn applied pyrethroids but such an approach would of necessity suffered from an unacceptable lack of replication.

Figs. 6.1-6.4.
Trapping rates of invertebrates in areas treated with deltamethrin (6.25g a.i./ha) as a percentage of control values. Comparison of data from the main open plots (1 ha) and the barriered sub-plots (7 x 7m).

N.B. Points labelled * and * * are significantly different from control values at $p<0.05$ and $p<0.01$ respectively (t-test).

Fig. 6.1 Total Carabidae.

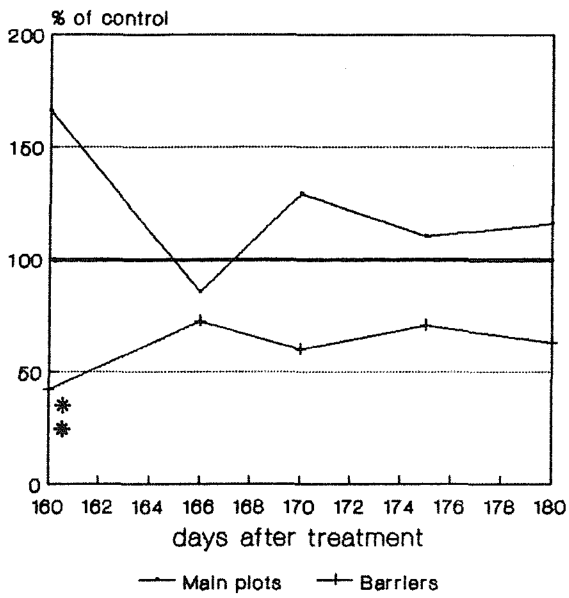


Fig. 6.2 B.obtusum.

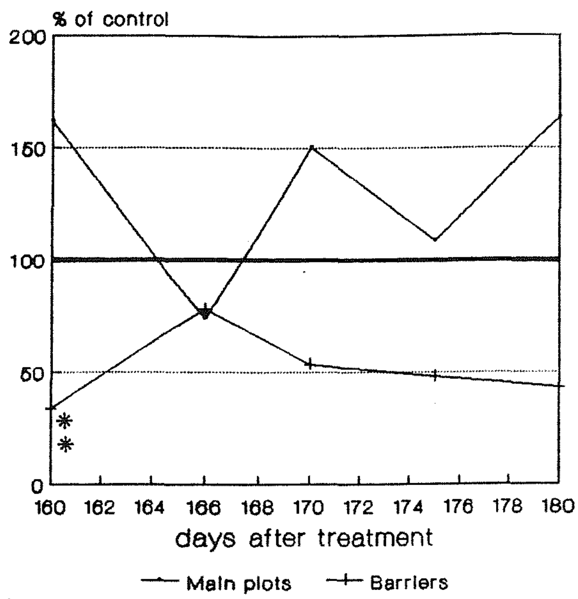


Fig. 6.3 Total Staphylinidae.

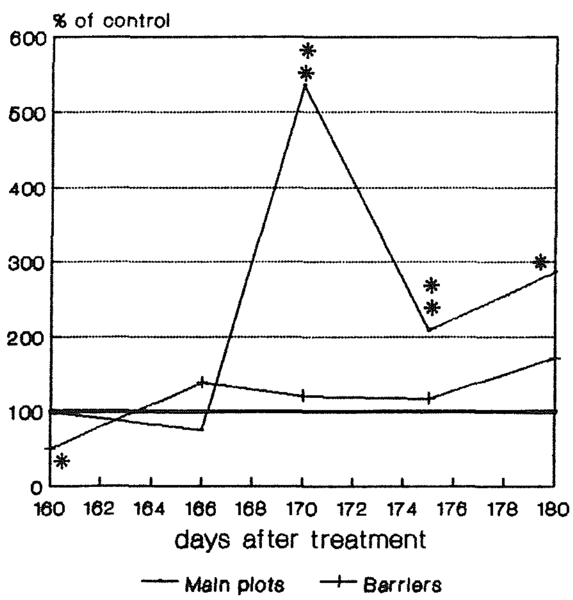


Fig. 6.4 Total Linyphiidae.

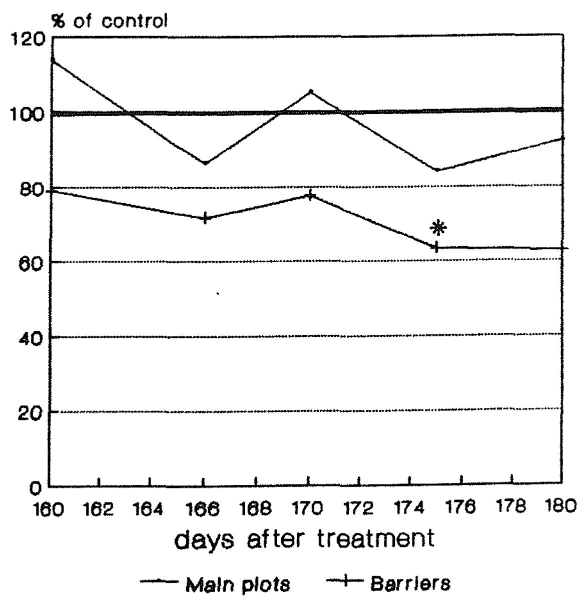


Fig. 6.5 Carabidae (Pitfall data). Rate of capture in deltamethrin plots as a percentage of control values. Comparison of data from the 1986/7 deltamethrin/DSM trial and the 1987/88 deltamethrin trial.
N.B. Points labelled ★ and ☆ were significantly different from control values ($p<0.05$) during 1986/7 (3x4ha) and 1987/88 (5x1ha) respectively.

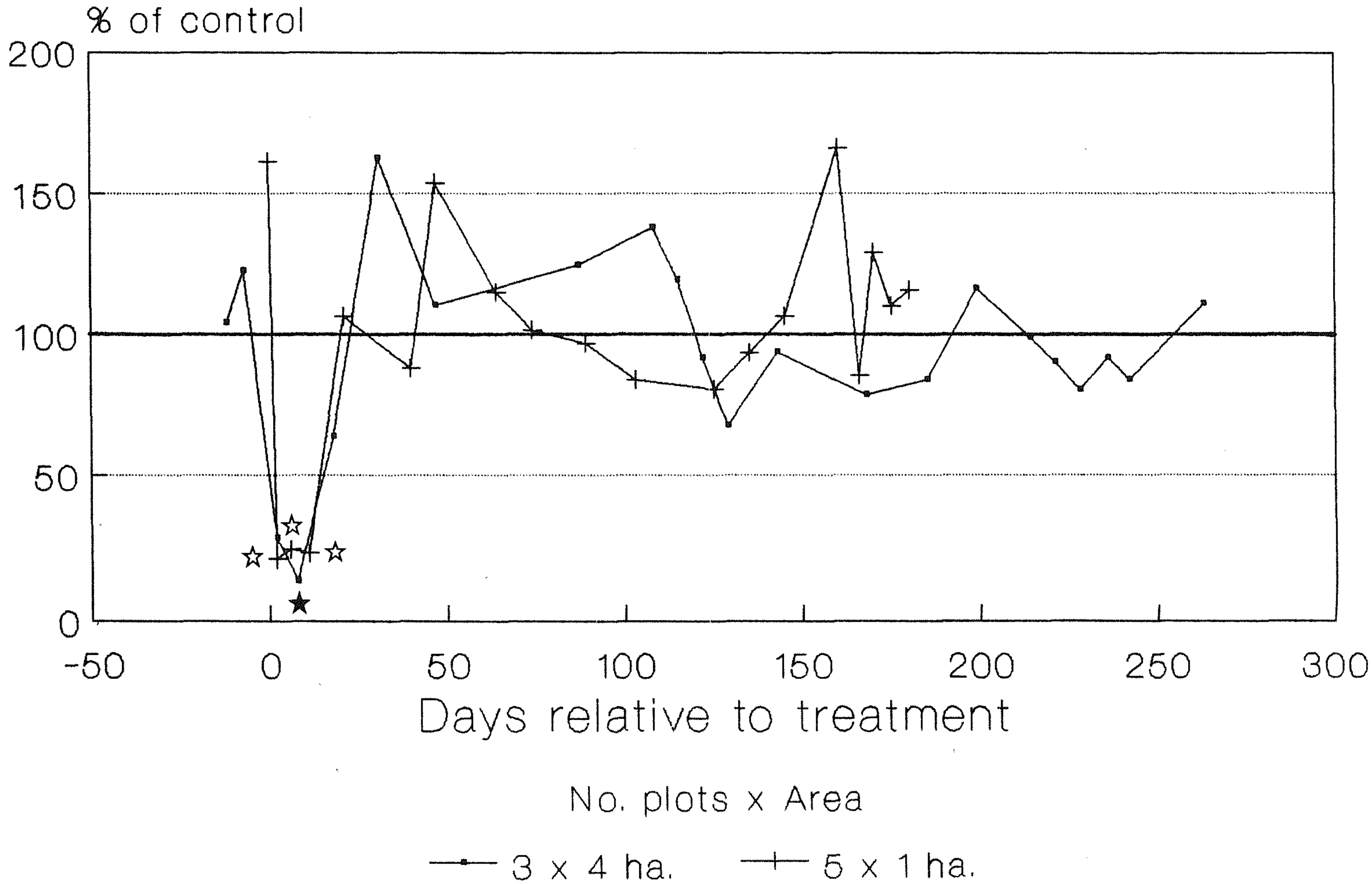


Fig. 6.6 Staphylinidae (Pitfall data). Rate of capture in deltamethrin plots as a percentage of control values. Comparison of data from the 1986/7 deltamethrin/DSM trial and the 1987/88 deltamethrin trial.
N.B. Points labelled ★ and ☆ were significantly different from control values ($p<0.05$) during 1986/7 (3x4ha) and 1987/88 (5x1ha) respectively.

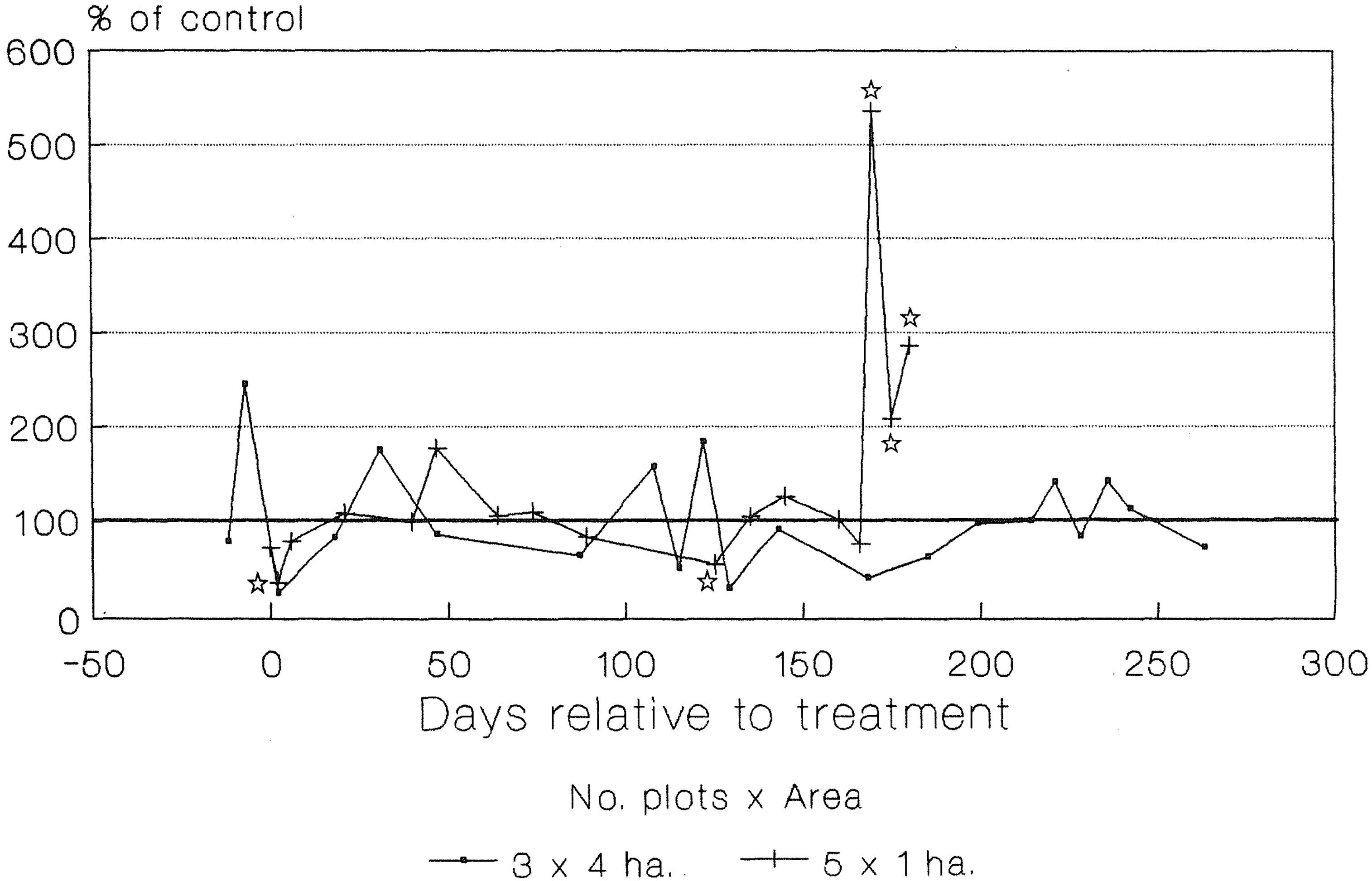
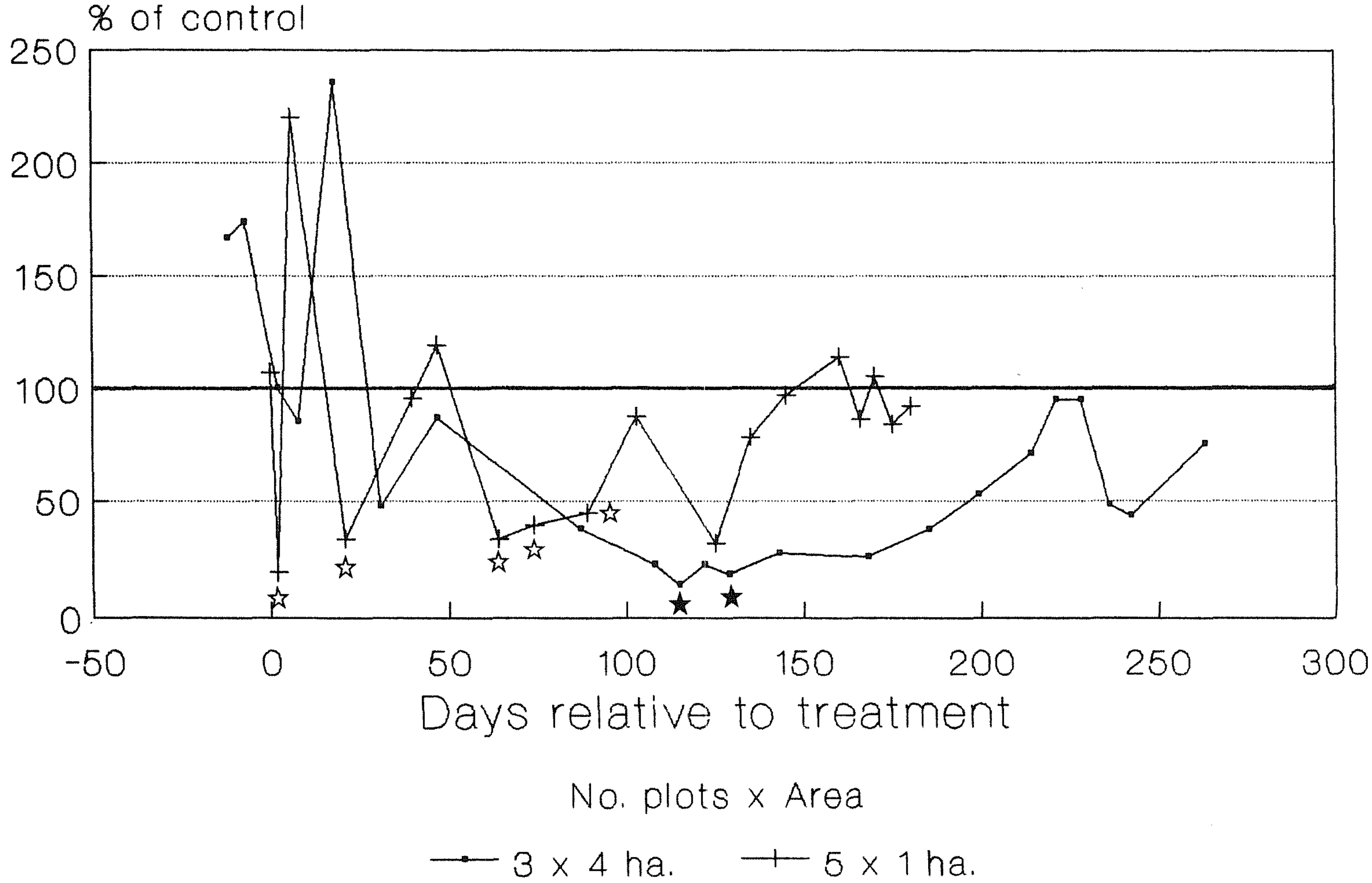


Fig. 6.7 Linyphiidae (Pitfall data). Rate of capture in deltamethrin plots as a percentage of control values. Comparison of data from the 1986/7 deltamethrin/DSM trial and the 1987/88 deltamethrin trial.
N.B. Points labelled ★ and ☆ were significantly different from control values ($p<0.05$) during 1986/7 (3x4ha) and 1987/88 (5x1ha) respectively.



In conclusion, with reference to those points raised in Figure 2.2 and accepting the limitations of scale, the effects of autumn applied pyrethroid insecticides were as follows.

1) EFFECTIVE ABUNDANCE OF POLYPHAGOUS PREDATORS.

Autumn applications of the pyrethroids cypermethrin (25g a.i./ha) and deltamethrin (6.25g a.i./ha) induced post-treatment reductions in all three of the major polyphagous predatory arthropod groups; the Carabidae, Staphylinidae and Linyphiidae. The organophosphate demeton-S-methyl (243.6g a.i./ha) produced significant reductions in the apparent abundance of a number of species of linyphiid spider but not in members of the Carabidae or Staphylinidae.

Populations of carabids exposed to autumn applications of pyrethroids typically underwent 70-80% reductions in apparent abundance with recovery occurring within 1-2 weeks in the case of cypermethrin (2 ha plots) and 3-5 weeks for deltamethrin (1-4 ha plots).

Staphylinids appeared to exhibit only limited susceptibility to autumn applications of cypermethrin, deltamethrin and demeton-S-methyl.

All three autumn applied aphicides typically produced significant decreases in the effective abundance of linyphiid spiders which persisted until late in the spring of the following year. Cypermethrin also induced significant reductions in the abundance of linyphiid spiders when applied to barriered plots of winter wheat during the summer. There appeared to be a disproportionate impact on male spiders when compared to reductions in the abundance of female linyphiids.

2) FECUNDITY OF PREDATORS AND VIABILITY OF IMMATURES.

Dissections of the autumn breeder <u>T.quadristriatus</u> indicated that there was no prolonged treatment-related effect on egg production in the autumn nor any significant differences in the level of supplementary reproduction during the spring. There also appeared to be no significant effect on the rate of development through the winter-active larval stages of N.brevicollis.

3) OVERWINTERING SUCCESS OF PREDATORS.

The use of plastic barriers to isolate areas from the effects of plot reinvasion indicated that populations of species overwintering exclusively in the field (eg. B.obtusum) underwent depressions in abundance which persisted until late in the spring of the following year.

4) PREDATORY CAPACITY OF THE POLYPHAGOUS ARTHROPOD COMMUNITY.

Autumn applications of deltamethrin and DSM did not significantly impair the capacity of the predator complex to restrict the development of summer infestations of cereal aphids. During the summer, higher peak aphid densities and an associated reduction in grain quality were recorded in plots which had not been treated with an autumn aphicide.

5) IRRITANT EFFECTS ON PREDATORS.

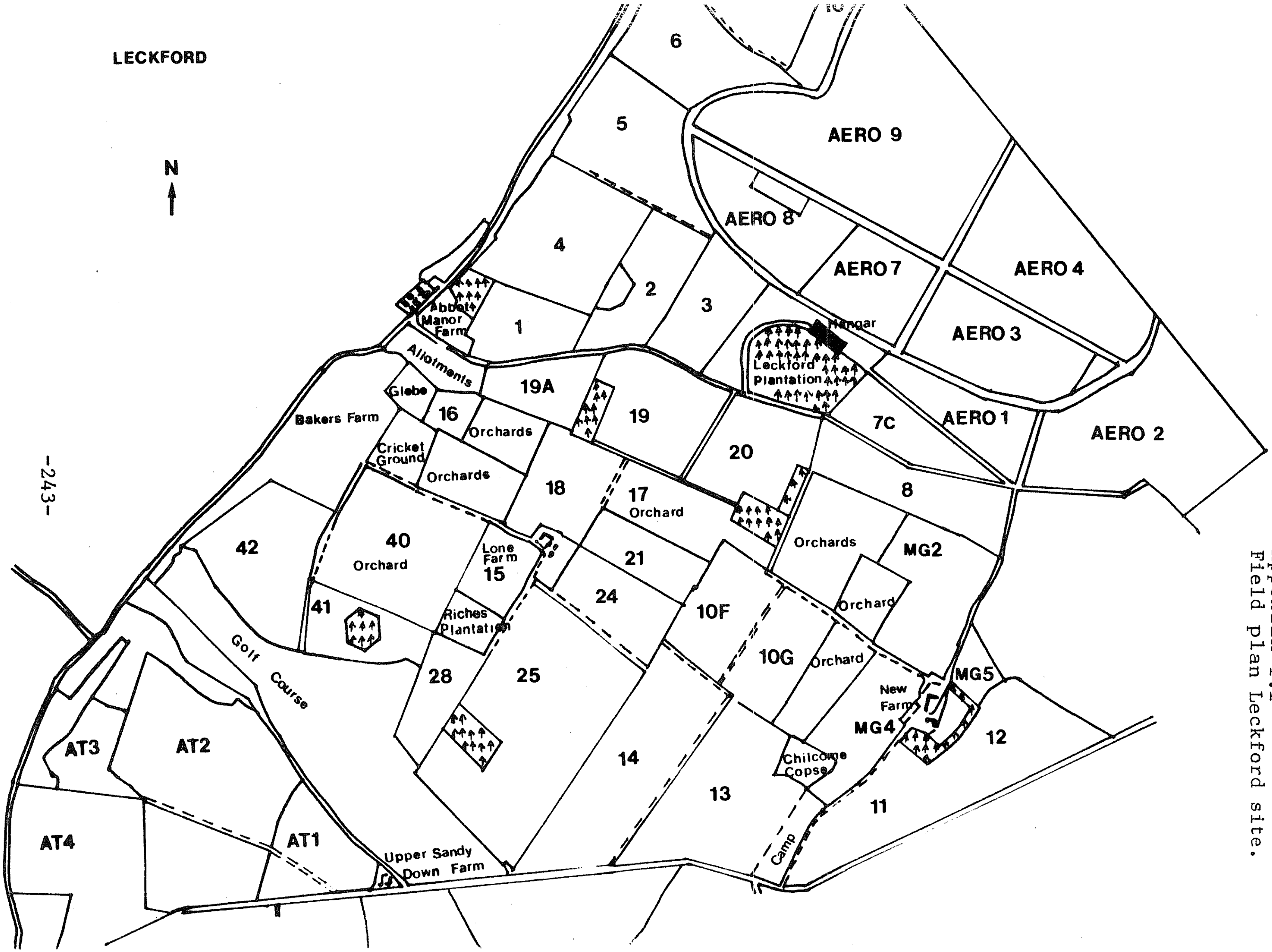
The pyrethroid-induced reductions in the abundance of linyphiid spiders were frequently preceded by bouts of hyperactivity induced by irritant effects during the initial stages of intoxication. There was also weak evidence to suggest that exposure to deltamethrin during the autumn resulted in the premature deposition of eggs by fecund female T.quadristriatus.

6) EFFECTIVE ABUNDANCE OF ALTERNATIVE PREY.

The relative abundances of the alternative prey groups Acari, Collembola and Diptera exhibited only slight and extremely transient reductions following autumn applications of deltamethrin and DSM.

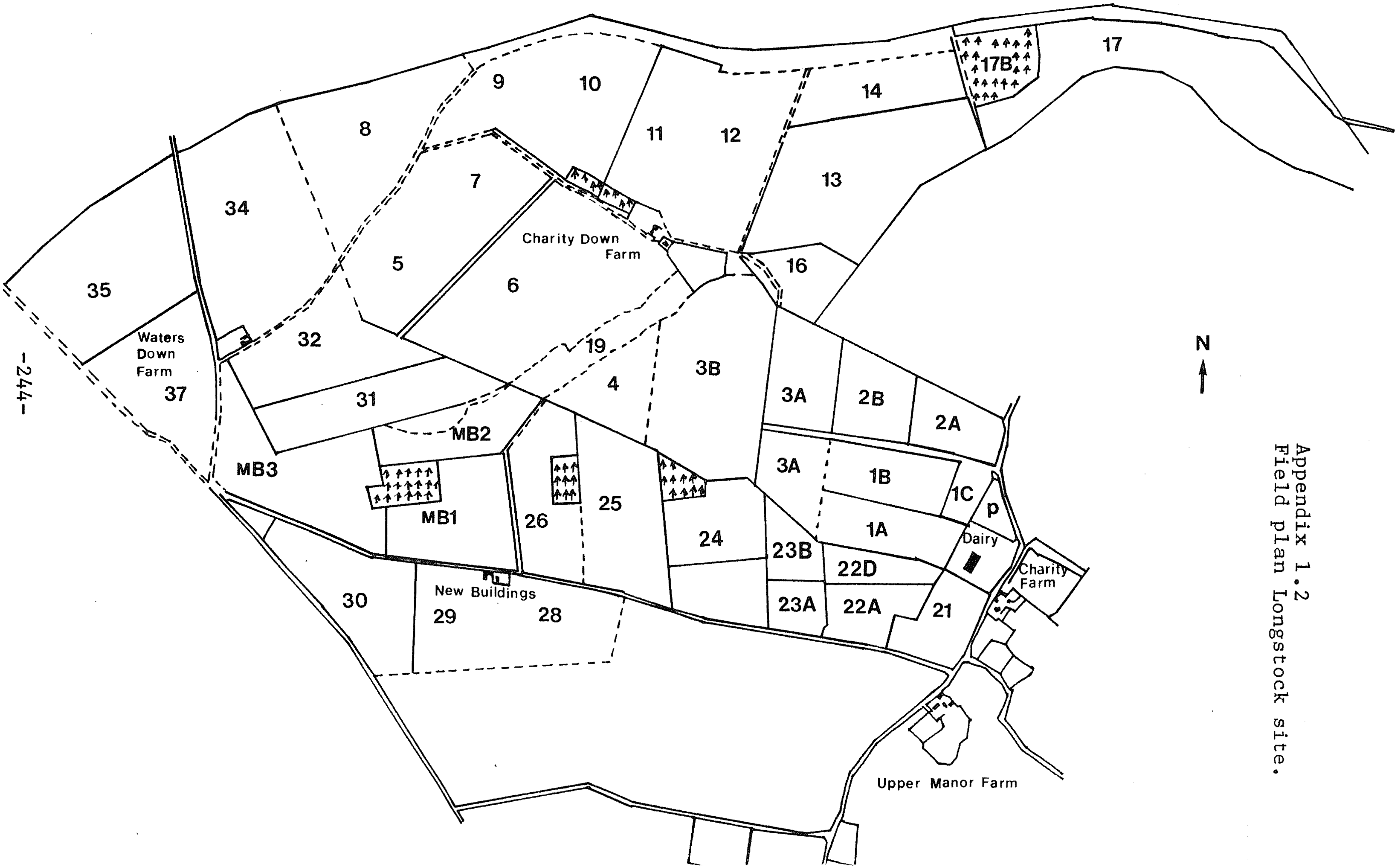
As indicated in section 1.1, the Game Conservancy Trust was interested in the effects of autumn applied pyrethroids on those species of invertebrate which act as components of the diet of gamebird chicks. For a review of the effects of insect availability on mortality in partridge chicks see 'The Partridge: Pesticides, Predation and Conservation', Potts, G.R. (1986).

The results obtained from this series of field trials indicated that all groups of potentially important arthropods had recovered to control levels prior to the end of June which is the peak period of hatching for partridge chicks (Potts, 1986). The limitations of scale placed on these trials have already been pointed out and it is possible that more extensive autumn applications of pyrethroids would induce a more prolonged impact on the epigeal arthropod fauna. The recent clearance of two pyrethroids for use as summer aphicides must raise serious concerns with regard to the potential disruption of both the natural enemy population and the availability of preferred dietary components for gamebird chicks.



Appendix 1.1
Field plan Leckford site.

LONGSTOCK



Appendix 1.2 Field plan Longstock site.

Appendix 2.1
Pitfall trap data for total adult Carabidae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
-14	0.7379 ± 0.2004	0.6651 ± 0.3541	0.5366	0.5989
-12	0.2506 ± 0.1903	0.2202 ± 0.1313	0.3979	0.6990
-11	0.3067 ± 0.2042	0.3010 ± 0.2129	0.0577	0.9547
-07	0.1524 ± 0.0853	0.2031 ± 0.1360	-0.9465	0.3580
-05	0.2025 ± 0.1733	0.1502 ± 0.1575	0.6695	0.5127
00	0.2089 ± 0.2276	0.2267 ± 0.2904	-0.1447	0.8867
01	0.0669 ± 0.1327	0.1003 ± 0.2129	-0.4001	0.6944
02	0.0865 ± 0.1771	0.2357 ± 0.2160	-1.7960	0.0914
03	0.1003 ± 0.1505	0.1003 ± 0.1505	0.0000	1.0000
07	0.1147 ± 0.1004	0.0607 ± 0.0772	1.2795	0.2190
09	0.2089 ± 0.1128	0.2758 ± 0.1102	-1.2730	0.2212
14	0.1373 ± 0.0930	0.1959 ± 0.0897	-1.3612	0.1923
16	0.0000 ± 0.0000	0.0391 ± 0.0777	-1.5119	0.1501
21	0.0978 ± 0.0693	0.1559 ± 0.1028	-1.4057	0.0789
23	0.0000 ± 0.0000	0.0726 ± 0.1147	-1.8986	0.0758
28	0.1089 ± 0.0353	0.2139 ± 0.1177	-2.5617	0.0209 *
30	0.0196 ± 0.0587	0.0921 ± 0.1158	-1.6775	0.1129
38	0.0542 ± 0.0822	0.0551 ± 0.0377	-0.0277	0.9783
46	0.1779 ± 0.0735	0.1376 ± 0.0581	1.0750	0.2983
53	0.0905 ± 0.0864	0.1189 ± 0.0748	-0.7456	0.4668
74	0.0022 ± 0.0067	0.0067 ± 0.0101	-1.1094	0.2837
88	0.0738 ± 0.0667	0.1115 ± 0.1089	-0.8853	0.3891
96	0.0171 ± 0.0256	0.0108 ± 0.0232	0.4586	0.6527
121	0.0019 ± 0.0057	0.0019 ± 0.0057	0.0000	1.0000

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.1 (continued).

Days +or-	Mean no./trap/day log(n+1) with SD		t-stat	Sig.Level
	Treatment	Control		
128	0.0172 ± 0.0516	0.0064 ± 0.0193	0.5858	0.5662
135	0.1733 ± 0.0701	0.1188 ± 0.1242	1.1469	0.2683
142	0.1986 ± 0.0795	0.1366 ± 0.0591	1.8772	0.0789
160	0.0304 ± 0.0249	0.0411 ± 0.0462	-0.6090	0.5511
176	0.0672 ± 0.0472	0.0635 ± 0.0564	0.1528	0.8805
184	0.3019 ± 0.1044	0.2766 ± 0.0759	0.5863	0.5659
193	0.4249 ± 0.1030	0.2358 ± 0.0698	4.5597	0.0003**

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.2
Pitfall trap data for total adult Staphylinidae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
-14	0.3067 ± 0.2042	0.1533 ± 0.1897	1.6508	0.1183
-12	0.0196 ± 0.0587	0.0530 ± 0.1097	-0.8063	0.4319
-11	0.0334 ± 0.1003	0.0000 ± 0.0000	1.0000	0.3322
-07	0.0573 ± 0.0935	0.0323 ± 0.0485	0.7134	0.4859
-05	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
00	0.0176 ± 0.0349	0.0338 ± 0.0543	-0.7543	0.4616
01	0.0000 ± 0.0000	0.1003 ± 0.1505	-2.0000	0.0628
02	0.0000 ± 0.0000	0.0334 ± 0.1003	-1.0000	0.3322
03	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
07	0.0284 ± 0.0613	0.0000 ± 0.0000	1.3887	0.1840
09	0.1313 ± 0.1064	0.0391 ± 0.0777	2.0987	0.0521
14	0.0264 ± 0.0396	0.0391 ± 0.0777	-0.4382	0.6671
16	0.0000 ± 0.0000	0.0587 ± 0.0881	-2.0000	0.0628
21	0.0677 ± 0.0576	0.0088 ± 0.0264	2.7859	0.0132 *
23	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
28	0.0176 ± 0.0349	0.0088 ± 0.0264	0.6030	0.5550
30	0.0530 ± 0.1097	0.0530 ± 0.1097	0.0000	1.0000
38	0.0165 ± 0.0346	0.0000 ± 0.0000	1.4270	0.1728
46	0.0301 ± 0.0531	0.0064 ± 0.0193	1.2556	0.2273
53	0.0301 ± 0.0531	0.0000 ± 0.0000	1.7002	0.1085
74	0.0000 ± 0.0000	0.0022 ± 0.0067	-1.0000	0.3322
88	0.0324 ± 0.0544	0.0072 ± 0.0142	1.3461	0.1971
96	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
121	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.2 (continued).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
128	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
135	0.0430 ± 0.0510	0.0193 ± 0.0290	1.2094	0.2441
142	0.0365 ± 0.0525	0.0129 ± 0.0256	1.2149	0.2421
160	0.0000 ± 0.0000	0.0026 ± 0.0078	-1.0000	0.3322
176	0.0198 ± 0.0275	0.0145 ± 0.0188	0.4841	0.6349
184	0.1799 ± 0.1061	0.1617 ± 0.0801	0.4103	0.6871
193	0.1023 ± 0.0772	0.1334 ± 0.0585	-0.9607	0.3510

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.3
Pitfall trap data for total adult Araneae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
-14	0.5947 ± 0.2576	0.3736 ± 0.1893	2.0752	0.0545
-12	0.2418 ± 0.1517	0.2413 ± 0.2205	0.0052	0.0996
-11	0.2202 ± 0.2306	0.1150 ± 0.1897	0.6722	0.5111
-07	0.2482 ± 0.1150	0.1471 ± 0.1415	1.6635	0.1157
-05	0.0726 ± 0.1147	0.2089 ± 0.1128	-2.5435	0.0217 *
00	0.1113 ± 0.0819	0.1457 ± 0.1126	0.9817	0.3409
01	0.0669 ± 0.1327	0.1672 ± 0.1587	-1.4552	0.1650
02	0.0334 ± 0.1003	0.1533 ± 0.1897	-1.6764	0.1131
03	0.1199 ± 0.1869	0.1869 ± 0.2104	0.1480	0.8842
07	0.0519 ± 0.0661	0.0998 ± 0.1200	-1.0496	0.3095
09	0.1837 ± 0.1535	0.2701 ± 0.1386	-1.2542	0.2278
14	0.1130 ± 0.0672	0.0176 ± 0.0349	3.7799	0.0016**
16	0.0783 ± 0.0928	0.0978 ± 0.0982	-0.4472	0.6607
21	0.1117 ± 0.0772	0.0639 ± 0.0820	1.2707	0.2220
23	0.0334 ± 0.1003	0.1338 ± 0.1586	-1.6036	0.1284
28	0.0426 ± 0.0546	0.0548 ± 0.0844	-0.3622	0.7220
30	0.0000 ± 0.0000	0.1364 ± 0.1477	-2.7688	0.0137
38	0.0586 ± 0.0555	0.0309 ± 0.0588	1.0251	0.3206
46	0.0250 ± 0.0403	0.0293 ± 0.0593	-0.1808	0.8584
53	0.0422 ± 0.0576	0.0000 ± 0.0000	2.1975	0.0431 *
74	0.0067 ± 0.0101	0.0216 ± 0.0261	-1.5986	0.1295
88	0.0376 ± 0.0368	0.1003 ± 0.0679	-2.4327	0.0271
96	0.0114 ± 0.0226	0.0000 ± 0.0000	1.5119	0.1501
121	0.0038 ± 0.0075	0.0019 ± 0.0057	0.6030	0.5550

N.B. * and ** indicate significant differences at p<0.05 and p<0.01 respectively (t-test).

Appendix 2.3 (continued).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
128	0.0064 ± 0.0193	0.0243 ± 0.0482	-1.0304	0.3182
135	0.1341 ± 0.0322	0.4016 ± 0.0693	-8.1885	<0.0001**
142	0.1572 ± 0.0830	0.5007 ± 0.1148	-7.2723	<0.0001**
160	0.0270 ± 0.0386	0.0620 ± 0.0480	-1.7044	0.1077
176	0.0893 ± 0.0509	0.1534 ± 0.0639	-2.3541	0.0317 *
184	0.3235 ± 0.0621	0.5066 ± 0.0900	-5.0255	0.0001**
193	0.3961 ± 0.1171	0.3792 ± 0.0945	0.3362	0.7411

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.4
Pitfall trap data for total Collembola.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
-14	0.4845 ± 0.5911	1.3784 ± 0.4009	-3.7545	0.0017**
-12	0.6073 ± 0.3683	0.6604 ± 0.2001	-0.3799	0.7090
-11	0.7094 ± 0.2167	1.1007 ± 0.2273	-3.7382	0.0018**
-07	0.3733 ± 0.1970	0.7584 ± 0.3526	-3.6060	0.0024**
-05	0.3264 ± 0.3208	0.5004 ± 0.1134	-1.5342	0.1445
00	0.4827 ± 0.2292	0.3650 ± 0.1539	1.2790	0.2191
01	0.7865 ± 0.2103	0.7377 ± 0.2712	0.4268	0.6752
02	0.7154 ± 0.3425	0.6558 ± 0.2618	0.4143	0.6842
03	0.9113 ± 0.3542	1.0683 ± 0.2163	-1.1352	0.2730
07	1.2569 ± 0.2583	1.3558 ± 0.2170	-0.8790	0.3924
09	1.5268 ± 0.2367	1.5936 ± 0.2152	-0.6267	0.5397
14	0.5560 ± 0.1302	0.3795 ± 0.1782	2.3997	0.0289 *
16	0.8350 ± 0.2567	0.6933 ± 0.1921	1.3260	0.2035
21	0.7725 ± 0.2344	0.6123 ± 0.2624	1.3662	0.1908
23	0.6445 ± 0.0921	0.5904 ± 0.1880	0.7755	0.4494
28	1.2600 ± 0.1131	1.3235 ± 0.1752	-0.9142	0.3742
30	0.9203 ± 0.2348	0.9048 ± 0.2458	0.1367	0.8930
38	0.3556 ± 0.1448	0.1980 ± 0.1523	2.1503	0.0389 *
46	1.0764 ± 0.3443	0.4627 ± 0.2347	4.4186	0.0004**
53	0.9115 ± 0.1892	0.4487 ± 0.1917	5.1548	0.0001**
74	0.0403 ± 0.0358	0.0455 ± 0.0475	-0.2619	0.7968
88	0.9081 ± 0.1883	0.4331 ± 0.1716	5.5937	<0.0001**
96	0.4271 ± 0.1841	0.1558 ± 0.0880	3.9876	0.0011**
121	0.1424 ± 0.0594	0.0000 ± 0.0000	7.1923	<0.0001**

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.4 (continued).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
128	0.5238 ± 0.3464	0.2449 ± 0.2848	1.8662	0.0805
135	1.8583 ± 0.1271	1.1297 ± 0.3052	6.6117	<0.0001**
142	1.2341 ± 0.3897	0.7742 ± 0.2771	2.8855	0.0108 *
160	0.2539 ± 0.1065	0.2917 ± 0.1687	-0.5685	0.5776
176	0.6410 ± 0.1998	0.5110 ± 0.1837	1.4374	0.1699
184	1.1553 ± 0.2120	0.9429 ± 0.3909	1.4326	0.1712
193	0.9686 ± 0.1899	0.9500 ± 0.1357	0.2392	0.8140

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.5
Pitfall trap data for total Acari.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
-14	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
-12	0.0000 ± 0.0000	0.0391 ± 0.0777	-1.5119	0.1501
-11	0.0334 ± 0.1003	0.0669 ± 0.1327	-0.6030	0.5550
-07	0.0000 ± 0.0000	0.0108 ± 0.0323	-1.0000	0.3322
-05	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
00	0.0108 ± 0.0323	0.0108 ± 0.0323	0.0000	1.0000
01	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
02	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
03	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
07	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
09	0.0196 ± 0.0587	0.0391 ± 0.0777	-0.6030	0.5550
14	0.0426 ± 0.0545	0.0162 ± 0.0487	1.0831	0.2948
16	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
21	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
23	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
28	0.0162 ± 0.0487	0.0000 ± 0.0000	1.0000	0.3322
30	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
38	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3322
46	0.0390 ± 0.0781	0.0000 ± 0.0000	1.4985	0.1535
53	0.0273 ± 0.0528	0.0000 ± 0.0000	1.3435	0.1979
74	0.0195 ± 0.0257	0.0232 ± 0.0362	-0.2486	0.8069
88	0.0777 ± 0.1247	0.0914 ± 0.1303	-0.2277	0.8228
96	0.0278 ± 0.0359	0.0768 ± 0.0719	-1.8286	0.0862
121	0.0037 ± 0.0111	0.0037 ± 0.0111	0.0000	1.0000

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.5 (continued).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
128	0.0000 ± 0.0000	0.0064 ± 0.0193	-1.0000	0.3322
135	0.5197 ± 0.2515	0.3615 ± 0.2392	1.3674	0.1904
142	0.4902 ± 0.0802	0.3631 ± 0.1940	1.8161	0.0882
160	0.1445 ± 0.0492	0.1443 ± 0.0965	0.0052	0.9959
176	0.0247 ± 0.0388	0.0083 ± 0.0249	1.0705	0.3003
184	0.1420 ± 0.0971	0.1818 ± 0.1007	-0.8538	0.4058
193	0.0524 ± 0.1179	0.0632 ± 0.0972	-0.2121	0.8347

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.6
Pitfall trap data for total Diptera.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Day +or-	Mean no./trap/day log(n+1) with SD		t-stat	Sig.Level
	Treatment	Control		
-14	0.7674 ± 0.2748	1.0876 ± 0.1188	-3.2091	0.0055**
-12	0.2815 ± 0.1981	0.4660 ± 0.1944	-1.9942	0.0635
-11	0.1868 ± 0.2654	0.5610 ± 0.2074	-3.3336	0.0042**
-07	0.4064 ± 0.1416	0.4521 ± 0.0940	-0.8060	0.4321
-05	0.3911 ± 0.2204	0.5305 ± 0.1193	-1.6694	0.1145
00	0.2655 ± 0.0738	0.5305 ± 0.1193	-2.0259	0.0598
01	0.2114 ± 0.2368	0.4071 ± 0.2011	-1.8891	0.0772
02	0.1338 ± 0.1586	0.4378 ± 0.2109	-3.4510	0.0033**
03	0.0000 ± 0.0000	0.3923 ± 0.2919	-4.0403	0.0010**
07	0.2179 ± 0.1000	0.3562 ± 0.1050	-2.8636	0.3322
09	0.4065 ± 0.1939	0.4644 ± 0.1884	-0.6599	0.5187
14	0.2106 ± 0.1069	0.1044 ± 0.1106	2.0714	0.0549
16	0.1060 ± 0.1333	0.1647 ± 0.1073	-1.0294	0.3186
21	0.2333 ± 0.1040	0.0974 ± 0.1516	2.2179	0.0414 *
23	0.1029 ± 0.1397	0.0783 ± 0.0928	0.4409	0.6652
28	0.1569 ± 0.1226	0.2148 ± 0.1354	-0.9524	0.3551
30	0.2171 ± 0.1408	0.2670 ± 0.2374	-0.5424	0.5950
38	0.4069 ± 0.1776	0.2824 ± 0.2072	1.3689	0.1900
46	0.4428 ± 0.1564	0.2797 ± 0.1889	1.9936	0.0632
53	0.5036 ± 0.1494	0.4411 ± 0.2959	0.5653	0.5797
74	0.1955 ± 0.1060	0.0951 ± 0.0700	0.0081	0.9936
88	0.2673 ± 0.0544	0.2679 ± 0.1218	-0.0135	0.9894
96	0.1129 ± 0.1074	0.0980 ± 0.0614	0.3612	0.7227
121	0.0310 ± 0.0248	0.0197 ± 0.0308	0.8547	0.4053

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.6 (continued).

Days +or-	Mean no./trap/day log(n+1) with SD		t-stat	Sig.Level
	Treatment	Control		
128	0.2004 ± 0.1333	0.2196 ± 0.2149	-0.2282	0.8224
135	0.1418 ± 0.0892	0.0810 ± 0.1047	1.3256	0.2036
142	0.0487 ± 0.0556	0.0659 ± 0.0622	-0.6193	0.5445
160	0.0280 ± 0.0235	0.0474 ± 0.0544	-0.9855	0.3391
176	0.0670 ± 0.0754	0.0498 ± 0.0611	0.5305	0.6031
184	0.3729 ± 0.1258	0.2190 ± 0.1028	2.8431	0.0118 *
193	0.4133 ± 0.2016	0.2281 ± 0.0569	2.6514	0.0174 *

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.7
Gutter trap data for total adult Carabidae. (Field 1)
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
-11	0.6577 ± 0.2631	0.7113 ± 0.0728	-0.4388	0.6724
-07	0.4816 ± 0.1038	0.3757 ± 0.2242	0.9588	0.3657
-05	0.4395 ± 0.2636	0.5190 ± 0.1683	-0.5690	0.5850
00	0.2953 ± 0.1307	0.3223 ± 0.1552	-0.2982	0.7731
01	0.5010 ± 0.1869	0.3204 ± 0.2486	1.2990	0.2301
02	0.3113 ± 0.3314	0.4567 ± 0.4602	-0.5734	0.5821
03	0.3204 ± 0.3273	0.4803 ± 0.3077	-0.7958	0.4491
07	0.3032 ± 0.1773	0.2537 ± 0.3088	0.3106	0.7640
09	0.4451 ± 0.1388	0.4669 ± 0.1742	-0.2193	0.8319
14	0.2593 ± 0.2130	0.2440 ± 0.0409	0.1587	0.8779
16	0.0352 ± 0.0788	0.0000 ± 0.0000	1.0000	0.3466
21	0.2364 ± 0.1493	0.1762 ± 0.1762	0.5899	0.5716
23	0.0352 ± 0.0788	0.0352 ± 0.0788	0.0000	1.0000
28	0.3385 ± 0.1368	0.4304 ± 0.1956	-0.8611	0.4142
30	0.0602 ± 0.1346	0.0954 ± 0.2134	-0.3122	0.7629
41	0.0831 ± 0.0525	0.0858 ± 0.0186	-0.0618	0.9523
46	0.1412 ± 0.0720	0.1735 ± 0.0948	-0.6076	0.5603
75	0.0090 ± 0.0134	0.0121 ± 0.0126	-0.3694	0.7215
88	0.0369 ± 0.0395	0.0614 ± 0.0290	-1.1179	0.2961
96	0.0731 ± 0.0807	0.0000 ± 0.0000	2.0269	0.0772
121	0.0102 ± 0.0093	0.0034 ± 0.0076	1.2649	0.2415
128	0.0566 ± 0.0387	0.0934 ± 0.0800	-0.9262	0.3815
135	0.1720 ± 0.0949	0.1120 ± 0.0861	1.0473	0.3256
142	0.2909 ± 0.1525	0.1112 ± 0.0897	2.2696	0.0529

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.7 (continued)

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
160	0.1279 ± 0.0675	0.1068 ± 0.0883	0.4249	0.6821
176	0.1398 ± 0.1057	0.0749 ± 0.0689	1.1503	0.2832
184	0.7750 ± 0.2045	0.6345 ± 0.0615	1.2622	0.2424
193	0.8804 ± 0.2069	0.7128 ± 0.2091	1.2384	0.2384

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.8
Gutter trap data for total adult Carabidae. (Field 2)
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
01	0.1204 ± 0.1649	0.2158 ± 0.2097	-0.7998	0.4469
02	0.1806 ± 0.1649	0.3400 ± 0.2326	-1.2504	0.2465
03	0.3112 ± 0.1950	0.2158 ± 0.2097	0.7451	0.4776
07	0.1440 ± 0.1387	0.2711 ± 0.1871	-1.2205	0.2570
09	0.3056 ± 0.1337	0.3849 ± 0.1742	-0.6387	0.5409
14	0.1521 ± 0.1773	0.1017 ± 0.0772	0.5823	0.5764
16	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0609 ± 0.0619	0.2476 ± 0.1376	-2.7667	0.0244 *
23	0.2011 ± 0.1721	0.0954 ± 0.1379	1.0712	0.3153
28	0.1035 ± 0.0647	0.0919 ± 0.1234	0.1865	0.8567
30	0.2194 ± 0.2041	0.0352 ± 0.0788	1.8820	0.0966
41	0.0635 ± 0.0498	0.0227 ± 0.0207	1.6935	0.1288
47	0.1521 ± 0.0679	0.0870 ± 0.0666	1.5304	0.1644
53	0.2776 ± 0.0352	0.1624 ± 0.0667	3.4191	0.0091**
75	0.0070 ± 0.0106	0.0150 ± 0.0242	-0.6140	0.5563
88	0.0658 ± 0.0480	0.1060 ± 0.0144	-1.7916	0.1110
96	0.0501 ± 0.0343	0.0296 ± 0.0437	0.8249	0.4333
121	0.0067 ± 0.0149	0.0101 ± 0.0150	-0.3595	0.7285
128	0.1908 ± 0.4267	0.7634 ± 0.4267	-2.1213	0.0667
135	0.0553 ± 0.0546	0.1066 ± 0.1134	-0.9119	0.3885
142	0.0669 ± 0.0453	0.1857 ± 0.1034	-2.3531	0.0465 *
160	0.0094 ± 0.0129	0.1125 ± 0.0861	-2.6493	0.0293 *
184	0.2977 ± 0.1265	0.4289 ± 0.0740	-2.0015	0.0803
193	0.6827 ± 0.1275	0.5118 ± 0.2630	1.3073	0.2274

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.9
Gutter trap data for total adult Staphylinidae. (Field 1) comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
-11	0.2155 ± 0.2097	0.1806 ± 0.1649	0.2952	0.7753
-07	0.1092 ± 0.0728	0.0194 ± 0.0433	2.3715	0.0451 *
-05	0.1148 ± 0.1757	0.0704 ± 0.0965	0.4950	0.6339
00	0.1053 ± 0.1662	0.0292 ± 0.0653	0.9521	0.3689
01	0.0000 ± 0.0000	0.1204 ± 0.1649	-1.6330	0.1411
02	0.0602 ± 0.1346	0.1204 ± 0.1649	-0.6325	0.5447
03	0.2158 ± 0.2097	0.1556 ± 0.2220	0.4408	0.6711
07	0.0546 ± 0.0798	0.1965 ± 0.2144	-1.3866	0.2030
09	0.2102 ± 0.1500	0.1556 ± 0.1509	0.5738	0.5819
14	0.0669 ± 0.1108	0.0292 ± 0.0653	0.6552	0.5307
16	0.0000 ± 0.0000	0.0352 ± 0.0788	-1.0000	0.3466
21	0.1401 ± 0.0835	0.0475 ± 0.0434	2.1995	0.0590
23	0.0602 ± 0.1346	0.0000 ± 0.0000	1.0000	0.3466
28	0.1445 ± 0.1656	0.1370 ± 0.1768	0.0698	0.9461
30	0.0704 ± 0.0965	0.0704 ± 0.0965	0.0000	1.0000
41	0.0221 ± 0.0326	0.0151 ± 0.0207	0.4026	0.6978
46	0.0961 ± 0.1079	0.0451 ± 0.0661	0.9022	0.3933
75	0.0030 ± 0.0068	0.0000 ± 0.0000	1.0000	0.3466
88	0.0253 ± 0.0262	0.0064 ± 0.0144	1.4141	0.1951
96	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
121	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
128	0.0450 ± 0.0461	0.0426 ± 0.0676	0.0667	0.9485
135	0.0450 ± 0.0461	0.0658 ± 0.0558	-0.6415	0.5392
142	0.1204 ± 0.0918	0.0116 ± 0.0259	2.5502	0.0342 *

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.9 (continued).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
160	0.0047 ± 0.0105	0.0047 ± 0.0105	0.0000	1.0000
176	0.0382 ± 0.0575	0.0053 ± 0.0118	1.2544	0.2451
184	0.1521 ± 0.0432	0.0751 ± 0.0661	2.1820	0.0607
193	0.1410 ± 0.0738	0.0683 ± 0.0550	1.7680	0.1151

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.10
Gutter trap data for total adult Staphylinidae. (Field 2) Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
01	0.1204 ± 0.1649	0.1556 ± 0.2220	-0.2848	0.7830
02	0.1204 ± 0.1649	0.1806 ± 0.2693	-0.4265	0.6810
03	0.0000 ± 0.0000	0.1204 ± 0.2693	-1.0000	0.3466
07	0.2102 ± 0.2307	0.1728 ± 0.2090	0.2688	0.7949
09	0.3190 ± 0.1566	0.3492 ± 0.3492	-0.2253	0.8274
14	0.2808 ± 0.1494	0.1211 ± 0.1171	1.8809	0.0968
16	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.1972 ± 0.1960	0.1397 ± 0.1751	0.4892	0.6378
23	0.2454 ± 0.1916	0.1306 ± 0.1297	1.1097	0.2994
28	0.4517 ± 0.2335	0.2475 ± 0.2017	1.4798	0.1772
30	0.6007 ± 0.2216	0.3349 ± 0.1700	2.1286	0.0659
41	0.1647 ± 0.1435	0.0000 ± 0.0000	2.5669	0.0333 *
47	0.3862 ± 0.2276	0.0268 ± 0.0367	3.4864	0.0082**
53	0.2154 ± 0.0841	0.0986 ± 0.1246	1.7384	0.1203
75	0.0292 ± 0.0369	0.0116 ± 0.0106	1.0269	0.3345
88	0.1722 ± 0.1093	0.0709 ± 0.0537	1.8607	0.0998
96	0.0205 ± 0.0280	0.0205 ± 0.0280	0.0000	1.0000
121	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
128	0.0116 ± 0.0259	0.0771 ± 0.0485	-2.6647	0.0286 *
135	0.0785 ± 0.0280	0.0843 ± 0.0736	-0.1653	0.8728
142	0.1632 ± 0.0185	0.0654 ± 0.1165	1.8537	0.1009
160	0.0094 ± 0.0129	0.0442 ± 0.0412	-1.8041	0.1089
184	0.0788 ± 0.0603	0.1209 ± 0.0371	-1.3290	0.2205
193	0.2883 ± 0.0959	0.2517 ± 0.1366	0.4913	0.6364

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.11
Gutter trap data for total adult Araneae. (Field 1)
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
-11	0.1556 ± 0.2220	0.1556 ± 0.2220	0.0000	1.0000
-07	0.0352 ± 0.0780	0.0000 ± 0.0000	1.0000	0.3466
-05	0.0000 ± 0.0000	0.0352 ± 0.0788	-1.0000	0.3466
00	0.0511 ± 0.1142	0.0700 ± 0.0981	-0.2820	0.7851
01	0.1204 ± 0.1649	0.1806 ± 0.3693	-0.4265	0.6810
02	0.2894 ± 0.3452	0.0602 ± 0.1346	1.3834	0.2039
03	0.1556 ± 0.2220	0.3010 ± 0.0129	-1.0571	0.3214
07	0.2796 ± 0.2685	0.3935 ± 0.2256	-0.7264	0.4883
09	0.4085 ± 0.2135	0.2011 ± 0.2676	1.3548	0.2125
14	0.3499 ± 0.2530	0.0859 ± 0.0900	2.1981	0.0592
16	0.0352 ± 0.0788	0.0000 ± 0.0000	1.0000	0.3466
21	0.3176 ± 0.1348	0.0859 ± 0.0900	3.1963	0.0127 *
23	0.1306 ± 0.1297	0.1398 ± 0.1944	-0.0874	0.9325
28	0.1313 ± 0.1279	0.2772 ± 0.2091	-1.3304	0.2201
30	0.0352 ± 0.0788	0.1148 ± 0.1757	-0.9243	0.3824
41	0.0221 ± 0.0326	0.0151 ± 0.0207	0.4026	0.6978
46	0.1612 ± 0.1524	0.0408 ± 0.0913	1.5156	0.1681
75	0.0000 ± 0.0000	0.0030 ± 0.0068	-1.0000	0.3466
88	0.0563 ± 0.0776	0.1020 ± 0.1001	-0.8068	0.4431
96	0.0205 ± 0.0280	0.0030 ± 0.0068	1.3515	0.2135
121	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
128	0.0334 ± 0.0492	0.0334 ± 0.0492	0.0000	1.0000
135	0.0450 ± 0.0461	0.1844 ± 0.1131	-2.5519	0.0341 *
142	0.1830 ± 0.0779	0.3470 ± 0.1363	-2.7199	0.0263 *

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.11 (continued).

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
160	0.0324 ± 0.0122	0.0758 ± 0.0609	1.5628	0.1567
176	0.1674 ± 0.1161	0.0664 ± 0.0930	1.5187	0.1673
184	0.3785 ± 0.0430	0.4293 ± 0.1481	-0.7374	0.4820
193	0.4726 ± 0.0706	0.4435 ± 0.1509	0.3912	0.7059

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.12
Gutter trap data for total adult Araneae. (Field 2)
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
01	0.1556 ± 0.2220	0.4669 ± 0.1950	-2.3553	0.0463 *
02	0.0602 ± 0.1346	0.3362 ± 0.2270	-2.3391	0.0475 *
03	0.1204 ± 0.1649	0.3806 ± 0.2775	-1.8028	0.1091
07	0.4203 ± 0.2405	0.2776 ± 0.1921	1.0368	0.3301
09	0.3599 ± 0.2596	0.4680 ± 0.1556	-0.7986	0.4476
14	0.1791 ± 0.1617	0.1327 ± 0.1229	0.5110	0.6232
16	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.1677 ± 0.1234	0.1797 ± 0.1670	-0.1293	0.9004
23	0.0352 ± 0.0788	0.0602 ± 0.1346	-0.3582	0.7295
28	0.1722 ± 0.1063	0.1662 ± 0.1597	0.0697	0.9462
30	0.0352 ± 0.0788	0.0704 ± 0.0965	-0.6325	0.5447
41	0.0680 ± 0.0700	0.0145 ± 0.0325	1.5503	0.1597
47	0.0620 ± 0.0720	0.0576 ± 0.0958	0.0828	0.9360
53	0.0870 ± 0.0666	0.0444 ± 0.0992	0.7974	0.4482
75	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
88	0.0425 ± 0.0455	0.1098 ± 0.0868	-1.5356	0.1632
96	0.0205 ± 0.0280	0.0102 ± 0.0229	0.6325	0.5447
121	0.0000 ± 0.0000	0.0068 ± 0.0093	-1.6330	0.1411
128	0.0116 ± 0.0259	0.1755 ± 0.1148	-3.1131	0.0144 *
135	0.1112 ± 0.0897	0.1824 ± 0.0815	-1.3132	0.2255
142	0.1563 ± 0.0918	0.5578 ± 0.1858	-4.3315	0.0025**
160	0.0320 ± 0.0254	0.1091 ± 0.0356	-3.9415	0.0045**
184	0.1567 ± 0.1009	0.2743 ± 0.1374	-1.5427	0.1615
193	0.4294 ± 0.0151	0.4979 ± 0.1519	-1.0033	0.3451

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 2.13
Table of dates associated with days relative to treatment for the autumn 1985 cypermethrin field trial.

DAYS	DATE	DAYS	DATE
-14	15-10-85	38	06-12-85
-12	17-10-85	41	09-12-85
-11	18-10-85	46	14-12-85
-07	22-10-85	47	15-12-85
-05	24-10-85	53	21-12-85
00	29-10-85	74	11-01-86
01	30-10-85	75	12-01-86
02	31-10-85	88	25-01-86
03	01-11-85	96	02-02-86
07	05-11-85	121	27-02-86
09	07-11-85	128	06-03-86
14	12-11-85	135	13-06-86
16	14-11-85	142	20-03-86
21	19-11-85	160	07-04-86
23	21-11-85	176	23-04-86
28	26-11-85	184	01-05-86
30	28-11-85	193	10-05-86

Appendix 3.1

Pitfall trap data for <u>Pterostichus melanarius</u> (Illiger). Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0768a ±.0232	.0250b ±.0250	.0625ab ±.0198	.0268b ±.0164	1.539	0.2430
-01	.1341 ±.0186	.1430 ±.0262	.1473 ±.0301	.1512 ±.0329	0.071	0.9744
01	.2099 ±.0266	.2039 ±.0455	.2226 ±.0405	.2308 ±.0413	0.097	0.9607
03	.0796bc ±.0424	.0204a ±.0135	.0453ab ±.0235	.1059c ±.0229	2.288	0.1175
09	.0424 ±.0160	.0356 ±.0175	.0390 ±.0068	.0624 ±.0091	0.840	0.4915
12	.1289 ±.0447	.0921 ±.0385	.1107 ±.0269	.0852 ±.0204	0.335	0.8005
16	.0700b ±.0260	.0173a ±.0094	.0436ab ±.0153	.0310a ±.0099	1.833	0.1818
22	.0486b ±.0179	.0317ab ±.0137	.0142a ±.0023	.0209a ±.0084	1.542	0.2422
25	.0277b ±.0186	.0139ab ±.0262	.0047a ±.0301	.0141ab ±.0329	1.693	0.2085

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals.

Appendix 3.2
Pitfall trap data for total adult Carabidae
Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0870 ±.0298	.0383 ±.0252	.0846 ±.0367	.0766 ±.0456	0.413	0.7459
-01	.1652 ±.0289	.1419 ±.0259	.1619 ±.0321	.1612 ±.0333	0.123	0.9454
01	.2174 ±.0311	.1858 ±.0645	.2328 ±.0353	.2378 ±.0435	0.265	0.8493
03	.1117 ±.0528	.0541 ±.0079	.0571 ±.0279	.1176 ±.0200	1.162	0.3549
09	.0424 ±.0160	.0425 ±.0152	.0476 ±.0086	.0667 ±.0201	0.551	0.6550
12	.1485 ±.0560	.1186 ±.0377	.1107 ±.0269	.1093 ±.0315	0.213	0.8857
16	.0833b ±.0319	.0193a ±.0124	.0561ab ±.0178	.0438ab ±.0143	1.678	0.2120
22	.0636b ±.0270	.0415ab ±.0208	.0211a ±.0043	.0289ab ±.0071	1.114	0.3724
25	.0404b ±.0144	.0174ab ±.0174	.0094a ±.0058	.0300ab ±.0086	1.214	0.3367

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals.

Appendix 3.3

Pitfall trap data for total adult Staphylinidae. Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0250ab ±.0250	.0632b ±.0482	.0000a ±.0000	.0134ab ±.0134	0.945	0.4422
-01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
01	.0250 ±.0250	.0352 ±.0352	.0444 ±.0444	.0352 ±.0352	0.050	0.9849
03	.0134a ±.0134	.1235b ±.0512	.0333a ±.0177	.0397a ±.0190	2.729	0.0783
09	.0325b ±.0042	.0363b ±.0125	.0093a ±.0068	.0233ab ±.0064	2.204	0.1272
12	.0000a ±.0000	.0496b ±.0107	.0094a ±.0058	.0577b ±.0140	9.626	0.0007
16	.0267 ±.0171	.0106 ±.0043	.0105 ±.0070	.0204 ±.0135	0.464	0.7112
22	.0000a ±.0000	.0094b ±.0058	.0048ab ±.0029	.0024b ±.0024	1.361	0.2902
25	.0047 ±.0047	.0000 ±.0000	.0047 ±.0047	.0000 ±.0000	0.667	0.5847

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals.

Appendix 3.4
Pitfall trap data for *Erigone atra* (Blackwall).
Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SD				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0870 ±.0298	.1088 ±.0338	.1204 ±.0322	.1046 ±.0454	0.150	0.9284
-01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
01	.1455 ±.0481	.1599 ±.0379	.0970 ±.0598	.1430 ±.0262	0.371	0.7748
03	.0879 ±.0261	.0950 ±.0206	.0591 ±.0187	.0333 ±.0177	1.815	0.1851
09	.1356a ±.0396	.1505a ±.0481	.1477a ±.0342	.5164b ±.0943	9.928	0.0006
12	.1805a ±.0326	.2177a ±.0300	.2569ab ±.0586	.4174b ±.0526	5.331	0.0097
16	.1069a ±.0377	.0957a ±.0294	.1494ab ±.0376	.2854b ±.0372	5.969	0.0062
22	.0536 ±.0250	.0255 ±.0083	.0726 ±.0237	.1062 ±.0560	1.049	0.3981
25	.0478 ±.0221	.0000 ±.0000	.0315 ±.0146	.0827 ±.0306	2.891	0.0678

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals.

Appendix 3.5
Pitfall trap data for <u>Erigone dentipalpis</u> (Wider).
Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
-01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
03	.0167 ±.0167	.0167 ±.0167	.0000 ±.0000	.0000 ±.0000	0.667	0.5847
09	.0339a ±.0135	.0209a ±.0084	.0296a ±.0120	.1520b ±.0306	11.574	0.0003
12	.0273a ±.0131	.0405a ±.0144	.0411a ±.0082	.1213b ±.0282	5.945	0.0064
16	.0070a ±.0070	.0205ab ±.0123	.0310ab ±.0099	.0823b ±.0248	4.754	0.0148
22	.0024 ±.0024	.0071 ±.0047	.0093 ±.0068	.0494 ±.0292	2.046	0.1480
25	.0047 ±.0047	.0000 ±.0000	.0000 ±.0000	.0047 ±.0047	0.667	0.5847

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals.

Appendix 3.6
Pitfall trap data for <u>Oedothorax fuscus</u> (Blackwall). Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
-01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
01	.0250 ±.0250	.0268 ±.0164	.0134 ±.0134	.0134 ±.0134	0.168	0.9165
03	.0263 ±.0189	.0453 ±.0235	.0134 ±.0134	.0000 ±.0000	1.373	0.2869
09	.0285 ±.0193	.0233 ±.0072	.0140 ±.0068	.0407 ±.0124	0.796	0.5137
12	.0141 ±.0058	.0539 ±.0108	.0609 ±.0207	.0803 ±.0254	2.527	0.0942
16	.0235 ±.0152	.0339 ±.0139	.0341 ±.0119	.0200 ±.0159	0.255	0.8565
22	.0140 ±.0068	.0071 ±.0047	.0139 ±.0084	.0306 ±.0200	0.746	0.5404
25	.0092 ±.0092	.0186 ±.0086	.0094 ±.0058	.0047 ±.0047	0.636	0.6028

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals.

Appendix 3.7
Pitfall trap data for total Erigoninae.
Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0870 ±.0298	.1088 ±.0338	.1204 ±.0322	.1046 ±.0454	0.150	0.9284
-01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
01	.1676 ±.0618	.1765 ±.0453	.1104 ±.0557	.1760 ±.0370	0.389	0.7624
03	.1268 ±.0274	.1429 ±.0268	.0955 ±.0426	.0333 ±.0177	2.601	0.0880
09	.1768a ±.0547	.1799a ±.0543	.1799a ±.0444	.5764b ±.0983	8.998	0.0010
12	.2105a ±.0338	.2820a ±.0307	.3164ab ±.0553	.4896b ±.0623	6.669	0.0039
16	.1288a ±.0492	.1379a ±.0416	.1911ab ±.0487	.3431b ±.0543	4.151	0.0236
22	.0664 ±.0314	.0382 ±.0147	.0918 ±.0328	.1485 ±.0725	1.169	0.3524
25	.0619 ±.0344	.0186 ±.0086	.0399 ±.0182	.0914 ±.0275	1.650	0.2176

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals.

Appendix 3.8
Pitfall trap data for <u>Meioneta rurestris</u> (C.L.Koch).
Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
-01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
01	.0620 ±.0322	.0736 ±.0347	.0444 ±.0444	.0652 ±.0198	0.131	0.9400
03	.0333ab ±.0177	.0931b ±.0284	.0601ab ±.0117	.0000a ±.0000	4.979	0.0125
09	.0514 ±.0138	.0513 ±.0145	.0185 ±.0093	.0541 ±.0085	2.039	0.1490
12	.0355 ±.0178	.0424 ±.0265	.0525 ±.0200	.0893 ±.0199	1.265	0.3198
16	.0621 ±.0205	.0933 ±.0283	.0835 ±.0190	.0960 ±.0452	0.261	0.8521
22	.0233 ±.0072	.0071 ±.0047	.0430 ±.0118	.0509 ±.0271	1.652	0.2172
25	.0355 ±.0178	.0277 ±.0085	.0610 ±.0198	.0453 ±.0314	0.465	0.7104

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals.

Appendix 3.9
Pitfall trap data for total Linyphiinae.
Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
-01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
01	.0870 ±.0556	.1198 ±.0331	.0660 ±.0510	.0652 ±.0198	0.365	0.7789
03	.0639ab ±.0257	.1106b ±.0267	.0948ab ±.0211	.0139a ±.0085	3.836	0.0303
09	.0676 ±.0179	.0618 ±.0149	.0826 ±.0239	.0748 ±.0088	0.273	0.8441
12	.0520 ±.0227	.0621 ±.0320	.0721 ±.0257	.0893 ±.0199	0.390	0.7618
16	.0711 ±.0208	.0989 ±.0286	.1027 ±.0245	.1110 ±.0496	0.277	0.8408
22	.0299 ±.0098	.0093 ±.0068	.0472 ±.0129	.0641 ±.0324	1.617	0.2247
25	.0490 ±.0156	.0413 ±.0045	.0699 ±.0159	.0574 ±.0337	0.362	0.7811

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals.

Appendix 3.10
Pitfall trap data for total Linyphiidae.
Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0870 ±.0298	.1088 ±.0338	.1204 ±.0322	.1046 ±.0454	0.150	0.9284
-01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
01	.2191 ±.0860	.2442 ±.0652	.1502 ±.0716	.1954 ±.0434	0.343	0.7945
03	.1722b ±.0431	.2228b ±.0405	.1518b ±.0323	.0472a ±.0124	4.647	0.0161
09	.2205a ±.6601	.2172a ±.0597	.2344a ±.0521	.5998b ±.0926	7.665	0.0021
12	.2083a ±.0091	.2859ab ±.0481	.3503b ±.0601	.5338c ±.0515	8.906	0.0011
16	.1794a ±.0561	.2191a ±.0473	.2582a ±.0525	.3919b ±.0698	2.687	0.0814
22	.0863ab ±.0355	.0467a ±.0160	.1302ab ±.0345	.1848b ±.0868	1.373	0.2869
25	.1015 ±.0424	.1791 ±.1228	.2230 ±.1152	.1338 ±.0503	0.344	0.7938

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals.

Appendix 3.11
Pitfall trap data for male Linyphiidae.
Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0652 ±.0198	.0634 ±.0279	.0736 ±.0347	.0736 ±.0347	0.033	0.9916
-01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
01	.1430 ±.0537	.1840 ±.0494	.1180 ±.0759	.1717 ±.0311	0.291	0.8309
03	.0873 ±.0288	.1631 ±.0423	.1038 ±.0313	.0343 ±.0106	3.031	0.0599
09	.1669a ±.0527	.1639a ±.0543	.1865a ±.0444	.5718b ±.0870	10.480	0.0005
12	.2275a ±.0249	.2662a ±.0458	.3110ab ±.0670	.4975b ±.0459	6.141	0.0056
16	.1264a ±.0577	.1835ab ±.0483	.2266ab ±.0511	.3719b ±.0678	3.416	0.0430
22	.0673 ±.0284	.0835 ±.0123	.0986 ±.0297	.1599 ±.0787	1.347	0.2944
25	.0741 ±.0092	.0139 ±.0086	.0505 ±.0058	.0905 ±.0047	0.991	0.4219

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals.

Appendix 3.12
Pitfall trap data for female Linyphiidae.
Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0268 ±.0164	.0536 ±.0134	.0268 ±.0164	.0384 ±.0252	0.477	0.7030
-01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
01	.1158 ±.0637	.0962 ±.0371	.0518 ±.0236	.0384 ±.0252	0.802	0.5110
03	.1111b ±.0246	.0846b ±.0116	.0601ab ±.0117	.0139a ±.0085	7.180	0.0029
09	.0815 ±.0192	.0797 ±.0181	.0760 ±.0165	.1111 ±.0321	0.522	0.6731
12	.0320 ±.0114	.0807 ±.0237	.0697 ±.0174	.1103 ±.0280	2.358	0.1101
16	.0690 ±.0152	.0411 ±.0139	.0536 ±.0119	.0502 ±.0159	0.805	0.5095
22	.0292 ±.0068	.0095 ±.0047	.0406 ±.0084	.0457 ±.0200	1.110	0.3742
25	.0322 ±.0087	.0454 ±.0097	.0577 ±.0140	.0569 ±.0188	0.798	0.5130

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals.

Appendix 3.13
Pitfall trap data for total Syrphidae.
Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
-01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
01	.0134 ±.0134	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	1.000	0.4182
03	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
09	.0228b ±.0111	.0233b ±.0062	.0142ab ±.0044	.0048a ±.0029	1.621	0.2239
12	.0275b ±.0109	.0277b ±.0085	.0094a ±.0058	.0094a ±.0058	1.718	0.2035
16	.0618 ±.0208	.0500 ±.0162	.0338 ±.0147	.0468 ±.0154	0.463	0.7120
22	.0399b ±.0182	.0094a ±.0058	.0186ab ±.0086	.0047a ±.0047	2.116	0.1383
25	.0186 ±.0092	.0094 ±.0086	.0186 ±.0058	.0047 ±.0047	0.942	0.4436

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 3.14
Pitfall trap data for total Diptera.
Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
-01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
01	.0250 ±.0250	.0134 ±.0134	.0000 ±.0000	.0000 ±.0000	0.722	0.5532
03	.0070 ±.0070	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	1.000	0.4182
09	.1117b ±.0087	.0953b ±.0192	.0510a ±.0164	.0384a ±.0133	5.499	0.0086
12	.1716b ±.0316	.1812b ±.0169	.1675b ±.0345	.0979a ±.0148	2.174	0.1309
16	.3753b ±.0983	.2870ab ±.0598	.1881a ±.0507	.2750ab ±.0600	1.209	0.3386
22	.1736ab ±.0068	.0800a ±.0047	.2000b ±.0084	.1690ab ±.0200	1.299	0.3089
25	.1636ab ±.0248	.1571ab ±.0369	.2236b ±.0615	.0791a ±.0297	2.118	0.1381

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 3.15
Pitfall trap data for Sitobion avenae.
Comparison of, log(n+1) transformed, no./trap/day values for barriered plots treated with different rates of cypermethrin where N = normal field rate (25g a.i./ha) and C = unsprayed control.

Days +or-	Mean no./trap/day log(n+1) with SE				F-ratio	Sig. Level
	2N	N	N/2	C		
-03	.0828 ±.0419	.1088 ±.0578	.0500 ±.0306	.0846 ±.0367	0.317	0.8133
-01	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	.0000 ±.0000	0.000	1.0000
01	.5497c ±.0240	.3537b ±.0414	.4806c ±.1057	.0634a ±.0279	12.978	0.0001
03	.3075b ±.0408	.2481b ±.0819	.2658b ±.0512	.0500a ±.0306	4.409	0.0193
09	.3023c ±.0349	.3078c ±.0188	.2397b ±.0272	.0907a ±.0093	17.092	<.0001
12	.3854b ±.0536	.4436b ±.0508	.3845b ±.0674	.1596a ±.0053	6.294	0.0050
16	.6799bc ±.0614	.7955c ±.0753	.6247b ±.0443	.3008a ±.0414	13.692	0.0001
22	.2442b ±.0484	.2267b ±.0526	.2760b ±.0540	.0619a ±.0140	4.461	0.0185
25	.0522a ±.0213	.0483a ±.0201	.1055b ±.0323	.0317a ±.0135	1.963	0.1602

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 3.16
Table of dates associated with days relative to treatment for the summer 1986 multiple rate cypermethrin barrier trial.

DAYS	DATE
-03	13-07-86
-01	15-07-86
01	17-07-86
03	19-07-86
09	25-07-86
12	28-07-86
16	01-08-86
22	07-08-86
25	10-08-86

Appendix 4.1
Pitfall trap data for *Agonum dorsale* (Pont.).
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
-07	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0014 ± 0.0014	0.000	0.4219
02	0.0000 ± 0.0000	0.0071 ± 0.0071	0.0000 ± 0.0000	0.000	0.4219
08	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
18	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
31	0.0022 ± 0.0011	0.0000 ± 0.0000	0.0000 ± 0.0000	4.000	0.0707
47	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
87	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
108	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
115	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
122	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
129	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
143	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
168	0.0017 ± 0.0010	0.0012 ± 0.0012	0.0000 ± 0.0000	0.984	0.4271
185	0.0158 ± 0.0044	0.0182 ± 0.0066	0.0235 ± 0.0156	0.150	0.8636

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.1 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.1344 ± 0.0439	0.1801 ± 0.0589	0.1203 ± 0.0673	0.295	0.7546
214	0.0670 ± 0.0183	0.0932 ± 0.0208	0.0720 ± 0.0257	0.408	0.6821
221	0.0411 ± 0.0111	0.0538 ± 0.0160	0.0873 ± 0.0133	3.069	0.1208
228	0.0258 ± 0.0107	0.0544 ± 0.0274	0.0803 ± 0.0167	1.942	0.2237
236	0.0557 ± 0.0097	0.1047 ± 0.0185	0.0804 ± 0.0117	3.146	0.1163
242	0.0582 ± 0.0129	0.0430 ± 0.0150	0.0495 ± 0.0153	0.278	0.7663
-12	0.0469 ± 0.0308	0.0148 ± 0.0052	0.0108 ± 0.0036	1.188	0.3676

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.2
Pitfall trap data for total adults of the genus <u>Amara</u>. Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0021 ± 0.0010	0.0031 ± 0.0018	0.0031 ± 0.0018	0.143	0.8697
-07	0.0029 ± 0.0029	0.0000 ± 0.0000	0.0000 ± 0.0000	1.000	0.4219
02	0.0071 ± 0.0071	0.0138 ± 0.0138	0.0071 ± 0.0071	0.156	0.8588
08	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
18	0.0014 ± 0.0014	0.0014 ± 0.0014	0.0000 ± 0.0000	0.500	0.6297
31	0.0065 ± 0.0065	0.0000 ± 0.0000	0.0000 ± 0.0000	1.000	0.4219
47	0.0000 ± 0.0000	0.0005 ± 0.0005	0.0000 ± 0.0000	1.000	0.4219
87	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
108	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
115	0.0010 ± 0.0010	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	0.4219
122	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
129	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
143	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
168	0.0046 ± 0.0038	0.0034 ± 0.0017	0.0017 ± 0.0010	0.337	0.7263
185	0.0034 ± 0.0022	0.0051 ± 0.0029	0.0042 ± 0.0030	0.092	0.9134

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.2 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0121 ± 0.0061	0.0180 ± 0.0103	0.0041 ± 0.0021	0.982	0.4275
214	0.0029 ± 0.0017	0.0067 ± 0.0025	0.0048 ± 0.0034	0.523	0.6177
221	0.0259 ± 0.0104	0.0159 ± 0.0129	0.0140 ± 0.0110	0.310	0.7443
228	0.0220 ± 0.0071	0.0241 ± 0.0059	0.0162 ± 0.0053	0.448	0.6586
236	0.0160 ± 0.0030	0.0124 ± 0.0046	0.0141 ± 0.0063	0.134	0.8774
242	0.0279 ± 0.0067	0.0141 ± 0.0081	0.0233 ± 0.0083	0.833	0.4793
263	0.0068 ± 0.0029	0.0028 ± 0.0007	0.0068 ± 0.0018	1.350	0.3279

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.3
Pitfall trap data for Bembidion lampros (Herbst.).
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0051 ± 0.0027	0.0132 ± 0.0070	0.0072 ± 0.0027	0.831	0.4803
-07	0.0487 ± 0.0363	0.0394 ± 0.0373	0.0302 ± 0.0281	0.073	0.9303
02	0.0141 ± 0.0071	0.0000 ± 0.0000	0.0071 ± 0.0071	1.500	0.2963
08	0.0036 ± 0.0036	0.0036 ± 0.0036	0.0082 ± 0.0082	0.232	0.8000
18	0.0007 ± 0.0007	0.0000 ± 0.0000	0.0000 ± 0.0000	1.000	0.4219
31	0.0022 ± 0.0022	0.0011 ± 0.0011	0.0011 ± 0.0011	0.167	0.8503
47	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
87	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
108	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
115	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
122	0.0021 ± 0.0021	0.0000 ± 0.0000	0.0000 ± 0.0000	1.000	0.4219
129	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
143	0.0021 ± 0.0021	0.0000 ± 0.0000	0.0000 ± 0.0000	1.000	0.4219
168	0.0495 ± 0.0235	0.0502 ± 0.0303	0.0601 ± 0.0348	0.040	0.9608
185	0.1474 ± 0.0355	0.1408 ± 0.0388	0.1195 ± 0.0505	0.120	0.8889

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.3 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.3022 ± 0.1184	0.2963 ± 0.1069	0.2613 ± 0.0518	0.052	0.9497
214	0.1596 ± 0.0541	0.1614 ± 0.0653	0.1144 ± 0.0124	0.290	0.7582
221	0.2643 ± 0.0585	0.2567 ± 0.0681	0.2363 ± 0.0884	0.039	0.9615
228	0.3124 ± 0.0763	0.3095 ± 0.0705	0.2946 ± 0.0916	0.014	0.9860
236	0.3606 ± 0.0766	0.3390 ± 0.0773	0.2874 ± 0.1002	0.194	0.8287
242	0.3355 ± 0.0665	0.2964 ± 0.0593	0.2827 ± 0.1024	0.123	0.8868
263	0.2237 ± 0.0508	0.2164 ± 0.0567	0.1807 ± 0.0709	0.147	0.8665

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.4
Pitfall trap data for Bembidion obtusum (Serville).
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0112 ± 0.0036	0.0152 ± 0.0046	0.0132 ± 0.0044	0.224	0.8058
-07	0.1180 ± 0.0333	0.1683 ± 0.0349	0.0857 ± 0.0176	1.975	0.2193
02	0.1822 a ± 0.0995	0.8272 b ± 0.0684	0.7837 b ± 0.1746	8.656	0.0170
08	0.1168 a ± 0.0493	0.6459 b ± 0.0929	0.6772 b ± 0.1574	8.302	0.0187
18	0.0567 a ± 0.0241	0.2030 b ± 0.0216	0.1167 ab ± 0.0271	9.134	0.0151
31	0.8563 ± 0.1373	0.8285 ± 0.0682	0.6902 ± 0.0648	0.843	0.4758
47	0.2122 ± 0.0594	0.3309 ± 0.1058	0.2064 ± 0.0654	0.779	0.5004
87	0.0135 ± 0.0044	0.1705 ± 0.1516	0.0115 ± 0.0014	1.085	0.3961
108	0.3712 ± 0.0563	0.3612 ± 0.0160	0.3178 ± 0.0585	0.352	0.7167
115	0.1433 ± 0.0166	0.1527 ± 0.0253	0.1350 ± 0.0248	0.154	0.8606
122	0.4426 ± 0.0521	0.6119 ± 0.0936	0.4796 ± 0.0814	1.314	0.3363
129	0.3082 ± 0.0841	0.3674 ± 0.1021	0.4218 ± 0.0284	0.529	0.6143
143	0.1628 ± 0.0488	0.2336 ± 0.0427	0.1805 ± 0.0647	0.485	0.6377
168	0.2250 ± 0.0535	0.3517 ± 0.0435	0.2963 ± 0.0968	0.857	0.4704
185	0.0477 ± 0.0158	0.0708 ± 0.0145	0.0932 ± 0.0507	0.512	0.6232

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.4 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.2551 ± 0.0604	0.3120 ± 0.0649	0.3529 ± 0.0693	0.572	0.5926
214	0.0853 ± 0.0105	0.1412 ± 0.0595	0.1669 ± 0.1052	0.354	0.7154
221	0.0519 ± 0.0165	0.1033 ± 0.0212	0.0978 ± 0.0453	0.861	0.4689
228	0.1121 ± 0.0104	0.1316 ± 0.0212	0.2141 ± 0.0540	2.535	0.1592
236	0.0748 ± 0.0239	0.1029 ± 0.0222	0.2074 ± 0.0600	3.138	0.1168
242	0.0839 ± 0.0235	0.1324 ± 0.0251	0.1354 ± 0.0401	0.899	0.4556
263	0.0671 ± 0.0137	0.0819 ± 0.0066	0.0905 ± 0.0272	0.432	0.6682

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.5
Pitfall trap data for Bembidion obtusum (Serville). Comparison of 'k' values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean 'k' values with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
02	-0.0641 a ± 0.0910	-0.6589 b ± 0.0462	-0.6980 b ± 0.1900	8.140	0.0195
08	0.0013 ± 0.0657	-0.4775 ± 0.1275	-0.5916 ± 0.1742	5.828	0.0392
18	0.0613 ± 0.0416	-0.0347 ± 0.0545	-0.0310 ± 0.0446	1.328	0.3330
31	-0.7376 ± 0.1232	-0.6601 ± 0.0987	-0.5045 ± 0.0416	1.587	0.2797
47	-0.0942 ± 0.0356	-0.1625 ± 0.0800	-0.1207 ± 0.0787	0.257	0.7816
87	0.1045 ± 0.0299	0.1379 ± 0.0340	0.0742 ± 0.0187	1.270	0.3467
108	-0.2532 ± 0.0597	-0.1928 ± 0.0504	-0.2322 ± 0.0759	0.237	0.7960
115	-0.0252 ± 0.0413	0.0157 ± 0.0561	-0.0493 ± 0.0388	0.509	0.6247
122	-0.3245 ± 0.0689	-0.4436 ± 0.1259	-0.3939 ± 0.0960	0.360	0.7120
129	-0.1568 ± 0.1278	-0.1990 ± 0.1353	-0.3361 ± 0.0351	0.735	0.5183
143	-0.0448 ± 0.0809	-0.0653 ± 0.0775	-0.0949 ± 0.0803	0.100	0.9061
168	-0.1069 ± 0.0841	-0.1834 ± 0.0391	-0.1009 ± 0.1713	0.167	0.8498
185	0.0703 ± 0.0471	0.1141 ± 0.0380	-0.0075 ± 0.0648	1.450	0.3065
199	-0.1370 ± 0.0782	-0.1437 ± 0.0520	-0.2672 ± 0.0816	1.042	0.4089
214	0.0327 ± 0.0361	0.0272 ± 0.0279	-0.0812 ± 0.1182	0.771	0.5034

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.5 (continued)

Days +or- spray	mean 'k' values with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
221	0.0661 ± 0.0469	0.0651 ± 0.0189	-0.0121 ± 0.0576	1.028	0.4132
228	0.0059 ± 0.0419	0.0368 ± 0.0547	-0.1284 ± 0.0539	3.021	0.1237
236	0.0432 ± 0.0560	0.0654 ± 0.0553	-0.1217 ± 0.0536	3.459	0.1002
242	0.0341 ± 0.0536	0.0359 ± 0.0561	-0.0497 ± 0.0550	0.795	0.4941
263	0.0509 ± 0.0450	0.0836 ± 0.0401	-0.0048 ± 0.0424	1.165	0.3737

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.6
Pitfall trap data for *Loricera pilicornis* (F.).
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0010 ± 0.0010	0.0031 ± 0.0018	0.0031 ± 0.0018	0.571	0.5927
-07	0.0000 ± 0.0000	0.0014 ± 0.0014	0.0000 ± 0.0000	1.000	0.4219
02	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0141 ± 0.0071	4.000	0.0787
08	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
18	0.0000 ± 0.0000	0.0036 ± 0.0007	0.0043 ± 0.0025	2.400	0.1714
31	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
47	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
87	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
108	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
115	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
122	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
129	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
143	0.0162 ± 0.0055	0.0151 ± 0.0079	0.0122 ± 0.0052	0.107	0.9002
168	0.0203 ± 0.0066	0.0196 ± 0.0107	0.0157 ± 0.0100	0.071	0.9318
185	0.0231 ± 0.0077	0.0124 ± 0.0086	0.0324 ± 0.0128	1.012	0.4182

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.6 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0700 ± 0.0137	0.0773 ± 0.0289	0.0819 ± 0.0329	0.051	0.9509
214	0.0404 ± 0.0077	0.0420 ± 0.0102	0.0422 ± 0.0062	0.015	0.9856
221	0.0756 ± 0.0063	0.0855 ± 0.0149	0.0804 ± 0.0144	0.155	0.8595
228	0.1170 ± 0.0276	0.0538 ± 0.0161	0.0902 ± 0.0197	2.152	0.1974
236	0.0758 ± 0.0128	0.0879 ± 0.0093	0.0743 ± 0.0116	0.435	0.6664
242	0.0575 ± 0.0217	0.0858 ± 0.0243	0.0748 ± 0.0123	0.504	0.6276
263	0.0215 ± 0.0013	0.0248 ± 0.0026	0.0241 ± 0.0030	0.520	0.6192

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.7
Pitfall trap data for <u>Nebria brevicollis</u> (F.).
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.1162 ± 0.0060	0.1145 ± 0.0102	0.1194 ± 0.0190	0.038	0.9630
-07	0.1130 ± 0.0602	0.0743 ± 0.0552	0.1681 ± 0.1169	0.328	0.7327
02	0.0543 ± 0.0064	0.0450 ± 0.0350	0.2319 ± 0.1185	2.172	0.1952
08	0.0222 ± 0.0089	0.0256 ± 0.0082	0.1044 ± 0.0638	1.539	0.2887
18	0.0114 ± 0.0043	0.0050 ± 0.0026	0.0196 ± 0.0101	1.257	0.3500
31	0.0044 ± 0.0029	0.0044 ± 0.0011	0.0768 ± 0.0543	1.767	0.2492
47	0.0063 ± 0.0004	0.0045 ± 0.0004	0.0390 ± 0.0126	7.074	0.0264
87	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0010 ± 0.0010	1.007	0.4196
108	0.0024 ± 0.0009	0.0014 ± 0.0009	0.0010 ± 0.0010	0.559	0.5990
115	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0010 ± 0.0010	0.996	0.4231
122	0.0071 ± 0.0037	0.0021 ± 0.0021	0.0051 ± 0.0051	0.449	0.6584
129	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
143	0.0021 ± 0.0010	0.0021 ± 0.0010	0.0010 ± 0.0010	0.333	0.7290
168	0.0023 ± 0.0012	0.0035 ± 0.0010	0.0034 ± 0.0017	0.232	0.8000
185	0.0261 ± 0.0115	0.0198 ± 0.0097	0.0890 ± 0.0303	3.834	0.0845

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.7 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.1752 ± 0.0986	0.0970 ± 0.0415	0.2129 ± 0.0581	0.708	0.5297
214	0.1220 ± 0.0251	0.0459 ± 0.0181	0.1292 ± 0.0182	4.969	0.0534
221	0.1775 ± 0.0344	0.1542 ± 0.0179	0.2324 ± 0.0145	2.827	0.1364
228	0.0376 ± 0.0038	0.0357 ± 0.0033	0.0374 ± 0.0082	0.036	0.9652
236	0.0278 ± 0.0090	0.0278 ± 0.0094	0.0313 ± 0.0058	0.060	0.9421
242	0.0323 ± 0.0098	0.0209 ± 0.0104	0.0254 ± 0.0112	0.297	0.7535
263	0.0075 ± 0.0044	0.0095 ± 0.0029	0.0068 ± 0.0047	0.188	0.8904

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.8
Pitfall trap data for first instar larvae of N.brevicollis. Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
-07	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
02	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
08	0.0084 ± 0.0012	0.0095 ± 0.0012	0.0071 ± 0.0041	0.221	0.8077
18	0.0014 ± 0.0014	0.0043 ± 0.0022	0.0064 ± 0.0032	1.096	0.3924
31	0.0483 b ± 0.0078	0.0226 ab ± 0.0085	0.0044 a ± 0.0029	10.400	0.0112
47	0.0169 ± 0.0017	0.0185 ± 0.0065	0.0186 ± 0.0030	0.052	0.9494
87	0.0002 ± 0.0002	0.0007 ± 0.0007	0.0000 ± 0.0000	0.784	0.4984
108	0.0010 ± 0.0006	0.0010 ± 0.0006	0.0003 ± 0.0003	0.579	0.5891
115	0.0021 ± 0.0010	0.0010 ± 0.0010	0.0010 ± 0.0010	0.333	0.7290
122	0.0010 ± 0.0010	0.0000 ± 0.0000	0.0000 ± 0.0000	1.000	0.4291
129	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0021 ± 0.0021	1.000	0.4219
143	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
168	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	1.000	1.0000
185	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	1.000	1.0000

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.8 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
214	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
221	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
228	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
236	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
242	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
263	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.9
Pitfall trap data for second instar larvae of N.brevicollis
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
-07	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0014 ± 0.0014	0.000	0.4219
02	0.0000 ± 0.0000	0.0202 ± 0.0202	0.0138 ± 0.0138	0.534	0.6115
08	0.0036 ± 0.0021	0.0119 ± 0.0031	0.0071 ± 0.0036	1.943	0.2236
18	0.0029 ± 0.0019	0.0092 ± 0.0050	0.0223 ± 0.0097	2.420	0.1696
31	0.0516 ± 0.0190	0.0444 ± 0.0035	0.0290 ± 0.0214	0.479	0.6412
47	0.0272 ± 0.0022	0.0288 ± 0.0067	0.0296 ± 0.0081	0.040	0.9611
87	0.0015 ± 0.0010	0.0009 ± 0.0007	0.0009 ± 0.0005	0.200	0.8242
108	0.0134 ± 0.0088	0.0044 ± 0.0029	0.0038 ± 0.0012	0.991	0.4249
115	0.0031 ± 0.0018	0.0031 ± 0.0018	0.0092 ± 0.0030	2.358	0.1755
122	0.0101 ± 0.0061	0.0051 ± 0.0027	0.0071 ± 0.0056	0.248	0.7877
129	0.0000 ± 0.0000	0.0021 ± 0.0021	0.0061 ± 0.0035	1.752	0.2516
143	0.0010 ± 0.0010	0.0010 ± 0.0010	0.0021 ± 0.0021	0.167	0.8503
168	0.0000 ± 0.0000	0.0006 ± 0.0006	0.0035 ± 0.0020	2.419	0.1697
185	0.0009 ± 0.0009	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.9 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
214	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
221	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
228	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
236	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
242	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
263	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.10
Pitfall trap data for third instar larvae of <u>N.brevicollis</u>. Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
-07	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
02	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
08	0.0012 ± 0.0012	0.0048 ± 0.0024	0.0024 ± 0.0024	0.778	1.0000
18	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
31	0.0163 ± 0.0049	0.0162 ± 0.0080	0.0119 ± 0.0088	0.116	0.8926
47	0.0151 ± 0.0044	0.0063 ± 0.0032	0.0090 ± 0.0009	2.019	0.2136
87	0.0018 ± 0.0010	0.0020 ± 0.0010	0.0036 ± 0.0016	0.607	0.5753
108	0.0454 ± 0.0126	0.0272 ± 0.0090	0.0652 ± 0.0027	4.375	0.0673
115	0.0336 ± 0.0092	0.0180 ± 0.0095	0.0421 ± 0.0093	1.709	0.2585
122	0.0683 ± 0.0132	0.0589 ± 0.0203	0.0771 ± 0.0124	0.338	0.7256
129	0.0572 ± 0.0187	0.0392 ± 0.0122	0.1046 ± 0.0439	1.412	0.3145
143	0.0297 ± 0.0104	0.0202 ± 0.0026	0.0318 ± 0.0051	0.825	0.4823
168	0.0322 ± 0.0169	0.0120 ± 0.0045	0.0185 ± 0.0087	0.839	0.4773
185	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.10 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0021 ± 0.0021	0.000	1.0000
214	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
221	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
228	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
236	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
242	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
263	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.11
Pitfall trap data for total larvae of N.brevicollis. Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
-07	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
02	0.0000 ± 0.0000	0.0202 ± 0.0202	0.0138 ± 0.0138	0.534	0.6115
08	0.0130 ± 0.0031	0.0257 ± 0.0050	0.0164 ± 0.0091	1.107	0.3897
18	0.0043 ± 0.0033	0.0134 ± 0.0070	0.0284 ± 0.0123	2.096	0.2040
31	0.1077 ± 0.0214	0.0792 ± 0.0042	0.0431 ± 0.0311	2.180	0.1943
47	0.0566 ± 0.0067	0.0515 ± 0.0134	0.0549 ± 0.0111	0.058	0.9441
87	0.0034 ± 0.0015	0.0036 ± 0.0022	0.0045 ± 0.0020	0.088	0.9168
108	0.0582 ± 0.0181	0.0322 ± 0.0120	0.0687 ± 0.0018	2.239	0.1878
115	0.0383 ± 0.0115	0.0218 ± 0.0120	0.0513 ± 0.0122	1.536	0.2894
122	0.0779 ± 0.0138	0.0632 ± 0.0218	0.0830 ± 0.0142	0.368	0.7065
129	0.0572 ± 0.0187	0.0409 ± 0.0140	0.1103 ± 0.0469	1.439	0.3087
143	0.0306 ± 0.0113	0.0212 ± 0.0034	0.0337 ± 0.0069	0.689	0.5376
168	0.0322 ± 0.0169	0.0120 ± 0.0045	0.0218 ± 0.0100	0.759	0.5082
185	0.0009 ± 0.0009	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.11 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0021 ± 0.0021	0.000	1.0000
214	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
221	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
228	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
236	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
242	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
263	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.12
Pitfall trap data for Notiophilus biguttatus (F.).
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0072 ± 0.0027	0.0112 ± 0.0053	0.0052 ± 0.0010	0.768	0.5048
-07	0.0293 ± 0.0041	0.0279 ± 0.0059	0.0261 ± 0.0155	0.027	0.9733
02	0.0416 ± 0.0216	0.0473 ± 0.0170	0.0604 ± 0.0109	0.319	0.7385
08	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
18	0.0043 ± 0.0043	0.0072 ± 0.0031	0.0051 ± 0.0014	0.226	0.8040
31	0.0247 ± 0.0082	0.0152 ± 0.0075	0.0267 ± 0.0105	0.485	0.6377
47	0.0032 ± 0.0012	0.0032 ± 0.0012	0.0027 ± 0.0013	0.041	0.9599
87	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0002 ± 0.0002	1.001	0.4217
108	0.0048 ± 0.0028	0.0020 ± 0.0010	0.0017 ± 0.0012	0.821	0.4838
115	0.0000 ± 0.0000	0.0010 ± 0.0010	0.0000 ± 0.0000	1.001	0.4216
122	0.0112 ± 0.0040	0.0061 ± 0.0030	0.0112 ± 0.0036	0.663	0.5494
129	0.0061 ± 0.0035	0.0000 ± 0.0000	0.0000 ± 0.0000	3.033	0.1230
143	0.0288 ± 0.0099	0.0298 ± 0.0089	0.0308 ± 0.0085	0.012	0.9881
168	0.0153 ± 0.0051	0.0108 ± 0.0034	0.0176 ± 0.0031	0.746	0.5138
185	0.0134 ± 0.0036	0.0084 ± 0.0033	0.0158 ± 0.0054	0.800	0.4922

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.12 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0395 ± 0.0038	0.0296 ± 0.0114	0.0261 ± 0.0039	0.901	0.4548
214	0.0067 ± 0.0009	0.0086 ± 0.0043	0.0048 ± 0.0025	0.413	0.6791
221	0.0278 ± 0.0102	0.0238 ± 0.0121	0.0239 ± 0.0102	0.043	0.9579
228	0.0240 ± 0.0090	0.0180 ± 0.0090	0.0317 ± 0.0084	0.609	0.5744
236	0.0412 ± 0.0100	0.0280 ± 0.0045	0.0345 ± 0.0102	0.586	0.5854
242	0.0346 ± 0.0077	0.0457 ± 0.0058	0.0565 ± 0.0021	3.695	0.0900
263	0.0102 ± 0.0031	0.0122 ± 0.0020	0.0142 ± 0.0020	0.692	0.5364

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.13
Pitfall trap data for Pterostichus melanarius (Illiger). Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
-07	0.0029 ± 0.0014	0.0000 ± 0.0000	0.0029 ± 0.0029	0.800	0.4921
02	0.0264 ± 0.0264	0.0138 ± 0.0138	0.0071 ± 0.0071	0.308	0.7457
08	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
18	0.0007 ± 0.0007	0.0022 ± 0.0022	0.0000 ± 0.0000	0.696	0.5346
31	0.0011 ± 0.0011	0.0011 ± 0.0011	0.0055 ± 0.0011	5.333	0.0467
47	0.0005 ± 0.0005	0.0000 ± 0.0000	0.0000 ± 0.0000	1.000	0.4219
87	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
108	0.0007 ± 0.0003	0.0003 ± 0.0003	0.0003 ± 0.0003	0.333	0.7290
115	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
122	0.0031 ± 0.0000	0.0041 ± 0.0010	0.0010 ± 0.0010	3.500	0.0983
129	0.0021 ± 0.0021	0.0000 ± 0.0000	0.0000 ± 0.0000	1.000	0.4219
143	0.0423 ± 0.0050	0.0487 ± 0.0067	0.0428 ± 0.0134	0.154	0.8605
168	0.0392 ± 0.0047	0.0424 ± 0.0069	0.0479 ± 0.0113	0.291	0.7574
185	0.0804 ± 0.0093	0.0550 ± 0.0266	0.0916 ± 0.0074	1.248	0.3523

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.13 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.2318 ± 0.0545	0.1776 ± 0.0494	0.2406 ± 0.0282	0.563	0.5967
214	0.2077 ± 0.0028	0.2088 ± 0.0062	0.2075 ± 0.0093	0.011	0.9888
221	0.2978 ± 0.0066	0.3018 ± 0.0103	0.3027 ± 0.0130	0.065	0.9380
228	0.5387 ± 0.0571	0.5775 ± 0.0608	0.5495 ± 0.0465	0.132	0.8787
236	0.6921 ± 0.0482	0.5212 ± 0.1606	0.7351 ± 0.0242	1.338	0.3307
242	0.8216 ± 0.0530	0.7264 ± 0.1316	0.8797 ± 0.0127	1.091	0.3943
263	0.4670 ± 0.0067	0.4468 ± 0.0220	0.4514 ± 0.0282	0.255	0.7827

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.14
Pitfall trap data for *Trechus quadristriatus* (Schrank). Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.1154 ± 0.0062	0.1019 ± 0.0258	0.0971 ± 0.0255	0.201	0.8233
-07	0.4443 ± 0.2075	0.2396 ± 0.1911	0.2765 ± 0.2431	0.257	0.7812
02	0.4095 ± 0.1821	0.6128 ± 0.2267	0.5858 ± 0.2176	0.277	0.7670
08	0.1366 ± 0.0605	0.2706 ± 0.0691	0.3285 ± 0.1196	1.280	0.3445
18	0.0765 ± 0.0256	0.1135 ± 0.0373	0.0637 ± 0.0374	0.583	0.5867
31	0.5215 ± 0.1293	0.3924 ± 0.1523	0.3654 ± 0.1447	0.343	0.7226
47	0.1248 ± 0.0451	0.0999 ± 0.0765	0.0737 ± 0.0272	0.227	0.8031
87	0.0054 ± 0.0024	0.0062 ± 0.0040	0.0027 ± 0.0016	0.421	0.6743
108	0.0884 ± 0.0517	0.0456 ± 0.0389	0.0308 ± 0.0148	0.611	0.5735
115	0.0303 ± 0.0168	0.0157 ± 0.0157	0.0147 ± 0.0132	0.327	0.7332
122	0.0892 ± 0.0344	0.0615 ± 0.0345	0.0485 ± 0.0239	0.440	0.6631
129	0.0409 ± 0.0151	0.0255 ± 0.0164	0.0555 ± 0.0323	0.441	0.6629
143	0.0201 ± 0.0060	0.0071 ± 0.0056	0.0061 ± 0.0031	2.371	0.1742
168	0.0603 ± 0.0266	0.0202 ± 0.0091	0.0212 ± 0.0098	1.777	0.2477
185	0.0570 ± 0.0286	0.0115 ± 0.0115	0.0163 ± 0.0138	1.647	0.2690

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.14 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.3274 ± 0.1671	0.1188 ± 0.1188	0.1154 ± 0.1093	0.820	0.4845
214	0.1192 ± 0.0599	0.0553 ± 0.0458	0.0548 ± 0.0351	0.595	0.5809
221	0.1284 ± 0.0436	0.1745 ± 0.0621	0.1192 ± 0.0498	0.320	0.7380
228	0.1104 ± 0.0552	0.1797 ± 0.0807	0.1544 ± 0.0643	0.269	0.7729
236	0.0984 ± 0.0507	0.0429 ± 0.0377	0.0743 ± 0.0284	0.483	0.6388
242	0.1052 ± 0.0237	0.1270 ± 0.0602	0.1945 ± 0.0693	0.724	0.5227
263	0.0582 ± 0.0139	0.0558 ± 0.0134	0.0627 ± 0.0176	0.054	0.9479

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.15
Pitfall trap data for Trechus quadristriatus (Schrank). Comparison of 'k' values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or-spray	Mean 'k' values with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
02	0.0348 ± 0.1723	-0.3732 ± 0.0465	-0.3010 ± 0.1264	4.088	0.0758
08	0.3077 ± 0.1951	-0.0310 ± 0.1236	-0.0520 ± 0.1264	1.764	0.2498
18	0.3678 ± 0.1894	0.1261 ± 0.1552	0.2128 ± 0.2058	0.440	0.6635
31	-0.0773 ± 0.0935	-0.1528 ± 0.0396	-0.0889 ± 0.0997	0.245	0.7898
47	0.3021 ± 0.1800	0.1397 ± 0.1150	0.2028 ± 0.2164	0.217	0.8108
87	0.4392 ± 0.2063	0.2334 ± 0.1872	0.2738 ± 0.2418	0.262	0.7778
108	0.3558 ± 0.1722	0.1940 ± 0.1523	0.2457 ± 0.2311	0.193	0.8295
115	0.4140 ± 0.1923	0.2239 ± 0.1755	0.2674 ± 0.2536	0.241	0.7929
122	0.3551 ± 0.1832	0.1763 ± 0.1580	0.2280 ± 0.2259	0.232	0.7999
129	0.4034 ± 0.2108	0.2141 ± 0.1748	0.2210 ± 0.2117	0.289	0.7592
143	0.4241 ± 0.2020	0.2325 ± 0.1855	0.2704 ± 0.2416	0.231	0.8003
168	0.3839 ± 0.1867	0.2194 ± 0.1820	0.2553 ± 0.2381	0.180	0.8396
185	0.3873 ± 0.1789	0.2281 ± 0.1797	0.2602 ± 0.2294	0.182	0.8383
199	0.1169 ± 0.0634	0.1208 ± 0.0729	0.1611 ± 0.1340	0.066	0.9368
214	0.3250 ± 0.1478	0.1843 ± 0.1455	0.2217 ± 0.2081	0.185	0.8359

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.15 (continued)

Days +or-spray	Mean 'k' values with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
221	0.3159 ± 0.1641	0.0651 ± 0.1546	0.1573 ± 0.1997	0.532	0.6128
228	0.3339 ± 0.1523	0.0599 ± 0.1605	0.1221 ± 0.2339	0.597	0.5802
236	0.3459 ± 0.1585	0.1967 ± 0.1534	0.2022 ± 0.2222	0.219	0.8093
242	0.3391 ± 0.2307	0.1126 ± 0.2219	0.0820 ± 0.1832	0.435	0.6661
263	0.3861 ± 0.1943	0.1838 ± 0.1984	0.2138 ± 0.2516	0.255	0.7832

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.16
Pitfall trap data for total adult Carabidae.
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.2237 ± 0.0034	0.2242 ± 0.0175	0.2167 ± 0.0087	0.135	0.8765
-07	0.5579 ± 0.1882	0.3894 ± 0.1882	0.4011 ± 0.2518	0.198	0.8257
02	0.5462 ± 0.1615	1.0128 ± 0.1461	1.0678 ± 0.0837	4.526	0.0633
08	0.2402 a ± 0.0704	0.7433 b ± 0.0462	0.8366 b ± 0.0515	31.678	0.0006
18	0.1377 a ± 0.0372	0.2898 b ± 0.0240	0.1902 ab ± 0.0162	8.070	0.0199
31	0.9913 ± 0.1191	0.9396 ± 0.0347	0.8211 ± 0.0939	0.943	0.4404
47	0.2967 ± 0.0713	0.3739 ± 0.1311	0.2799 ± 0.0559	0.297	0.7536
87	0.0187 ± 0.0067	0.0205 ± 0.0151	0.0151 ± 0.0012	0.081	0.9231
108	0.4139 ± 0.0644	0.3852 ± 0.0076	0.3365 ± 0.0488	0.697	0.5342
115	0.1664 ± 0.0165	0.1656 ± 0.0175	0.1427 ± 0.0222	0.507	0.6260
122	0.4864 ± 0.0474	0.6361 ± 0.0786	0.5031 ± 0.0766	1.412	0.3144
129	0.3334 ± 0.0801	0.3825 ± 0.0913	0.4484 ± 0.0328	0.631	0.5640
143	0.1512 ± 0.0607	0.2976 ± 0.0291	0.2480 ± 0.0573	2.126	0.2004
168	0.3378 ± 0.0277	0.4175 ± 0.0471	0.3882 ± 0.0689	0.631	0.5639
185	0.3174 ± 0.0262	0.2781 ± 0.0223	0.3599 ± 0.0124	3.753	0.0877

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.16 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.8007 ± 0.0592	0.6937 ± 0.1060	0.7537 ± 0.0124	0.579	0.5888
214	0.5113 ± 0.0437	0.4890 ± 0.0800	0.5156 ± 0.0368	0.063	0.9392
221	0.6304 ± 0.0465	0.6530 ± 0.0547	0.6676 ± 0.0368	0.162	0.8539
228	0.7277 ± 0.0392	0.8011 ± 0.0385	0.8035 ± 0.0546	0.929	0.4453
236	0.8667 ± 0.0264	0.7785 ± 0.0634	0.8995 ± 0.0260	2.179	0.1943
242	0.9507 ± 0.0424	0.9004 ± 0.0750	1.0223 ± 0.0201	1.439	0.3087
263	0.6122 ± 0.0184	0.6010 ± 0.0313	0.5774 ± 0.0313	0.706	0.5306

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.17
Pitfall trap data for total adult Carabidae.
Comparison of 'k' values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean 'k' values with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
02	0.0027 ± 0.1582	-0.6234 ± 0.0615	-0.6667 ± 0.2188	5.490	0.0441
08	0.3087 ± 0.2111	-0.3539 ± 0.2301	-0.4356 ± 0.2906	2.747	0.1422
18	0.4111 ± 0.1934	0.0996 ± 0.1774	0.2109 ± 0.2366	0.599	0.5792
31	-0.4424 ± 0.1734	-0.5502 ± 0.1805	-0.4201 ± 0.1958	0.144	0.8689
47	0.2521 ± 0.1415	0.0155 ± 0.0909	0.1211 ± 0.2703	0.416	0.6775
87	0.5302 ± 0.1940	0.3689 ± 0.1731	0.3859 ± 0.2506	0.181	0.8391
108	0.1349 ± 0.2012	0.0042 ± 0.1828	0.0645 ± 0.3006	0.078	0.9257
115	0.3825 ± 0.1962	0.2238 ± 0.1957	0.2583 ± 0.2614	0.144	0.8689
122	0.0625 ± 0.2200	-0.2466 ± 0.2615	-0.1021 ± 0.3073	0.340	0.7248
129	0.2154 ± 0.2771	0.0069 ± 0.2721	-0.0474 ± 0.2403	0.277	0.7673
143	0.3977 ± 0.1383	0.0907 ± 0.2178	0.1531 ± 0.2929	0.518	0.6199
168	0.2111 ± 0.2213	-0.0280 ± 0.1546	0.0129 ± 0.2942	0.308	0.7460
185	0.2315 ± 0.1762	0.1114 ± 0.1773	0.0412 ± 0.2487	0.223	0.8061
199	-0.2519 ± 0.1587	-0.3043 ± 0.1027	-0.3526 ± 0.2423	0.081	0.9235
214	0.0376 ± 0.1543	-0.0996 ± 0.1116	-0.1145 ± 0.2769	0.187	0.8343

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.17 (continued)

Days +or-spray	Mean 'k' values with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
221	-0.0815 ± 0.1573	-0.2636 ± 0.1367	-0.2665 ± 0.2169	0.372	0.7040
228	-0.1789 ± 0.1609	-0.4117 ± 0.1547	-0.4024 ± 0.2200	0.531	0.6135
236	-0.3178 ± 0.1998	-0.3891 ± 0.2394	-0.4948 ± 0.2262	0.167	0.8498
242	-0.4018 ± 0.2302	-0.5110 ± 0.2624	-0.6212 ± 0.2329	0.205	0.8201
263	-0.0633 ± 0.1813	-0.2115 ± 0.1843	-0.1763 ± 0.2495	0.139	0.8727

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.18
Pitfall trap data for total carabid larvae.
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0422 ± 0.0066	0.0348 ± 0.0019	0.0365 ± 0.0074	0.445	0.6604
-07	0.2320 ± 0.1139	0.1190 ± 0.1147	0.1137 ± 0.1074	0.356	0.7145
02	0.1224 ± 0.0336	0.2745 ± 0.1495	0.2450 ± 0.1509	0.422	0.6736
08	0.0960 ± 0.0284	0.0814 ± 0.0341	0.1804 ± 0.1155	0.560	0.5986
18	0.0899 ± 0.0282	0.0651 ± 0.0278	0.1802 ± 0.1370	0.542	0.6078
31	0.1328 ± 0.0127	0.1259 ± 0.0183	0.1147 ± 0.0511	0.081	0.9232
47	0.0614 ± 0.0054	0.0548 ± 0.0124	0.0905 ± 0.0368	0.704	0.5312
87	0.0041 ± 0.0015	0.0059 ± 0.0033	0.0070 ± 0.0034	0.252	0.7850
108	0.0597 ± 0.0179	0.0362 ± 0.0136	0.0719 ± 0.0035	1.905	0.2288
115	0.0401 ± 0.0126	0.0238 ± 0.0127	0.0549 ± 0.0127	1.517	0.2929
122	0.0797 ± 0.0129	0.0641 ± 0.0214	0.0960 ± 0.0074	1.119	0.3863
129	0.0607 ± 0.0193	0.0467 ± 0.0115	0.1156 ± 0.0443	1.613	0.2751
143	0.0333 ± 0.0139	0.0221 ± 0.0043	0.0365 ± 0.0080	0.620	0.5693
168	0.0376 ± 0.0170	0.0142 ± 0.0044	0.0274 ± 0.0071	1.153	0.3771
185	0.0026 ± 0.0015	0.0108 ± 0.0065	0.0126 ± 0.0043	1.368	0.3239

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.18 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0179 ± 0.0123	0.0350 ± 0.0172	0.0450 ± 0.0082	1.101	0.3914
214	0.0019 ± 0.0019	0.0142 ± 0.0049	0.0067 ± 0.0034	2.942	0.1287
221	0.0616 ± 0.0279	0.0633 ± 0.0289	0.0583 ± 0.0253	0.009	0.9915
228	0.0752 ± 0.0144	0.0790 ± 0.0080	0.0535 ± 0.0192	0.889	0.4589
236	0.0621 ± 0.0095	0.0702 ± 0.0241	0.0601 ± 0.0164	0.093	0.9128
242	0.2151 ± 0.0653	0.2755 ± 0.0450	0.3176 ± 0.0023	1.265	0.3479
263	0.1029 ± 0.0111	0.0751 ± 0.0050	0.0762 ± 0.0165	1.783	0.2467

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.19
Pitfall trap data for total adult Staphylinidae.
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0318 ± 0.0059	0.0318 ± 0.0070	0.0404 ± 0.0025	0.835	0.4787
-07	0.2480 ± 0.1173	0.1256 ± 0.1005	0.1103 ± 0.0999	0.506	0.6267
02	0.1921 ± 0.0562	0.4581 ± 0.1358	0.4102 ± 0.2065	0.939	0.4417
08	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
18	0.0843 ± 0.0460	0.0653 ± 0.0266	0.0859 ± 0.0658	0.055	0.9467
31	0.3293 ± 0.1366	0.2006 ± 0.1217	0.1989 ± 0.1370	0.321	0.7368
47	0.0608 ± 0.0312	0.0716 ± 0.0366	0.0711 ± 0.0324	0.033	0.9676
87	0.0036 ± 0.0022	0.0046 ± 0.0038	0.0057 ± 0.0046	0.081	0.9228
108	0.0075 ± 0.0032	0.0031 ± 0.0010	0.0050 ± 0.0035	0.611	0.5733
115	0.0021 ± 0.0010	0.0010 ± 0.0010	0.0041 ± 0.0041	0.382	0.6979
122	0.0111 ± 0.0056	0.0071 ± 0.0044	0.0061 ± 0.0035	0.330	0.7311
129	0.0061 ± 0.0035	0.0101 ± 0.0054	0.0200 ± 0.0078	1.500	0.2964
143	0.0182 ± 0.0034	0.0152 ± 0.0030	0.0201 ± 0.0069	0.267	0.7745
168	0.0063 ± 0.0015	0.0092 ± 0.0032	0.0153 ± 0.0054	1.535	0.2895
185	0.0824 ± 0.0208	0.1079 ± 0.0391	0.1219 ± 0.0609	0.212	0.8145

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.19 (continued)

Days +or-spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.3461 ± 0.0581	0.3205 ± 0.0638	0.3393 ± 0.1006	0.030	0.9706
214	0.3511 ± 0.0537	0.3316 ± 0.0295	0.3598 ± 0.0171	0.155	0.8596
221	0.5172 ± 0.0172	0.5390 ± 0.0257	0.4161 ± 0.0399	5.065	0.0515
228	0.1785 ± 0.0368	0.1357 ± 0.0363	0.2122 ± 0.0198	1.439	0.3086
236	0.2252 ± 0.0209	0.1915 ± 0.0457	0.1657 ± 0.0502	0.529	0.6144
242	0.2203 ± 0.0364	0.2011 ± 0.0522	0.2034 ± 0.0180	0.075	0.9283
263	0.0804 ± 0.0271	0.0741 ± 0.0141	0.1123 ± 0.0049	1.315	0.3360

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.20
Pitfall trap data for _Erigone atra_ (Blackwall). Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0021 ± 0.0021	0.0010 ± 0.0010	0.0010 ± 0.0010	0.167	0.8503
-07	0.0181 ± 0.0122	0.0164 ± 0.0164	0.0122 ± 0.0092	0.076	0.9279
02	0.0599 ± 0.0185	0.0699 ± 0.0062	0.0478 ± 0.0064	0.660	0.5508
08	0.0300 ± 0.0116	0.0153 ± 0.0046	0.0142 ± 0.0020	1.464	0.3050
18	0.0135 ± 0.0039	0.0029 ± 0.0019	0.0050 ± 0.0019	4.213	0.0719
31	0.0066 a ± 0.0019	0.0164 ab ± 0.0019	0.0249 b ± 0.0028	16.904	0.0034
47	0.0054 ± 0.0000	0.0063 ± 0.0009	0.0072 ± 0.0009	1.500	0.2963
87	0.0000 a ± 0.0000	0.0000 a ± 0.0000	0.0014 b ± 0.0005	8.289	0.0188
108	0.0038 ± 0.0003	0.0145 ± 0.0034	0.0200 ± 0.0079	2.804	0.1381
115	0.0051 a ± 0.0020	0.0152 a ± 0.0035	0.0337 b ± 0.0051	15.018	0.0046
122	0.0082 ± 0.0010	0.0645 ± 0.0330	0.0795 ± 0.0250	2.466	0.1654
129	0.0041 ± 0.0021	0.0781 ± 0.0214	0.1467 ± 0.0480	5.514	0.0438
143	0.0231 ± 0.0040	0.0871 ± 0.0162	0.1220 ± 0.0471	3.023	0.1236
168	0.0296 ± 0.0024	0.1229 ± 0.0185	0.1631 ± 0.0523	4.566	0.0623
185	0.0928 ± 0.0125	0.1658 ± 0.0533	0.2177 ± 0.0639	1.671	0.2650

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.20 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.2698 ± 0.0321	0.3367 ± 0.0409	0.3967 ± 0.0409	2.011	0.2146
214	0.1785 ± 0.0497	0.1747 ± 0.0068	0.2449 ± 0.0274	1.429	0.3108
221	0.1782 ± 0.0169	0.2307 ± 0.0514	0.1828 ± 0.0351	0.610	0.5738
228	0.1790 ± 0.0485	0.2174 ± 0.0293	0.1818 ± 0.0324	0.321	0.7370
236	0.1505 ± 0.0298	0.2175 ± 0.0670	0.2829 ± 0.0741	1.210	0.3617
242	0.2803 ± 0.0317	0.4293 ± 0.1221	0.5333 ± 0.1178	1.628	0.2723
263	0.1852 ± 0.0538	0.1787 ± 0.0679	0.2905 ± 0.0338	1.365	0.3247

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.21
Pitfall trap data for <u>Erigone dentipalpis</u> (Wider).
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0010 ± 0.0010	0.0010 ± 0.0010	0.0010 ± 0.0010	0.000	1.0000
-07	0.0029 ± 0.0029	0.0029 ± 0.0029	0.0029 ± 0.0029	0.000	1.0000
02	0.0212 ± 0.0000	0.0141 ± 0.0071	0.0071 ± 0.0071	1.500	0.2963
08	0.0024 ± 0.0012	0.0012 ± 0.0012	0.0012 ± 0.0012	0.333	0.7290
18	0.0000 ± 0.0000	0.0073 ± 0.0073	0.0000 ± 0.0000	1.000	0.4219
31	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0022 ± 0.0022	1.000	0.4219
47	0.0009 ± 0.0009	0.0009 ± 0.0009	0.0009 ± 0.0009	0.000	1.0000
87	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0003 ± 0.0002	4.000	0.0787
108	0.0007 ± 0.0003	0.0038 ± 0.0017	0.0088 ± 0.0039	2.834	0.1360
115	0.0010 a ± 0.0010	0.0010 a ± 0.0010	0.0082 b ± 0.0010	16.380	0.0037
122	0.0000 ± 0.0000	0.0092 ± 0.0035	0.0062 ± 0.0000	5.379	0.0459
129	0.0000 ± 0.0000	0.0101 ± 0.0054	0.0142 ± 0.0020	4.910	0.0545
143	0.0021 a ± 0.0010	0.0072 b ± 0.0010	0.0041 ab ± 0.0010	6.383	0.0327
168	0.0023 ± 0.0006	0.0137 ± 0.0010	0.0102 ± 0.0059	2.832	0.1361
185	0.0084 ± 0.0022	0.0214 ± 0.0082	0.0206 ± 0.0082	1.152	0.3771

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.21 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0280 ± 0.0052	0.0869 ± 0.0332	0.0905 ± 0.0163	2.646	0.1500
214	0.0170 ± 0.0043	0.0375 ± 0.0131	0.0375 ± 0.0123	1.237	0.3551
221	0.0543 ± 0.0037	0.0432 ± 0.0049	0.0412 ± 0.0087	1.325	0.3338
228	0.0299 ± 0.0067	0.0393 ± 0.0083	0.0336 ± 0.0101	0.319	0.7388
236	0.0160 ± 0.0030	0.0427 ± 0.0133	0.0427 ± 0.0117	2.201	0.1919
242	0.0648 ± 0.0303	0.1175 ± 0.0414	0.1109 ± 0.0361	0.630	0.5645
263	0.0175 ± 0.0018	0.0109 ± 0.0037	0.0189 ± 0.0018	2.756	0.1416

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.22
Pitfall trap data for total adults of the genus Oedothorax. Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0021 ± 0.0021	0.0010 ± 0.0010	0.0010 ± 0.0010	0.167	0.8503
-07	0.0057 ± 0.0038	0.0057 ± 0.0057	0.0043 ± 0.0000	0.041	0.9597
02	0.0071 ± 0.0071	0.0071 ± 0.0071	0.0000 ± 0.0000	0.500	0.6297
08	0.0048 ± 0.0012	0.0060 ± 0.0024	0.0130 ± 0.0023	4.769	0.0576
18	0.0029 ± 0.0007	0.0014 ± 0.0014	0.0015 ± 0.0007	0.682	0.5407
31	0.0175 ± 0.0028	0.0174 ± 0.0039	0.0227 ± 0.0066	0.406	0.6834
47	0.0081 ± 0.0015	0.0063 ± 0.0009	0.0107 ± 0.0015	2.721	0.1442
87	0.0003 ± 0.0002	0.0005 ± 0.0003	0.0003 ± 0.0002	0.255	0.7827
108	0.0021 ± 0.0006	0.0021 ± 0.0012	0.0028 ± 0.0003	0.261	0.7789
115	0.0010 a ± 0.0010	0.0082 ab ± 0.0020	0.0122 b ± 0.0017	11.903	0.0082
122	0.0122 ± 0.0030	0.0092 ± 0.0030	0.0142 ± 0.0027	0.760	0.5079
129	0.0239 ± 0.0102	0.0082 ± 0.0020	0.0061 ± 0.0035	2.367	0.1747
143	0.0092 ± 0.0017	0.0220 ± 0.0068	0.0162 ± 0.0040	1.892	0.2306
168	0.0176 a ± 0.0006	0.0355 b ± 0.0032	0.0237 a ± 0.0016	18.531	0.0027
185	0.0286 ± 0.0090	0.0634 ± 0.0157	0.0594 ± 0.0198	1.510	0.2943

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.22 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0885 ± 0.0193	0.1473 ± 0.0278	0.1711 ± 0.0313	2.554	0.1576
214	0.0507 ± 0.0098	0.0499 ± 0.0083	0.0708 ± 0.0112	1.453	0.3057
221	0.0465 ± 0.0318	0.0583 ± 0.0253	0.0703 ± 0.0094	0.244	0.7910
228	0.0704 ± 0.0064	0.0679 ± 0.0190	0.0822 ± 0.0138	0.294	0.7556
236	0.0412 ± 0.0100	0.1046 ± 0.0199	0.0996 ± 0.0264	3.122	0.1177
242	0.2012 ± 0.0571	0.3655 ± 0.0387	0.3335 ± 0.0581	2.794	0.1388
263	0.0580 ± 0.0167	0.0738 ± 0.0246	0.0852 ± 0.0189	0.453	0.6561

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.23
Pitfall trap data for total Erigoninae.
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0051 ± 0.0027	0.0031 ± 0.0018	0.0021 ± 0.0021	0.493	0.6335
-07	0.0298 ± 0.0202	0.0240 ± 0.0240	0.0181 ± 0.0117	0.092	0.9135
02	0.0839 ± 0.0232	0.0905 ± 0.0157	0.0540 ± 0.0126	1.203	0.3636
08	0.0377 ± 0.0135	0.0222 ± 0.0080	0.0291 ± 0.0011	0.735	0.5181
18	0.0163 ± 0.0035	0.0050 ± 0.0040	0.0064 ± 0.0021	3.503	0.0982
31	0.0249 ± 0.0028	0.0332 ± 0.0027	0.0493 ± 0.0081	5.755	0.0402
47	0.0142 ± 0.0018	0.0116 ± 0.0018	0.0186 ± 0.0015	4.377	0.0673
87	0.0005 a ± 0.0003	0.0005 a ± 0.0003	0.0022 b ± 0.0003	8.795	0.0165
108	0.0069 ± 0.0003	0.0205 ± 0.0052	0.0316 ± 0.0110	3.114	0.1181
115	0.0072 a ± 0.0027	0.0240 a ± 0.0061	0.0507 b ± 0.0056	19.188	0.0025
122	0.0201 ± 0.0040	0.0797 ± 0.0360	0.0964 ± 0.0245	2.525	0.1601
129	0.0276 ± 0.0135	0.0960 ± 0.0275	0.1653 ± 0.0474	4.464	0.0649
143	0.0357 ± 0.0033	0.1129 ± 0.0207	0.1370 ± 0.0480	3.059	0.1214
168	0.0513 ± 0.0022	0.1599 ± 0.0200	0.1880 ± 0.0547	4.597	0.0616
185	0.1239 ± 0.0133	0.2247 ± 0.0631	0.2641 ± 0.0733	1.645	0.2694

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.23 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.3434 ± 0.0196	0.4457 ± 0.0574	0.5141 ± 0.0539	3.360	0.1049
214	0.2273 ± 0.0428	0.2092 ± 0.0119	0.3031 ± 0.0279	2.706	0.1453
221	0.2446 ± 0.0245	0.2935 ± 0.0322	0.2544 ± 0.0367	0.673	0.5448
228	0.2456 ± 0.0419	0.2832 ± 0.0208	0.2559 ± 0.0410	0.293	0.7562
236	0.1916 ± 0.0219	0.3070 ± 0.0736	0.3563 ± 0.0814	1.714	0.2577
242	0.4274 ± 0.0416	0.6349 ± 0.1071	0.6818 ± 0.1173	2.040	0.2109
263	0.2392 ± 0.0450	0.2441 ± 0.0510	0.3026 ± 0.0094	0.791	0.4955

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.24
Pitfall trap data for <u>Bathyphantes</u> <u>gracilis</u> (Blackwall). Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
-07	0.0043 ± 0.0025	0.0057 ± 0.0057	0.0014 ± 0.0014	0.347	0.7200
02	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
08	0.0024 ± 0.0024	0.0012 ± 0.0012	0.0048 ± 0.0031	0.578	0.5892
18	0.0015 ± 0.0007	0.0007 ± 0.0007	0.0015 ± 0.0007	0.333	0.7290
31	0.0099 ± 0.0033	0.0110 ± 0.0011	0.0279 ± 0.0082	3.879	0.0829
47	0.0072 ± 0.0009	0.0063 ± 0.0009	0.0090 ± 0.0009	2.328	0.1785
87	0.0003 ± 0.0002	0.0002 ± 0.0002	0.0002 ± 0.0002	0.333	0.7290
108	0.0000 ± 0.0000	0.0011 ± 0.0006	0.0010 ± 0.0000	2.813	0.1375
115	0.0010 ± 0.0010	0.0031 ± 0.0018	0.0010 ± 0.0010	0.800	0.4921
122	0.0021 ± 0.0021	0.0021 ± 0.0021	0.0041 ± 0.0041	0.159	0.8561
129	0.0041 a ± 0.0021	0.0062 ab ± 0.0000	0.0221 b ± 0.0052	9.154	0.0150
143	0.0062 ± 0.0018	0.0031 ± 0.0018	0.0010 ± 0.0010	2.715	0.1447
168	0.0029 ± 0.0006	0.0029 ± 0.0006	0.0006 ± 0.0006	5.229	0.0484
185	0.0076 a ± 0.0014	0.0084 a ± 0.0008	0.0175 b ± 0.0025	10.278	0.0115

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.24 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0354 ± 0.0118	0.0240 ± 0.0090	0.0389 ± 0.0170	0.358	0.7134
214	0.0142 ± 0.0049	0.0123 ± 0.0047	0.0123 ± 0.0041	0.057	0.9450
221	0.0279 ± 0.0078	0.0221 ± 0.0039	0.0319 ± 0.0019	0.898	0.4558
228	0.0201 ± 0.0040	0.0220 ± 0.0071	0.0201 ± 0.0052	0.039	0.9621
236	0.0211 ± 0.0060	0.0142 ± 0.0047	0.0141 ± 0.0063	0.497	0.6312
242	0.0455 ± 0.0095	0.0711 ± 0.0041	0.0581 ± 0.0154	1.416	0.3136
263	0.0129 ± 0.0024	0.0169 ± 0.0018	0.0142 ± 0.0012	1.217	0.3599

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.25
Pitfall trap data for <u>Lepthyphantes</u> <u>tenuis</u> (Blackwall). Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
-07	0.0153 ± 0.0113	0.0057 ± 0.0057	0.0126 ± 0.0105	0.275	0.7684
02	0.0405 ± 0.0193	0.0543 ± 0.0064	0.0839 ± 0.0232	1.546	0.2874
08	0.0095 ± 0.0012	0.0095 ± 0.0042	0.0246 ± 0.0034	7.384	0.0241
18	0.0029 ± 0.0007	0.0014 ± 0.0014	0.0022 ± 0.0014	0.223	0.8066
31	0.0184 ± 0.0075	0.0142 ± 0.0039	0.0347 ± 0.0152	1.164	0.3740
47	0.0125 ± 0.0009	0.0089 ± 0.0018	0.0125 ± 0.0023	1.363	0.3251
87	0.0002 ± 0.0002	0.0003 ± 0.0002	0.0002 ± 0.0002	0.333	0.7290
108	0.0017 a ± 0.0007	0.0051 b ± 0.0000	0.0031 ab ± 0.0006	10.640	0.0106
115	0.0010 ± 0.0010	0.0052 ± 0.0010	0.0031 ± 0.0018	2.400	0.1715
122	0.0031 ± 0.0018	0.0021 ± 0.0010	0.0051 ± 0.0037	0.404	0.6847
129	0.0141 ± 0.0073	0.0041 ± 0.0021	0.0142 ± 0.0053	1.183	0.3689
143	0.0072 ± 0.0027	0.0052 ± 0.0010	0.0102 ± 0.0044	0.693	0.5363
168	0.0012 ± 0.0012	0.0017 ± 0.0010	0.0063 ± 0.0037	1.454	0.3055
185	0.0076 ± 0.0039	0.0092 ± 0.0047	0.0134 ± 0.0017	0.695	0.5352

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.25 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0122 ± 0.0000	0.0219 ± 0.0111	0.0260 ± 0.0051	1.011	0.4184
214	0.0133 ± 0.0009	0.0086 ± 0.0016	0.0104 ± 0.0041	0.817	0.4853
221	0.0200 ± 0.0086	0.0261 ± 0.0020	0.0337 ± 0.0051	1.371	0.3232
228	0.0299 ± 0.0034	0.0299 ± 0.0034	0.0240 ± 0.0068	0.514	0.6221
236	0.0280 ± 0.0017	0.0141 ± 0.0063	0.0280 ± 0.0034	3.574	0.0950
242	0.0667 ± 0.0096	0.0745 ± 0.0170	0.0761 ± 0.0210	0.092	0.9135
263	0.0102 ± 0.0031	0.0149 ± 0.0029	0.0149 ± 0.0047	0.551	0.6032

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.26
Pitfall trap data for Meioneta rurestris (C.L.Koch). Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
-07	0.0057 ± 0.0038	0.0029 ± 0.0029	0.0014 ± 0.0014	0.579	0.5888
02	0.0141 ± 0.0071	0.0071 ± 0.0071	0.0000 ± 0.0000	1.500	0.2963
08	0.0036 ± 0.0021	0.0048 ± 0.0024	0.0036 ± 0.0021	0.100	0.9063
18	0.0029 b ± 0.0007	0.0007 ab ± 0.0007	0.0000 a ± 0.0000	6.637	0.0302
31	0.0033 ± 0.0019	0.0022 ± 0.0011	0.0033 ± 0.0019	0.143	0.8697
47	0.0009 ± 0.0009	0.0009 ± 0.0009	0.0018 ± 0.0009	0.333	0.7290
87	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0003 ± 0.0002	4.000	0.0787
108	0.0007 a ± 0.0003	0.0031 ab ± 0.0012	0.0048 b ± 0.0007	6.455	0.0319
115	0.0010 ± 0.0010	0.0041 ± 0.0021	0.0142 ± 0.0044	5.841	0.0391
122	0.0021 ± 0.0021	0.0061 ± 0.0046	0.0101 ± 0.0061	0.769	0.5042
129	0.0000 a ± 0.0000	0.0102 b ± 0.0020	0.0202 c ± 0.0020	38.770	0.0004
143	0.0021 ± 0.0010	0.0092 ± 0.0000	0.0219 ± 0.0115	2.277	0.1838
168	0.0092 a ± 0.0020	0.0312 b ± 0.0047	0.0220 ab ± 0.0029	10.767	0.0103
185	0.0175 ± 0.0051	0.0355 ± 0.0140	0.0535 ± 0.0059	3.822	0.0850

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.26 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0348 ± 0.0197	0.0551 ± 0.0219	0.0773 ± 0.0070	1.483	0.2996
214	0.0234 ± 0.0056	0.0215 ± 0.0072	0.0359 ± 0.0079	1.266	0.3479
221	0.0806 ± 0.0121	0.0697 ± 0.0185	0.0685 ± 0.0092	0.231	0.8003
228	0.0631 ± 0.0302	0.0833 ± 0.0212	0.0751 ± 0.0166	0.189	0.8323
236	0.0159 ± 0.0060	0.0125 ± 0.0018	0.0107 ± 0.0031	0.429	0.6697
242	0.0188 ± 0.0046	0.0323 ± 0.0091	0.0500 ± 0.0078	4.463	0.0650
263	0.0062 ± 0.0023	0.0193 ± 0.0091	0.0186 ± 0.0105	0.827	0.4817

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.27
Pitfall trap data for total Linyphiinae
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
-07	0.0246 ± 0.0169	0.0138 ± 0.0138	0.0152 ± 0.0131	0.160	0.8553
02	0.0532 ± 0.0226	0.0607 ± 0.0607	0.0839 ± 0.0232	0.733	0.5191
08	0.0154 ± 0.0042	0.0154 ± 0.0031	0.0325 ± 0.0041	6.712	0.0295
18	0.0072 ± 0.0007	0.0029 ± 0.0014	0.0036 ± 0.0026	1.755	0.2512
31	0.0309 ± 0.0111	0.0266 ± 0.0056	0.0630 ± 0.0217	1.894	0.2303
47	0.0203 ± 0.0009	0.0160 ± 0.0015	0.0212 ± 0.0026	2.385	0.1729
87	0.0005 ± 0.0003	0.0005 ± 0.0003	0.0007 ± 0.0002	0.115	0.8936
108	0.0024 a ± 0.0003	0.0092 b ± 0.0010	0.0099 b ± 0.0009	26.864	0.0010
115	0.0031 a ± 0.0018	0.0122 ab ± 0.0030	0.0182 b ± 0.0034	7.195	0.0255
122	0.0072 ± 0.0010	0.0101 ± 0.0054	0.0190 ± 0.0098	0.896	0.4566
129	0.0181 a ± 0.0069	0.0202 a ± 0.0020	0.0562 b ± 0.0018	25.230	0.0012
143	0.0162 ± 0.0043	0.0172 ± 0.0027	0.0327 ± 0.0072	3.340	0.1060
168	0.0136 a ± 0.0034	0.0355 b ± 0.0042	0.0286 ab ± 0.0016	11.979	0.0080
185	0.0318 ± 0.0083	0.0514 ± 0.0182	0.0805 ± 0.0051	4.222	0.0717

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.27 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0785 ± 0.0180	0.0943 ± 0.0281	0.1310 ± 0.0067	1.883	0.2319
214	0.0500 ± 0.0009	0.0412 ± 0.0092	0.0590 ± 0.0139	0.862	0.4688
221	0.1191 ± 0.0226	0.1102 ± 0.0160	0.1232 ± 0.0093	0.156	0.8588
228	0.1055 ± 0.0296	0.1253 ± 0.0234	0.1118 ± 0.0150	0.185	0.8357
236	0.0620 ± 0.0108	0.0397 ± 0.0060	0.0509 ± 0.0101	1.469	0.3025
242	0.1210 ± 0.0101	0.1591 ± 0.0157	0.1646 ± 0.0059	4.427	0.0659
263	0.0286 ± 0.0065	0.0388 ± 0.0033	0.0362 ± 0.0063	0.920	0.4482

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.28
Pitfall trap data for total Linyphiidae
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0051 ± 0.0027	0.0031 ± 0.0018	0.0018 ± 0.0018	0.301	0.7508
-07	0.0516 ± 0.0346	0.0357 ± 0.0357	0.0321 ± 0.0237	0.106	0.9011
02	0.1267 ± 0.0390	0.1405 ± 0.0140	0.1295 ± 0.0186	0.076	0.9272
08	0.0516 ± 0.0170	0.0369 ± 0.0058	0.0596 ± 0.0042	1.172	0.3719
18	0.0232 ± 0.0031	0.0078 ± 0.0050	0.0100 ± 0.0046	3.752	0.0877
31	0.0541 ± 0.0111	0.0582 ± 0.0071	0.1054 ± 0.0266	2.771	0.1405
47	0.0173 ab ± 0.0008	0.0138 a ± 0.0012	0.0199 b ± 0.0015	6.727	0.0293
87	0.0011 ± 0.0006	0.0011 ± 0.0006	0.0029 ± 0.0002	4.229	0.0715
108	0.0092 ± 0.0006	0.0293 ± 0.0060	0.0408 ± 0.0101	5.597	0.0425
115	0.0102 a ± 0.0044	0.0356 b ± 0.0071	0.0694 c ± 0.0085	18.628	0.0027
122	0.0270 ± 0.0045	0.0874 ± 0.0399	0.1123 ± 0.0194	2.894	0.1319
129	0.0444 a ± 0.0175	0.1123 ab ± 0.0272	0.2048 b ± 0.0436	6.607	0.0305
143	0.0507 ± 0.0040	0.1262 ± 0.0216	0.1619 ± 0.0432	4.119	0.0748
168	0.0634 ± 0.0039	0.1846 ± 0.0214	0.2072 ± 0.0515	5.734	0.0405
185	0.1477 ± 0.0187	0.2536 ± 0.0715	0.3109 ± 0.0664	2.085	0.2054

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.28 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.3815 ± 0.0142	0.4805 ± 0.0634	0.5590 ± 0.0494	3.565	0.0954
214	0.2578 ± 0.0405	0.2527 ± 0.0137	0.3340 ± 0.0243	2.569	0.1563
221	0.3177 ± 0.0155	0.3522 ± 0.0376	0.3284 ± 0.0267	0.397	0.6889
228	0.3070 ± 0.0534	0.3522 ± 0.0316	0.3227 ± 0.0330	0.320	0.7376
236	0.2325 ± 0.0228	0.3286 ± 0.0665	0.3819 ± 0.0728	1.680	0.2634
242	0.4772 ± 0.0374	0.6782 ± 0.0999	0.7233 ± 0.1087	2.222	0.1896
263	0.2563 ± 0.0433	0.2671 ± 0.0480	0.3210 ± 0.0098	0.846	0.4745

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.29
Pitfall trap data for total Acari.
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0192 ± 0.0043	0.0182 ± 0.0046	0.0222 ± 0.0026	0.280	0.7649
-07	0.1424 ± 0.0701	0.0779 ± 0.0672	0.0700 ± 0.0578	0.371	0.7048
02	0.1732 ± 0.0965	0.3825 ± 0.1925	0.2177 ± 0.0599	0.730	0.5204
08	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
18	0.0991 ± 0.0481	0.0800 ± 0.0413	0.0620 ± 0.0367	0.193	0.8293
31	0.2233 ± 0.0967	0.1312 ± 0.0290	0.0909 ± 0.0405	1.169	0.3726
47	0.1475 ± 0.0157	0.1358 ± 0.0539	0.0998 ± 0.0612	0.269	0.7730
87	0.0096 ± 0.0072	0.0141 ± 0.0122	0.0056 ± 0.0027	0.259	0.7798
108	0.0597 ± 0.0209	0.0438 ± 0.0267	0.0316 ± 0.0161	0.422	0.6740
115	0.0240 ± 0.0068	0.0204 ± 0.0188	0.0092 ± 0.0030	0.435	0.6659
122	0.1756 ± 0.0571	0.1360 ± 0.0454	0.0987 ± 0.0686	0.443	0.6618
129	0.0505 ± 0.0091	0.0745 ± 0.0226	0.1070 ± 0.0897	0.279	0.7660
143	0.0250 ± 0.0086	0.0367 ± 0.0201	0.0168 ± 0.0138	0.447	0.6593
168	0.0578 ± 0.0160	0.0347 ± 0.0124	0.0417 ± 0.0088	0.866	0.4673
185	0.0084 ± 0.0022	0.0093 ± 0.0017	0.0100 ± 0.0058	0.047	0.9545

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.29 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.0827 ± 0.0267	0.0916 ± 0.0346	0.0776 ± 0.0458	0.038	0.9633
214	0.0261 ± 0.0048	0.0225 ± 0.0058	0.0225 ± 0.0032	0.199	0.8249
221	0.0393 ± 0.0083	0.0598 ± 0.0018	0.0487 ± 0.0080	2.312	0.1801
228	0.0395 ± 0.0038	0.0469 ± 0.0055	0.0542 ± 0.0072	1.684	0.2628
236	0.0380 ± 0.0044	0.0227 ± 0.0092	0.0295 ± 0.0095	0.918	0.4490
242	0.0721 ± 0.0210	0.0467 ± 0.0230	0.0543 ± 0.0304	0.269	0.7731
263	0.0175 ± 0.0054	0.0161 ± 0.0076	0.0135 ± 0.0041	0.117	0.8918

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.30
Pitfall trap data for total Collembola.
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0010 ± 0.0010	0.0000 ± 0.0000	0.0010 ± 0.0010	0.500	0.6297
-07	0.0829 ± 0.0545	0.0402 ± 0.0402	0.1199 ± 0.1199	0.252	0.7852
02	0.1110 a ± 0.0360	0.1734 a ± 0.0475	0.4700 b ± 0.0379	12.244	0.0076
08	0.0000 ± 0.0000	0.0000 ± 0.0000	0.0000 ± 0.0000	0.000	1.0000
18	0.0223 ± 0.0114	0.0005 ± 0.0005	0.0646 ± 0.0635	0.766	0.5056
31	0.2081 ± 0.0475	0.1862 ± 0.0981	0.2533 ± 0.1303	0.122	0.8876
47	0.0031 ± 0.0020	0.0036 ± 0.0036	0.0106 ± 0.0080	0.646	0.5570
87	0.0003 ± 0.0002	0.0007 ± 0.0007	0.0005 ± 0.0005	0.141	0.8711
108	0.0254 ± 0.0031	0.0179 ± 0.0114	0.0425 ± 0.0245	0.644	0.5580
115	0.1094 ± 0.0401	0.1154 ± 0.0425	0.1807 ± 0.0978	0.362	0.7105
122	0.0312 ± 0.0177	0.0523 ± 0.0292	0.0336 ± 0.0101	0.319	0.3787
129	0.0821 ± 0.0409	0.1586 ± 0.0731	0.2108 ± 0.1667	0.361	0.7111
143	0.0230 ± 0.0094	0.0294 ± 0.0163	0.0855 ± 0.0689	0.697	0.5342
168	0.0308 ± 0.0213	0.0176 ± 0.0029	0.0649 ± 0.0361	1.013	0.4177
185	0.0782 ± 0.0203	0.0373 ± 0.0089	0.1022 ± 0.0404	1.522	0.2920

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.30 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.1010 ± 0.0016	0.1047 ± 0.0349	0.1757 ± 0.0446	1.651	0.2684
214	0.0709 ± 0.0207	0.0705 ± 0.0247	0.0565 ± 0.0130	0.165	0.8513
221	0.2026 ± 0.0496	0.2102 ± 0.0434	0.2007 ± 0.0623	0.009	0.9915
228	0.1397 ± 0.0387	0.1305 ± 0.0309	0.2406 ± 0.0366	2.955	0.1279
236	0.1833 ± 0.0455	0.1856 ± 0.0457	0.1491 ± 0.0451	0.202	0.8223
242	0.1938 ± 0.0426	0.2794 ± 0.0169	0.2249 ± 0.0349	1.694	0.2610
263	0.0962 ± 0.0340	0.1836 ± 0.0111	0.1264 ± 0.0407	2.013	0.2143

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.31
Pitfall trap data for total Diptera.
Comparison of, log(n+1) transformed, no./trap/day values for plots treated with deltamethrin, demeton-S-methyl (DSM) and unsprayed control plots.

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
-12	0.0102 ± 0.0010	0.0062 ± 0.0018	0.0072 ± 0.0010	2.581	0.1553
-07	0.1558 ± 0.0785	0.1010 ± 0.0967	0.1423 ± 0.1338	0.073	0.9303
02	0.4369 ± 0.0322	0.5934 ± 0.0835	0.5852 ± 0.0806	1.599	0.2776
08	0.0782 a ± 0.0020	0.1604 b ± 0.0073	0.1763 b ± 0.0244	12.755	0.0069
18	0.0585 ± 0.0201	0.0465 ± 0.0071	0.0550 ± 0.0038	0.246	0.7896
31	0.2242 ± 0.0635	0.1973 ± 0.0543	0.1742 ± 0.0809	0.139	0.8729
47	0.0277 ± 0.0128	0.0269 ± 0.0116	0.0232 ± 0.0082	0.047	0.9548
87	0.0027 ± 0.0011	0.0038 ± 0.0023	0.0104 ± 0.0080	0.751	0.5116
108	0.0861 ± 0.0496	0.1300 ± 0.0630	0.1532 ± 0.0268	0.488	0.6361
115	0.1262 ± 0.0781	0.1977 ± 0.0846	0.1427 ± 0.0222	0.306	0.7474
122	0.1036 ± 0.0484	0.2349 ± 0.0983	0.1912 ± 0.0512	0.918	0.4489
129	0.1186 ± 0.0371	0.1854 ± 0.0878	0.2172 ± 0.0390	0.717	0.5260
143	0.1621 ± 0.0344	0.2816 ± 0.1154	0.3405 ± 0.1333	0.768	0.5048
168	0.1054 ± 0.0199	0.1307 ± 0.0421	0.1823 ± 0.0972	0.398	0.6884
185	0.3522 ± 0.0688	0.2945 ± 0.0710	0.2713 ± 0.0405	0.456	0.6542

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.31 (continued)

Days +or- spray	Mean no./trap/day log(n+1) with SE			F-ratio	Sig. Level
	Deltamethrin	DSM	Control		
199	0.1966 ± 0.0620	0.2075 ± 0.0489	0.1773 ± 0.0073	0.112	0.8961
214	0.0752 ± 0.0260	0.0686 ± 0.0186	0.0770 ± 0.0162	0.045	0.9562
221	0.0536 ± 0.0178	0.1087 ± 0.0300	0.0786 ± 0.0158	1.557	0.2853
228	0.1254 ± 0.0214	0.1080 ± 0.0227	0.1022 ± 0.0142	0.374	0.7029
236	0.0428 ± 0.0091	0.0567 ± 0.0194	0.0550 ± 0.0207	0.193	0.8296
242	0.0774 ± 0.0282	0.0893 ± 0.0277	0.0589 ± 0.0276	0.304	0.7484
263	0.0227 ± 0.0074	0.0187 ± 0.0092	0.0207 ± 0.0074	0.063	0.9395

N.B. For each sample date values sharing the same letter are not significantly different according to 95% confidence intervals (ANOVA).

Appendix 4.32
Table of dates associated with days relative to treatment for the autumn 1986 deltamethrin / DSM field trial.

DAYS	DATE
-12	22-10-86
-07	27-10-86
02	05-11-86
08	11-11-86
18	21-11-86
31	04-12-86
47	20-12-86
87	29-01-87
108	19-02-87
115	26-02-87
122	05-03-87
129	12-03-87
143	26-03-87
168	20-04-87
185	07-05-87
199	21-05-87

DAYS	DATE
208	30-05-87
209	31-05-87
214	04-06-87
220	10-06-87
221	11-06-87
222	12-06-87
228	18-06-87
234	24-06-87
236	26-06-87
237	27-06-87
241	01-07-87
242	02-07-87
247	07-07-87
263	23-07-87
264	24-07-87
279	08-08-87

Appendix 5.1
Pitfall trap data for <u>Bembidion</u> <u>lampros</u> (Herbst.).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0017 ± 0.0035	0.0000 ± 0.0000	1.0000	0.3466
02	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
06	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
11	0.0000 ± 0.0000	0.0009 ± 0.0019	-1.0000	0.3466
21	0.0000 ± 0.0000	0.0009 ± 0.0019	-1.0000	0.3466
40	0.0005 ± 0.0010	0.0000 ± 0.0000	1.0000	0.3466
47	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
64	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
74	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
89	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
103	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
125	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
135	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
145	0.0250 ± 0.0173	0.0194 ± 0.0127	0.5889	0.5722
160	0.0484 ± 0.0284	0.0498 ± 0.0327	-0.0868	0.9474
166	0.0631 ± 0.0333	0.0500 ± 0.0431	0.5354	0.6069
170	0.1330 ± 0.0476	0.0802 ± 0.0282	2.1319	0.0656
175	0.0696 ± 0.0298	0.0746 ± 0.0151	-0.3372	0.7446
180	0.0713 ± 0.0248	0.0805 ± 0.0129	-0.7337	0.4841

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.2
Pitfall trap data for Bembidion obtusum (Serville).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.6690 ± 0.1483	0.5357 ± 0.1483	1.6755	0.1324
02	0.1499 ± 0.0509	0.5386 ± 0.0798	-9.1842	<0.0001**
06	0.0834 ± 0.0363	0.3830 ± 0.0363	-5.5943	0.0005**
11	0.0636 ± 0.0241	0.3143 ± 0.0633	-8.2739	<0.0001**
21	0.9297 ± 0.0346	0.9033 ± 0.1191	0.4767	0.6463
40	0.4782 ± 0.0732	0.5343 ± 0.0767	-1.1829	0.2708
47	1.0026 ± 0.2413	0.8742 ± 0.1601	0.9913	0.3506
64	0.7214 ± 0.1058	0.6693 ± 0.1354	0.6775	0.5172
74	0.7781 ± 0.0711	0.7536 ± 0.1684	0.2998	0.7720
89	0.4779 ± 0.0698	0.4744 ± 0.1302	0.0530	0.9591
103	0.1695 ± 0.0641	0.1985 ± 0.0678	-0.6950	0.5068
125	0.2864 ± 0.1271	0.2979 ± 0.2276	-0.0985	0.9240
135	0.2994 ± 0.0474	0.3037 ± 0.0808	-0.1027	0.9208
145	0.0598 ± 0.0119	0.0629 ± 0.0109	-0.4231	0.6834
160	0.2065 ± 0.0463	0.1353 ± 0.0698	1.8985	0.0942
166	0.2252 ± 0.0621	0.2776 ± 0.1042	-0.9481	0.3708
170	0.2103 ± 0.0701	0.1513 ± 0.0520	1.5117	0.1691
175	0.0609 ± 0.0252	0.0564 ± 0.0237	0.2897	0.7794
180	0.0570 ± 0.0397	0.0364 ± 0.0165	1.0742	0.3141

N.B. * and ** indicate significant differences at p<0.05 and p<0.01 respectively (t-test).

Appendix 5.3
Pitfall trap data for <u>Bembidion obtusum</u> (Serville).
Comparison of 'k' values for treated and untreated areas.

Days +or-	Treatment 'k'	Control 'k'	t-stat	Sig.Level
00	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
02	0.5155 ± 0.1399	-0.0029 ± 0.1348	5.9656	0.0003**
06	0.5856 ± 0.1355	0.2053 ± 0.0855	5.3096	0.0007**
11	0.6054 ± 0.1257	0.1965 ± 0.0891	5.9354	0.0004**
21	-0.2608 ± 0.1227	-0.3676 ± 0.1616	1.1769	0.3731
40	0.1908 ± 0.2136	0.0014 ± 0.1390	1.6611	0.1353
47	-0.3336 ± 0.3626	-0.3384 ± 0.1949	0.0263	0.9797
64	-0.0524 ± 0.2242	-0.1461 ± 0.1521	0.7732	0.4616
74	-0.1091 ± 0.1855	-0.2178 ± 0.1891	0.9180	0.3855
89	0.1911 ± 0.2017	0.0488 ± 0.1777	1.1839	0.2704
103	0.4995 ± 0.1448	0.3372 ± 0.1642	1.6571	0.1361
125	0.3826 ± 0.2734	0.2252 ± 0.2944	0.8756	0.4068
135	0.3696 ± 0.1901	0.2195 ± 0.1663	1.3294	0.2204
145	0.6092 ± 0.1556	0.4603 ± 0.0990	1.8057	0.1086
160	0.4625 ± 0.1821	0.3878 ± 0.0953	0.8129	0.4398
166	0.4358 ± 0.1755	0.2465 ± 0.1659	1.7525	0.1178
170	0.4587 ± 0.2084	0.3719 ± 0.1140	0.8173	0.4374
175	0.6081 ± 0.1627	0.4668 ± 0.0866	1.7152	0.1247
180	0.6116 ± 0.1562	0.4868 ± 0.1041	1.4873	0.1753

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.4
Pitfall trap data for <u>Loricera pilicornis</u> (F.).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
02	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
06	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
40	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
47	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
64	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
74	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
89	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
103	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
125	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
135	0.0277 ± 0.0046	0.0269 ± 0.0055	0.2555	0.8048
145	0.0308 ± 0.0129	0.0317 ± 0.0116	-0.1081	0.9166
160	0.0522 ± 0.0104	0.0152 ± 0.0137	4.8219	0.0013**
166	0.0383 ± 0.0230	0.0312 ± 0.0304	0.4140	0.6898
170	0.0428 ± 0.0252	0.0574 ± 0.0392	-0.6991	0.5043
175	0.0492 ± 0.0055	0.0412 ± 0.0146	1.1419	0.2865
180	0.0444 ± 0.0132	0.0461 ± 0.0069	-0.2522	0.8073

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.5
Pitfall trap data for <u>Nebria brevicollis</u> (F.).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0051 ± 0.0113	0.0153 ± 0.0070	-1.7215	0.1235
02	0.0042 ± 0.0095	0.0284 ± 0.0332	-1.5612	0.1571
06	0.0147 ± 0.0173	0.0063 ± 0.0140	0.8397	0.4255
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0252 ± 0.0097	0.0534 ± 0.0462	-1.3343	0.2189
40	0.0059 ± 0.0038	0.0023 ± 0.0032	1.6344	0.1408
47	0.0441 ± 0.0433	0.0362 ± 0.0262	0.3494	0.7358
64	0.0212 ± 0.0152	0.0263 ± 0.0216	-0.4317	0.6774
74	0.0102 ± 0.0065	0.0085 ± 0.0099	0.3300	0.7499
89	0.0080 ± 0.0023	0.0091 ± 0.0042	-0.5124	0.6222
103	0.0011 ± 0.0024	0.0000 ± 0.0000	1.0000	0.3466
125	0.0016 ± 0.0016	0.0091 ± 0.0162	-1.0381	0.3296
135	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
145	0.0017 ± 0.0024	0.0009 ± 0.0019	0.6325	0.5447
160	0.0017 ± 0.0039	0.0069 ± 0.0039	-2.1213	0.0667
166	0.0014 ± 0.0032	0.0000 ± 0.0000	1.0000	0.3466
170	0.0064 ± 0.0059	0.0021 ± 0.0048	1.2649	0.2415
175	0.0017 ± 0.0039	0.0017 ± 0.0039	0.0000	1.0000
180	0.0034 ± 0.0047	0.0000 ± 0.0000	1.6330	0.1411

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.6
Pitfall trap data for Notiophilus biguttatus (F.).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0034 ± 0.0047	0.0156 ± 0.0198	-1.3388	0.2174
02	0.0000 ± 0.0000	0.0127 ± 0.0116	-2.4495	0.0400 *
06	0.0085 ± 0.0116	0.0189 ± 0.0134	-1.3217	0.2228
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0286 ± 0.0114	0.0290 ± 0.0192	-0.0634	0.9510
40	0.0108 ± 0.0094	0.0050 ± 0.0010	1.3520	0.2134
47	0.0169 ± 0.0129	0.0182 ± 0.0094	-0.1796	0.8620
64	0.0131 ± 0.0041	0.0120 ± 0.0083	0.2517	0.8076
74	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
89	0.0046 ± 0.0016	0.0075 ± 0.0025	-2.1413	0.0646
103	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
125	0.0020 ± 0.0014	0.0020 ± 0.0034	0.0123	0.9905
135	0.0069 ± 0.0038	0.0069 ± 0.0038	0.0000	1.0000
145	0.0136 ± 0.0055	0.0161 ± 0.0069	-0.6364	0.5423
160	0.0168 ± 0.0167	0.0234 ± 0.0176	-0.6075	0.5603
166	0.0057 ± 0.0078	0.0086 ± 0.0059	-0.6585	0.5287
170	0.0208 ± 0.0215	0.0148 ± 0.0119	0.5362	0.6064
175	0.0085 ± 0.0085	0.0103 ± 0.0038	-0.4235	0.6831
180	0.0086 ± 0.0060	0.0102 ± 0.0071	-0.4038	0.6969

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.7
Pitfall trap data for *Pterostichus melanarius* (Illiger). Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0051 ± 0.0076	0.0017 ± 0.0038	0.8913	0.3988
02	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
06	0.0000 ± 0.0000	0.0085 ± 0.0089	-2.1453	0.0643
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0052 ± 0.0047	0.0868 ± 0.0052	-1.0853	0.3094
40	0.0005 ± 0.0010	0.0000 ± 0.0000	1.0000	0.3466
47	0.0110 ± 0.0079	0.0086 ± 0.0069	0.5113	0.6230
64	0.0046 ± 0.0011	0.0051 ± 0.0040	-0.2594	0.8019
74	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
89	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
103	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
125	0.0032 ± 0.0026	0.0004 ± 0.0009	2.2208	0.0571
135	0.0069 ± 0.0024	0.0056 ± 0.0030	-0.9956	0.3486
145	0.0310 ± 0.0061	0.0219 ± 0.0094	1.8007	0.1094
160	0.0678 ± 0.0422	0.0304 ± 0.0195	1.7970	0.1101
166	0.0636 ± 0.0299	0.0691 ± 0.0190	-0.3465	0.7379
170	0.0407 ± 0.0274	0.0639 ± 0.0512	-0.8945	0.3972
175	0.0119 ± 0.0076	0.0051 ± 0.0076	1.4142	0.1950
180	0.0135 ± 0.0140	0.0000 ± 0.0000	2.1516	0.0636

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.8
Pitfall trap data for *Trechus quadristriatus* (Schrank). Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.3476 ± 0.1191	0.2114 ± 0.0692	2.2104	0.0581
02	0.0857 ± 0.0276	0.2139 ± 0.0958	-2.8763	0.0206 *
06	0.0479 ± 0.0374	0.1444 ± 0.0151	-5.3452	0.0007**
11	0.0389 ± 0.0307	0.1007 ± 0.0346	-2.9870	0.0174 *
21	0.3663 ± 0.0641	0.2996 ± 0.0723	1.5451	0.1609
40	0.0792 ± 0.0286	0.0436 ± 0.0355	1.7465	0.1189
47	0.2964 ± 0.1992	0.1593 ± 0.0855	1.4143	0.1950
64	0.1308 ± 0.0704	0.0952 ± 0.0454	0.9493	0.3703
74	0.0419 ± 0.0183	0.0404 ± 0.0170	0.1373	0.8942
89	0.0209 ± 0.0032	0.0225 ± 0.0102	-0.3298	0.7500
103	0.0055 ± 0.0045	0.0031 ± 0.0022	1.0853	0.3094
125	0.0185 ± 0.0087	0.0105 ± 0.0075	1.5532	0.1590
135	0.0178 ± 0.0091	0.0301 ± 0.0116	-1.8670	0.0989
145	0.0034 ± 0.0036	0.0026 ± 0.0024	0.4472	0.6666
160	0.0117 ± 0.0163	0.0000 ± 0.0000	1.6077	0.1466
166	0.0126 ± 0.0164	0.0072 ± 0.0050	0.7093	0.4983
170	0.0127 ± 0.0114	0.0021 ± 0.0048	1.9050	0.0933
175	0.0034 ± 0.0047	0.0017 ± 0.0039	0.6325	0.5447
180	0.0034 ± 0.0047	0.0000 ± 0.0000	1.6330	0.1411

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.9
Pitfall trap data for <u>Trechus quadristriatus</u> (Schrank).
Comparison of 'k' values for treated and untreated areas.

Days +or-	Treatment 'k'	Control 'k'	t-stat	Sig.Level
00	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
02	0.2620 ± 0.1297	-0.0025 ± 0.0829	3.8411	0.0049**
06	0.2997 ± 0.0881	0.0671 ± 0.0560	4.9846	0.0011**
11	0.3087 ± 0.0934	0.1108 ± 0.0614	3.9600	0.0042**
21	-0.0187 ± 0.0717	-0.0881 ± 0.1295	1.0488	0.3249
40	0.2684 ± 0.1169	0.1679 ± 0.0927	1.5076	0.1701
47	0.0512 ± 0.1741	0.0521 ± 0.1079	0.0101	0.9922
64	0.2168 ± 0.0771	0.1162 ± 0.1028	1.7505	0.1182
74	0.3058 ± 0.1191	0.1585 ± 0.0635	2.4400	0.0406 *
89	0.2705 ± 0.1840	0.1900 ± 0.0700	0.9150	0.3870
103	0.3421 ± 0.1212	0.2083 ± 0.0680	2.1521	0.0636
125	0.3291 ± 0.1189	0.2010 ± 0.0680	2.0930	0.0697
135	0.3298 ± 0.1190	0.1814 ± 0.0800	2.3156	0.0493 *
145	0.3442 ± 0.1183	0.2089 ± 0.0698	2.2027	0.0588
160	0.3359 ± 0.1306	0.2114 ± 0.0692	1.8827	0.0965
166	0.3350 ± 0.1155	0.2043 ± 0.0688	2.1754	0.0613
170	0.3349 ± 0.1301	0.2093 ± 0.0705	1.8983	0.0942
175	0.3442 ± 0.1154	0.2097 ± 0.0703	2.2256	0.0567
180	0.3459 ± 0.1193	0.2114 ± 0.0692	2.1794	0.0609

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.10
Pitfall trap data for total adult Carabidae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.7738 ± 0.1510	0.6189 ± 0.0967	1.9313	0.0895
02	0.2163 ± 0.0357	0.6239 ± 0.0626	12.6559	<0.0001**
06	0.1409 ± 0.0477	0.4223 ± 0.0530	-8.8242	<0.0001**
11	0.1035 ± 0.0326	0.3428 ± 0.0472	-9.3229	<0.0001**
21	1.0004 ± 0.0320	0.9647 ± 0.1176	0.6540	0.5315
40	0.5114 ± 0.0771	0.5490 ± 0.0830	-0.7419	0.4794
47	1.0439 ± 0.2615	0.9064 ± 0.1612	1.0008	0.3462
64	0.7546 ± 0.1148	0.6995 ± 0.1385	0.6850	0.5127
74	0.7869 ± 0.0720	0.7634 ± 0.1630	0.2951	0.7754
89	0.4874 ± 0.0671	0.4885 ± 0.1213	-0.0181	0.9860
103	0.1747 ± 0.0661	0.1837 ± 0.0343	-0.2703	0.7938
125	0.2864 ± 0.1271	0.3035 ± 0.2268	-0.1469	0.8868
135	0.3351 ± 0.0429	0.3474 ± 0.0751	-0.3176	0.7589
145	0.1459 ± 0.0139	0.1384 ± 0.0144	0.8431	0.4237
160	0.3338 ± 0.0640	0.2254 ± 0.0872	2.2417	0.0553
166	0.3293 ± 0.0909	0.3632 ± 0.1131	-0.5227	0.6154
170	0.3529 ± 0.1069	0.2973 ± 0.0855	0.9090	0.3899
175	0.1815 ± 0.0181	0.1677 ± 0.0154	1.3033	0.2287
180	0.1811 ± 0.0450	0.1613 ± 0.0272	0.8456	0.4223

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.11
Pitfall trap data for total adult Carabidae.
Comparison of 'k' values for treated and untreated areas.

Days +or-	Treatment 'k'	Control 'k'	t-stat	Sig.Level
00	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
02	0.5574 ± 0.1313	-0.0050 ± 0.1035	7.5210	0.0001**
06	0.6328 ± 0.1274	0.0129 ± 0.4687	2.8544	0.0213 *
11	0.6702 ± 0.1308	0.2761 ± 0.0724	5.8954	0.0004**
21	-0.2266 ± 0.1226	-0.3458 ± 0.1772	1.2370	0.2512
40	0.2623 ± 0.2197	0.0699 ± 0.1479	1.6248	0.1429
47	-0.0817 ± 0.4636	-0.2875 ± 0.2068	0.9066	0.3911
64	0.0191 ± 0.2145	-0.0814 ± 0.1543	0.8508	0.4196
74	-0.0131 ± 0.1751	-0.1444 ± 0.1841	1.1559	0.2811
89	0.2863 ± 0.1883	0.1304 ± 0.1607	1.4090	0.1965
103	0.5991 ± 0.1632	0.4353 ± 0.1281	1.7657	0.1154
125	0.4873 ± 0.2774	0.3154 ± 0.2730	0.9876	0.3523
135	0.4386 ± 0.1905	0.2715 ± 0.1577	1.5109	0.1693
145	0.6278 ± 0.1550	0.4805 ± 0.0947	1.8136	0.1073
160	0.4399 ± 0.1955	0.3935 ± 0.1447	0.4269	0.6807
166	0.4445 ± 0.2057	0.2557 ± 0.1555	1.6368	0.1403
170	0.4208 ± 0.2537	0.3223 ± 0.1130	0.7930	0.4507
175	0.5915 ± 0.1538	0.4512 ± 0.0891	1.7644	0.1157
180	0.5926 ± 0.1507	0.4577 ± 0.1224	1.5545	0.1587

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.12
Pitfall trap data for Nebria brevicollis (F.) larvae. Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-spra	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0280 ± 0.0259	0.0297 ± 0.0232	-0.1120	0.9136
02	0.0085 ± 0.0116	0.0671 ± 0.0342	-3.6266	0.0067**
06	0.0021 ± 0.0048	0.0106 ± 0.0106	-1.6304	0.1417
11	0.0000 ± 0.0000	0.0085 ± 0.0085	-2.2413	0.0553
21	0.0583 ± 0.0102	0.0618 ± 0.0219	-0.3165	0.7597
40	0.0104 ± 0.0061	0.0213 ± 0.0097	-2.1479	0.0640
47	0.0877 ± 0.0269	0.0637 ± 0.0279	1.3816	0.2045
64	0.0378 ± 0.0278	0.0397 ± 0.0170	-0.1329	0.8975
74	0.0585 ± 0.0285	0.0507 ± 0.0089	0.5831	0.5759
89	0.0069 ± 0.0025	0.0092 ± 0.0031	-1.2682	0.2404
103	0.0110 ± 0.0062	0.0092 ± 0.0048	0.5189	0.6179
125	0.0043 ± 0.0043	0.0047 ± 0.0056	-0.1145	0.9117
135	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
145	0.0017 ± 0.0024	0.0017 ± 0.0024	0.0000	1.0000
160	0.0085 ± 0.0103	0.0085 ± 0.0085	-0.0033	0.9974
166	0.0029 ± 0.0039	0.0043 ± 0.0039	-0.5774	0.5796
170	0.0084 ± 0.0137	0.0043 ± 0.0059	0.6229	0.5507
175	0.0034 ± 0.0047	0.0034 ± 0.0047	0.0000	1.0000
180	0.0000 ± 0.0000	0.0034 ± 0.0076	-1.0000	0.3466

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.13
Pitfall trap data for total Carabid larvae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0436 ± 0.0314	0.0376 ± 0.0255	0.3322	0.7483
02	0.0873 ± 0.0520	0.1226 ± 0.0710	-0.8957	0.3966
06	0.0293 ± 0.0112	0.0388 ± 0.0255	-0.7647	0.4664
11	0.0235 ± 0.0122	0.0314 ± 0.0208	-0.7312	0.4855
21	0.1188 ± 0.0508	0.1021 ± 0.0331	0.6138	0.5564
40	0.0178 ± 0.0111	0.0272 ± 0.0173	-1.0275	0.3343
47	0.1127 ± 0.0360	0.0844 ± 0.0453	1.0934	0.3061
64	0.0517 ± 0.0278	0.0568 ± 0.0240	0.3122	0.7629
74	0.1009 ± 0.0412	0.0765 ± 0.0238	1.1483	0.2840
89	0.0153 ± 0.0038	0.0170 ± 0.0071	-0.4657	0.6539
103	0.0157 ± 0.0106	0.0110 ± 0.0063	0.8646	0.4124
125	0.0120 ± 0.0078	0.0138 ± 0.0143	-0.2453	0.8124
135	0.0026 ± 0.0024	0.0026 ± 0.0039	0.0000	1.0000
145	0.0069 ± 0.0049	0.0043 ± 0.0030	0.9967	0.3481
160	0.0168 ± 0.0168	0.0166 ± 0.0209	0.0117	0.9910
166	0.0070 ± 0.0121	0.0099 ± 0.0095	-0.4182	0.6868
170	0.0147 ± 0.0173	0.0064 ± 0.0059	1.0064	0.3437
175	0.0069 ± 0.0039	0.0086 ± 0.0060	-0.5264	0.6129
180	0.0068 ± 0.0071	0.0017 ± 0.0039	1.4142	0.1950

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.14
Pitfall trap data for total adult Staphylinidae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.1033 ± 0.0515	0.1429 ± 0.0559	-1.1645	0.2778
02	0.0447 ± 0.0253	0.1139 ± 0.0613	-2.3334	0.0479 *
06	0.0622 ± 0.0196	0.0783 ± 0.0312	-0.9749	0.3582
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.1490 ± 0.0306	0.1369 ± 0.0565	0.4202	0.6854
40	0.0324 ± 0.0132	0.0320 ± 0.0339	0.0270	0.9791
47	0.1099 ± 0.0582	0.0645 ± 0.0577	1.2400	0.2501
64	0.0558 ± 0.0350	0.0536 ± 0.0253	0.1118	0.9137
74	0.0200 ± 0.0200	0.0186 ± 0.0119	0.1363	0.8949
89	0.0080 ± 0.0013	0.0097 ± 0.0043	-0.8313	0.4299
103	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
125	0.0059 ± 0.0014	0.0109 ± 0.0040	-2.6586	0.0289 *
135	0.0203 ± 0.0054	0.0195 ± 0.0063	0.2254	0.8274
145	0.0035 ± 0.0020	0.0034 ± 0.0056	0.0303	0.9766
160	0.0331 ± 0.0170	0.0331 ± 0.0185	0.0036	0.9972
166	0.0114 ± 0.0081	0.0141 ± 0.0139	-0.3786	0.7148
170	0.1201 ± 0.0465	0.0291 ± 0.0166	4.1208	0.0033**
175	0.0444 ± 0.0130	0.0219 ± 0.0074	3.3566	0.0100**
180	0.0637 ± 0.0281	0.0236 ± 0.0069	3.1047	0.0146 *

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.15
Pitfall trap data for _Erigone atra_ (Blackwall).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0068 ± 0.0071	0.0068 ± 0.0071	0.0000	1.0000
02	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
06	0.0000 ± 0.0000	0.0042 ± 0.0095	-1.0000	0.3466
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0043 ± 0.0030	0.0195 ± 0.0070	-4.4550	0.0021**
40	0.0077 ± 0.0046	0.0073 ± 0.0029	0.1713	0.8683
47	0.0170 ± 0.0078	0.0206 ± 0.0053	-0.8565	0.4166
64	0.0021 ± 0.0021	0.0110 ± 0.0103	-1.9062	0.0931
74	0.0034 ± 0.0019	0.0094 ± 0.0046	-2.6679	0.0285 *
89	0.0035 ± 0.0024	0.0086 ± 0.0020	-3.6558	0.0064**
103	0.0049 ± 0.0056	0.0043 ± 0.0035	0.1978	0.8482
125	0.0094 ± 0.0046	0.0429 ± 0.0258	-2.8686	0.0209 *
135	0.0195 ± 0.0064	0.0302 ± 0.0066	-2.6014	0.0316 *
145	0.1385 ± 0.0286	0.1449 ± 0.0254	-0.3727	0.7190
160	0.1677 ± 0.0390	0.1502 ± 0.0688	0.4933	0.6337
166	0.1040 ± 0.0595	0.1209 ± 0.0554	-0.4656	0.6539
170	0.1731 ± 0.0406	0.1331 ± 0.0470	1.4435	0.1869
175	0.1279 ± 0.0241	0.1345 ± 0.0185	-0.4893	0.6378
180	0.1377 ± 0.0318	0.1290 ± 0.0274	0.4627	0.6559

N.B. * and ** indicate significant differences at p<0.05 and p<0.01 respectively (t-test).

Appendix 5.16
Pitfall trap data for <u>Erigone</u> <u>dentipalpis</u> (Wider).
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD		t-stat	Sig.Level
	Treatment	Control		
00	0.0017 ± 0.0039	0.0034 ± 0.0047	-0.6325	0.5447
02	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
06	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0000 ± 0.0000	0.0026 ± 0.0039	-1.5000	0.1720
40	0.0014 ± 0.0030	0.0050 ± 0.0043	-1.5356	0.1632
47	0.0000 ± 0.0000	0.0025 ± 0.0034	-1.6330	0.1411
64	0.0000 ± 0.0000	0.0061 ± 0.0038	-3.5487	0.0075**
74	0.0000 ± 0.0000	0.0017 ± 0.0039	-1.0000	0.3466
89	0.0000 ± 0.0000	0.0029 ± 0.0021	-3.1623	0.0134 *
103	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
125	0.0012 ± 0.0018	0.0016 ± 0.0026	-0.2880	0.7807
135	0.0103 ± 0.0038	0.0103 ± 0.0038	0.0000	1.0000
145	0.0341 ± 0.0131	0.0261 ± 0.0067	1.2108	0.2605
160	0.0334 ± 0.0081	0.0217 ± 0.0172	1.3696	0.2080
166	0.0280 ± 0.0068	0.0298 ± 0.0318	-0.1237	0.9046
170	0.0189 ± 0.0136	0.0429 ± 0.0216	-2.0993	0.0690
175	0.0034 ± 0.0047	0.0102 ± 0.0071	-1.7846	0.1122
180	0.0000 ± 0.0000	0.0153 ± 0.0070	-4.8929	0.0012**

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.17
Pitfall trap data for <u>Oedothorax fuscus</u> (Blackwall). Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0136 ± 0.0075	0.0202 ± 0.0127	-0.9988	0.3471
02	0.0000 ± 0.0000	0.0042 ± 0.0095	-1.0000	0.3466
06	0.0106 ± 0.0106	0.0000 ± 0.0000	2.2403	0.0554
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0094 ± 0.0076	0.0209 ± 0.0170	-1.3794	0.2051
40	0.0036 ± 0.0034	0.0073 ± 0.0033	-1.6977	0.1280
47	0.0086 ± 0.0033	0.0025 ± 0.0034	2.8958	0.0200 *
64	0.0026 ± 0.0031	0.0076 ± 0.0062	-1.6286	0.1420
74	0.0026 ± 0.0039	0.0017 ± 0.0039	0.3536	0.7328
89	0.0029 ± 0.0021	0.0029 ± 0.0021	0.0000	1.0000
103	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
125	0.0016 ± 0.0016	0.0012 ± 0.0026	0.2880	0.7807
135	0.0017 ± 0.0024	0.0017 ± 0.0024	0.0000	1.0000
145	0.0094 ± 0.0036	0.0086 ± 0.0043	0.3473	0.7374
160	0.0219 ± 0.0094	0.0216 ± 0.0197	0.0286	0.9779
166	0.0113 ± 0.0107	0.0170 ± 0.0063	-1.0230	0.3363
170	0.0106 ± 0.0128	0.0211 ± 0.0073	-1.6026	0.1477
175	0.0086 ± 0.0060	0.0086 ± 0.0060	0.0000	1.0000
180	0.0086 ± 0.0060	0.0068 ± 0.0071	0.4126	0.6907

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.18
Pitfall trap data for total Erigoninae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0281 ± 0.0230	0.0360 ± 0.0258	-0.5132	0.6217
02	0.0000 ± 0.0000	0.0085 ± 0.0116	-1.6330	0.1411
06	0.0106 ± 0.0106	0.0000 ± 0.0000	2.2403	0.0554
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0144 ± 0.0096	0.0396 ± 0.0157	-3.0570	0.0157 *
40	0.0126 ± 0.0033	0.0192 ± 0.0061	-2.1118	0.0677
47	0.0287 ± 0.0112	0.0287 ± 0.0095	-0.0030	0.9977
64	0.0051 ± 0.0040	0.0241 ± 0.0151	-2.7223	0.0262 *
74	0.0060 ± 0.0024	0.0136 ± 0.0090	-1.8186	0.1065
89	0.0069 ± 0.0032	0.0142 ± 0.0020	-4.3151	0.0026**
103	0.0049 ± 0.0056	0.0043 ± 0.0035	0.1978	0.8482
125	0.0120 ± 0.0052	0.0458 ± 0.0310	-2.4057	0.0428 *
135	0.0310 ± 0.0054	0.0413 ± 0.0088	-2.2355	0.0558
145	0.1729 ± 0.0308	0.1732 ± 0.0255	-0.0157	0.9879
160	0.2202 ± 0.0460	0.1853 ± 0.0903	0.7718	0.4624
166	0.1470 ± 0.0681	0.1593 ± 0.0788	-0.2626	0.7995
170	0.2057 ± 0.0509	0.1860 ± 0.0557	0.5834	0.5757
175	0.1430 ± 0.0273	0.1556 ± 0.0205	-0.8252	0.4332
180	0.1454 ± 0.0270	0.1503 ± 0.0279	-0.2835	0.7840

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.19
Pitfall trap data for <u>Bathyphantes</u> <u>gracilis</u> (Blackwall). Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0017 ± 0.0039	0.0000 ± 0.0000	1.0000	0.3466
02	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
06	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0085 ± 0.0073	0.0136 ± 0.0075	-1.0794	0.3119
40	0.0121 ± 0.0071	0.0086 ± 0.0058	0.8677	0.4108
47	0.0074 ± 0.0027	0.0037 ± 0.0034	1.9013	0.0938
64	0.0031 ± 0.0028	0.0051 ± 0.0025	-1.2168	0.2584
74	0.0000 ± 0.0000	0.0009 ± 0.0019	-1.0000	0.3466
89	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
103	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
125	0.0000 ± 0.0000	0.0012 ± 0.0026	-1.0000	0.3466
135	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
145	0.0026 ± 0.0024	0.0026 ± 0.0024	0.0000	1.0000
160	0.0085 ± 0.0085	0.0017 ± 0.0039	1.6298	0.1418
166	0.0043 ± 0.0064	0.0000 ± 0.0000	1.5044	0.1709
170	0.0043 ± 0.0059	0.0000 ± 0.0000	1.6330	0.1411
175	0.0034 ± 0.0047	0.0017 ± 0.0039	0.6325	0.5447
180	0.0051 ± 0.0076	0.0034 ± 0.0047	0.4196	0.6858

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.20
Pitfall trap data for <u>Lepthyphantes tenuis</u> (Blackwall). Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0203 ± 0.0094	0.0153 ± 0.0092	0.8479	0.4211
02	0.0042 ± 0.0095	0.0208 ± 0.0207	-1.6263	0.1425
06	0.0085 ± 0.0089	0.0063 ± 0.0140	0.3015	0.7708
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0111 ± 0.0057	0.0366 ± 0.0076	-6.0004	0.0003**
40	0.0114 ± 0.0046	0.0139 ± 0.0029	0.1826	0.8597
47	0.0180 ± 0.0172	0.0133 ± 0.0135	0.4797	0.6443
64	0.0041 ± 0.0014	0.0066 ± 0.0022	-2.1320	0.0656
74	0.0000 ± 0.0000	0.0026 ± 0.0024	-2.4495	0.0400 *
89	0.0000 ± 0.0000	0.0029 ± 0.0021	-3.1623	0.0134 *
103	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
125	0.0004 ± 0.0009	0.0016 ± 0.0016	-1.4140	0.1951
135	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
145	0.0034 ± 0.0056	0.0017 ± 0.0024	0.6291	0.5468
160	0.0052 ± 0.0047	0.0017 ± 0.0039	1.2649	0.2451
166	0.0014 ± 0.0032	0.0029 ± 0.0039	-0.6325	0.5447
170	0.0021 ± 0.0048	0.0021 ± 0.0048	0.0000	1.0000
175	0.0017 ± 0.0039	0.0051 ± 0.0076	-0.8913	0.3988
180	0.0034 ± 0.0076	0.0017 ± 0.0039	0.4409	0.6710

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.21
Pitfall trap data for <u>Meioneta rurestris</u> (C.L.Koch). Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0218 ± 0.0158	0.0202 ± 0.0127	0.1723	0.8675
02	0.0042 ± 0.0095	0.0293 ± 0.0111	-3.8428	0.0049**
06	0.0021 ± 0.0048	0.0000 ± 0.0000	1.0000	0.3466
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0060 ± 0.0024	0.0333 ± 0.0118	-5.0695	0.0010**
40	0.0009 ± 0.0013	0.0027 ± 0.0025	-1.4638	0.1814
47	0.0061 ± 0.0086	0.0049 ± 0.0051	0.2594	0.8019
64	0.0015 ± 0.0023	0.0051 ± 0.0047	-1.4981	0.1725
74	0.0034 ± 0.0047	0.0069 ± 0.0049	-1.1285	0.2918
89	0.0029 ± 0.0021	0.0046 ± 0.0033	-0.9951	0.3488
103	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
125	0.0047 ± 0.0054	0.0039 ± 0.0067	0.2126	0.8370
135	0.0051 ± 0.0056	0.0043 ± 0.0000	0.3371	0.7447
145	0.0269 ± 0.0086	0.0356 ± 0.0152	-1.1234	0.2939
160	0.0311 ± 0.0270	0.0470 ± 0.0277	-0.9141	0.3874
166	0.0197 ± 0.0124	0.0348 ± 0.0047	-2.5464	0.0344 *
170	0.0352 ± 0.0169	0.0539 ± 0.0351	-1.0744	0.3140
175	0.0136 ± 0.0046	0.0300 ± 0.0123	-2.7838	0.0238 *
180	0.0203 ± 0.0094	0.0331 ± 0.0187	-1.3666	0.2089

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.22
Pitfall trap data for total Linyphiinae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0504 ± 0.0209	0.0379 ± 0.0186	0.9963	0.3483
02	0.0125 ± 0.0186	0.0594 ± 0.0370	-2.5344	0.0350 *
06	0.0127 ± 0.0116	0.0063 ± 0.0140	0.7903	0.4522
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0269 ± 0.0046	0.0788 ± 0.0215	-5.2682	0.0008**
40	0.0165 ± 0.0074	0.0113 ± 0.0041	1.3877	0.2027
47	0.0308 ± 0.0194	0.0216 ± 0.0141	0.8565	0.4166
64	0.0086 ± 0.0049	0.0165 ± 0.0066	-2.1439	0.0644
74	0.0034 ± 0.0047	0.0102 ± 0.0065	-1.9040	0.0934
89	0.0029 ± 0.0021	0.0075 ± 0.0038	-2.3679	0.0454 *
103	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
125	0.0051 ± 0.0052	0.0066 ± 0.0104	-0.2854	0.7826
135	0.0051 ± 0.0056	0.0043 ± 0.0000	0.3371	0.7447
145	0.0326 ± 0.0053	0.0396 ± 0.0151	-0.9811	0.3553
160	0.0455 ± 0.0261	0.0535 ± 0.0204	-0.5382	0.6051
166	0.0250 ± 0.0172	0.0374 ± 0.0076	-1.4703	0.1797
170	0.0431 ± 0.0163	0.0557 ± 0.0358	-0.7173	0.4936
175	0.0186 ± 0.0070	0.0366 ± 0.0072	-4.0018	0.0039**
180	0.0283 ± 0.0159	0.0380 ± 0.0155	-0.9732	0.3590

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.23
Pitfall trap data for total Linyphiidae.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0755 ± 0.0283	0.0705 ± 0.0390	0.2322	0.8222
02	0.0125 ± 0.0186	0.0671 ± 0.0336	-3.1788	0.0130 *
06	0.0229 ± 0.0184	0.0105 ± 0.0149	1.1729	0.2746
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0396 ± 0.0139	0.1120 ± 0.0256	-5.5483	0.0005**
40	0.0287 ± 0.0062	0.0300 ± 0.0065	-0.3183	0.7584
47	0.0573 ± 0.0272	0.0491 ± 0.0122	0.6188	0.5532
64	0.0136 ± 0.0067	0.0397 ± 0.0185	-2.9687	0.0179 *
74	0.0094 ± 0.0036	0.0236 ± 0.0103	-2.8942	0.0201 *
89	0.0097 ± 0.0038	0.0215 ± 0.0032	-5.3463	0.0007**
103	0.0049 ± 0.0056	0.0043 ± 0.0035	0.1978	0.8482
125	0.0170 ± 0.0083	0.0513 ± 0.0389	-1.9290	0.0899
135	0.0357 ± 0.0087	0.0452 ± 0.0088	-1.7196	0.1238
145	0.1950 ± 0.0309	0.2003 ± 0.0248	-0.2966	0.7743
160	0.2481 ± 0.0492	0.2183 ± 0.0917	0.6399	0.5401
166	0.1651 ± 0.0668	0.1857 ± 0.0759	-0.4544	0.6617
170	0.2332 ± 0.0503	0.2218 ± 0.0722	0.2904	0.7789
175	0.1565 ± 0.0267	0.1814 ± 0.0229	-1.5787	0.1531
180	0.1661 ± 0.0254	0.1772 ± 0.0354	-0.5703	0.5841

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.24
Pitfall trap data for total Acari.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0451 ± 0.0324	0.0169 ± 0.0132	1.8041	0.1089
02	0.0328 ± 0.0269	0.0568 ± 0.0086	-1.9038	0.0934
06	0.0106 ± 0.0106	0.0168 ± 0.0174	-0.6744	0.5191
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0404 ± 0.0156	0.0651 ± 0.0308	-1.6030	0.1476
40	0.0277 ± 0.0156	0.0240 ± 0.0058	0.4938	0.6348
47	0.1113 ± 0.0553	0.0839 ± 0.0384	0.9080	0.3904
64	0.0338 ± 0.0084	0.0674 ± 0.0398	-1.8473	0.1019
74	0.0236 ± 0.0090	0.0242 ± 0.0184	-0.0676	0.9477
89	0.0114 ± 0.0052	0.0108 ± 0.0064	0.1566	0.8795
103	0.0068 ± 0.0040	0.0019 ± 0.0028	2.2674	0.0531
125	0.0181 ± 0.0079	0.0153 ± 0.0138	0.3884	0.7079
135	0.0086 ± 0.0030	0.0111 ± 0.0048	-0.9915	0.3505
145	0.0136 ± 0.0069	0.0195 ± 0.0070	-1.3340	0.2189
160	0.0235 ± 0.0108	0.0185 ± 0.0135	0.6512	0.5332
166	0.0263 ± 0.0205	0.0224 ± 0.0148	0.3468	0.7377
170	0.0425 ± 0.0300	0.0232 ± 0.0086	1.3851	0.2034
175	0.0052 ± 0.0047	0.0034 ± 0.0047	0.5774	0.5796
180	0.0068 ± 0.0071	0.0034 ± 0.0047	0.8902	0.3993

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.25
Pitfall trap data for total Collembola.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.0386 ± 0.0352	0.0219 ± 0.0127	1.0014	0.3460
02	0.0708 ± 0.0338	0.0702 ± 0.0423	0.0256	0.9802
06	0.0000 ± 0.0000	0.0121 ± 0.0272	-1.0000	0.3466
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.0603 ± 0.0348	0.0436 ± 0.0146	0.9910	0.3507
40	0.0131 ± 0.0055	0.0100 ± 0.0034	1.0773	0.3128
47	0.0061 ± 0.0061	0.0061 ± 0.0061	0.0000	1.0000
64	0.0146 ± 0.0048	0.0150 ± 0.0110	-0.0746	0.9424
74	0.0168 ± 0.0145	0.0110 ± 0.0102	0.7291	0.4867
89	0.0108 ± 0.0110	0.0114 ± 0.0069	-0.1035	0.9201
103	0.0000 ± 0.0000	0.0005 ± 0.0010	-1.0000	0.3466
125	0.0090 ± 0.0047	0.0169 ± 0.0229	-0.7609	0.4685
135	0.0260 ± 0.0088	0.0317 ± 0.0097	-0.9661	0.3623
145	0.1857 ± 0.0371	0.1416 ± 0.0604	1.3923	0.2013
160	0.1507 ± 0.0197	0.1533 ± 0.0640	-0.0868	0.9330
166	0.1744 ± 0.0707	0.2348 ± 0.1108	-1.0275	0.3343
170	0.2222 ± 0.0450	0.1830 ± 0.0581	1.1920	0.2674
175	0.3613 ± 0.0626	0.4080 ± 0.0690	-1.1211	0.2948
180	0.3115 ± 0.1831	0.4230 ± 0.1396	-1.0832	0.3103

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.26
Pitfall trap data for total Diptera.
Comparison of, log(n+1) transformed, no./trap/day values for treated and untreated areas.

Days +or-	Mean no./trap/day log(n+1) with SD Treatment	Control	t-stat	Sig.Level
00	0.2062 ± 0.0492	0.2452 ± 0.0596	-1.1275	0.2922
02	0.0908 ± 0.0532	0.2436 ± 0.0458	-4.8679	0.0012**
06	0.1008 ± 0.0379	0.1709 ± 0.0733	-1.8981	0.0943
11	0.0000 ± 0.0000	0.0000 ± 0.0000	1.0000	0.3466
21	0.1522 ± 0.0626	0.2031 ± 0.0538	-1.3796	0.2050
40	0.0214 ± 0.0063	0.0257 ± 0.0218	-0.4298	0.6787
47	0.0276 ± 0.0090	0.0252 ± 0.0112	0.3737	0.7183
64	0.0151 ± 0.0053	0.0155 ± 0.0066	-0.1221	0.9059
74	0.0160 ± 0.0131	0.0103 ± 0.0048	0.9262	0.3814
89	0.0102 ± 0.0101	0.0097 ± 0.0032	0.1012	0.9219
103	0.0005 ± 0.0010	0.0000 ± 0.0000	1.0000	0.3466
125	0.0121 ± 0.0029	0.0211 ± 0.0109	-1.7893	0.1114
135	0.0244 ± 0.0084	0.0161 ± 0.0054	1.8473	0.1019
145	0.0724 ± 0.0145	0.0595 ± 0.0221	1.0937	0.3059
160	0.1467 ± 0.0570	0.0935 ± 0.0381	1.7345	0.1211
166	0.1011 ± 0.0482	0.0483 ± 0.0308	2.0628	0.0731
170	0.1176 ± 0.0386	0.1011 ± 0.0314	0.7381	0.4816
175	0.0517 ± 0.0265	0.0613 ± 0.0126	-0.7345	0.4836
180	0.0583 ± 0.0126	0.0678 ± 0.0347	-0.5773	0.5796

N.B. * and ** indicate significant differences at $p<0.05$ and $p<0.01$ respectively (t-test).

Appendix 5.27
Table of dates associated with days relative to treatment for the autumn 1987 deltamethrin field trial.

DAYS	DATE
00	05-11-87
02	07-11-87
06	11-11-87
11	16-11-87
21	26-11-87
40	15-12-87
47	22-12-87
64	08-01-88
74	18-01-88
89	02-02-88
103	16-02-88
125	09-03-88
135	19-03-88
145	29-03-88
160	13-04-88
166	19-04-88
170	23-04-88
175	28-04-88
180	03-05-88

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