REBECA

Wageningen Macrobials Workshop, April 2006

Methods for Environmental Risk Assessment

Establishment: the predictive power of laboratory data

Jeff Bale, University of Birmingham, UK

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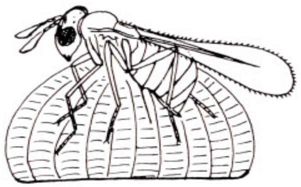
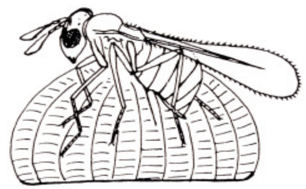


REBECA: Macrobials Objectives

- Consider mechanisms by which to produce a single regulatory system for macrobial agents encompassing different taxonomic groups and licensing situations

- Develop appropriate research methodologies to support the regulatory system

- Make recommendations for the implementation of a pan-European regulatory system for macrobial BCAs



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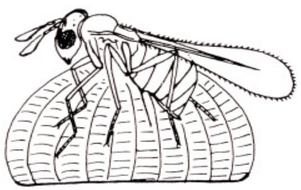
REBECA: Macrobials Deliverables

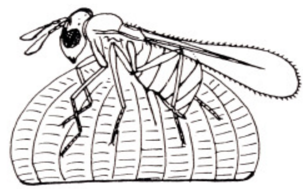
- Draft guidelines for a hierarchical regulatory system for macrobial BCAs
- Describe research methodologies to underpin proposed regulatory system for macrobial BCAs
- Agree criteria for inclusion of species of macrobial BCAs on a ‘Positive List’



REBECA: Macrobials Deliverables

(*continued*)

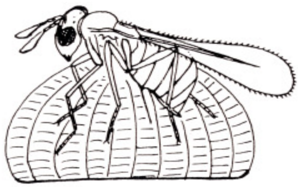
- Evaluate options for implementing a pan-European regulatory system for macrobial BCAs, including creation and terms of reference for an ‘Expert Group’ and its relationship to National Competent Authorities
- Propose a regulatory system and testing guidelines for macrobial BCAs based on retrospective case studies



Macrobial BCAs – Historical context

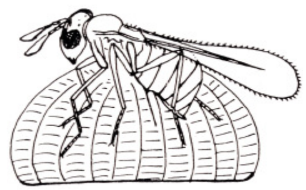
- Macrobial BCAs have been used in pest management for over 100 years
- "More than 5000 introductions of about 2000 species of exotic arthropods for control of arthropod pests in 196 countries or islands during the past 120 years have rarely resulted in negative environmental effects."
- "Yet, risks of environmental effects caused by releases of exotics are of growing concern. Twenty countries have implemented regulations for release of biological control agents."

Van Lenteren *et al.,* Ann. Rev. Ent. **51**, 2006



Macrobial BCAs – no problems?

- Is it realistic to propose that macrobial BCAs need no regulation? No
- Regulation in some EU countries is the responsibility of the 'Ministry of the Environment'
- Regulation in some countries involves routine consultation with NGOs - environmental agencies
- Establishment of non-native species *even without any adverse effects*, may be considered highly undesirable in some countries



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REBECA - realistic aim:

To develop a balanced regulatory system that minimizes the costs imposed on industry without compromising risks to human health or the environment

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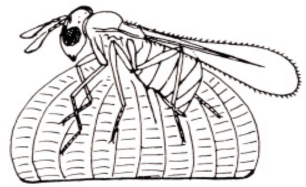
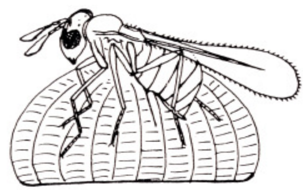


Balanced regulatory system

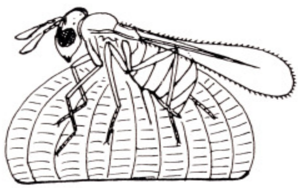
- Explicit guidelines on production of licence applications
- Agreement on guidelines across countries
- Clear statements about essential information and research methodologies
- Licensing requirements to be proportionate to risk with ‘hierarchical’ approach



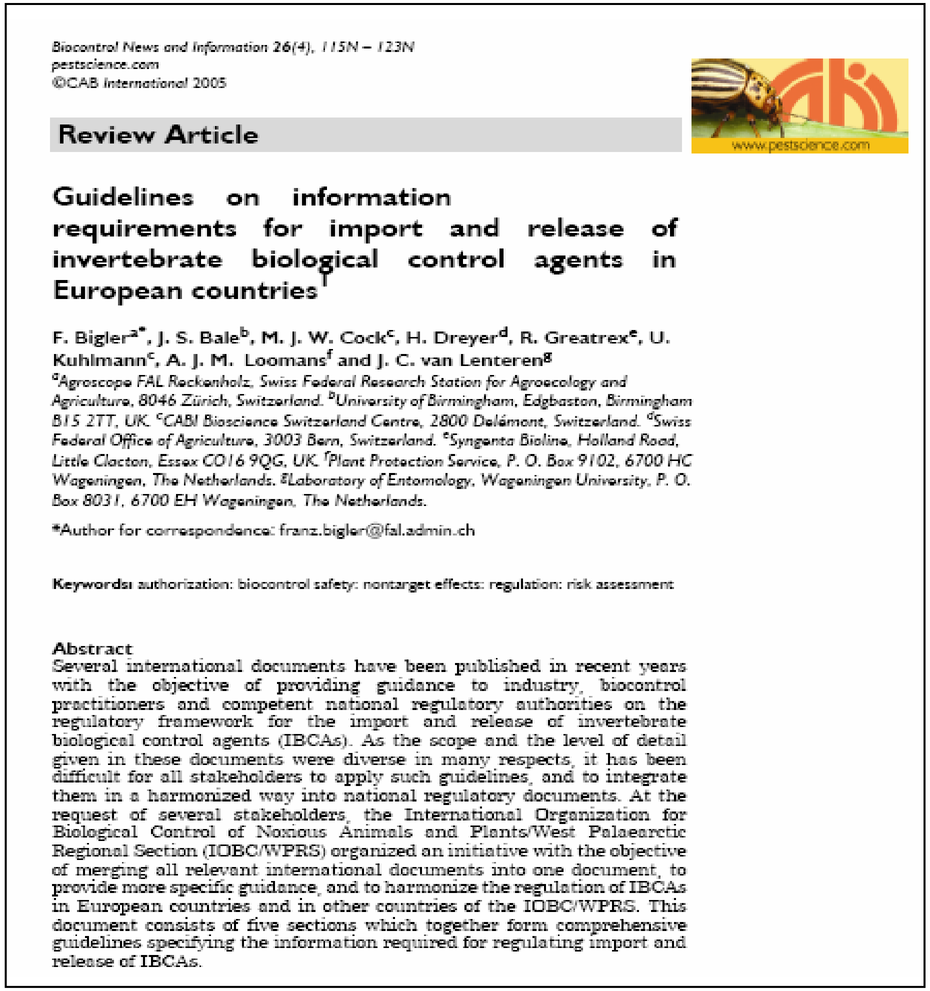
Balanced regulatory system

(*continued*)

- Recognition of previous ‘safe’ releases in other countries
- Creation of a ‘Positive List’
- Process to be ‘managed’ by an EU ‘Expert Group’, with powers devolved from National Competent Authorities



IOBC-WPRS initiative - CHIBCA



Biocontrol News and Information 26(4), 115N – 123N
pestscience.com

Review Article

Guidelines on information requirements for import and release of invertebrate biological control agents in European countries[1]

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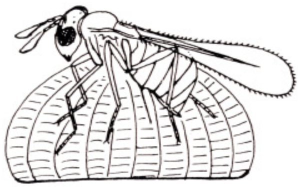
Keywords: authorization: biocontrol safety: nontarget effects: regulation: risk assessment

Abstract
Several international documents have been published in recent years with the objective of providing guidance to industry, biocontrol practitioners and competent national regulatory authorities on the regulatory framework for the import and release of invertebrate biological control agents (IBCAs). As the scope and the level of detail given in these documents were diverse in many respects, it has been difficult for all stakeholders to apply such guidelines, and to integrate them in a harmonized way into national regulatory documents. At the request of several stakeholders, the International Organization for Biological Control of Noxious Animals and Plants/West Palaearctic Regional Section (IOBC/WPRS) organized an initiative with the objective of merging all relevant international documents into one document, to provide more specific guidance, and to harmonize the regulation of IBCAs in European countries and in other countries of the IOBC/WPRS. This document consists of five sections which together form comprehensive guidelines specifying the information required for regulating import and release of IBCAs.

CHIBCA

- Commission on harmonisation of invertebrate biocontrol agents
- Merged previous documents of FAO, EPPO and OECD
- Guidelines produced by representatives of industry, regulatory bodies and science

See Bigler *et al.*, Biocontrol News and Information **26**, 2005



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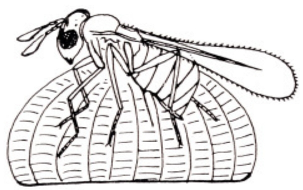
Environmental Risk Assessment (ERA) for macrobial BCAs

Environmental Risk Assessment should be:

- Quantifiable - environmental effects of different biological control agents can be compared and choices made
- Hierarchical - a tiered or step-wise procedure
- Provide quick identification of safe or hazardous agents with minimum costs



ERA for macrobial BCAs

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ASSESSING RISKS OF RELEASING EXOTIC BIOLOGICAL CONTROL AGENTS OF ARTHROPOD PESTS

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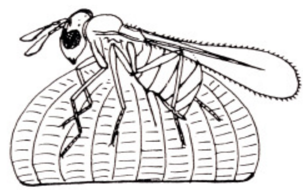
Key Words environmental risk assessment, host range, establishment, dispersal, nontarget effects

■ Abstract More than 5000 introductions of about 2000 species of exotic arthropod agents for control of arthropod pests in 196 countries or islands during the past 120 years rarely have resulted in negative environmental effects. Yet, risks of environmental effects caused by releases of exotics are of growing concern. Twenty countries have implemented regulations for release of biological control agents. Soon, the International Standard for Phytosanitary Measures (ISPM3) will become the standard for all biological control introductions worldwide, but this standard does not provide methods by which to assess environmental risks. This review summarizes documented nontarget effects and discusses the development and application of comprehensive and quick-scan environmental risk assessment methods.

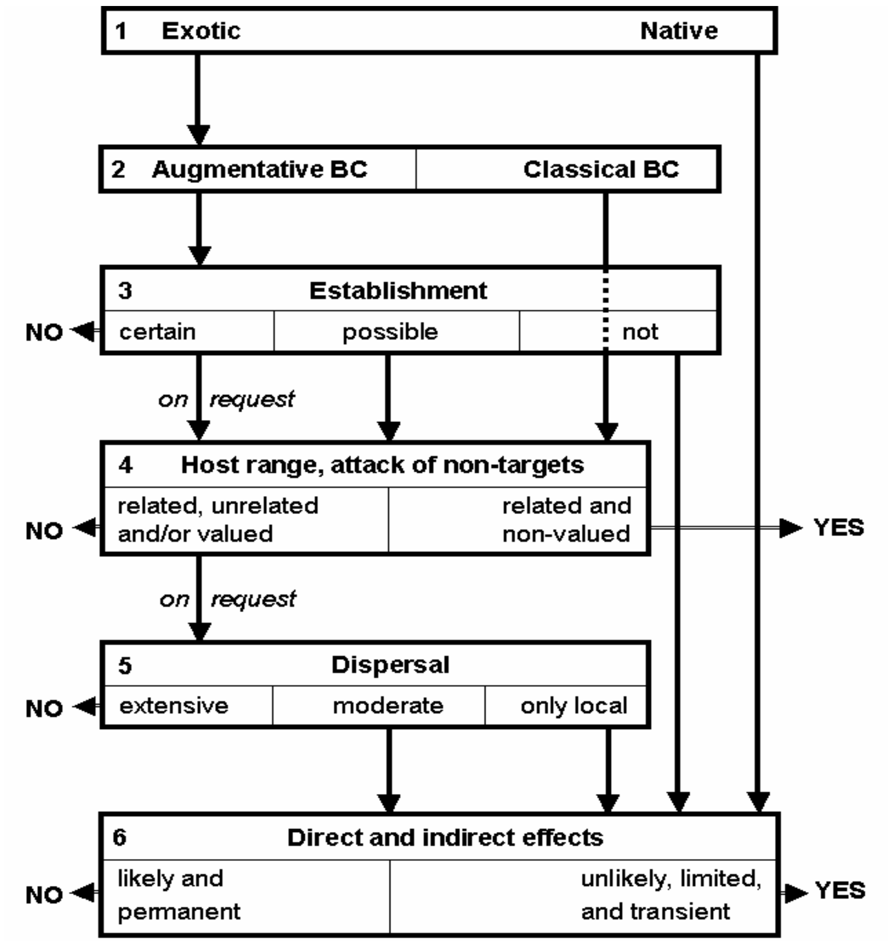
- Recent article in Annual Review of Entomology **51**, (2006) covers many issues relevant to ERA of macrobial agents

- Key recommendation is need for a step-wise (hierarchical) testing system

See Van Lenteren *et al.,* Ann. Rev. Ent. **51**, 2006



Generic hierarchical ERA



- Distinguishes between Exotic/Native, and Augmentative/Classical control
- Has 'Full' and 'Quick' Scan options
- Identifies key features of ERA:

  Establishment

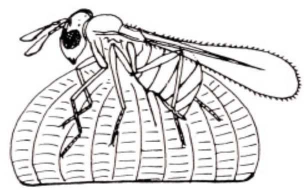
  Host range

  Dispersal

  Direct effects

  Indirect effects

See Van Lenteren *et al.,* Biocontrol **48**, 2003



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Identification of risks

1 Establishment in non-target habitats

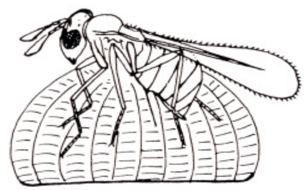
2 Host specificity: non-target host range

3 Dispersal into non-target habitats

4 Direct effects on non-target species

5 Indirect effects on non-target species

Factors 1-3 are intrinsic features of BCAs that determine scale of direct and indirect effects



REBECA Deliverables

Describe research methodologies to underpin proposed regulatory system for macrobial BCAs

- Main problem in all guidelines is distinction between *available* and *essential* information for ERA
- If information is essential but not available, it must be *generated* i.e. by research
- Simple but effective methods required for:

Establishment, Host Range and Dispersal

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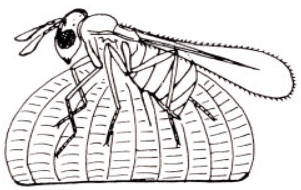


ERA methods: Establishment

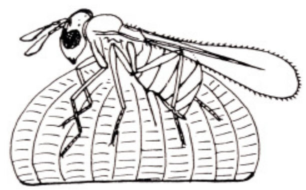
Paradox of Establishment

- Open field systems

Permanent establishment is the aim - extensive pre-release research on climate matching between collection and release sites, and on target and alternative prey

- Protected environments (glasshouses)

Expectation that escaping individuals will die out (in winter) with no disruption of native ecosystems



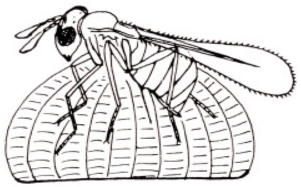
Unexpected establishment

Neoseiulus californicus

- First released in UK in 1991 as a control for glasshouse spider mite (*Tetranychus urticae*)
- Wild populations found close to release sites in 1998
- Effects on native species and ecosystem unknown

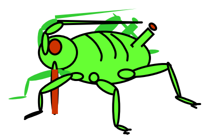
Macrolophus caliginosus

- First released in UK in 1995 as control against glasshouse whitefly (*Trialeurodes vaporariorum*)
- Regular occurrence outside of glasshouses in winter
- Effect on native species and ecosystem unknown



Factors affecting establishment of non-native glasshouse biocontrol agents in the UK

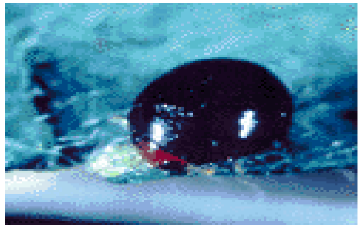
- Most species originate from tropical or Mediterranean climates
- Requires an adequate thermal budget (day-degrees) above the developmental threshold to allow development from egg to adult
- Must be able to produce an overwintering stage capable of survival at low temperature
- Must have alternative wild prey



REBECA

Establishment of non-native glasshouse biocontrol agents in the UK

Macrolophus caliginosus

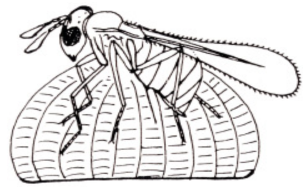


Delphastus catalinae

Typhlodromips montdorensis

Neoseiulus californicus

Eretmocerus eremicus



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Typhlodromips montdorensis

- Predatory mite - first described in New Caledonia
- Currently being tested as both an 'open field' and glasshouse biological control agent
- Feeds on thrips and other mites
- Licensed for release in UK in 2004

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Establishment of non-native glasshouse biocontrol agents in the UK

- Assessed multiple thermal indices for each species:

Developmental threshold

Annual voltinism

Lethal temperature

Acclimation response

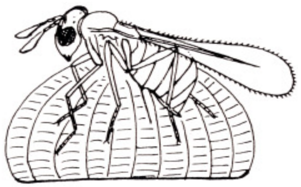
Day-degree requirement per generation

Freezing temperature

Lethal times

Ability to diapause

- Tested for correlation between laboratory indices and winter field survival



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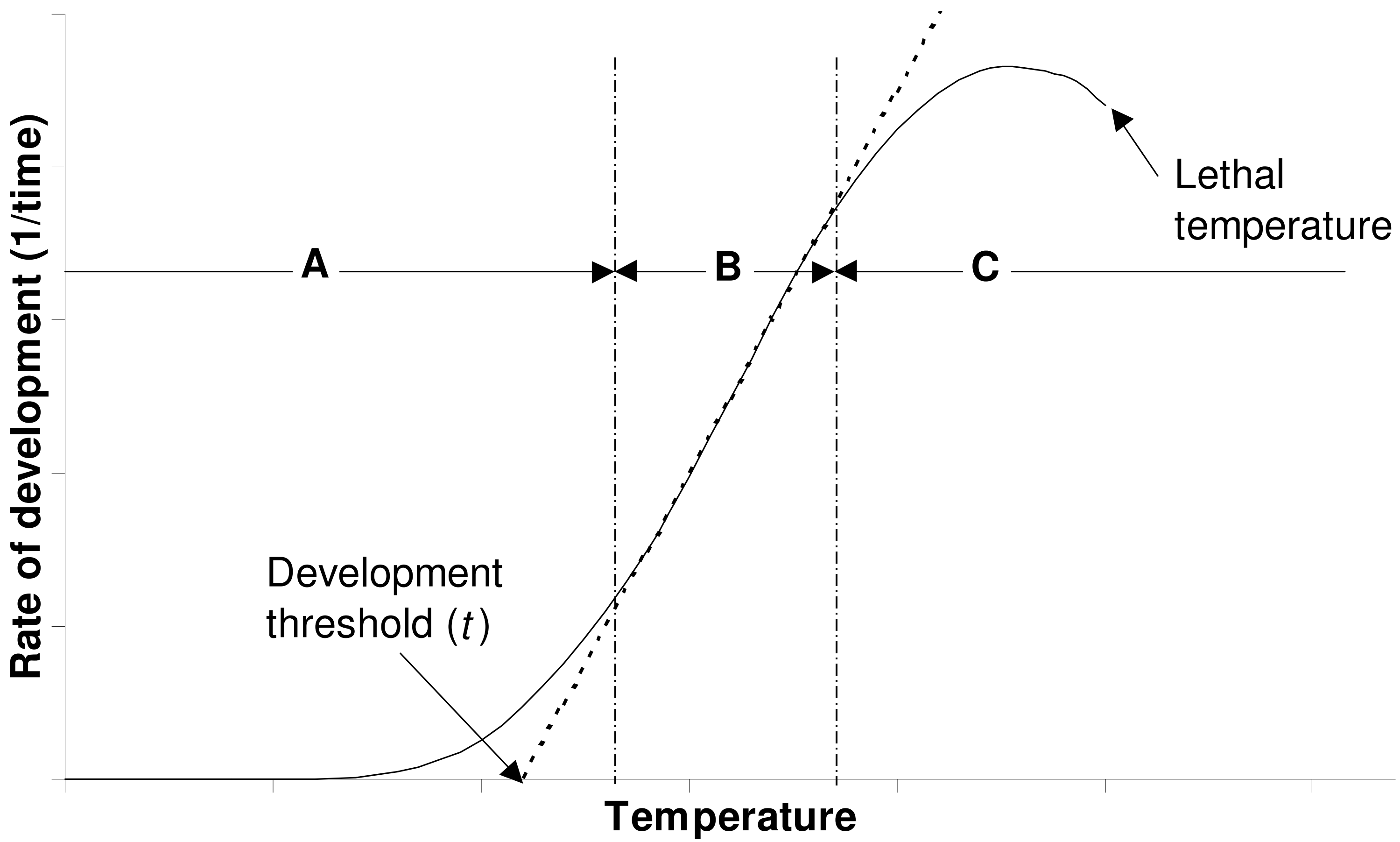
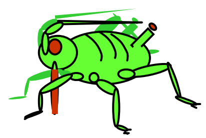
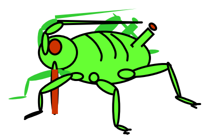
Schematic relationship between temperature and rate of development



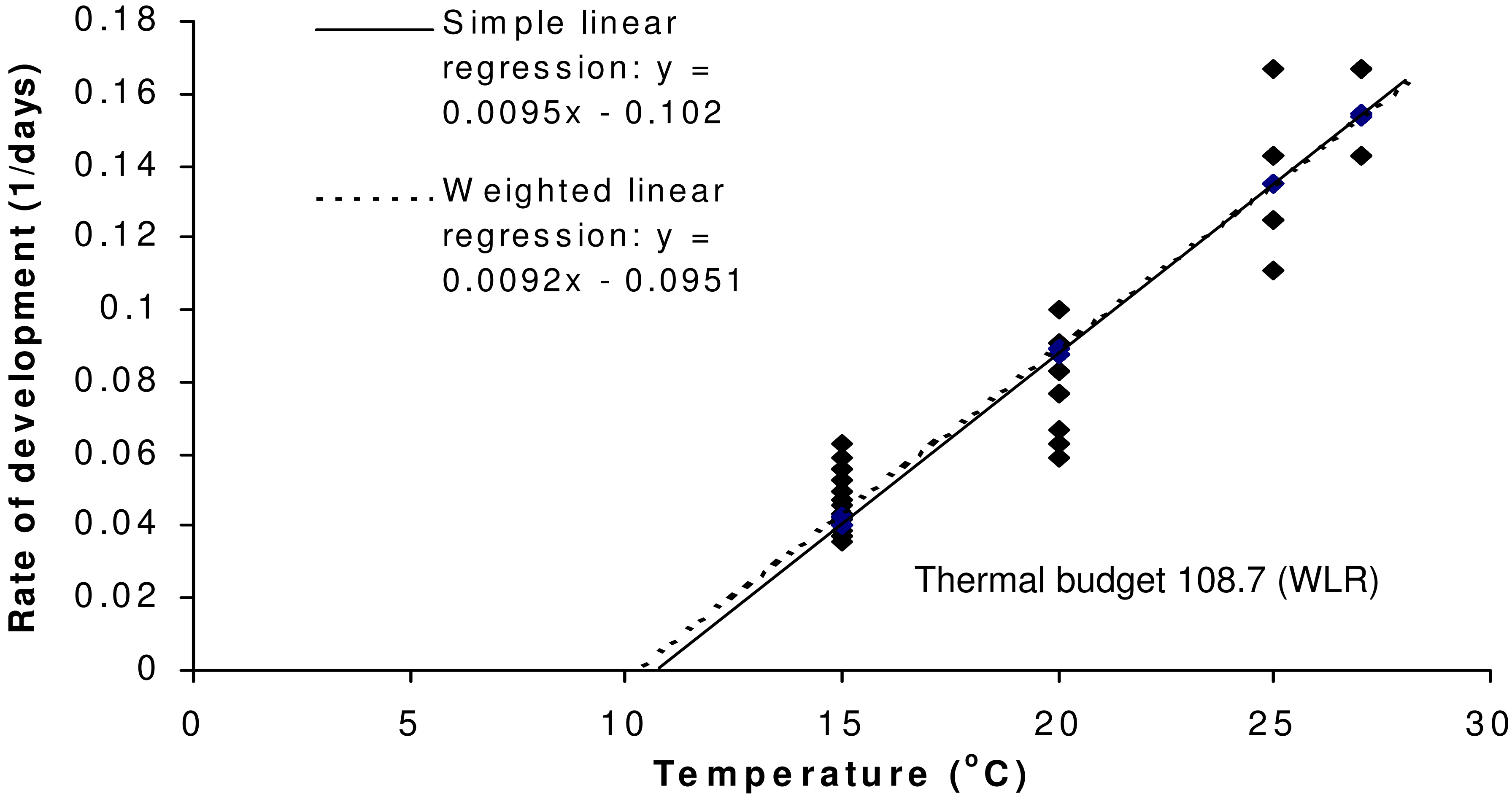


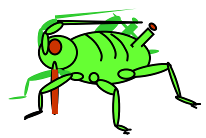
Effect of rearing temperature on development time (days ± standard error) of *Typhlodromips montdorensis*

Temperature (°C)	Egg hatch	Larvae	Protonymph	Deutonymph	Total time egg-adult
15	7.1 ± 0.22	2.9 ± 0.02	5.8 ± 0.07	6.3 ± 0.06	22.1 ± 0.6
20	4.5 ± 0.13	1.9 ± 0.13	3.6 ± 0.22	2.9 ± 0.16	12.9 ± 0.34
25	2.7 ± 0.09	0.9 ± 0.08	2.0 ± 0.14	1.9 ± 0.16	7.5 ± 0.16
27	2.4 ± 0.09	0.9 ± 0.07	1.5 ± 0.12	1.5 ± 0.12	6.3 ± 0.12
30	2.7 ± 0.09	0.9 ± 0.10	1.9 ± 0.13	2.5 ± 0.17	8.0 ± 0.24



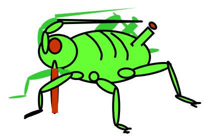
Effect of rearing temperature on rate of development of *Typhlodromips montdorensis*





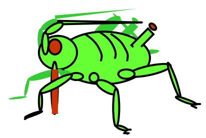
Estimated annual voltinism of *Typhlodromips montdorensis* in the UK

Year	Annual available day-degrees	Theoretical number of generations a year
1991	654.3	6.2 (6)
1992	650.7	6.2 (6)
1993	500.4	4.8 (4)
1994	626.3	6.0 (6)
1995	841.1	8.0 (8)
1996	617.1	5.9 (5)
1997	730.2	6.9 (6)
1998	621.5	5.9 (5)
1999	695.1	6.6 (6)
2000	638.8	6.1 (6)
Mean	657.55	6.3 (6)

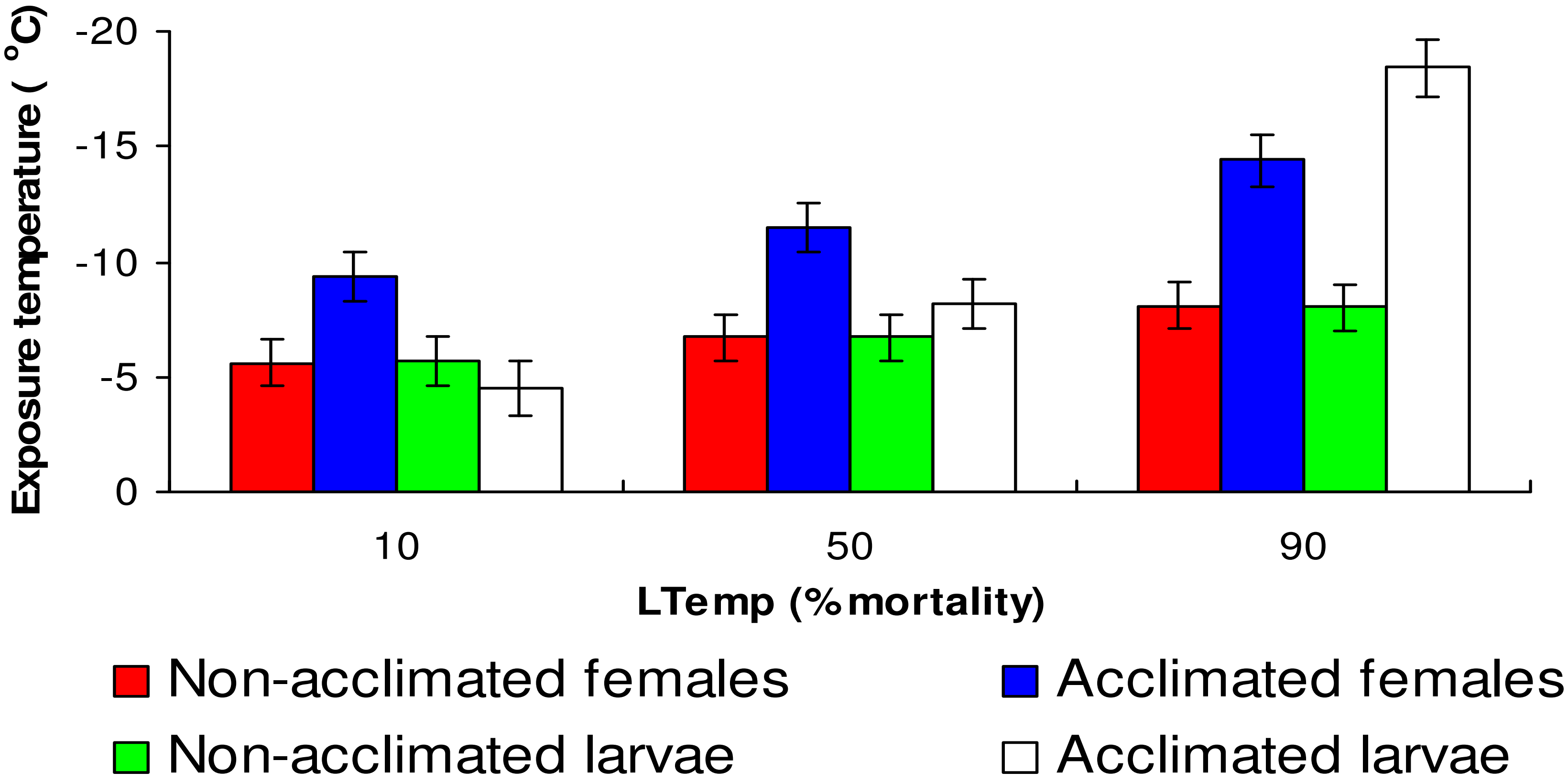


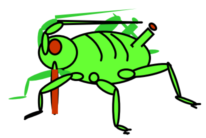
Mean ± SE (°C) and range of supercooling points of different acclimated and non-acclimated life-cycle stages of *Typhlodromips montdorensis*

Mite group	n	Mean ± SE (°C)	Range (°C)
Non-acclimated females	20	-24.1 ± 0.61	-19.7 to -28.2
Acclimated females	20	-22.4 ± 0.48	-20.5 to -25.9
Non-acclimated larvae	20	-24.3 ± 0.38	-21.4 to -28.2
Acclimated larvae	20	-22.6 ± 0.26	-20.8 to -24.6

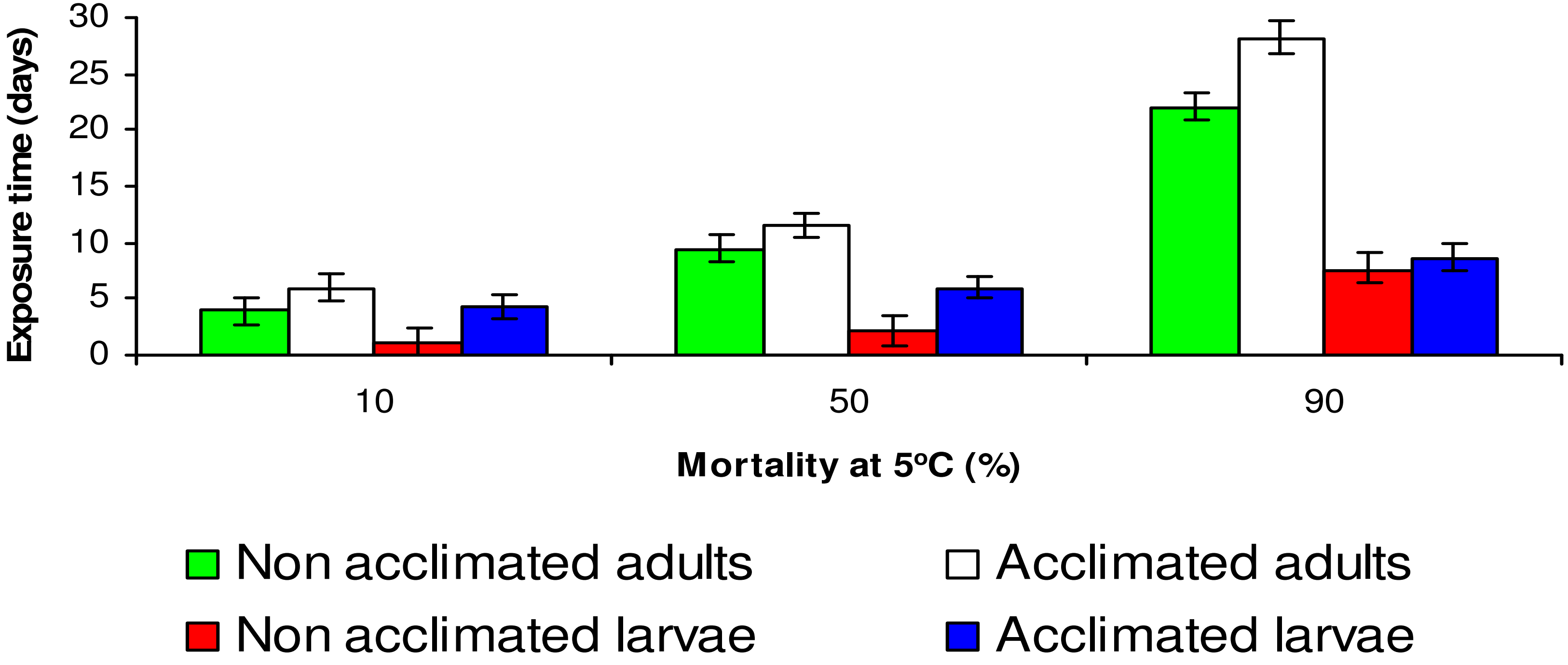


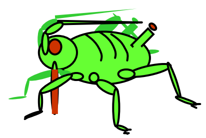
Lethal temperatures (10, 50 and 90%) of different acclimated and non-acclimated life-cycle stages of *Typhlodromips montdorensis*



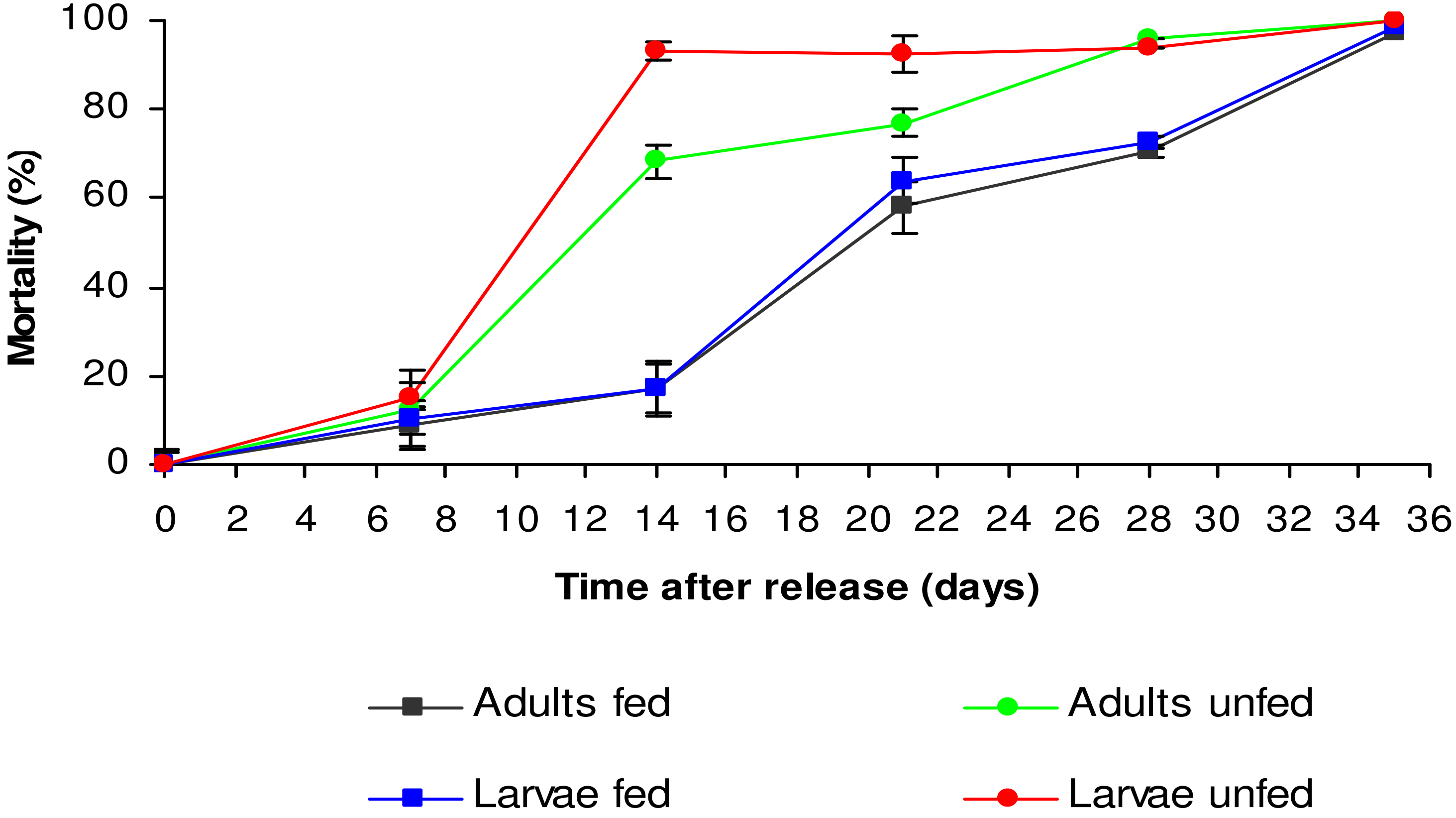


Lethal times (10, 50 and 90%) of different life-cycle stages of *Typhlodromips montdorensis* at 5°C

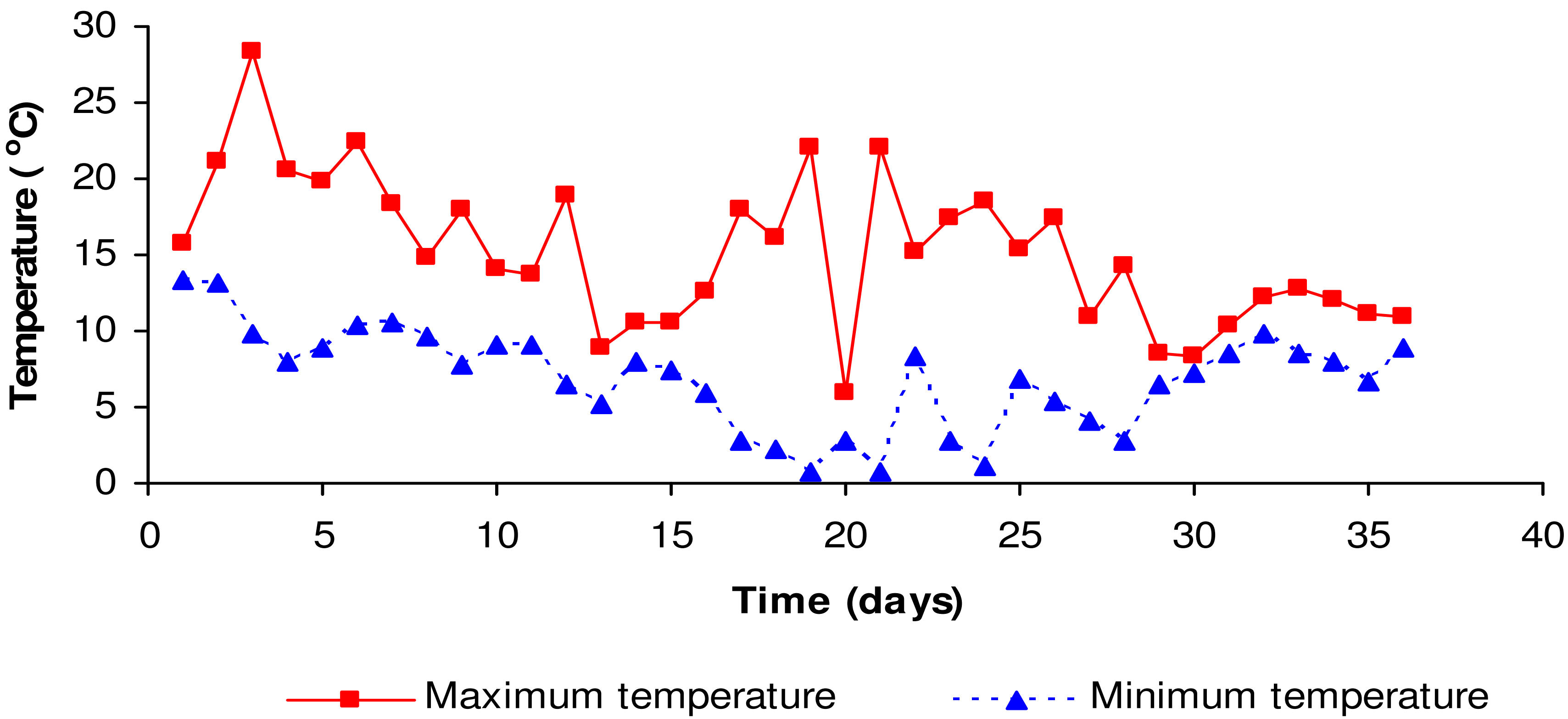




Mortality of non-acclimated nymphal and adult *Typhlodromips montdorensis* with and without spider mite prey in winter

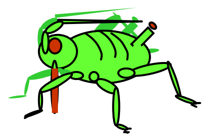


Maximum and minimum microclimate temperatures during *Typhlodromips montdorensis* winter field exposure



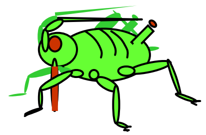
Ecophysiological data for *Neoseiulus californicus* and *Typhlodromips montdorensis* as part of a risk assessment protocol: rate of development

	N. californicus	*T. montdorensis*
Developmental threshold (°C)	8.6	10.3
Thermal budget (DD)	142.9	108.7
Mean annual voltinism	7	6
Development in winter	Yes	No



Ecophysiological data for *Neoseiulus californicus* and *Typhlodromips montdorensis* as part of a risk assessment protocol: cold tolerance

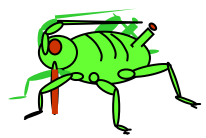
	N. californicus	*T. montdorensis*
Mean SCP ± SE (°C)		
Acclimated female	-22.2 ± 0.4	-22.4 ± 0.5
Non-acclimated female	-21.6 ± 0.3	-24.1 ± 0.6
$LTemp_{50}$ ± 95% fiducial limits (°C)		
Acclimated female	**-17.7 ± 0.3**	**-11.5 ± 1.0**
Non-acclimated female	**-13.9 ± 0.3**	**-6.7 ± 1.1**
$LTime_{50}$ ± 95% fiducial limits (days at 5°C)		
Acclimated female	**65.4 ± 2.5**	**11.6 ± 1.1**
Non-acclimated female	**38.6 ± 1.9**	**9.5 ± 1.1**



Ecophysiological data for *Neoseiulus californicus* and *Typhlodromips montdorensis* as part of a risk assessment protocol: winter field survival

	N. californicus	*T. montdorensis*
Maximum survival time (days)		
Without prey	**100**	**35**
With prey	**112***	**35**
Reproduction in winter	Yes	No
Ability to diapause[+]	No	No

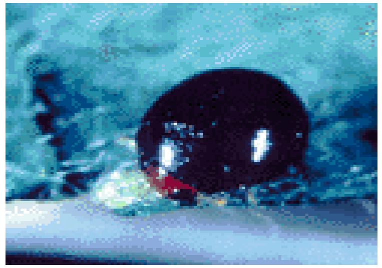
*10% still alive after 112 days
[+]Refers to tested strain



Establishment of non-native glasshouse biocontrol agents in the UK

Macrolophus caliginosus

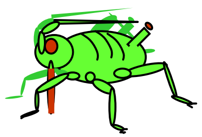
Typhlodromips montdorensis



Delphastus catalinae

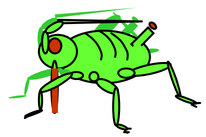
Neoseiulus californicus

Eretmocerus eremicus



Comparative thermal data of non-native glasshouse biocontrol agents in the UK

Species	SCP	LTemp (℃)	LTime (days at 5℃)	Winter survival
D. catalinae	-19.5	-16.3	32	1 month
E. eremicus	-20.8	-20.5	14	1 month
M. caliginosus	-19.7	-15.6	47	> 6 months
N. californicus	-22.2	-17.7	63	3 months
T. montdorensis	-24.1	-6.7	9.5	1 month



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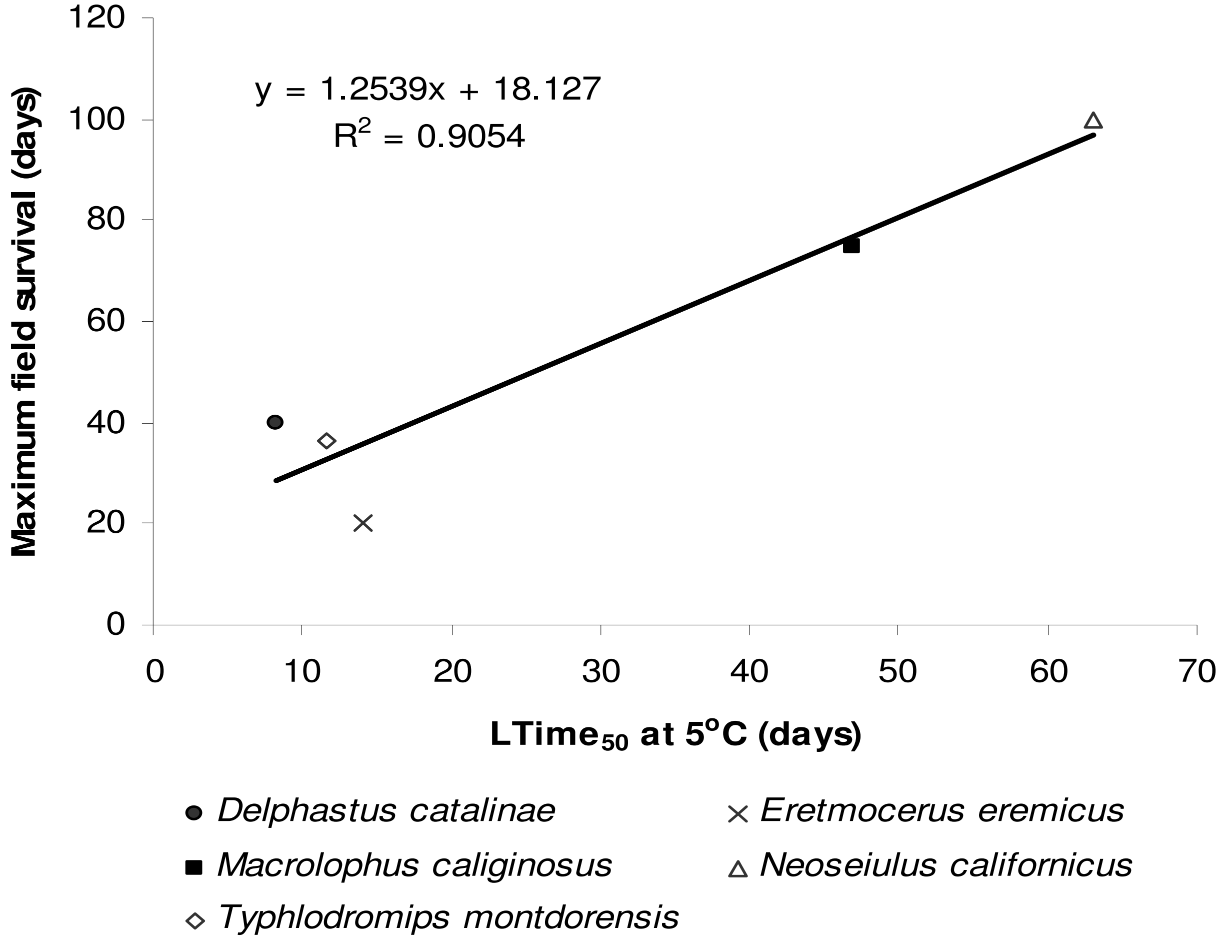
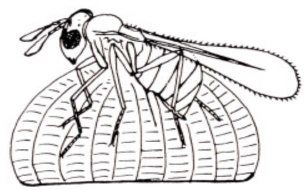
Relationship between LTime50 at 5℃ (laboratory) and winter field survival of five non-native glasshouse biocontrol agents





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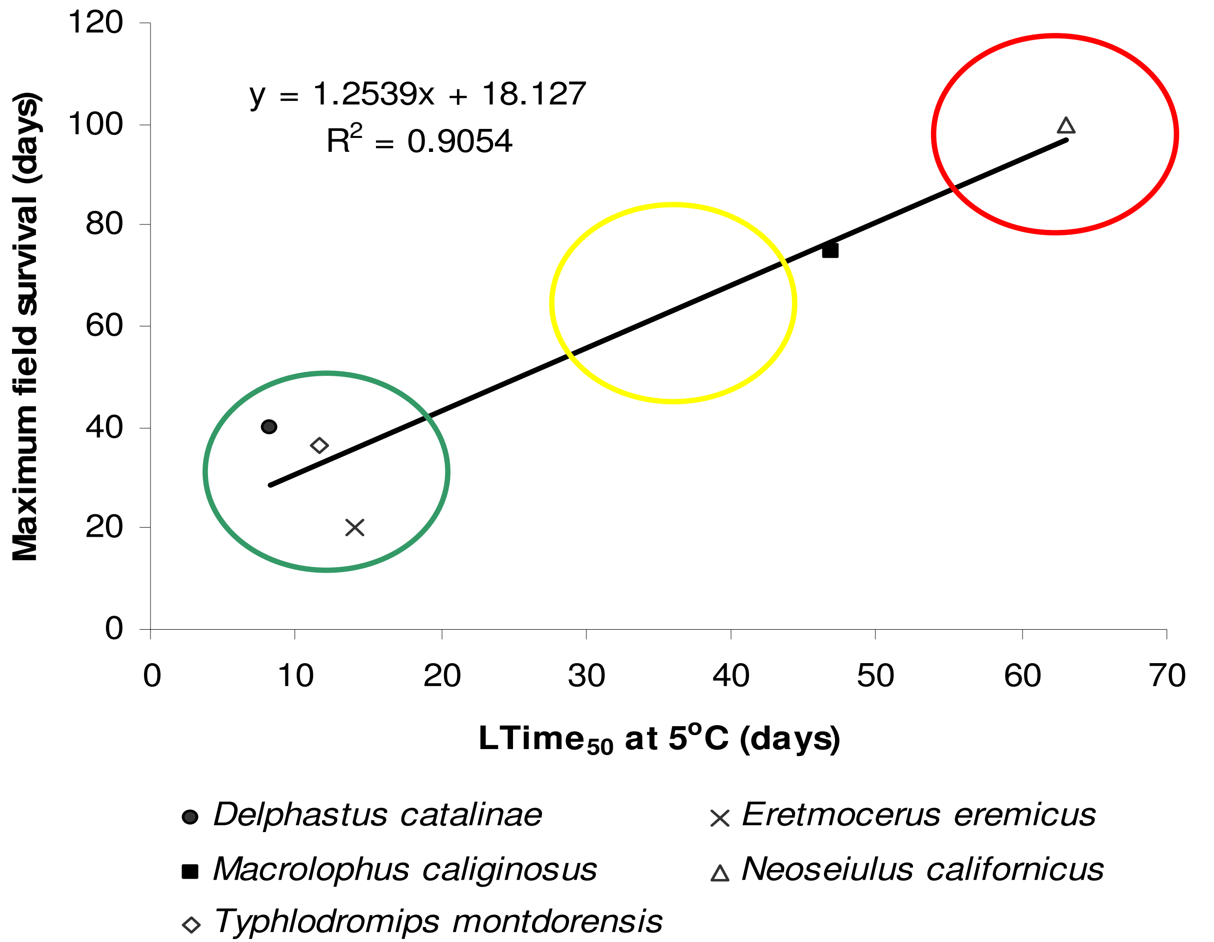
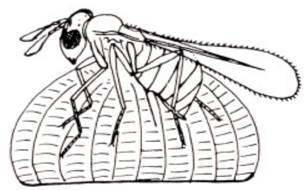
Relationship between LTime50 at 5℃ (laboratory) and winter field survival of five non-native glasshouse biocontrol agents





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Conclusions

- Strong correlation between laboratory - derived indices of cold tolerance and field survival
- System provides retrospective explanation for establishment of *N. californicus* in UK
- Identifies safe species for release
- Combining assessments of cold tolerance with availability and use of wild prey provides an effective screen for establishment potential of non - native IBCAs in UK and elsewhere in Europe