

Proposal to licence the release of augmentative arthropod biological control agents outside of glasshouses

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# Background

In England and Wales, under section 14 of the Wildlife and Countryside Act 1981, non-native animals [more precisely, animals of a kind not ordinarily resident in the wild in GB, or which are listed on schedule 9 to the Act] are not allowed to be released into the environment (including in glasshouses) (WCA, 1981). An option exists, under the same Act, to issue licences for the release of otherwise prohibited biological control agents (BCAs) to control plant pests and weeds (WCA, 1981). These licences can be issued for either classical biological control agents or augmentative biological control agents. Classical agents are those which are introduced with the intention that they become established in the environment to control a pest in the long term. Augmentative agents, on the other hand, are not expected to establish in the environment and need to be periodically re-introduced into crops to control a pest(s).

Defra currently licenses the release of certain non-native augmentative arthropod biological control agents in glasshouses, but they do not allow their release in other protected structures or outdoors. The one exception to this is the mite *Amblyseius swirskii*, which has recently been licensed for use in polytunnels. The augmentative arthropod biological control agents that Defra currently licence are shown in table 1.

**Table 1.** Augmentative arthropod biological control agents licensed by Defra.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Species | Family | Organism type | Target pest group(s) | Target crop(s) |
| *Amblydromalus limonicus* | Phytoseiidae | Predatory mite | Thrips, whitefly | Many protected crops, including tomato, sweet pepper, cucumber, and strawberry |
| *Amblyseius degenerans* | Phytoseiidae | Predatory mite | Thrips | Fruit crops, such as sweet pepper and aubergine |
| *Amblyseius* (*Transeius*) *montdorensis* | Phytoseiidae | Predatory mite | Thrips (*Frankliniella occidentalis*) and whitefly (*Aleyrodes* spp., *Bemisia tabaci*, *Trialeruodes* spp.) | Vegetable, fruit and ornamental crops under protection |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Amblyseius swirskii* (now approved for polytunnel release)** | Phytoseiidae | Predatory mite | Thrips (*Frankliniella occidentalis*) and whitefly (*Bemisia tabaci*, *Trialeruodes* *vaporariorum*) | Fruit and ornamental crops, including tomato, sweet pepper, cucumber, strawberry, rose, and poinsettia |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Delphastus catalinae* | Coccinellidae | Predatory beetle | Whitefly (*Bemisia tabaci*, *Trialeurodes vaporariorum*) | Crops under protection, including cucumber, tomato, aubergine, sweet pepper and ornamentals |
| *Eretmocerus eremicus* | Aphelinidae | Parasitoid wasp | Whitefly (*Bemisia tabaci*) | Fruit and ornamental crops, including sweet pepper, aubergine, rose, and poinsettia |
| *Neoseiulus californicus* | Phytoseiidae | Predatory mite | Spider mites (Tetranychidae) | Vegetable, fruit and ornamental crops under protection |

Information from 65 countries worldwide provided by a representative in the International Biocontrol Manufacturers’ Association (IBMA) indicates that there is only one country (Austria) that restricts releases of biological control agents to glasshouses. There are also three other countries which have some restriction:

* Ireland, which restricts releases to a ‘confined area’
* Switzerland, which generally restricts releases to glasshouses, but will also allow releases in polytunnels if they are sufficiently covered
* Sweden, which in some cases restricts releases to glasshouses

In this report, we provide justification for removing the restriction to glasshouses in England and for allowing the release of augmentative arthropod biological control agents under all protected conditions.

# Justification

## There is a similar risk to glasshouses

Polytunnels and other protected structures represent a similar risk to glasshouses, into which releases of these agents are already licensed. Like polytunnels, glasshouses do not offer complete physical protection from escape. For example, escape can occur through open doors, vents, and any other openings, and on staff, equipment and plants. The same is true for polytunnels, but there is simply a greater potential for spread from the majority of these structures.

There are also some glasshouses which have retractable roofs and panes of glass that can be removed from the sides during the summer (see images below provided by Fargro). These are in effect as open as some polytunnels and, in some cases, more open. It is therefore disproportionate not to allow releases in polytunnels and other protected structures but allow them in glasshouses.

 

**Figure 2.** Glasshouse with a retractable roof, which leaves large openings (Fargro Ltd).

**Figure 1.** Glasshouse with panes of glass removed from the sides (Fargro Ltd).

## The biological control agents are unlikely to establish outdoors

When Defra, as part of the review process, assess whether to allow the release of an augmentative arthropod biological control agent (for use under protected conditions), they base it on the agent’s ability to establish in the UK. If it is very unlikely to establish, then Defra view it as safe to release as it will only have a transient impact if it was to escape. This would also be the case if Defra allowed a release of an agent into a polytunnel, as they have already assessed it as being safe and so even if it spreads outside of the polytunnel, it will not establish and any impact will be transient and limited.

The augmentative arthropod biological control agents under licence are unlikely to establish in the UK. The one exception is *Neoseiulus californicus*. There are reports that this mite has established in parts of the UK (Jolly, 2000), and Hart *et al.* (2002) has shown that non-diapausing strains of the mite could survive for over 3 months in winter under sheltered conditions and could oviposit. There is therefore a high risk that this mite could establish in the UK. If this mite had been assessed under Defra’s current regulatory processes, it is unlikely they would have permitted the release of this biological control agent.

A summary of the cold tolerance of the species currently under licence is provided in table 2.

**Table 2.** Cold tolerance of the augmentative arthropod biological control agents under licence.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Species | Ltime50 at 5°C | Max field survival | Risk of establishment | References |
| *Amblydromalus limonicus*  | 24 days | 48 days | Low-medium risk of establishment  | Internal Koppert report (2009) |
| *Amblyseius degenerans* | No data  | No data  | Limited data but may not be able to survive the UK winter (see 2.1.2).  | - |
| *Amblyseius montdorensis* | ~ 13 days | 14 days (mid and late winter), 36 days (early winter) | Low risk of establishment | Hatherly *et al.* (2003) |
| *Amblyseius swirskii* (now approved for polytunnel release) | ~ 4 days | 8 days | Low risk of establishment | Allen (2010) |
| *Delphastus catalinae* | ~ 40 days | ~ 35 days | Low risk of establishment | Bale and Walters (2002) |
| *Eretmocerus eremicus* | 13 days | ~ 35 days | Low risk of establishment | Bale and Walters (2002); Tullet *et al.* (2004) |
| *Neoseiulus californicus* | ~ 65 days | 112 days | High risk of establishment | Bale and Walters (2002) |

### Detailed cold tolerance data on the species currently under licence

* + 1. Amblydromalus limonicus

The natural habitat range of *Amblydromalus limonicus* is limited to areas with moderate temperatures and high relative humidities (RH) such as Australia, Hawaii, New Zealand and North, Central and South America (Knapp *et al.*, 2007). The only reports of established outdoor populations in Europe are from Catalonia, North Eastern Spain, despite the widespread use of the mite as a BCA across Europe (Escudero-Colomar and Chorąży, 2012 as cited by Nielsen *et al.*, 2020). These distribution data suggest that it would be unable to survive cold winters despite limited information on its tolerance in natural environments (Nielsen *et al.*, 2020). Its preferred conditions were investigated by Clymans *et al.* (2017) who carried out laboratory studies on several predatory mites, to establish whether they thrived in cool, moderate or warm regimes. *Amblydromalus limonicus* was most successful in the moderate regime which consisted of day temperatures of 18°C, night temperatures of 10°C, humidity of 70% during the day and 80% at night with a 12L:12D hour photoperiod - conditions designed to mimic late season polytunnel or table top production in Northern European countries (Belgian study). Under the cool regime (consisting of 12°C day and 8°C night, day humidity of 55% and 70% at night with a 8L:16D hour photoperiod), populations were significantly reduced, with a 50% reduction in numbers by 6 days.

In terms of developmental rates, preliminary tests carried out by Koppert found that *A. limonicus* can remain active at low temperatures, with 87% of *A. limonicus* eggs tested developing into adults after 22.5 days at 13°C (Koppert, unpublished as cited by Knapp *et al.*, 2007).However, in terms of oviposition, in this study it was found that females laid 0.8 eggs per day at this temperature, whilst work by McMurty and Scriven (1965) (as cited by Knapp *et al.*, 2007) found 0.1 eggs per day were laid at 10°C, showing a significant decrease in oviposition rates as temperatures decrease.

Further *in vitro* studies by Koppert (internal report, 2009) found that the Ltime50 of *A. limonicus* at 5°C is a maximum of 24 days which using modelling by Hatherly *et al.* (2005) equates to a maximum field survival in the UK of 48 days. From this it was concluded that *A. limonicus* could not survive outside glasshouses in the UK during the winter (Koppert, unpublished).

* + 1. Amblyseius degenerans

The natural distribution of A. degenerans is spread across North, Central and Southern Africa, and it is also present in parts of Asia and Europe including Greece, Italy and Turkey (Vantornhout, 2006). This distribution also suggests that the UK climate is likely to be unsuitable and that the mite is unlikely to be able to overwinter. Development studies by Tsoukanas et al. (2006) (as cited by Varntournhout, 2006) found that the lower developmental thresholds for eggs and immature stages ranged between 10-11.5°C, whereas larval stages could still develop at 7°C - although high humidity levels appear to be critical for survival. This species is also unable to enter diapause as a survival strategy.

Whilst this indicates some cold tolerance, the developmental studies by Clymans et al. (2017) found that the population was significantly reduced after 6 days in the cool regime (12°C day and 8°C night, day humidity of 55% and 70% at night with a 8L:16D hour photoperiod), indicating it is unlikely that populations of A. degenerans would be able to survive a UK winter.

* + 1. Amblyseius montdorensis

*Amblyseius montdorensis* is naturally found in Australia and Pacific Islands including Fiji, New Caledonia, Tahiti and Vanuatu (Moraes *et al.,* 2004). The species is particularly sensitive to low humidity with egg hatch falling below 10% when RH is under 60% (Steiner *et al.,* 2003). Studies have shown the species to have a developmental threshold temperature of between 10.3 and 10.7°C (Hatherley *et al.*, 2003).

Hatherley *et al.* (2003) suggest that the species could complete up to six generations a year outside but the same study estimated the Ltime50 of *A. montdorensis* at 5°C to be a maximum of 13 days equating to a maximum field survival in the UK of 36 days in early winter or 14 in mid or late winter. In follow up studies, all eggs of *A. montdorensis* died under field conditions within 7 days, with the minimum temperature recorded during the work as -1.9°C and the lowest mean temperature recorded as 3.7°C. This study also suggested that diapause was not a trait of *A. montdorensis* and so it is not an overwintering strategy for this species (Hatherley *et al.*, 2005b). It is therefore considered unlikely the mite could survive the winter outdoors in the UK.

* + 1. Amblyseius swirskii

*Amblyseius swirskii* is native to Israel, Italy, Cyprus, Turkey, Greece and Egypt and is found on a wide range of outdoor crops in this range (Doğramaci *et al.*, 2016). Given the mite is only found in a Mediterranean climate, it is unlikely that the climate of the UK would be conducive to the mite’s survival, particularly over winter.

Developmental studies by Lee and Gillespie (2011) found that the mites developed between 18 and 36°C at 60% RH, with no development being seen at 13°C but modelling suggested that the lower development threshold was 11.3°C. The lower threshold for population growth in this study was 15.49°C with an optimum temperature of 30.1°C. In the studies by Clymans *et al.* (2017), *A. swirskii* populations were significantly reduced after 6 days in the cooler regime and performed best at the warmest regime (25°C day and 12°C night, day humidity of 60% and 85% at night with a 16L:8D hour photoperiod).

Studies by Allen (2010) suggest the Ltime50 at 5°C of *A. swirskii* to be 4 days with a maximum field survival of 8 days. These data suggest the mite is unlikely to be able to overwinter, especially given it is unable to enter diapause as a strategy (Doğramaci *et al.*, 2016). Therefore, it is considered there is a low risk of *A. swirskii* being able to establish outdoors in the UK.

* + 1. Delphastus catalinae

*Delphastus catalinae* is a tropical species that is native to Colombia but found in Central and South America, Trinidad, Canary Islands, Hawaii, Southern California and Southern Florida (Simmons and Legaspi, 2004). This distribution does not suggest that the UK has a climatic suitability for establishment of the beetle.

Simmons and Legaspi (2004) carried out laboratory studies to determine the survival of *D. catalinae* when exposed to different temperatures. No beetles survived after 24 hours exposure to -10°C, under 1% survived at -5°C, around 30% survived at 0°C and over 90% survived at 5°C. Whilst the data suggest the beetle may be able to survive short exposure to low temperatures or relatively mild winters it also suggests that short exposures to temperatures at or below freezing are likely to have a large impact on survival.

Bale and Walters (2002) found that the Ltime50 at 5°C of *D. catalinae* is around 40 days with a maximum field survival of 35 days. Follow up studies by Simmons and Legaspi (2007) found that survival at 15°C was up to 9 months, whilst at 5°C survival was up to 16 days and eggs held at this temperature did not hatch, suggesting overwintering in the UK is very unlikely.

* + 1. Eretmocerus eremicus

*Eretmocerus emericus* is native to the south-western desert regions of California and Arizona in the USA (Luczynski *et al.*, 2007). The establishment potential of the BCA in Britain has been assessed by Tullett *et al.* (2004) who concluded that typical British winter temperatures would prevent establishment in the wild. The developmental thresholds calculated were between 6.1°C and 11.6°C with the day degrees required for one generation ranging between 256.3 at a thermal constant of 11.6°C and 366.8 at a thermal constant of 6.1°C. Cold tolerance was lacking with 50% mortality of larvae seen between 7 days at -5°C and 13 days at 5°C. In addition to this, field trials found that there were no surviving larvae after one month of naturally fluctuating winter temperatures (Tullet *et al.*, 2004).

Studies by Luczynski *et al.* (2007) focus on cold storage of *E. eremicus* as a BCA but echo these results with all fitness parameters measured in the study reducing with increased duration of cold storage.

Bale and Walters (2002) found that the Ltime50 at 5°C of *E. eremicus* is around 13 days with a maximum field survival of 35 days, and with this and the evidence from the other studies it is not very likely that *E. eremicus* could overwinter in the UK.

* + 1. Neoseiulus californicus

*Neoseiulus californicus* prefers warm temperatures (10-33°C) and natural populations of the mite are found in Argentina, Chile, Japan, Southern Europe, the USA and along the border of the Mediterranean. Despite preferring these warm temperatures, they can survive short exposures to colder temperatures, for instance surviving the winter in North Florida where temperatures can drop below freezing overnight (Rhodes *et al.*, 2015). There are also European reports of overwintering *N. californicus* surviving and expanding populations the following year, although this is in Southern France where the conditions may differ to the UK (Raworth *et al.*, 1994).

Whilst not directly comparable, survival studies looking at long term storage of *N. californicus* as a BCA by Ghazy *et al.* (2012) found that, even with constant high humidity in laboratory conditions, the entire population of unmated and mated females were wiped out at around 70 and 110 days respectively at 5°C. The mean survival times of these females was 45 and 63.1 days respectively.

Studies by Canlas *et al.* (2006) calculated the degree days required for development from egg to adult was 71.43 with a thermal constant of 10.64°C. Bale and Walters (2002) found that the Ltime50 at 5°C of *N. californicus* is around 65 days with a maximum field survival of 112 days. This information suggests that of all the BCAs discussed, *N. californicus* is the most likely to be able to overwinter and establish outdoors in the UK.

## The biological control agents under licence are widely used in Europe

The European and Mediterranean Plant Protection Organisation (EPPO) has produced a list of biological control agents widely used in the EPPO region (EPPO, 2016). The agents must fit the following criteria:

* A Biological control agent which is (or has been) commercially available, and is either
	+ indigenous and widespread in the EPPO region;
	+ established and widespread in the EPPO region; or
	+ has been used for at least 5 years in at least 5 EPPO countries (exceptionally less if crops are grown in few countries).

The criteria for a biological control agent to be added to the list will also require no reports of unacceptable adverse effects.

All the biological control agents under licence in England are on the EPPO list (see table 3 for the information included on this list).

**Table 3.** Summary information from the EPPO PM 6/3 List of biological control agents used in the EPPO region (EPPO, 2016).

|  |  |  |  |
| --- | --- | --- | --- |
| Species | Distribution in EPPO region | Date of first use | EPPO countries used |
| *Amblydromalus limonicus* | Established in north-east Spain | 2010 | Austria, Belgium, Denmark, England, Finland, France, Germany, Ireland, the Netherlands, Poland, Russia, Sweden and Ukraine, UK |
| *Amblyseius degenerans* | Mediterranean | 1993 | Belgium, Czechia, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Jersey, Netherlands, Norway, Poland, Spain, Switzerland, Tunisia, Turkey, UK |
| *Amblyseius* (*Transeius*) *montdorensis* | Unknown | 2004 | Belgium, Denmark, Finland, France, Germany, Greece, the Netherlands, Poland, Romania, Spain and UK |
| *Amblyseius swirskii* | East of Mediterranean region, naturally occurs in Israel, Italy, Cyprus, Greece and Egypt | 2005 | Austria, Belarus, Belgium, Denmark, Finland, France, Germany, Greece, Guernsey, Hungary, Italy, Jersey, Morocco, the Netherlands, Norway, Poland, Spain, Turkey, UK |
| *Delphastus catalinae* | Not established | 1993 | Belgium, Czechia, Denmark, Finland, France, Germany, Greece, Jordan, Netherlands, Poland, Russia, Spain, Tunisia, UK |
| *Eretmocerus eremicus* | Mediterranean | 1994 | Belgium, Czechia, Denmark, Finland, France, Germany, Greece, Guernsey, Hungary, Italy, Lithuania, Malta, Morocco, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Switzerland, Tunisia, Turkey, UK |
| *Neoseiulus californicus* | Mediterranean | 1985 | Belgium, Czechia, Denmark, Finland, France, Germany, Greece, Guernsey, Ireland, Italy, Jersey, Malta, Netherlands, Poland, Portugal, Spain, Switzerland, Tunisia, UK |

It should also be noted that supplier, distributor and grower licences for the biological agents state that should any negative impacts be identified, Defra should be informed. The Defra Risk and Horizon Scanning team have not received any reports of negative environmental impacts from the use of these agents. Although, low level impacts are unlikely to be picked up through the monitoring of suppliers, distributors and growers.

## Release of *Amblyseius swirskii* in polytunnels

Koppert carried out trial releases of the mite in strawberry polytunnels at three sites in England in 2019 and 2020 (Koppert, 2020). Samples of plant material were taken at two week intervals within the polytunnels, and at 3, 6 and 9 m from the polytunnels, following the release of the mite in the polytunnels. Most mites were found on plants within the polytunnels, and only a few individuals were found at the 3 m mark at two sites in 2019. Based on the minimal risk shown during these trials, licences allowing the release of the mite in polytunnels were issued to Koppert.

This is the first augmentative non-native arthropod biological control agent to be released in polytunnels in England.

# Potential risk

While there are glasshouses more open than some polytunnels, the majority of polytunnels will be more open than glasshouses. There is therefore an increased risk of biological control agents spreading from the polytunnels and having an impact on native fauna during the growing season through non-target attack and competition. It should also be noted that polytunnels are popular for some crops, such as strawberries, and may be greater than glasshouse production based on data from 2008 (Centre for Rural Research, 2008).

# Conclusion

Based on the justifications in this document, there is very little extra risk of allowing release of biological control agents in polytunnels or other protected structures.

Restricting biological control agents to glasshouses is also potentially prohibitive to horticultural production. Under the new regulation for approving pesticides (1107/2009), the approval of pesticides has switched from using risk based criteria to using hazard based criteria (Reg. 1107/2009, 2009). These criteria are far more restrictive and have meant that fewer pesticides have been approved over the last decade, reducing the chemical control options available in horticultural situations (though more are available under protection than outside). The Sustainable Use Directive 2009/128/EC and, subsequently, the Plant Protection Products (Sustainable Use) Regulations 2012, have also encouraged the use of integrated crop management and measures to protect our aquatic environment, public spaces and special conservation areas (Sustainable Use Directive, 2009; Plant Protection Products Regulations, 2012). These regulatory changes favour the use of biological control agents over the use of products based on synthetic chemicals. As there are fewer biological control agents available for use outside of glasshouses, controlling pests, such as thrips and whitefly, in polytunnels could be a challenge, and there are indications that this is affecting the production of crops like strawberries and cherries (Koppert personal communication 2018). Over reliance on certain pesticides in these situations may also result in pesticide resistance. Whether biological controls are of benefit, however, should be considered in the context of what control options are available to growers for their particular crop production systems.

# Recommendation

**We recommend that the restriction to release the arthropod augmentative biological control agents *A. limonicus*, *A. degenerans*, *A. montdorensis*, *D. catalinae* and *E. eremicus* to glasshouses is removed, and that they should be able to be released under all protected conditions.**

**The exception to this would be *N. californicus*, given its potential to establish in the UK. We do not recommend relaxing the restrictions for this species.**

**The decision to release agents outside of glasshouses in future will be made on a case by case basis.**

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