



VKM Report 2014: 07

# Risk assessment of the biological control product «Gulløyelarver» with the active organism *Chrysoperla carnea*

**Opinion of the Panel on Plant Protection Products of the Norwegian Scientific Committee for Food Safety**

**Report from the Norwegian Scientific Committee for Food Safety (VKM) 2014: 07  
Risk assessment of the biological control product “Gulløyelarver” with the active  
organism *Chrysoperla carnea*.**

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## Contributors

Persons working for the Norwegian Scientific Committee for Food Safety (VKM), either as appointed members of the Committee or as ad hoc experts, do this by virtue of their scientific expertise, not as representatives for their employers. The Civil Services Act instructions on legal competence apply for all work prepared by VKM.

## Acknowledgements

Anette Sundbye at the Norwegian Institute for Agricultural and Environmental Research (Bioforsk) is acknowledged for contribution to the environmental risk assessment of Gulløyelarver. Preben Ottesen at the Norwegian Institute of Public Health is acknowledged for contribution on health risk aspects of Gulløyelarver.

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## Summary

Gulløyelarver (green lacewing larvae, *Chrysoperla carnea*) is a product for biological control. The application is for use against aphids in green-houses and tunnels.

Gulløyelarver was used in Norway from 1985-1993. An assessment in 2001 concluded however that the use of products with *Chrysoperla carnea* could represent an environmental risk since it was not known if the species in the products were the same as the ones with natural occurrence in Scandinavia.

In this regard, The Norwegian Food Safety Authority would like VKM to perform an assessment of possible risks related to health and environment in light of possible new data.

VKM's conclusions are as follows:

### Health

The larvae of *Chrysoperla carnea* have hollow jaws through which they can inject digestive enzymes into their prey. In contact with humans, the larvae are capable of delivering painful bites which may cause local swelling. Such bites are however not considered dangerous, and can be avoided with preventive measures.

Allergic asthma and rhino conjunctivitis has been reported in persons working in the production of biological agents with *Chrysoperla carnea*, but it is the opinion of VKM that such effects are not likely to be relevant for users of the agents.

### Environment

A previous assessment in 2001 concluded that the use of products with *Chrysoperla carnea* represented an environmental risk because of the risk of genetic interference with natural populations of the species in Norway.

Lacewings belonging to the *Chrysoperla carnea* complex are considered established and indigenous in Norway, and a recent study by the Norwegian Institute for Agricultural and Environmental Research (Bioforsk) strongly suggests that the lacewings in the commercial products belong to the same cryptic species complex as individuals sampled in Norway. In case the species in the products is different from those present in Norway, any genetic interference with local populations in Norway is prevented by differences in duetting songs.

If an invertebrate biological control agent is indigenous and has limited direct or indirect effect on the environment, it is the opinion of VKM that it could be authorized for release in greenhouses or plastic tunnels.

*Chrysoperla carnea* is polyphagous and cannibalistic. They prefer aphids, but may also consume other insects and mites. It is however the opinion of VKM that the environmental risk from this will be minimized in greenhouses and tunnels where the release will be in a contained environment and directed against aphid colonies.

Establishment, host range and dispersal ability should be carefully reviewed, even if the species is indigenous. *Chrysoperla carnea* may establish in the greenhouse and plastic tunnels and may also possess the ability to disperse and survive in the field. However, it is the opinion of VKM that the direct and indirect effects of this are at most moderate, although it cannot be

completely excluded that *Chrysoperla carnea* species in the products might also have properties that have not been reviewed.

## Background

VKM performs risk assessments in the context of pesticide registration of invertebrate biological control agents (IBCA) cf. Regulation § on Pesticides 4. The Norwegian Food Safety Authority, National Registration Section, is responsible for reviewing and evaluating the documentation submitted by the applicant. The Norwegian Food Safety Authority takes the final regulatory action regarding registration or deregistration of IBCAs based on VKMs risk assessment, along with a comparative assessment of risk and benefits and the availability of alternatives (the principle of substitution).

The Norwegian Food Safety Authority submitted a request on October 29, 2013 for VKM to perform a risk assessment on use of “Gulløyelarver” containing the active organism *Chrysoperla carnea*. The application is for use against aphids on crops in green-houses and tunnels.

The risk assessments were finalized by VKM in September, 2014.

## Terms of reference

“Gulløyelarver” is a new IBCA product containing the active organism *Chrysoperla carnea*. The application is against aphids in crops in green-houses and tunnels.

In this regard, The Norwegian Food Safety Authority would like an assessment of the following:

- Distribution of the active species and in particular if the organism is indigenous in Norway.
- The potential for establishment and dispersal under Norwegian conditions when used in green-houses and poly-tunnels/field.
- Undissolved issues as regards taxonomy which complicates a risk assessment.
- An assessment of health risk to users of the product.

## 1 Background documentation

The Norwegian Food Safety Authority has compiled the documentation submitted by the applicant and performed an initial assessment. The Norwegian Institute for Agricultural and Environmental Research (Bioforsk) was contracted to prepare an eco-toxicological assessment of *Chrysoperla carnea*, the active species in the product, for VKMs Panel on Plant Protection Products. Preben Ottesen at the Norwegian Institute of Public Health has provided an assessment of possible human health risks. The present opinion of VKMs Panel on Plant Production Products is based on these contributions.

## 2 Identity etc.

### 2.1 PRODUCT NAME

Gulløyelarver

- 1) 500 larvae in corrugated cardboard (“MC-500”)
- 2) 1000 larvae in sterile buckwheat (“Buchweisen”)
- 3) 10 000 eggs in a cardboard box (“Eier lose”)

### 2.2 APPLICATION BACKGROUND?

Products with *C. carnea* were used on dispensation in Norway from 1985-1993. In 2001 the Norwegian regulation for registration of invertebrate biological control agents (IBCA) were amended. Efficacy evaluation and risk assessments were conducted for all applied products with IBCA. This included the products “Chrysopa MC-500”, “Chrysopela carnea”, “Guldøje-larver” (MC-500). See the conclusion of previous risk assessment in section 5.3.

*C. carnea* is on the “List of biological control agents widely used in the EPPO region” ([http://archives.eppo.int/EPPOStandards/biocontrol\\_web/bio\\_list.htm#biolist](http://archives.eppo.int/EPPOStandards/biocontrol_web/bio_list.htm#biolist))

### 2.3 TARGET PESTS/ ORGANISM(S)

The products are applied against aphids (all species).

### 2.4 AREA FOR USE

The products are applied for all crops in greenhouses and poly-tunnels.

## 3 Health hazards

Preben Ottesen at the Institute of Public Health has reviewed possible human health aspects of *Chrysoperla carnea*, and found that the larvae, which have strong pointed hollow jaws through which they can inject digestive enzymes into their prey, are also capable of delivering painful bites in contact with humans. Such bites can cause local swelling, but are not

considered to be dangerous. Bites are however rare and can be prevented by protective measures.

Cases of allergic asthma and rhino conjunctivitis have been reported in persons working in the production of biological agents such as *C. carnea* and other arthropods (Lugo et al. 1994). The average exposure period among responding individuals were 18 months. Following the use of protective equipment in the production facilities, reported cases of allergy seems to have been significantly reduced. Risks of allergic effects among users of the biological agent are unlikely due to far lower exposure.

## 4 Taxonomy and origin of biological control agent

### 4.1 CLASS/ORDER/FAMILY

The species belongs to the class *Insecta*, order *Neuroptera* and family *Chrysopidae*.

### 4.2 GENUS AND SPECIES NAME

*Chrysoperla carnea* (Stephens, 1836).

Common name: Common green lacewing, NO: vanlig gulløye/ vintergulløye.

### 4.3 TAXONOMIC CHALLENGES

*C. carnea* was originally considered to be a single species with a Holarctic distribution but it has now been shown to be a complex of many cryptic, sibling species, generally referred to as *C. carnea sensu lato* (s.l. = "in the broad sense") (Lourenço et al. 2006). These are indistinguishable from each other morphologically but can be recognized by variations in the vibrational songs the insects use to communicate with each other, especially during courtship (Henry et al. 2002) and to a certain extent by molecular (DNA) analyses (Lourenço et al. 2006). The data by Lourenço et al. 2006 suggest that *C. carnea sensu stricto* (s.s. = "in the strict sense") is a well-supported, separate taxon, but that other taxa of the complex are not consistently differentiated by the current DNA data. A more recent and extensive study by Henry et al. (2012) shows that many nodes on the phylogenetic tree of the *C. carnea* complex are well supported, but several taxa appear on more than one branch.

Today, the *C. carnea* complex comprises 21 valid described species (Table 1). In addition, several new cryptic taxa have been identified but not yet described. Poor sampling of the *C. carnea* complex across much of Asia, northern and central Africa, and western North America makes it very likely that many new species remain to be discovered (Henry et al. 2013).

The song of each of the more than 20 described species exhibits a unique acoustical phenotype that reproductively isolates the taxon from all other species with which it might come into contact. Hybrids have not been found in nature. However, in experiments two cryptic species even those native to different continents, will eventually hybridize when confined with no conspecific option in a small arena. They can produce healthy progeny that are capable of having viable offspring (Henry et al. 2013).

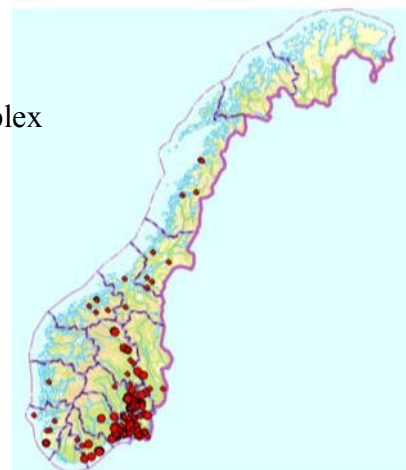


Table 1: Recognized species and subspecies of the *carnea*-group, with citations to literature where their duet songs are described (Henry et al. 2013).

<i>C. plorabunda</i> (Fitch, 1855)	Henry (1985 <i>b</i> ), Henry & Wells (1990), Henry <i>et al.</i> (1993) and Wells & Henry (1992 <i>b</i> )
<i>C. adamsi</i> Henry <i>et al.</i> (1993)	Henry (1991), Henry <i>et al.</i> (1993) and Wells & Henry (1992 <i>b</i> )
<i>C. johnsoni</i> Henry <i>et al.</i> (1993)	Henry (1993 <i>a</i> ), Henry <i>et al.</i> (1993) and Wells & Henry (1992 <i>b</i> )
<i>C. johnsoni</i> 'mohave ecotype'	Henry (1993 <i>b</i> )
<i>C.</i> 'downesi-2' (= 'western downesi')	Henry (1985 <i>a,b</i> )
<i>C. downesi</i> (Smith, 1932)	Henry (1980)
<i>C. downesi</i> 'mohave ecotype' (Banks, 1938)	Henry (1993 <i>b</i> )
<i>C. calocedrii</i> Henry <i>et al.</i> (2012)	Henry <i>et al.</i> (2012)
'CcX-Asia'	(present review)
<i>C.</i> 'adamsi-Kyrgyzstan'	Henry <i>et al.</i> (1999 <i>b</i> )
<i>C. zastrowi sillemi</i> (Esbén-Petersen, 1935)	Henry <i>et al.</i> (2006) and Henry <i>et al.</i> (2010)
<i>C. zastrowi zastrowi</i> (Esbén-Petersen, 1928)	Henry <i>et al.</i> (2006)
<i>C. agilis</i> Henry <i>et al.</i> (2003)	Henry <i>et al.</i> (2003) and Henry <i>et al.</i> (2011)
<i>C. lucasina</i> (Lacroix, 1912)	Henry <i>et al.</i> (1996)
<i>C.</i> 'nipponensis B'	Henry <i>et al.</i> (2009)
<i>C. nipponensis</i> (Okamoto, 1914)	Henry <i>et al.</i> (2009)
<i>C.</i> 'downesi-Kyrgyzstan'	Henry & Wells (2004) and Wells & Henry (1998)
<i>C. pallida</i> Henry <i>et al.</i> (2002)	Henry <i>et al.</i> (2002 <i>a</i> )
<i>C.</i> 'carnea-Kyrgyzstan' (= 'motorboat KR')	Wells & Henry (1998)
<i>C. carnea</i> (Stephens, 1936)	Henry <i>et al.</i> (2002 <i>a</i> )
<i>C. mediterranea</i> (Hölzel, 1972)	Henry <i>et al.</i> (1999 <i>a</i> )

In Norway it is recorded 16 lacewing species by morphological methods (Greve 1987\*, Greve & Kobre 2009\*\*, Greve et.al 2011\*\*\*):

1. *Nineta flava*\*
2. *Nineta inpunctata* (sjelden)\*
3. *Nineta vittata*\*
4. *Chrysotropia ciliata*\*
5. *Chrysoperla carnea* (syn. *Chrysopa carnea*)\* - complex
6. *Chrysopa abbreviate*\*
7. *Chrysopa dorsalis*\*
8. *Chrysopa phyllochroma*\*
9. *Chrysopa perla*\*
10. *Chrysopa septempunctata*\*
11. *Anisochrysa flavifrons*\*
12. *Anisochrysa prasina*\*
13. *Anisochrysa ventralis*\*
14. *Cunctochrysa albolineata*\*
15. *Micromus variegatus*\*\*
16. *Peyerimhoffina gracilis*\*\*\*



#### 4.4 INDIGENOUS OR NON-INDIGENOUS (IN NORWAY)

The species is considered indigenous to Norway and is recorded as described in Figure 1 (Artsdatabanken 2014). The recordings are conducted by biologists from “Biofokus” and “Norsk entomologisk forening” from 1995-2014. The identification methods are not described, but it is probably morphological observations. Since the species are difficult to distinguish morphologically (section 4.3), we assume that all morphological identifications of *C. carnea* in Norway are actually one of the species in the *C. carnea* complex (Table 1).

In a study Bioforsk conducted, specimens of *Chrysopidae* were collected naturally in Norway in 2013, and commercially available lacewing products were ordered in January 2014. The specimens were preserved in 95% ethanol. Molecular analysis (DNA barcoding) was performed at Bioforsk as described below.

Collected specimens (37 specimens) (Location – Date collected – Number of specimens):

- Sandefjord (13.10.13) – 15 specimens
- Kråkstad (10.10.13) – 9 specimens
- Gressvik (25.06.13, 10.10.13) – 4 specimens
- Ås (28.06.13 (3)/02.09.13 (1)/20.09.13 (1)) – 5 specimens
- Oslo (27.11.13) – 2 specimens
- Lier (03.09.13) – 1 specimen
- Balestrand (20.06.13) – 1 specimen

Commercial products (40 specimens) (Product name – Company – Number of specimens):

- Chrysopa (Koppert) - 8 specimens
- Biocarn (BioProduction) - 8 specimens
- Chrysopa-System (Biobest) - 8 specimens
- Chrysoline C (Syngenta Bioline) - 8 specimens
- "MC-500" Guldøje-larver (Borregaard BioPlant) - 8 specimens

#### Results:

All individuals from the five commercial lacewing products and all the collected specimens were barcoded using the mitochondrial cytochrome c oxidase subunit I gene (COI) (Fomler et al. 1994). The analysis showed that the four products «Chrysopa», «Biocarn», «Chrysoline C» and «MC-500» all contained identical gene sequences, that is all products contained two haplotypes differing in only a single position out of 658 bp. The sequences from the «Chrysopa-System» differ from the other four products, but it is still evident that the insects from all five commercial products belong to the *C. carnea* complex (e.g. *C. carnea* s.s., *C. agilis*, *C. lucasina*, *C. pallida*) according to the The Barcode of Life Data Systems (<http://www.boldsystems.org/>).

The two haplotypes detected in the commercial products were also identified in 25 of the specimens collected in Norway (Sandefjord: 10, Kråkstad: 6, Ås: 3, Oslo: 2, Gressvik: 2, Lier: 1, Balestrand: 1). In addition, 11 other specimens had sequences differing in only 1-4 positions out of 658 bp. Finally, one of the specimens collected in Ås was identified as *Peyerimhoffina gracilis*, another member of the *Chrysopidae* family.

### **Conclusions:**

The two COI haplotypes detected in four of the commercial lacewing products were also identified in insect specimens collected from different locations in Norway. Species of the *C. carnea* complex are closely related and their mitochondrial DNA shows a high degree of similarity. Consequently, two distinct species may even share the same mitochondrial haplotype (Henry et al. 2013). The identical (or nearly identical) COI- sequences may therefore indicate, but do not guarantee that the lacewings in the commercial products belong to the same (cryptic) species as the individuals collected in Norway. Whether it will be possible to fully discriminate all the species within the *C. carnea* complex using molecular markers remains to be seen, but this is a primary goal for future research (Henry et al. 2013).

## **4.5 ASSOCIATED ORGANISMS AND FORMULATION (OR CONTAMINANTS)**

The products containing *C. carnea* are supplied as eggs in cardboard cup or as larvae in corrugated cardboard or in sterile buckwheat. There should not be any associated organisms in the products.

## **4.6 ORIGINAL AREA AND DISTRIBUTION OF THE SPECIES**

The *C. carnea* complex is cosmopolitan with Holarctic distribution. The Holarctic is the terrestrial ecozone that encompasses the majority of habitats found throughout the northern continents of the world. This region is divided into the Palearctic, consisting of North Africa and all of Eurasia, with the exception of Southeast Asia and the Indian subcontinent, and the Nearctic, consisting of North America north of southern Mexico.

## **4.7 GEOGRAPHICAL ORIGIN OF ORGANISM USED IN THE PRODUCT**

Germany is the original collection and production site of the organism in the product “Gulløyelarver” (“MC-500”, “Buchweisen” and “Eier lose”).

## **4.8 AREAS INTRODUCED TODAY AS IBCA**

Products with *C. carnea* are widely used for the control of aphids in greenhouses in Sweden, Denmark, Austria, Belgium, Czech Republic, Finland, France, Germany, Greece, Guernsey, Ireland, Italy, Netherlands, Portugal, Spain, Switzerland and UK. In some countries it is also used outdoors (EPPO 2014). In Norway products with *C. carnea* were used in greenhouses from 1985 to 1993.

## 5 Biology and ecology

### 5.1 LIFE CYCLE AND GENERATIONS/YEAR

Lacewings pass through 7 stages: the egg, three larval instars, the prepupal instar, pupa and adult (Figure 2). Fertility is particularly affected by the food intake of the adult lacewing. Mating takes place at dusk and after dark immediately following the emergence of the adults. A female can lay between 400 and 500 eggs. After 1 - 2 weeks the males die, but females have a longer life span. In north and mid Europe there are usually 2 generations per year, but in southern Europe there are 3 - 4 generations. More generations are possible in greenhouse (Malais & Ravensberg 2003).

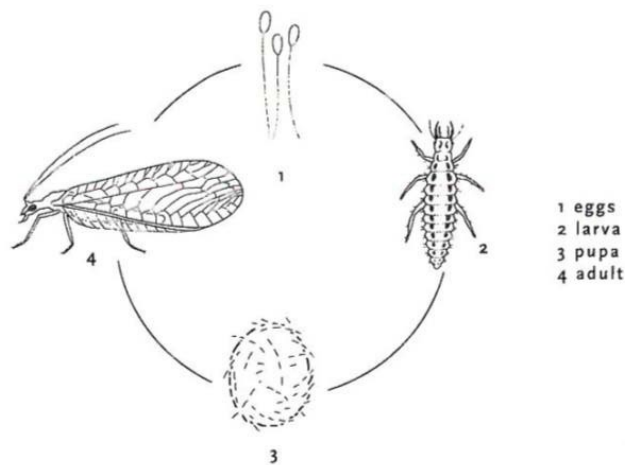


Figure 2: Lifecycle and appearance of green lacewings (Malais & Ravensberg 2003).

### 5.2 POSSIBLE OVERWINTERING STAGE

The adult stage overwinters. Overwintering adults acquire a yellow color. Diapause is triggered by shortened day-length (< 10 hours) and is broken in the spring by rising temperatures above 5 °C (Yin-Fu et al. 1996, Malais & Ravensberg, 2003).

### 5.3 CLIMATIC CONDITIONS (OPTIMAL, MAX. AND MIN.)

Population growth is dependent on temperature, the species of prey and on atmospheric humidity. Adult lacewings do not like extremes of temperature, and in warm periods they leave the greenhouse. The development from egg to adult takes an average of 69 days at 16°C, 35 days at 21°C and 25 days at 28°C. At constant temperatures below 10°C development is not completed. When low temperatures (even sub-zero temperatures) alternate with higher temperatures, development can take place to maturity. Temperature above 35°C is lethal (Malais & Ravensberg, 2003).

## 5.4 MECHANISMS FOR DISPERSAL

The larvae of the *C. carnea* complex can be very mobile when hungry, but compared to the effect of adult flight activities their movement is irrelevant with regard to the dispersal of a population. Adults are good fliers and manage to disperse into and colonize other plants and fields. In the first two nights after emergence the adult lacewings perform straight downwind dispersal flights. Take-off behavior is elicited by the decrease in illumination at sunset. In the Central Valley (California) an average initial flight distance of 40 km per night has been estimated (Duelli 1984). Lacewing (eggs, larvae, pupae and adults) can also disperse with human activity (handling and transportation of plant materials, etc.).

## 5.5 HABITAT RANGE

The *C. carnea* complex is associated with herbaceous vegetation (Henry et al. 2013). It has been found that the larvae do not establish well in tall growing crops. They establish better in lower-growing crops since they easily fall from the leaves, and in tall crops they are unable to reach the growing tips again where their prey congregate. Adults feed on pollen, nectar and honeydew (Malais & Ravensberg 2003). According to documentation (Wikipedia printout) from the applicant the gardeners can attract lacewings by using certain plants, and therefore ensure a steady supply of larvae. Adults Chrysopidae can be attracted mainly to *Asteraceae* (e.g. *Coreopsis*, *Cosmos*, *Helianthus* and *Taraxacum*) – and *Apiaceae* such as dill (*Anethum*) or angelica (*Angelica*). Volatiles from eggplant, okra, and peppers are also attractive to lacewings, while odors from tomato are not (Reddy 2002).

## 5.6 HOST RANGE

Lacewings prefer to feed on aphids, but will also prey on whitefly, spider mites and thrips. If present, other insects may also be consumed, like *Lepidopteran* eggs, small larvae (Klingen et al. 1996) and mealy bugs. When prey is scarce, the larvae can resort to cannibalism, with the older larvae eating the younger. Lacewing eggs are often ignored because they stand on stalks (Malais & Ravensberg, 2003).

# 6 Assessment of risks

## 6.1 HISTORY OF PREVIOUS RELEASES

See section 2.2. There are not recorded any environmental risk with previous releases in Norway.

## 6.2 REFERENCE TO PREVIOUS RISK ASSESSMENTS

The Norwegian Institute for Nature Research (NINA) conducted the risk assessment of commercial products containing specimens from the *C. carnea* complex in 2001, assigned by the Norwegian Food Safety Authority (Ødegaard 2001). This included the following products: “Chrysopa MC-500”, “Chrysopela carnea”, “Guldøje-larver” (MC-500).

### 6.3 OUTCOME OF PREVIOUS RISK ASSESSMENTS

In 2001 it was concluded that the use of products with specimens from the *C. carnea* complex represented high environmental risk, because of the risk of genetic interference with natural populations of the species in Norway. The species was only recommended if it was possible to use natural populations from biotypes in Scandinavia (Ødegaard 2001).

In 2003 van Lenteren *et al.* presented the first detailed criteria for risk assessment for macro-organisms. This method includes the calculation of an overall risk index based on a maximum score by giving values to each criterion. Table 5 in the publication by van Lenteren *et al.* (2003) gives details for the methodology and valuable references to the biology of many commercially available natural enemies used for inundative biological control in Europe. Risk score lower than 35 points will generally result in a proposal of no objection against release of the agent, a risk index higher than 70 points will generally result in the advice not to release the agent. Intermediate risk score between 35 and 70 points will result in the advice to come up with additional information before a conclusion concerning release will be drawn. The maximum score is 125 ( $5 \times 5 \times 5$ ). According to van Lenteren *et al.* (2003) *C. carnea* reach an index of 66 (Table 1). This means that it has intermediate environmental risk and the advice to come up with additional information before a conclusion concerning release should be drawn.

Table 1: Risk assessment index applied to *Chrysoperla carnea* (van Lenteren *et al.* 2003)

Biological control agent	Index level	Establishment	Dispersal	Host range	Direct effects	Indirect effects	Risk index (sum L × M's)
<i>Chrysoperla carnea</i>	Likelihood (L)	5	4	5	5	3	66
	Magnitude (M)	5	2	5	1	1	
	L × M	25	8	25	5	3	

Likelihood (L) of risk: 1 = very unlikely, 2 = unlikely, 3 = possible, 4 = likely, 5 = very likely

Magnitude (M) of environmental effects: 1 = minimal, 2 = minor, 3 = moderate, 4 = major, 5 = massive

### 6.4 POTENTIAL AND EVIDENCE FOR ESTABLISHMENT (PHYSICAL OR RESOURCE CONSTRAINS)

If an invertebrate biological control agent is indigenous and has no or very limited direct or indirect effect on environment, the VKM guidance document suggests that it could be authorized for release in greenhouses, plastic tunnels or in field (Hofsvang 2013). The *C. carnea* complex are considered established and indigenous in Norway (section 4.4), but Norwegian studies have until now only been identifying this complex with morphological methods. The Bioforsk survey (DNA analyses) indicates, but do not guarantee, that the lacewings in the commercial products belong to the same (cryptic) species as the individuals collected in Norway.

### 6.5 HOST RANGE: WILD HOSTS KNOWN

The *C. carnea* complex is polyphagous and cannibalistic. They prefer aphids, but if aphid prey is scarce they can also consume other non-target insects and mites (section 5.6). This could be a “massive” and “very likely” environmental risk according to Table 1. However, the risk will be minimized in greenhouse, where the release will be in a contained environment and directed against aphid colonies (hot spots), according to integrated/ biological control methods and the Norwegian label. There are also several other polyphagous biological control agents already registered in Norway (e.g. *Amblyseius*, *Hypoaspis*, *Diglyphus*, *Feltiella*,

*Cryptolaemus, Macrolophus and Orius*) (Klingen 2007). Further, the VKM guidance document suggests that it is not necessary to assess risk effects on host range (non-targets) if an invertebrate biological control agent is indigenous (Hofsvang (2013).

## 6.6 HOST RANGE: ORGANISMS TESTED IN CONTROLLED EXPERIMENTS

The *C. carnea* complex has been tested against different pests (Huang & Enkegaard 2009, Shrestha & Enkegaard 2013):

Aphids (*Aphis gossypii*, *Brevicoryne brassicae*, *Nasonovia ribisnigri*, etc.)

Lepidopteran species (e.g. *Spodoptera littoralis*, *Helicoverpa armigera*, *Heliothis zea*, *H. virescens*, *Mamestra brassicae*, *Plutella xylostella*, *Pieris brassicae*)

Western flower thrips (*Frankliniella occidentalis*)

Red spider mite (*Tetranychus ludeni*) and leaf miners

See the agronomic efficacy evaluation of *C. carnea* complex based products for more information.

## 6.7 TARGET AND NON-TARGET HOST PLANTS

Larvae of the *C. carnea* complex do not eat plant material, but adults feed on pollen and nectar. Adults are also attracted to certain plants (section 5.5). This does not pose any potential environmental risk.

## 6.8 ABILITY TO DISPERSE

See section 4.4. According to Hofsvang (2013) it is not necessary to assess risk effects on dispersal, if an invertebrate biological control agent is indigenous. However, for the *C. carnea* complex based products this is unclear. High dispersal ability (e.g. adult lacewings) would be important for the efficacy of the IBCA in some situations, for example when the target pests are unevenly distributed in the crop. It is also important that the dispersal ability is moderate when the IBCA (e.g. lacewing larvae) should persist at the site of application, for example in “hot spots” with target pests.

## 6.9 DIRECT AND/OR INDIRECT NON-TARGET ENVIRONMENTAL EFFECTS

Establishment, host range and dispersal ability may interact and produce direct and indirect effects, which should be carefully reviewed, even if the species is indigenous (Hofsvang 2013). The *C. carnea* complex can establish in the greenhouse and plastic tunnels after release. It also has the ability to disperse and survive in the field. However, we assume the direct/ indirect effects are moderate according to the assessments in section 5.4 and 5.8. The larvae are polyphagous and cannibalistic, but the direct/ indirect effects are probably minimal according to the assessments in section 5.5. Intraguild predation (killing and eating of potential competitors) is ubiquitous in nature. It occurs among several biological control agents (insects, mites, etc.), but it is claimed that it does not increase the pest densities and disrupt the systems (Janssen et al. 2006). The *C. carnea* complex species in the products might also have some different properties that are not reviewed.

## 7 Conclusion

### 7.1 HEALTH

The larva of *C. carnea* have hollow jaws through which they can inject enzymes into their prey. In contact with humans, the larva can deliver painful bites which may cause local swelling but are not considered dangerous.

Allergic asthma and rhino conjunctivitis has been reported in persons working in production of biological agents with *C. carnea*, but such effects are not likely to be relevant for users of the biological agents.

### 7.2 ENVIRONMENT

A previous assessment in 2001 concluded that the use of products with *C. carnea* represented an environmental risk because of the risk of genetic interference with natural populations of the species in Norway.

Lacewings belonging to the *C. carnea* complex are considered established and indigenous in Norway, and a recent study by Bioforsk strongly suggests that the lacewings in the commercial products belong to the same cryptic species complex as individuals sampled in Norway. In case the species in the products is different from those present in Norway, any genetic interference with local populations in Norway is prevented by differences in duetting songs.

If an invertebrate biological control agent is indigenous and has limited direct or indirect effect on environment, it is the opinion of VKM that it could be authorized for release in greenhouses or plastic tunnels.

*C. carnea* is polyphagous and cannibalistic. They prefer aphids, but may also consume other insects and mites. It is however the opinion of VKM that the environmental risk from this will be minimized in greenhouses and tunnels where the release will be in a contained environment and directed against aphid colonies.

Establishment, host range and dispersal ability should be carefully reviewed, even if the species is indigenous. *C. carnea* may establish in the greenhouse and plastic tunnels and may also possess the ability to disperse and survive in the field. However, it is the opinion of VKM that the direct and indirect effects of this are at most moderate, although it cannot be completely excluded that *C. carnea* species in the products might also have properties that have not been reviewed.



## 8 Documentation

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