

# Occurrence of two pest gall midges, *Obolodiplosis robiniae* (Haldeman) and *Dasineura gleditschiae* (Osten Sacken) (Diptera: Cecidomyiidae) on ornamental trees in Sweden

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In 2008, *Dasineura gleditschiae* (the honey locust pod gall midge) and *Obolodiplosis robiniae* (the black locust gall midge) were found for the first time in Sweden (Skåne). Both species originate from North America and both form leaf galls. *O. robiniae* forms marginal leaf roll galls on robinia (*Robinia pseudoacacia* L., Fabaceae) and the larvae of *D. gleditschiae* induce globular or pod-like leaflet galls on gleditsia (*Gleditsia triacanthos* L., Fabaceae). We successfully used sex pheromone traps to monitor and compare the swarming of *D. gleditschiae* in Alnarp, Sweden on one thorned and one thornless gleditsia variant.

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Here we report the first finding of two gall midge species: *Dasineura gleditschiae* (the honey locust pod gall midge) and *Obolodiplosis robiniae* (the black locust gall midge), in Sweden (Fig. 1, 10). The two species are pests on gleditsia (*Gleditsia triacanthos* L., Fabaceae) and robinia (*Robinia pseudoacacia* L., Fabaceae), respectively. Both gall midge species are found in the USA as well as in south and central Europe. This is the first report of them this far north.

Gleditsia is native to eastern North America. Since the eighteenth century the tree has become popular in many European towns because of its tolerance to dry conditions and soil salinity. It can tolerate a range of soils but prefers moist, fertile soils with neutral pH. There are two types of robinia. The original type (*Gleditsia triacanthos*) has 10–20 cm long thorns on the branches – *tria-*

*canthos* means “three-spined” (Fig. 2). Nearly all ornamental robinia are cultivated forms of a naturally occurring type and are without thorns (var. *inermis*).

Robinia (Fig. 13) is also from eastern North America (e.g., Virginia, North and South Carolina). It was introduced into Europe (France) in the seventeenth century for ornamental purposes (Buhl & Duso 2008) and to consolidate soils and to replant deforested areas (Wermelinger & Skuhrová 2007). Robinia exhibits a high competitiveness towards a large number of European tree species. It invaded European countries rapidly, with dramatic implications for the conservation of native forest stands (Pignatti 1982). Herbivores have had little influence on limiting the spread of Robinia, however, in the past decades a number of damaging arthropods have acciden-



Figure 1. The female *Dasineura gleditchiae* lays her eggs in unexpanded leaflets of *gleditsia* (*Gleditsia triacanthos*).

*Dasineura gleditchiae* hona som lägger ägg på outvecklade blad av korstörne.

tally been introduced from North America (Buhl & Duso 2008).

The gall midges (Diptera: Cecidomyiidae) are a highly diverse family of insects. More than 5000 species have been identified worldwide, but it is likely that many more species

await discovery (Lenteren et al. 2002). The family includes species that feed on plants, animals and fungi. Some species are serious herbivorous pests while others are important zoophagous predators some of which are used for biological control of pests (Harris & Foster 1999). When



Figure 2. *Gleditsia* (*Gleditsia triacanthos*) is the host of *Dasineura gleditchiae*. The original *gleditsia* has thorns (as shown on this picture), however most ornamental *gleditsia* in Sweden are clones without thorns.

Korstörne (*Gleditsia triacanthos*) är värdväxt för gallmyggan *Dasineura gleditchiae*. Den ursprungliga sorten av *gleditsia* har tornar, men de flesta prydnads-sorterna som förekommer i Sverige saknar sådana.



Figure 3. When ovipositing, female *Dasineura gleditchiae* insert either one single egg or a cluster into an unexpanded leaf. Each egg is only 0.3 mm, but one feeding larvae is enough to initiate galling of the leaf.

*Dasineura gleditchiae* honor lägger ett ägg eller en äggsamling på utvecklade blad. Äggen är bara 0,3 mm, men en larv räcker för att inducera gallbildning.

Figure 4. The first symptom of *Dasineura gleditchia* infestations is young unexpanded leaflets, followed by premature dropping of leaves. If the larval infestation is high it can kill whole branches.

De första tecknen på *Dasineura gleditchia* angrepp är unga outvecklade blad, följt av tidig lövfällning. Om angreppet är stort kan det leda till att hela grenar dör.



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gall midge larvae feed on a plant, gall formation is induced. Galls are irregular plant growths that are stimulated by the reaction between plant hormones and growth regulating chemicals secreted by the gall midge. The inner walls of the gall provide a high quality food source for the inhabitant as well as protection from insecticide sprays and shelter from natural enemies. Gall makers must attack at a very specific time in order to be successful; otherwise, they may not be able to stimulate the plant to produce the tissue which forms the galls ([www.ca.uky.edu/entomology/entomology.php](http://www.ca.uky.edu/entomology/entomology.php)).

Gall midges use pheromones for odor communication. Sex pheromones are long distance attractants released by the females with the males perceiving the signal and flying upwind to the calling female (Linn & Roelofs 1995). The pheromones are always highly specific i.e. males are only attracted to pheromones released by females of the same species. The first observation of a cecidomyiid sex pheromone was made by Cartwright (1922). He noticed that a female hessian fly (*Mayetiola destructor*) caught in mud attracted males over distances of several meters



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Figure 5. The presence of *Dasineura gleditchia* in Sweden was detected with pheromone traps. The traps were baited with a mimic of the female pheromone that attracts the male midges. At the bottom of the trap is an insert covered with glue that captures the males when they enter.

Förekomsten av *Dasineura gleditchia* upptäcktes med hjälp av feromonfällor. Fällorna var betade med det feromon honorna sänder ut för att locka till sig hanar. I botten av fällan finns en utbyttbar plasticskiva som är täckt med klister, som hanarna fastnar i när de flyger in i fällan.

(Harris & Foster 1999). Today many gall midge sex pheromones have been identified (e.g. Hillbur et al. 1999, Hillbur et al. 2005, Molnár et al. 2007, Andersson et al. 2009). The synthetic pheromones can be applied to traps, and used for detection of gall midges.

*O. robiniae* was first described in Pennsylvania (USA) as *Cecidomyia robiniae* (by Halde- man 1847). It was restricted to North America until the beginning of this century when it was found in South Korea, Japan (Kodoi et al. 2003) and Europe – the first finding was in the Veneto region in Italy (Duso & Skuhravá 2003). During the following years *O. robiniae* spread thorough Europe and was observed in e.g. South Tyrol, Slovenia, the Czech Republic, Hungary (Csóka 2006), Slovakia, Serbia and Germany (2006), and England, Montenegro and Switzerland (Wermelinger & Skuhravá 2007) (Fig. 6).

*D. gleditchiae* was first introduced to the Netherlands (Nijveldt 1980) and from there it spread to the rest of Europe e.g. the United Kingdom (Halstead 1992), Italy (Bolchi & Volunte 1985), Yugoslavia (Simova-Tosic & Skuhravá 1995), and Hungary (Ripka 1996).

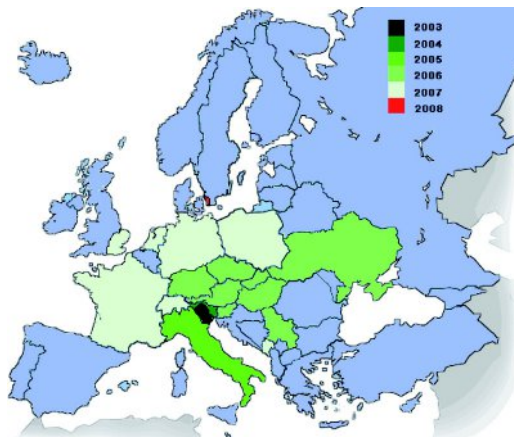


Figure 6. *Obolodiplosis robiniae* is originally from Pennsylvania (USA). It was introduced to Europe in 2003 where it was observed in Italy. From Italy *O. robiniae* has spread throughout Europe, and in 2008 it was observed in southern Sweden.

*Obolodiplosis robiniae* har ursprungligen beskrivits från Pennsylvania (USA). Den introducerades till Europa 2003 då den rapporterades från Italien. Därifrån har den spridit sig genom Europa och observerades för första gången i södra Sverige 2008.

## Material and methods

The presence of *D. gleditchiae* was detected with transparent pheromone traps (Fig. 5). We compared the swarming of *D. gleditchiae* on two types of gleditsia: *Gleditsia triacanthos* (thorned) and *G. triacanthos* var. *inermis* ‘Sunburst’ (thornless). ‘Sunburst’ is a clone commonly used for ornamental purposes. The pheromone traps were delta-shaped traps with transparent walls (Csalomon® RAG, Plant Protection Institute Hungarian Academy of Sciences, Budapest, Hungary) with exchangeable inserts (10 cm by 16 cm) coated with adhesive (Tangle Trap, Tanglefoot Co., Grand Rapids, Michigan). The synthetic sex pheromone compounds (10 µg) (Molnár et al. 2007) were applied to red rubber dispensers (MSZ 9691/6, TAURUS, Budapest, Hungary) in hexane (10 µl). The experiment was conducted in the botanical garden in Alnarp. The traps were placed 2 m above ground in the foliage of both types of gleditsia trees and were checked twice per day at 9:00 and 16:00. Three replicates was made, traps without dispenser were used as control at the same sites.

Leaves infested with *O. robiniae* larvae were



Figure 7. *Robinia pseudoacacia* infested with *Obolodiplosis robiniae* were found at 6 different localities in Skåne. Infested leaves were collected and adult midges emerged in the laboratory. The identification of the species was confirmed by Dr. Marcela Skuhravá.

*Robinia (Robinia pseudoacacia)* som var angripen av *Obolodiplosis robiniae* hittades på sex lokaler i Skåne. Angripna blad med larver samlades in och vuxna insekter kläcktes fram i laboratoriet. Identifieringen av arten bekräftades av Marcela Skuhravá.

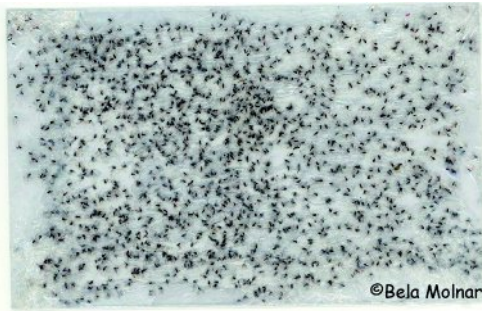


Figure 8. Males of *Dasineura gleditchiae* caught in the glue in the bottom of the pheromone traps. The traps were emptied twice pr. day and the number of caught males was counted. During some days the traps caught more than 300 male midges.

Hanar (767 stycken) av *Dasineura gleditchiae* fångade i klistret på botten av feromonfällan. Fällorna tömdes två gånger per dag och antalet hanar räknades. Vissa dagar fångade fällorna fler än 300 hanar.

collected from four locations in the area in and around Lund (Alnarp, Lomma and Burlöv) in September 2008. Additional infected trees were observed in Malmö and Skanör (Fig. 7). The collected leaves (10-15) were kept in a climate chamber (27 °C, 75% RH, 12:12 L:D) until the

adult midges emerged (approximately after 2 days). The identification of the species was confirmed by Dr. Marcela Skuhrová, CSc. (Bítovská 1227/9 140 00 Praha 4, Czech Republic).

## Results and Discussion

### *Dasineura gleditchiae*

The first observation of *D. gleditchiae* in Sweden was made in 2007 in Alnarp. In 2008 they were also found in Lund and Malmö. In 2008 the presence and population density of *D. gleditchiae* in Alnarp was monitored with pheromone traps (Fig. 8). Based on the trap catches and visual examination of infested trees, it was concluded that the population density of *D. gleditchiae* was lower at the study sites in Sweden than in other European countries (Bela Molnár's observations). The visual evidence of infestation is the galling of young, unexpanded leaflets (Fig. 4) and later, after emergence of the adult midges, premature dropping of leaves. Continued galling and repeated defoliation may cause the death of small branches (Rosetta et al. 1998). New shoots develop at the base of dead twigs, reducing the aesthetic value of the tree.

*D. gleditchiae* eggs are tiny (approx. 0.3 mm) and white/yellow/red (Fig. 3). They are inserted

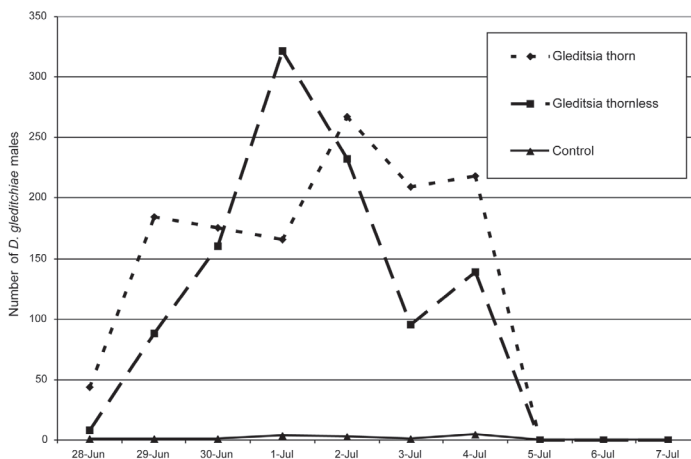


Figure 9. Male *Dasineura gleditchiae* was trapped both in thorned and thornless gleditchiae. There were no difference in how many midges that were caught in each tree variety. However, there might still be a difference in how sensitive the two varieties are to attack. The season for infestation is longer for the thornless variety, which continues to form new leaves longer than the thorned variety.

*Dasineura gleditchiae* hanar fångades både i korstörne med och utan tornar. Det var ingen skillnad i antal hanar som fångades i de båda sorterna, men eftersom sorten utan tornar utvecklar blad under en längre period är det tänkbart att den kan vara känsligare för angrepp.



Figure 10. The adult *Obolodiplosis robiniae* is a tiny insect, only a few mm long. Infested trees were found in 6 localities in Skåne.

*Obolodiplosis robiniae* är mycket små insekter, endast några få mm. Angripna robinia-träd hittades på 6 lokaler i Skåne.

singly or in clusters among the young unexpanded leaflets (Fig. 1). Only one larva is required to initiate galling of the leaf (Thompson 1998). Adult midges hatch in a few days. The first generation emerges from cocoons located in the top 2.5 cm soil within 2 m the tree trunks. The adults emerge at about the same time as the trees start to grow (Thompson 1998).

Generation times range from 21-30 days with several overlapping generations per year

(Thompson 1998). It is possible that the thornless gleditsia is more sensitive to gall midge infestation than the thorned type. Trap catches indicate that the number of midges is the same in both types during swarming (Fig. 9). However, in the thornless variety new leaves continue to form during the summer whereas the thorned species stop growing in the middle of the summer. The season for infestation is thus longer in the thornless type.



Figure 11. *Obolodiplosis robiniae* larvae next to their gall. Sometimes more than one female can oviposit in one leaf, which result in several larval stages co-existing in one gall.

*Obolodiplosis robiniae* larver bredvid en gall. Ibland kan mer än en hona lägga ägg i ett blad, vilket resulterar i att flera olika larvstadier finns i en gall.



Figure 12. The symptoms of *Obolodiplosis robiniae* infestation are thick and rolled leaf margins. During larval development the gall change colour from green to yellow/pink and ends up being dark brown when the larvae starts pupation.

Symptom på angrepp av *Obolodiplosis robiniae* är tjocka och inrullade bladkanter. Under tiden som larverna utvecklar ändrar gallen färg från grön till gulrosa och är slutligen mörkbrun när larverna börjar förpupas.

*Obolodiplosis robiniae*

We found *O. robiniae* (Fig. 10) in 2008 in Sweden, in the province of Skåne (in Alnarp, Lomma, Burlöv, Malmö, Lund and Skanör). We observed on average 2-3 larvae in each of the collected galls (approximately 50 galls were collected). In a few galls, we found up to 5 developing larvae (Fig. 11). The level of infestation was low compared to earlier findings (e.g. Skuhravá et al. 2007). We observed the largest number of galls on *R. pseudoacacia* 'Umbraculifera' (Fig. 13), a clone with globular form which is common in gardens and plantations in Sweden. In the opened galls, we found almost all developmental stages of the black locust gall midge larvae at the same time, from first to third instar, but no pupae were found. The symptoms of larval feeding are thick and rolled leaf margins (Fig. 12) resulting in the characteristic leaf margin roll galls also described by Hoffmann et al. (2007). The galls are green at the beginning of the larval development, but become yellow or pink, and may turn to dark brown when the larvae reach the third instar and begin pupation (Skuhravá et al. 2007).

All our observations were made in late summer and it is possible that several midges had already emerged. We also found many empty galls with destroyed surfaces, possibly because of bird predation. *O. robiniae* is multivoltine (Gagné 2002) with three to four generations per year (Skuhravá & Skuhravy 2005). The midge becomes active at the same time as robinia starts to grow in May and emergence continues as long as new leaves develop, often until the first frost. Summer generations pupate inside the galls; the larvae of overwintering generations pupate in the top soil close to the tree trunk.

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Figure 13. *Robinia pseudoacacia* 'Umbraculifera' is a common tree in Sweden. This was also the variety with highest density of *R. pseudoacacia* larvae.

*Robinia pseudoacacia* 'Umbraculifera' är ett vanligt träd i Sverige. Det var också den sort på vilken de flesta *R. pseudoacacia* larverna fanns.

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### Sammanfattning

*Dasineura gleditchiae* och *Obolodiplosis robiniae* hittades för första gången 2008 i Sverige (Skåne). Båda arterna kommer ursprungligen från Nordamerika och båda bildar bladgaller. *O. robiniae* bildar bladkantsgaller på robinia-träd (*Robinia pseudoacacia* L., Fabaceae) och larver av *D. gleditchiae* bildar runda eller baljliknande galler på korstörne (*Gleditchia triacanthos* L., Fabaceae). Feromonfällor användes framgångsrikt för att upptäcka och följa svärmingen av *D. gleditchiae* i Alnarp, Sverige. Antalet svärmande myggor jämfördes också mellan en taggig och en taggfri sort av korstörne för att se om skillnader i mängden skador kan förklaras av detta. Inga skillnader i antalet myggor kunde dock mätas så skillnad i skademängd bör bero på andra faktorer.