agriculture, nature
and food quality

PEST RISK ANALYSIS

Contarinia maculipennis

Dendrobium flowers infested with Contarinia maculipennis

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Gallmidge experts Dr M. Tokuda[1] and Mr W. Nijveldt[2] reviewed a concept version of the PRA assessment in 2004.

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STAGE 1: INITIATION		
The aim of the initiation stage is to identify the pest(s) and pathways, which are of phytosanitary concern and should be considered for risk analysis in relation to the identified PRA area.		
Question	**Yes / No / Score**	**Notes**
1. Give the reason for performing the PRA	Go to 2	In 2001, *C. maculipennis* was observed in a Dutch orchid greenhouse and subsequently eradicated. Since 2004, the Dutch Plant Protection Service has intercepted *Contarinia maculipennis* several times in imported *Dendrobium* cut flowers from Thailand.
2. Specify the pest or pests of concern and follow the scheme for each individual pest in turn. For intentionally introduced plants specify the intended habitats.	Go to 3	*Contarinia maculipennis* Felt
If no pest of concern has been identified, the PRA may stop at this point.		
3. Clearly define the PRA area.	*Go to 4*	The Netherlands
Earlier analysis		
4. Does a relevant earlier PRA exist ? *if yes go to 5* *if no go to 6*	**No**	
Section A: Pest categorization		
Identify the pest (or potential pest)		
6. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank? *if yes indicate the correct scientific name and taxonomic position go to 8*	**Yes**	Order : Diptera Family : Cecidomyiidae Genus : Contarinia Species : maculipennis Felt

Determining whether the organism is a pest

8. Is the organism in its area of current distribution a known pest (or vector of a pest) of plants or plant products? *if yes, the organism is considered to be a pest, go to 10* *if no, go to 9*	**Yes**	The larvae of *Contarinia maculipennis* feed inside unopened flower buds of *Dendrobium*. The buds usually remain closed, become deformed, discoloured and in severe infestations premature bud or blossom drop occurs. Even lightly damaged flower buds that manage to open show damaged petals, resulting in unmarketable plants. *C. maculipennis* already attacked buds of hibiscus, tomato and jasmine (Jasminum sabac) in Hawaii, before the first damage on *Dendrobium* spp was reported in 1995 (Osborne *et al*, 2001). Several farmers on Okinawa Island have given up the cultivation of *Dendrobium* because of the severe damage caused by *C. maculipennis* (Tokuda *et al*., 2002).

Presence or absence in the PRA area and regulatory status

10. Does the pest occur in the PRA area ? *if yes go to 11* *if no go to 12*	**No**	In the Netherlands, 46 and 157 inspections were performed in greenhouses in 2004 and 2005, respectively by the Dutch Plant Protection Service. *C. maculipennis* was not found during these inspections.

Potential for establishment and spread in the PRA area

12. Does at least one host-plant species (for pests directly affecting plants) or one suitable habitat (for non parasitic plants) occur in the PRA area (outdoors, in protected cultivation or both)? *if yes go to 13* *if no go to 17*	**Yes**	Several host plant species of *Contarinia maculipennis* (Table 1), such as *Dendrobium* spp., tomato (*Lycopersicon esculentum*), sweet pepper (*Capsicum annuum*), eggplant (*Solanum melongena*) and hibiscus (*Hibiscus rosa-sinensis*) are grown under protected conditions. **Table 1. Common and scientific names of species recorded as hosts of *C. maculipennis*** (*Uechi et al*, 2003).

Name	Scientific name
Apocynaceae	
Plumeria	Plumeria rubra *L.*
Brassicaceae	

		White stem cabbage / Chinese white cabbage	*Brassica chinensis* L.[1]
		Pak-choi	" "
		Cucurbitaceae	
		Bitter gourd	*Momordica charantia* L.
		Malvaceae	
		Hibiscus	*Hibiscus rosa-sinensis* L. [2]
		Oleaceae	
		Arabian Jasmine	*Jasminum sambac* (L.)
		Pikake	" "
		Orchidaceae	
		Dendrobium orchids	*Dendrobium phalaenopsis* Fitz. and other *Dendrobium* species [3]
		Solanaceae	
		Garden pepper and other names	*Capsicum frutescens* L.
		Cayenne pepper, Chilli pepper, Sweet pepper and other names	*Capsicum annuum* L.
		Tomato	*Lycopersicon esculentum* Mill.
		Tomato	*Lycopersicon chilense* Dun.
		Tomato	*Lycopersicon peruvianum* (L.) Mill.
		Eggplant	*Solanum melongena* L.
		Potato	*Solanum tuberosum* L.
		Paraguay nightshade	*Solanum rantonnetii* Carr.
		Blue potato bush	" "

[1] *The record of B. chinensis as a host plant is based on a single observation in the greenhouse by Jensen (1946) and has not been confirmed by subsequent observations (Uechi et al, 2003).*

[2] *Felt collected larvae from H. rosa-sinensis in 1933, but did not mention the specific name as a host plant in his study (Uechi et al, 2003)*

[3] *The family of the Orchidaceae consists of about 750 to 1,000 genera. One of the largest genera is the genus Dendrobium with approximately 1,500 species. In total, there are more than 25,000 species within the Orchidaceae family.*

13. If a vector is the only means by which the pest can spread, is a vector present in the PRA area? *if yes go to 14* *if no go to 17*	**No**	A vector is not needed
14. Does the known area of current distribution of the pest include ecoclimatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)? *if yes go to 15* *if no go to 17*	**Yes**	The climate in the Netherlands is incomparable to the tropical climate in Thailand and Hawaii where the pest is present outdoors. However, greenhouse conditions have proven to be suitable for survival and establishment. The pest is present in many *Dendrobium* greenhouses on Okinawa Island (Japan) and greenhouses in central and southern Florida (USA). In 2001, it was observed in one greenhouse in the Netherlands and subsequently eradicated (Hara and Niino-DuPonte, 2002; Tokuda *et al*, 2002; Goffau de, 2002; Gagné, 1995). In 2007, the pest was probably introduced into another greenhouse in the Netherlands and subsequently eradicated (information obtained from a Dutch grower; finding not confirmed by the Dutch Plant Protection Service).
Potential for economic consequences in PRA area		
15. With specific reference to the plant(s) or habitats which occur(s) in the PRA area, and the damage or loss caused by the pest in its area of current distribution, could the pest by itself, or acting as a vector, cause significant damage or loss to plants or other negative economic impacts through the effect on plant health in the PRA area? *if yes or uncertain go to 16* *if no go to 17*	**Yes**	There is no apparent reason why damage such as observed in Japanese greenhouses could not occur in The Netherlands (see also the answer on question 8).
Conclusion of pest categorization		
16. **This pest could present a risk to the PRA area** (Summarize the main elements leading to the	**Go to Section B**	*C. maculipennis* is a serious pest in greenhouses in the USA and Japan. It is able to enter The Netherlands and potentially cause damage to *Dendrobium* orchids and

conclusion that the pest presents a risk to the PRA area)		possibly other cultivated host plants in greenhouses.

Section B. Assessment of the probability of introduction and spread and of potential economic consequences

1. Probability of introduction

Introduction, as defined by the FAO Glossary of Phytosanitary Terms, is the entry of pest resulting in its establishment.

Probability of entry

1.1 Consider all relevant pathways and list them. *Relevant pathways are those with which the pest has a possibility of being associated (in a suitable life stage), on which it has the possibility of survival, and from which it has the possibility of transfer to a suitable host* Go to 1.2		1. *Dendrobium* spp. – nursery stock (cuttings) 2. *Dendrobium* spp. – cut flowers The following potential pathways are not analyzed in detail in this PRA: • *Dendrobium* pot plants. Pot plants have only incidentally been imported in the past. • Jasminum, because there is hardly any import. • Hibiscus cuttings. These plantlets are imported without buds and the imported volume from infested countries is minimal. • *Solanaceae* fruit. The pest is not believed to be associated with fruit. • *Solanaceae* plants. Import of plants from Solanaceae species originating from third countries is prohibited by Annex 3 of Council Directive 2000/29/EC. If this closed pathway would be *opened* again, there might be a low entry risk. Low, because the pest is mainly associated with plant material containing buds, while plantlets of tomato and other *Solanaceae* host plant species are imported without buds. • Plant species from 7 different plant families have been reported as host plants which indicate that *C. maculipennis* is polyfagous (see the answer on question 12). Many more plant species might act as a host that are currently unknown.

1.2 Estimate the number of relevant pathways, of different commodities, from different origins, to different end uses. Go to 1.3	Many	The genus *Dendrobium* consists of approximately 1,500 species. The score is mainly based on this high number of *Dendrobium* species. Al these species are grouped in the two mentioned pathways.
1.3. Select from the relevant pathways, using expert judgement, those which appear most important. If these pathways involve different origins and end uses, it is sufficient to consider only the realistic worst-case pathways. The following group of questions on pathways is then considered for each relevant pathway in turn, as appropriate, starting with the most important. Go to 1.4		1. *Dendrobium* spp. – nursery stock (cuttings) 2. *Dendrobium* spp. – cut flowers
Probability of the pest being associated with the individual pathway at origin.		
1.4 Is the prevalence of the pest on the pathway at origin likely to be high, taking into account factors like the prevalence of the pest at origin, the life stages of the pest, the period of the year? Go to 1.5	**Moderately likely**	Moderately likely for all pathways. *C. maculipennis* is present in Thailand and other Southeast Asian countries. *Dendrobium* is cultivated year-round, usually in the open field (unprotected conditions).
1.5 Is the prevalence of the pest on the pathway at origin likely to be high, taking into account factors like cultivation practices, treatment of consignments? Go to 1.6	**Unlikely**	Orchid farmers in Thailand probably use large quantities of insecticides, preventing most gall midges from laying their eggs into orchids (Tokuda, 2004; personal communication to W. Lammers). <u>*Dendrobium* spp. – nursery stock (cuttings)</u> *Dendrobium* cuttings are imported without buds and without soil into the Netherlands. Flower buds may, however, incidentally be present on propagation material according to

	Moderately likely	Dutch orchid growers (e.g. 1 : 10.000 plantlets may carry buds). These buds might contain eggs and larvae. The roots of the plantlets are grown around coir chips. Pupae might be present between the coir chips but is not likely (uncertainty). Some years ago, a few *Dendrobium* flowers were often sent together with imported cutting as an example according to one of the Dutch importing companies. This practice might have led to introduction in the past. It is unknown if this practice still occurs. Larger plants with flower buds are imported in few occasions only. In that case the prevalence of the pest at origin is likely to be high. These larger plants suffer much from transport and, therefore, the import of such plants (with flower buds) will stay limited. <u>*Dendrobium* spp. – cut flowers</u> In Thailand, the gall midge can easily attack the flower buds from the natural environment since orchids are mainly grown outside in Thailand, except for some big companies (Tokuda, 2004; personal communication to W. Lammers). The prevalence of the pest is likely to be higher on cut flowers than on cuttings since cut flowers carry buds while imported cuttings usually do not. So far, *C. maculipennis* has only been intercepted in imported cut flowers.
1.6 How large is movement along the pathway? Go to 1.7	**Major** **Massive**	*Dendrobium* cuttings and cut flowers are mainly imported from Thailand. No significant trade occurs with the USA or Japan, also countries belonging to the current area of the pest's distribution. <u>*Dendrobium* spp. – cuttings</u> In 2005, inspectors of the Dutch Plant Protection Service inspected consignments of *Dendrobium* propagation material, imported from Thailand, consisting of 3,9 million plants. <u>*Dendrobium* spp. – cut flowers</u> In 2005, about 1.6 million *Dendrobium* cut flowers were imported into the Netherlands and marketed at the Dutch auctions (VBN, 2006). Most orchid flowers imported into the EU originate from Thailand (Heinrichs, 2000).

1.7 How frequent is the movement along the pathway? Go to 1.8	**Often** **Very often**	<u>*Dendrobium* spp. – cuttings</u> Consignments from Thailand arrive several times a week, throughout the year. <u>*Dendrobium* spp. – cut flowers</u> Consignments from Thailand arrive almost daily, throughout the year.
Probability of survival during transport or storage		
1.8 How likely is the pest to survive during transport / storage? Go to 1.9	**Likely**	Cut flowers and cuttings are transported by airplane. Larvae and pupae most likely survive the short transit time by airplane. In 2004 and 2005, living larvae of *C. maculipennis* were intercepted 9 and 3 times, respectively, during import inspections.
1.9 How likely is the pest to multiply / increase in prevalence during transport / storage? Go to 1.10	**Unlikely** **Unlikely**	<u>*Dendrobium* spp. – cuttings</u> Since propagation material of *Dendrobium* orchids is usually imported without buds, adult midges are not able to lay their eggs inside the buds as they normally do. <u>*Dendrobium* spp. – cut flowers</u> If adult midges are present in the consignment, they may lay eggs inside the flower buds. However, *C. maculipennis* will not complete its life cycle during transit since the duration of the life cycle is longer than the transit time.
Probability of the pest surviving existing pest management procedures		
1.10 How likely is the pest to survive or remain undetected during existing phytosanitary procedures?	**Moderately likely**	<u>*Dendrobium* spp. – cuttings</u> Propagation material of *Dendrobium* orchids is imported without buds and soil (although incidentally buds may be present). The probability that eggs, larvae or pupae are present in

Go to 1.11	**Moderately**	this kind of material is likely to be low, because of the absence of buds and soil. The propagation material is rooted in coir chips that might harbour pupae (uncertainty). In case this would happen, the pupae will probably remain undetected during phytosanitary inspections. Buds may be incidentally present. In case these buds would be infested they could easily remain undetected during inspections. Council Directive 2000/29/EC prescribes measures for plants, intended for planting, other than bulbs, corms, rhizomes, seeds and tubers, originating in third countries. Plants for planting should: (a) originate in an area, established in the country of export by the national plant protection service in that country, as being free from *Thrips palmi* Karny (...) or (b) originate in a place of production, established in the country of export by the national plant protection service in that country, as being free from *Thrips palmi* Karny (...) or (c) immediately prior to export, have been subjected to an appropriate treatment against Thrips palmi Karny and have been officially inspected and found free from *Thrips palmi* Karny (...). In Thailand, option (a) and also (b) are difficult to implement. Therefore, plants for planting, including *Dendrobium* cuttings are very often treated with imidacloprid. The application of imidacloprid against *Thrips palmi* larvae will probably reduce the risk of the presence of living larvae of *C. maculipennis* in the propagation material as well. **Uncertainty**: it is unknown if pupae can be present among the coir chips in which the imported *Dendrobium* cuttings are rooted.

	likely	<u>*Dendrobium* spp. – cut flowers</u> If infested plants show typical symptoms, such as deformed or discoloured buds, detection of *C. maculipennis* is likely, but the symptoms may also be misinterpreted as 'poor quality'. If the number of specimens (larvae of adults) is low, the probability of detection will decrease. In addition, the eggs and larvae are inside the buds and therefore difficult to observe. EU Commission Decision 98/109/EC prescribes emergency measures against the dissemination of *Thrips palmi* as regards Thailand. Cut flowers of *orchidaceae* shall have been either, (a) produced at a place of production which has been found free from Thrips palmi Karny on official inspections carried out at least monthly during the three months prior to export or (b) as a consignment prior to export, subjected to an appropriate fumigation treatment to ensure freedom from *thysanoptera*. Since a pest free place of production is difficult to implement in Thailand (cultivation does not take place under 'closed', protected conditions), most orchid cut flowers are fumigated before export to the EU. However, despite of these measures *Thrips palmi* (and *C. maculipennis*), are still intercepted on this pathway. In 2004 and 2005, *T. palmi* was intercepted 16 and 23 times and *C. maculipennis* 9 and 3 times, respectively, in Orchid cut flowers from Thailand during import inspections in the Netherlands. These findings suggest that the applied fumigation doses may (sometimes) be too low to ensure complete eradication of *C. maculipennis*.
Probability of transfer to a suitable host or habitat		

1.11 In the case of a commodity pathway, how widely is the commodity to be distributed throughout the PRA area? Go to 1.12	**Limited** **Very widely**	<u>*Dendrobium* spp. – cuttings</u> About 5 Dutch glasshouse production sites import *Dendrobium* propagation material from Southeast Asia. Two of these growers sell imported propagation material to other growers and in total about 15 production sites use propagation material imported from Thailand (estimation from a Dutch grower that import *Dendrobium* propagation material). <u>*Dendrobium* spp. – cut flowers</u> *Dendrobium* cut flowers are finally sold to consumers throughout the PRA area.
1.12 In the case of a commodity pathway, do consignments arrive at a suitable time of year for pest establishment? If yes, go to 1.13 If no, go to 1.3 (and start with other pathway, if relevant)	**Yes**	Yes, for all pathways.
1.13 How likely is the pest to be able to transfer from the pathway to a suitable host or habitat? Go to 1.14	**Very likely** **Very unlikely**	<u>*Dendrobium* spp. – cuttings</u> If the species is present in a nursery stock consignment, transfer to host plants that are grown on the importing production site is very likely to occur. This can be illustrated by the outbreaks in Japan, Hawaii and The Netherlands. Import of *Dendrobium* (orchid) nursery stock from Southeast Asia (mainly Thailand) is believed to be the most likely pathway for the introduction of *C. maculipennis* in Hawaii (Gagné, 1995), Japan (Tokuda *et al*, 2002) and The Netherlands in the past. In all cases, the infested site had imported nursery stock from Thailand. <u>*Dendrobium* spp. – cut flowers</u> When imported cut flowers are (temporarily) stored in the vicinity of a production site that grow host plants, transfer to a host plant crop is possible but not very likely. In all other cases, transfer to a suitable host is considered very unlikely. The species is a weak flyer and is most

		likely unable to survive outside in the PRA area. The probability that *Contarinia maculipennis* moves from cut flowers into a commercial glasshouse may be larger during summer time than wintertime. However, also in summer time, the probability that this will happen is low since the conditions in houses are assumed to be too dry for survival of the pest. Moreover, no examples are known of tropical pests that have been introduced into commercial glasshouses by the import of infested cut flowers in the PRA area.
1.14 In the case of a commodity pathway, how likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat? Go to 1.15	**Very likely** **Very unlikely**	<u>*Dendrobium* spp. – cuttings</u> If *C. maculipennis* is present in a nursery stock consignment, it will be introduced into a glasshouse production site. <u>*Dendrobium* spp. – cut flowers</u> (Orchid) cut flowers are usually placed indoors in people's homes or offices, etc. This will probably not aid to multiplication, establishment and spread of the species to commercially grown crops.
Consideration of further pathways In principle, all the relevant pathways selected at point 1.3 may in turn be considered. However, the replies given for the pathway(s) so far considered may indicate that it is not necessary to consider any more.		
1.15 Do other pathways need to be considered? If yes, go back to 1.3 If no, go to conclusion on the probability of entry	**No**	
<u>Conclusion on the probability of entry</u>		
Describe the overall probability of entry and identify the risks presented by different		**Probability of entry**

pathways Go to 1.16		<u>*Dendrobium* cuttings</u> Import of *Dendrobium* (orchid) nursery stock from Southeast Asia (mainly Thailand) is believed to be the most likely pathway for introduction of *C. maculipennis* in Hawaii, Japan and the Netherlands. In all cases, the infested site had imported cuttings from Thailand prior to the infestation. Nevertheless, the overall entry risk is estimated to be 'low', because the prevalence of the pest on the pathway is most likely to be low because the cuttings do not or only incidentally carry buds, the only plant parts which (as far as known) can be infested by *C. maculipennis*. Plants with buds are imported in few occasions and in that particular case the probability of entry is estimated to be high. <u>*Dendrobium* cut flowers</u> Although *C. maculipennis* has been intercepted several times in *Dendrobium* cut flowers from Thailand, the overall entry risk is estimated to be 'very low'. The main reason is that it is considered very unlikely that the pest will spread from the pathway to a suitable host or habitat.

Probability of establishment		
Availability of suitable hosts or suitable habitats, alternate hosts and vectors in the PRA area		
1.16 Specify the host plant species (for pests directly affecting plants) or suitable habitats (for non parasitic plants) present in the PRA area. Go to 1.17		The following (potential) host plants are present in The Netherlands: *Dendrobium* spp., *Brassica chinensis* L (cabbage), *Jasminum sambac* (Jasmine), *Hibiscus rosa-sinensis* L. (Hibiscus), *Capsicum annuum* L. (sweet pepper), *Lycopersicon esculentum* (tomato), *Solanum melongena* L. (egg plant), *Solanum tuberosum* L. (potato). The plant species other than *Dendrobium* spp. may be less favoured by *Contarinia maculipennis* (see below). Potato and cabbage that are cultivated outside are considered irrelevant because of the unfavourable climate in the PRA area. Uechi *et al* (2003) have shown by DNA-analysis and morphological comparisons of isolates from Japan, Hawai and Thailand that *C. maculipennis* is a polyphagous species that can attack plant species from at least 7 plant families. The pest may strongly prefer *Dendrobium* spp and possibly also bitter gourd (*Momordica charantia*), since many larvae were found on bitter gourd on Okinawa Island in Japan in 2006 (Uechi *et al*, 2003; N. Uechi, pers. communication to J.W.Lammers, 2007). Other host plant species like tomato, sweet pepper and egg plant might be less favoured since no infestation of these crops has been reported so far on Okinawa island where these crops are grown both in the open field and in greenhouses (N. Uechi, pers. communication to J.W.Lammers, 2007). Many weeds belonging to the Solonaceae are also present on Okinawa Island but no infestation of these weeds has been reported either (N. Uechi, pers. comm.). In Florida, the pest is present in Dendrobium and Hibiscus glasshouses (Osborne et al., 2001; Tokuda et al, 2002). On Hawaii, a heavy infestation of tomato flowers (*Lycopersicon esculentum*) was reported in 1945 (Jensen, 1946) but recent reports on damage by *C. maculipennis* of crop plants that are grown in the Netherlands other than *Dendrobium* or *Hibiscus* spp. are not known.
1.17 How widespread are the host plants or suitable habitats in the PRA area? (specify)	**Widely**	Glasshouse production sites that grow host plants (tomato, sweet pepper, Hibiscus, Jasminum sambac, egg plant and *Dendrobium*) are present throughout the Netherlands.

Go to 1.18		
1.18 If an alternate host is needed to complete the life cycle, how widespread are alternate host plants in the PRA area? (not relevant for plants) Go to 1.19	**Not applicable**	No alternate host is needed.
1.19 If the pest requires another species for critical stages in its life cycle such as transmission, (e.g. vectors), growth (e.g. root symbionts), reproduction (e.g. pollinators) or spread (e.g. seed dispersers) how likely is the pest to become associated with such species? Go to 1.20	**Not applicable**	
Suitability of the environment		
1.20 How similar are the climatic conditions that would affect pest establishment, in the PRA area and in the area of current distribution? Go to 1.21	**Largely similar**	The climate in the Netherlands is completely different from the tropical climate in Thailand and Hawaii. However, the climate in greenhouses is probably comparable and favourable for development and survival of *Contarinia maculipennis* throughout the year. Greenhouse conditions have proven to be suitable for development and survival of *Contarinia maculipennis* in the USA (Hara and Niino-DuPonte, 2002; Gagné, 1995), Japan (Tokuda *et al*, 2002) and The Netherlands (De Goffau, 2002).
1.21 How similar are other abiotic factors that would affect pest establishment, in the PRA area and in the area of current distribution? Go to 1.22	**Unknown**	Hara *et al* (2002) have stated that pupation is most successful in soil that is moist but not wet. Natural soil type is, however, not an important issue in the cultivation of pot plants and tomatoes in glasshouses since they are usually grown on artificial substrates. It is unknown which other abiotic factors are important for the species' development and survival.
1.22 (Answer this question only if protected	**Often**	Since the mid 90's, *C. maculipennis* has been recorded in *Dendrobium* orchid greenhouses in

cultivation is important in the PRA area.) How often has the pest been recorded on crops in protected cultivation elsewhere? Go to 1.23		Hawaii (Gagné, 1995; Hara and Niino-DuPonte, 2002), in many *Dendrobium* greenhouses on Okinawa Island in Japan (Uechi *et al*, 2003; Tokuda *et al*, 2002). In the Netherlands, the pest has been recorded in one glasshouse in 2001 and 2007 (De Goffau, 2002; second finding reported by a grower, not confirmed by the Dutch Plant Protection Service).
1.23 How likely is establishment to be prevented by competition from existing species in the PRA area? Go to 1.24	**Very unlikely**	Most likely, the introduced specimens will not suffer from natural enemies, one reason being the pest's niche habitat (eggs and larvae in buds).
1.24 How likely is establishment to be prevented by natural enemies already present in the PRA area? Go to 1.25	**Very unlikely**	No natural enemies of *Contarinia maculipennis* are known outside its area of origin and no data are known of other species competing with *C. maculipennis*.
Cultural practices and control measures		
1.25 To what extent is the managed environment in the PRA area favourable for establishment? Go to 1.26	**Highly favourable**	Several host plants are grown under protected conditions. This is considered a highly favourable environment.
1.26 How likely are existing control or husbandry measures to prevent establishment of the pest? Go to 1.27	**Unlikely**	The kind of insecticides and the frequency of insecticide application depend on the occurrence of other pests in the crop. If the grower is using a systemic insecticide like imidacloprid against pests already present in the greenhouse, it may decrease the probability of establishment of *Contarinia maculipennis*. However, these kinds of insecticides are generally not applied at high frequencies and, therefore, establishment of the pest remains possible. Furthermore, the outbreak of *Contarinia maculipennis* in a greenhouse in The Netherlands in 2001 was not easy to control and eradicate (De Goffau, 2002). In 2007, *Contarinia maculipennis* was introduced into another greenhouse and subsequently eradicated by removal of flowers and buds and by spraying insecticides 3 times a week during a 3-week period (information obtained from a Dutch grower). Such an intensive control strategy is not common in the cultivation of *Dendrobium*.

1.27 How likely is it that the pest could be eradicated from the PRA area ? Go to 1.28	**Likely**	The pest has been introduced at least twice into the Netherlands and subsequently eradicated (second introduction not confirmed by the Plant Protection Service; information obtained from a Dutch grower).
Other characteristics of the pest affecting the probability of establishment		
1.28 How likely is the reproductive strategy of the pest and the duration of its life cycle to aid establishment? Go to 1.29	**Likely**	*Contarinia maculipennis* completes its life cycle in only 3-4 weeks and should be able to establish itself relatively easily in a new environment. Furthermore, *C. maculipennis* is a tiny species and several life-stages are present in a 'protected environment' (eggs and larvae in buds; pupae in soil) and can be overlooked quit easily.
1.29 How likely are relatively small populations or populations of low genetic diversity to become established? Go to 1.30	**Moderately likely**	Most likely, introductions of *Contarinia maculipennis* with nursery stock do not occur with large numbers of specimens. However, establishment of the species in greenhouses was reported from Japan, USA and The Netherlands using nursery stock from areas where the pest organism is present. As far as known, the pest has been introduced into the Netherlands twice and subsequently eradicated.
1.30 How adaptable is the pest? Go to 1.31	Adaptability is: **Moderate**	The species seems to be quit genetically adaptable considering its large range of host plants. It cannot be excluded that *Contarinia maculipennis* will adapt to more plant species in the future.
1.31 How often has the pest been introduced into new areas outside its original area of distribution? (specify the instances , if possible) Go to 1.32	**Occasionally**	The area of origin is probably South East Asia from which it has been introduced into Hawaii and into greenhouses on Okinawa Island (Japan), Florida and the Netherlands (Gagné, 1995; De Goffau, 2002; Hara and Niino Du Ponte, 2002).
1.32 Even if permanent establishment of the pest is unlikely, how likely are transient	**Not applicable**	

populations to occur in the PRA area through natural migration or entry through man's activities (including intentional release into the environment) ? (Transience = presence of a pest that is not expected to lead to establishment) Go to 1.33		
Probability of spread		
1.33 How likely is the pest to spread rapidly in the PRA area by natural means? Go to 1.34	**Moderately likely**	*Contarinia* species are weak flyers. However, wind can cause dispersal of the small gall midges over longer distances (Gagné, 1989). For example, wind dispersal has been considered the most likely pathway for introduction of the gall midge *Contarinia nasturtii* from Ontario into New York (Scott, 2004). However, *C. nasturtii* is capable of surviving climatic conditions in Ontario and New York and host plants are readily available outdoors in those areas. For *C. maculipennis* in The Netherlands, the situation is different since the outdoor climate is most likely unsuitable for establishment. It is therefore not very likely that the pest will spread rapidly AND successfully by natural means also because female midges only live up to 4 days. The probability of transfer will increase when glasshouse production sites that grow host plants are situated close to each other.
1.34 How likely is the pest to spread rapidly in the PRA area by human assistance? Go to 1.35	**Not very likely**	In the Netherlands, about 5 glasshouse production sites import *Dendrobium* nursery stock from Thailand. Two of these companies sell imported nursery stock to other production sites and in total about 15 production sites use nursery stock from Thailand (information obtained from a Dutch grower). According to M. Tokuda (AIST, Japan; personal communication to J.W. Lammers, July 2006), larvae of *C. maculipennis* may be spread attached to clothes or shoes and, therefore, visitors have to clean their shoes carefully before entering non-infested greenhouses in Japan. Thus, the risk of spread of *C. maculipennis* by human assistance is not very high but can certainly not be excluded in the Netherlands.

		If infested host plants, and especially nursery stock is traded, the pest can be spread rather quickly from one greenhouse to another.
1.35 How likely is it that the spread of the pest could be contained within the PRA area? *Go to Conclusion on the probability of introduction and spread*	**Likely**	As indicated above, natural spread over long distances could occur by wind dispersal. However, natural spread is not likely to occur: the outdoor climate is unfavourable for development most time of the year.
Conclusion on the probability of introduction (= entry + establishment) and spread		
Describe the overall probability of introduction and spread. The probability of introduction and spread may be expressed by comparison with PRAs on other pests. *Go to 1.36*		**Probability of introduction (entry + establishment)** It is estimated that the probability of entry with *Dendrobium* cuttings is low since these cuttings are free of buds and soil. Occasionally, plants with buds are imported. The probability of entry with this pathway (plants with buds) is moderate. When entry occurs, the pest will likely establish at *Dendrobium* production sites that import these cuttings since greenhouse climatic conditions are favourable. **Probability of spread** *C. maculipennis* is a weak flyer. Long-distance natural spread could occur by wind dispersal of the adult midges. However, this kind of spread is unlikely to occur: female midges only live up to 4 days and the climate is unfavourable most time of the year for the tropical species. Natural spread may play a significant role from *Dendrobium* glasshouses to other glasshouses with host plants (*Dendrobium*, tomato, sweet pepper, etc) in the near vicinity.
Conclusion regarding endangered areas		
1.36 Based on the answers to questions 1.16 to 1.35 identify the part of the PRA where presence of host plants or suitable habitats and ecological factors favour the		The endangered areas are primarily the greenhouse production sites that use *Dendrobium* cuttings imported from Thailand. In the Netherlands about 5 companies import cuttings from Thailand and about 15 companies use cutting from Thailand (a few companies sell cuttings to other companies). Secondly, greenhouse production sites are endangered that grow host

establishment and spread of the pest to define the endangered area. Go to 2 Assessment of potential economic consequences		plants and are situated close to one of the ca. 15 production sites with Dendrobium cuttings from Thailand. Thus, especially in areas where glasshouses are closely situated to each other, which is the case in several regions in the Netherlands, the infested area might increase by natural spread from one glasshouse site to another. Spread of the pest organism with human assistance by attachment of larvae or adults to clothes or shoes of people visiting different sites can neither be excluded. Thus, on the third place, all glasshouse production sites that grow host plant are endangered.

2. Assessment of potential economic consequences

Pest effects

2.1 How great a negative effect does the pest have on crop yield and/or quality to cultivated plants or on control costs within its area of current distribution? Go to 2.2	**Moderate**	According to Rojanavongse (1986) and Tokuda *et al* (2002*), C. maculipennis* is (one of) the most serious pests of *Dendrobium*. The larvae of *Contarinia maculipennis* feed inside unopened flower buds of *Dendrobium*. The buds usually remain closed, become deformed, discoloured and in severe infestations premature bud or blossom drop occurs. Even lightly damaged flower buds that manage to open show damaged petals, resulting in unmarketable plants. This kind of damage has been observed in glasshouses on Okinawa Island (Japan; Tokuda *et al*, 2002), Hawaii (USA; Hara and Niino-DuPonte, 2002) and the Netherlands (De Goffau, 2002). Since 2005, *C. maculipennis* has also been observed in *Dendrobium* glasshouses in other parts of Japan: Fukuoka (since 2005) and Miyazaki (since 2006). On Okinawa Island, the application frequency of insecticides in orchid greenhouses has doubled and several farmers have given up orchid cultivation after the introduction of *C. maculipennis* (Tokuda *et al*, 2002). In Japan, *C. maculipennis* is a quarantine organism (Tokuda, personal communication). In Hawaii, the species is present on many orchid farms and is able to cause severe damage. Sometimes, an orchid crop is totally infested with this gall midge and control is very difficult (Hara 2003, personal communication). In contrast, this gall midge is not very important as a pest of orchids in Thailand. The reason for this contrasting situation is unknown (M. Tokuda, 2003, personal communication). It is unknown how great a negative effect *C. maculipennis* has on host plants other than *Dendrobium* spp. In literature, infestation of several other host plants has been described but no damage levels are indicated: *C. maculipennis* already attacked buds of hibiscus, tomato and jasmine (Jasminum sabac) in Hawaii, before the first damage on *Dendrobium* spp was reported in 1995 (Osborne *et al*, 2001). It was observed that susceptibility varies between tomato varieties due to the flower structure. Host plant varieties in which petals remain tightly fitted until the bud is almost ready to open may be less susceptible than other

		varieties (Hara and Niino-DuPonte, 2002). In Japan on Okinawa Island and in Fukuoka and Miyazaki, *C. maculipennis* causes damage to *Dendrobium* spp in glasshouses. On Okinawa island, it also attacks bitter gourd in the open field. Up till now, the pest has not been reported in tomato, sweet pepper and egg plants that are grown both in glasshouses and in the open field on Okinawa island, neither has the pest been reported on weeds belonging to the genus Solanaceae (N. Uechi, 2007, personal communication to J.W. Lammers).

2.2 How great a negative effect is the pest likely to have on crop yield and/or quality in the PRA area? Go to 2.3	**Major** (for Dendrobium spp. and probably Hibiscus spp.) without control measures **Unknown** (other host plants)	Damage levels on *Dendrobium* spp. are expected to be similar to those observed in greenhouses in the USA and Japan (see 2.1). Comparable damage has been observed once in The Netherlands (De Goffau, 2002; fig 3) and the pest can have a major impact on the production of *Dendrobium* orchids. In 2005, about 1.8 million *Dendrobium* cut flowers (€ 0.5 million) and 2.2 million (pot) plants (€ 8.4 million) were marketed on the auctions in the Netherlands (VBN, 2006). About 10% of the cut flowers and almost all (pot) plants had been produced in the Netherlands. Thus, the total value of *Dendrobium* cut flowers and pot plants produced in the Netherlands was about € 9 million in 2005. *Hibiscus* is affected in Florida (Osborne et al, 2001), but little information is available on crop damage. Damage of *Hibiscus* flowers will probably have a large economic impact when no control measures are applied. In 2005, about 3 million Hibiscus pot plants (€ 5.9 million) were marketed on the auctions in the Netherlands (VBN, 2006). When appropriate control measures are applied at an early stage the negative effect on crop yield and quality will be low to moderate. If other greenhouse crops like tomato (production in 2004: 606.000 tons, information from Productschap Tuinbouw, Zoetermeer, the Netherlands) and sweet pepper would be seriously affected, the economic impact of the pest for glasshouse horticulture would increase greatly. It is, however, unknown how serious damage will be on host plants other than *Dendrobium* spp. like tomato, sweet pepper and eggplant that are grown on about 25% of the total glasshouse area in the Netherlands. In regions in Japan where the pest is present, no attack has been reported on tomato, sweet pepper and eggplant grown in glasshouses or in the open field (N. Uechi, 2007. personal communication to J.W. Lammers). These observations suggest that *C. maculipennis* is not a major pest of these crops. **Uncertainty:** It is uncertain if plant species other than *Dendrobium* spp. (and *Hibiscus* spp.) will be affected by *C. maculipennis.*

2.3 How great an increase in production costs (including control costs) is likely to be caused by the pest in the PRA area? Go to 2.4	**Moderate**	On Okinawa Island in Japan, the application frequency of insecticides in orchid greenhouses has doubled since the introduction of *C. maculipennis* (Tokuda *et al*, 2002). In Hawaii, the species is present on many orchid farms and is able to cause severe damage. Sometimes, an orchid crop is totally infested with this gall midge and control is highly difficult (Hara 2003, personal communication). In the Netherlands, control may be less difficult as shown by the eradication of a recent outbreak (2007) in a Dutch glasshouse (information from a Dutch grower). It appears that the gall midge can be eradicated from a Dutch glasshouse when appropriate measures are taken. In that case an increase in production costs (by yield losses and an increase in pesticide use) will be limited.
2.4 How great a reduction in consumer demand is the pest likely to cause in the PRA area? Go to 2.5	**Minimal**	It is unlikely that damage rises up to a level where it directly affects consumer demands.
2.5 How important is environmental damage caused by the pest within its area of current distribution? Go to 2.6	**Minimal**	No records are known of environmental damage caused by *Contarinia maculipennis*.
2.6 How important is the environmental damage likely to be in the PRA area? Go to 2.7	**Minimal**	No records of environmental damage due to the presence *Contarinia maculipennis* in its present area of distribution are known. Moreover, the climatic conditions in The Netherlands are considered unsuitable for *C. maculipennis*.
2.7 How important is social damage caused by the pest within its area of current distribution? Go to 2.8	**Moderate**	According to Tokuda (2002), several growers on Okinawa Island in Japan have given up orchid cultivation because of the severe damage caused by *C. maculipennis*. In Thailand, the pest seems to be of minor importance (M. Tokuda, pers. communication).
2.8 How important is the social damage likely to be in the PRA area? Go to 2.9	**Minor**	Several growers have given up orchid cultivation on Okinawa Island (Japan) because of severe losses caused by *C. maculipennis* (Tokuda, 2002). This will probably not happen in the Netherlands as long as effective pesticides are available. The pest was finally eradicated after introductions in Dutch glasshouses in 2001/2002 and recently in 2007 (information about the

		second introduction obtained from a Dutch grower).
2.9 How likely is the presence of the pest in the PRA area to cause losses in export markets? Go to 2.10	**Not very likely**	In case the presence of *C. maculipennis* larvae remains unnoticed before plants have been sold, the buyer of these plants will notice damage in a later stage. This negative effect on the quality of plants may lead to shifting export markets or phytosanitary measures. Probably, most plants will be noticed before they are sold and will not be marketed.
The evaluation of the following questions may not be necessary if any of the responses to questions 2.2, 2.3, 2.4, 2.6, or 2.8 is "major or massive" or "likely or very likely". You may go directly to point 2.16 unless a detailed study of impacts is required.		
2.10 How easily can the pest be controlled in the PRA area? Go to 2.11	**With some difficulty**	Reports from Okinawa Island in Japan indicate that it is difficult to control the pest (Tokuda *et al*., 2002). In Thailand, the pest seems to be of minor importance (M. Tokuda, pers. communication). According to De Goffau (2002) a control strategy using methomyl, imidacloprid and teflubenzuron was sufficiently effective in the PRA area (applied against the outbreak in one glasshouse in the PRA area in 2001/2002). The systemic insecticide imidacloprid (chemical group; neonicotinoids) may have been essential in that strategy. According to Nami Uechi (Okinawa Prefectural Agricultural Research Center, Japan, personal communication to J.W. Lammers, July, 2006), methomyl is not effective but imidacloprid and the related compound thiametoxam are effective. Imidacloprid has a systemic effect that may be essential for a good effect since the larvae are hidden in the flower buds. Teflubenzuron need to be taken up by the larvae to be effective and it is questionable if the larvae that are hidden in the buds will be sufficiently exposed to this compound. Recently in 2007, *Contarinia maculipennis* was introduced into a *Dendrobium* glasshouse in the Netherlands (introduction not confirmed by the Dutch Plant Protection Service). The grower had imported a small consignment of plants with buds from Thailand and a *Dendrobium* specialist from Thailand visiting the glasshouse confirmed the presence of the pest. The pest was eradicated by removal of all flowers and by spraying pesticides three times a week during a 3-week period. The pesticides used were abamectin, carbofuran, deltamethrin and imidacloprid (this information was obtained from a Dutch *Dendrobium* grower). In this case an intensive control program of 3 weeks was sufficient to eradicate the

		pest.
2.11 How probable is it that natural enemies, already present in the PRA area, will suppress populations of the pest if introduced? Go to 2.12	**Unlikely**	Eggs and larvae are present inside flower buds. In the PRA area, parasitoids are present that attack native *Contarinia* spp present in the open field. However, these *Contarinia* spp. still cause a lot of damage to their host plants. It is, therefore, unlikely that these parasitoids could significantly suppress *Contarinia maculipennis* in glasshouses. Moreover, insecticides used in many glasshouse crops will kill the parasitoids.
2.12 How likely are control measures to disrupt existing biological or integrated systems for control of other pests or to have negative effects on the environment? Go to 2.13	**Unlikely (Dendrobium)** **Likely (tomato, sweet pepper)**	The predatory mite *Hypoaspis miles* is used against Sciaridae and some other soil pest in the cultivation of *Dendrobium* (personal communication of G. Messelink, Applied Plant Research – Glasshouse Horticulture, to D.J. van der Gaag, 2006). Drip application of the systemic insecticide imidacloprid will not affect Hypoaspis populations. However, spray application of this compound (against the larvae) or synthetic pyrethroids (against the adults) will negatively affect Hypoaspis and may lead to disruption of the biological control of soil pests. Other pests in *Dendrobium* spp. are controlled chemically. The introduction of a new pest, however, will make the introduction of more integrated control systems in the cultivation of *Dendrobium* spp. more difficult in the future. It is difficult to answer this question for tomato, sweet pepper or eggplant, because hardly any information is available on attack of these plants by *C. maculipennis*. However, pests are usually controlled in a biological or integrated manner in these crops, and application of insecticides may disrupt this system. Spray application with for example imidacloprid (which presently is not a legal application) will certainly lead to disruption of these biological/integrated systems. Spray application of abamectin or deltamethrin will also disrupt biological/integrated systems. Carbofuran is not allowed to use in these crops. If drip irrigation of imidacloprid would be sufficiently effective the biological/integrated systems would be partially disrupted.
2.13 How important would other costs resulting from introduction be? Go to 2.14	**Minor**	Farmers have to be informed and advised about this new pest. Research may be needed on control strategies.

2.14 How likely is it that genetic traits can be carried to other species, modifying their genetic nature and making them more serious plant pests? Go to 2.15	**Unlikely**	No examples are known for *Contarinia* spp.
2.15. How likely is the pest to act as a vector or host for other pests? Go to 2.16	**Unlikely**	Not known to occur
2.16 Is the pest likely to develop resistance to plant protection products?	**Moderately likely** **(uncertain)**	Little information is available on the efficacy of insecticides against *C. maculipennis* in literature, except statements that control has appeared difficult. It has been suggested that the pest has developed resistance against various insecticides like organophosphates and carbamates (Tokuda *et al*, 2002). According to Nami Uechi (Okinawa Prefectural Agricultural Research Center, Japan, personal communication to J.W. Lammers, July, 2006), the neonicotinoids imidacloprid and thiametoxam are effective against *C. maculipennis*, while the carbamate methomyl is not effective. In the PRA area, several insecticides from different chemical groups are possibly effective against the larvae: imidacloprid and thiametoxam (both neonicotinoids), abamectin, and carbofuran. These insecticides act either (locally) systemic or translaminar and may reach the larvae present in the buds. Deltamethrin may be effective against the adults. **Uncertainty** Tokuda *et al* (2002) has suggested that *C. maculipennis* has developed resistance against various insecticides, such as organophosphorus, synthetic pyrethroid, carbamate and other major IGR chemicals. However, data on resistance development are lacking.
After completing this section, the assessor should comment on whether sufficient information exists to trust the answers given; or if he/she knows of other relevant factors that have not been considered in this evaluation.		

Comment on the used information

The main areas of uncertainty are:

- The damage levels on host plants other than *Dendrobium* spp. (e.g. tomato and sweet pepper);
- The host plant range: plant species from 7 different plant families have been reported as host plants which indicate that *C. maculipennis* is polyfagous and may attack more plant species than listed in table 1 (answer on question 12 of this PRA)
- It is uncertain if pupae of *C. maculipennis* can be present among the coir chips in which the imported *Dendrobium* cuttings are rooted.
- The efficacy of insecticides against the larvae present in the buds and against the adults.

3. Final Evaluation

Entry

Contarinia maculipennis has been intercepted several times during import inspections of *Dendrobium* cut flowers in The Netherlands. In 2001, the species was found in a *Dendrobium* greenhouse and subsequently eradicated. Import of *Dendrobium* cuttings or plants from Thailand was believed to be the most likely pathway for this introduction. The percentage of infested *Dendrobium* cutting consignments and the density of the pest in infested consignments is probably very low since the imported plantlets are free of flower buds and soil that are the most likely places where the pest may hide (incidentally a bud may be present). Plants with flower buds are imported in very few occasions. In 2007, the pest was probably introduced into a Dutch greenhouse with the import of plants with flower buds; the pest was subsequently eradicated (finding not confirmed by the Dutch Plant Protection Service). If imported *Dendrobium* cuttings/plants are infested, it is almost inevitable that the pest will enter a *Dendrobium* production site.

Probability of entry with *Dendrobium* cuttings (free of buds): (very) low

Probability of entry with *Dendrobium* plants having buds: low – moderate

C. maculipennis is much less likely to transfer from the pathway 'cut flowers' to other host plants (or suitable habitats) compared to the pathway 'cuttings'. Thus, despite the fact that *C. maculipennis* has been intercepted several times in cut flowers, the probability of entry with the import of cut flowers is considered lower than with the import of propagation material.

Probability of entry with *Dendrobium* cut flower: very low

Establishment

C. maculipennis has been able to establish outside its area of origin (Southeast Asia). Presently, this gall midge has established on Hawaii, in Florida and parts of Japan. It can survive outdoors on Hawaii and probably also on the tropical Okinawa Island in Japan. It was found twice in greenhouses in The Netherlands (second finding not confirmed by the Dutch Plant Protection Service) and subsequently eradicated. The outside climate in the Netherlands is probably not suitable for establishment.

Probability of establishment in greenhouses: (very) high

Probability of establishment outdoors: very low

Spread

C. maculipennis is a weak flyer. Long-distance natural spread could occur by wind dispersal of the adult midges. However, this kind of spread is unlikely to

occur in the PRA area: females only live up to 4 days and the outdoor climate is assumed to be unsuitable most time of the year. Natural spread may occur from infested glasshouses to other glasshouses that grow *Dendrobium* spp. (and maybe other crop plants that may act as host plant like tomato, sweet pepper and egg plant) and that are in the close vicinity of the infested glasshouse.

Spread by human assistance is not very likely to occur: no trade occurs between glasshouse production sites that import cuttings and other productions sites. Spread by human assistance can, however, not be excluded since larvae of *C. maculipennis* may be spread from greenhouse to greenhouse attached to clothes or shoes.

Probability of rapid spread: low

The endangered area

Primarily: greenhouse production sites that use *Dendrobium* cuttings from Thailand.
Secondly: greenhouse production sites that grow host plants and are closely situated to the production sites that use cuttings from Thailand.
Thirdly: all greenhouse production sites that grow one or more host plants of *C. maculipennis*.

Uncertainty: *C. maculipennis* has a broad host range including tomato, sweet pepper and eggplant. This broad host range is based on data from Hawaii where the pest reproduces year-round. It is, however, uncertain if crop plants other than *Dendrobium* spp. will be attacked by *C. maculipennis* in the Netherlands, since the pest has not been reported from plant species other than *Dendrobium* spp. and bitter gourd (*Momordia charantia*) on Okinawa Island (Japan) where tomato, sweet pepper and eggplant are grown both in glasshouses and in the open field. In Florida, *C. maculipennis* has been reported on *Dendrobium* and *Hibiscus* grown in glasshouses. Bitter gourd is not grown in the Netherlands and based on the observations in glasshouses in Japan and Florida, it is expected that besides *Dendrobium* also *Hibiscus* spp. can be infested by *C. maculipennis* in glasshouses in the Netherlands.

Economic impact

Larvae of *C. maculipennis* feed inside unopened flower buds of its host plants. Infested buds stay closed, become deformed and discoloured. In severe infestations, premature bud or blossom drop may occur. Even lightly damaged flower buds lead to unmarketable orchids. This kind of damage has been observed on *Dendrobium* orchids in Hawaii, Japan and The Netherlands. In Japan, where the organism is a quarantine pest, several growers have given up orchid cultivation because of this pest. The economic impact will largely depend on the availability of effective control measures against the pest. The pest can be controlled and eradicated in the PRA area by removal of flowers and application of several kinds of insecticides. When proper control measures are used at an early stage, damage will be limited. Once, the pest has been eradicated in a glasshouse, it will not re-enter easily from outside since, unlike Okinawa Island, the outdoor conditions are unfavourable for the pest in the PRA area. The economic impact of the pest on the cultivation of *Hibiscus* pot

plants in the Netherlands is expected to be similar to that of *Dendrobium* plants.

Economic impact for infested *Dendrobium* and *Hibicus* production sites:

major (without control measures)

low -moderate (with use of control measures)

Uncertainty: *C. maculipennis* may attack other crops than *Dendrobium* and *Hibuscus*, like tomato, sweet pepper and eggplant that are grown on about 25% of the total glasshouse area in the Netherlands. It is however uncertain if these crops will be attacked and, therefore, the economic impact on crops other than *Dendrobium* and *Hibiscus* cannot be estimated (see also "endangered area").

Final conclusions

The larvae of *C. maculipennis* cause damage in *Dendrobium* orchids that results in unmarketable plants. In Hawaii, this species has been found in flower buds of several other host plants a.o. tomato, hibiscus, *Jasminum sambac*, sweet pepper, bitter gourd and *Plumeria rubra*. In Florida, the pest has been reported on *Dendrobium* spp. and *Hibiscus* but as far as we know not on other plant species. On Okinawa Island in Japan, the pest has been found on *Dendrobium* orchids and bitter gourd but has not been reported in other crops like tomato, sweet pepper and eggplant that are grown on the island. Bitter gourd is not grown in the Netherlands, and it is concluded that it is uncertain if *C. maculipennis* would attack crop plants other than glasshouse *Dendrobium* spp. and *Hibiscus* crops in the PRA area.

The risk of *C. maculipennis* introduction with cut flowers is minimal. *C. maculipennis* can be introduced with *Dendrobium* cuttings, but the risk is minimal if cuttings are imported free of buds and soil. This is common practice in The Netherlands, the import of plants with buds (excl. cut flowers) is an exception. In case, the pest is introduced at a glasshouse production site, the probability that it will spread to other *Dendrobium* or *Hibiscus* glasshouse production sites is low. Sofar, two introductions of *C. maculipennis* into a Dutch glasshouse are known. In both cases, the grower eradicated the pest from the glasshouse.

Mainly because of the low risks of introduction and spread, *C. maculipennis* has not the characteristics of a quarantine organism and there is no need for regulation. This conclusion may have to be reconsidered if:

- the import op plant material carrying buds will significantly increase and, thereby, the probability that *C. maculipennis* will be introduced into the Netherlands, and/or
- new information indicates that tomato and/or other crop plants in the PRA area will have a high probability to be severely attacked by *C. maculipennis*. Especially, because control measures in crops like tomato and sweet pepper will probably disrupt existing biological control systems and, thereby, increase the use of chemical pesticides largely.

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