CSL PEST RISK ANALYSIS FOR *PSEUDAULACASPIS PENTAGONA*

STAGE 1: PRA INITIATION

1. What is the name of the pest?

Pseudaulacaspis pentagona (Targioni-Tozzetti) Hemiptera Diaspididae white peach scale

Notes on taxonomy:

This organism has been described under a great variety of names (see synonyms). However, since the middle of the Twentieth Century, there has been stability and the taxonomy of the pest now appears well established.

Synonyms

Diaspis pentagona Targioni Tozzetti, 1886	*Diaspis geranii* Maskell, 1897
Aulacaspis pentagona Cockerell, 1902	*Chionaspis prunicola* Maskell, 1895
Diaspis amygdali Tryon, 1889	*Diaspis lanata* Green, 1896
Pseudaulacaspis amygdali Tryon, 1889	*Howardia prunicola* Kirkaldy, 1902
Sasakiaspis pentagona Kuwana, 1926	*Aulacaspis pentagona rubra* Fernald, 1903
Diaspis lanatus Cockerell, 1892	*Aulacaspis pentagona auranticolor* Carnes, 1907
Diaspis patelliformis Sasaki, 1894	*Epidiaspis vitiensis* Lindinger, 1937
Aspidiotus vitiensis Maskell, 1895	*Aspidiotus lanatus* Ferris, 1941
Diaspis auranticolor Cockerell, 1899	*Diaspis rubra* Scott, 1952
Diaspis amygdali var. rubra Maskell, 1889	

2. What is the reason for the PRA?

In late summer 2006 a member of the public contacted the Natural History Museum (NHM) seeking help to identify some scale insects in his garden on *Catalpa bignonioides* trees (2-3m tall) that had come from Italy 4 or 5 years previously. NHM did not identify the scale insect and suspected that the species was non-indigenous and consequently contacted CSL. CSL then contacted the PHSI who visited the private garden in Kent with the infested trees and took samples that CSL confirmed as *Pseudaulacaspis pentagona* in September 2006. As a non-indigenous plant pest that is capable of killing hosts, and since the pest has also been detected on consignments entering England in the past, a PRA is warranted.

3. What is the PRA area?

Pseudaulacaspis pentagona already occurs across much of continental Europe so this PRA considers the UK as the PRA area.

STAGE 2: PEST RISK ASSESSMENT

4. Does the pest occur in the PRA area or does it arrive regularly as a natural migrant?

No. *Pseudaulacaspis pentagona* does not normally occur in the PRA area and does not arrive as a natural migrant.

5. Is there any other reason to suspect that the pest is already established in the PRA area?

Other than seeming to have established on a few trees in a single private garden in Kent, there is no reason to suspect that *P. pentagona* has established outdoors elsewhere in the UK.

In March 2006 *P. pentagona* was reported on potted plants growing in a polytunnel in a private garden in Oxfordshire. The plants had originated in the Netherlands four or five years previously. Options for appropriate pest management treatments were provided to the owners of the infested trees (CSL unpublished data).

6. What is the pest's status in the Plant Health Directive (Council Directive 2000/29/EC[1]) ?

Pseudaulacaspis pentagona is not listed in the EC Plant Health Directive.

7. What is the pest's list status in the European and Mediterranean Plant Protection Organisation (EPPO)? (www.eppo.org)

EPPO List:	A1 regulated pest list	No	A2 regulated pest list	No	Action list	No	Alert list	No

Pseudaulacaspis pentagona is not listed in any EPPO quarantine lists. It is worth noting that Belarus, Russia, Turkey, Ukraine and Chile list *P. pentagona* as a quarantine pest (EPPO, 2005).

8. What are the pests' host plants?

Pseudaulacaspis pentagona has a very wide range of major and minor hosts. A datasheet in the CABI Crop Protection Compendium (CABI, 2006) provides a comprehensive list. The list below includes key major species of commercial significance in the UK.

Major *Pseudaulacaspis pentagona* hosts grown in the UK

Catalpa, Celtis (nettle tree), *Euonymus* (spindle trees), *Ficus, Juglans* (walnuts), *Malus* (ornamental apple species), *Morus* (mulberry tree), *Nerium* (oleander), *Philadelphus coronarius* (mock orange), *Prunus* spp., *Pyrus* (pears), *Ribes* (currants), *Rubus* (blackberry, raspberry), *Sorbus* (rowan), *Vitis* (grape).

9. What hosts are of economic and/or environmental importance in the PRA area?

All species listed in 8. are of economic importance in the UK.

10. If the pest needs a vector, is it present in the PRA area?

No vector is required. This is a free-living organism.

11. What is the pest's present geographical distribution?

[1] http://europa.eu.int/eur-lex/en/consleg/pdf/2000/en_2000L0029_do_001.pdf

A detailed description of the global distribution of *Pseudaulacaspis pentagona* is provided in EPPO (2005) and CABI (2006). A summary is provided in Table 1.

Table 1: Distribution of *Pseudaulacaspis pentagona*

North America:	USA (mainly in eastern states from Maine to Florida, but also elsewhere).
Central America:	Antigua and Barbuda, Bahamas, Barbados, Bermuda, Costa Rica, Cuba, Dominica, Dominican Republic, Guadeloupe, Haiti, Honduras, Jamaica, Netherlands Antilles, Panama, Puerto Rico, St Kitts-Nevis, St Vincent and the Grenadines, Trinidad and Tobago, Virgin Islands (US)
South America:	Argentina, Bolivia, Brazil, Colombia, Peru, Suriname, Uruguay, Venezuela
Europe:	Azerbaijan, Bulgaria, France, Georgia, Germany, Greece, Hungary, Italy, Macedonia, Malta, Netherlands, Portugal, Russia, Serbia and Montenegro, Spain, Switzerland, Turkey, Ukraine
Africa:	Cape Verde, Egypt, Ghana, Madagascar, Malawi, Mauritius, Reunion, Saint Helena, Sao Tome & Principe, Seychelles, South Africa, Tanzania, Zimbabwe
Asia:	Brunei Darussalam, China, India, Indonesia, Iran, Iraq, Israel, Japan, N Korea, S Korea, Malaysia, Maldives, Nepal, Philippines, Sri Lanka, Syria, Taiwan, Vietnam
Oceania:	Australia, Fiji, Guam, Micronesia, New Caledonia, Norfolk Island, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu, Wallis and Futuna Islands

Sources: EPPO (2005) and CABI (2006).

P. pentagona originated in eastern Asia. It was accidentally introduced to Italy in the nineteenth century, and has now spread to all major continents. In the past 20 years it has spread northwards outdoors in Europe, perhaps as a result of climate change (CABI, 2006). The reported occurrences of *P. pentagona* in New Zealand and the UK by CABI (2006) is erroneous (EPPO, 2005; CSL file note).

In colder countries, e.g. Sweden, *P. pentagona* only lives in protected environments i.e. glasshouses.

12. How likely is the pest to enter the PRA area[2]?

very Unlikely		Unlikely		Moderate likelihood	✓	Likely		very Likely	

Pseudaulacaspis pentagona has been detected in consignments imported into England & Wales on a number of occasions. Table 2 provides details.

[2] Pest entry includes an assessment of the likelihood of transfer to a suitable host (ISPM No. 11, FAO, Rome)

The likelihood that individuals that enter the UK on fruit could transfer to another host is very low. However, a growing plant infested with *P. pentagona* is more likely to be planted or positioned relatively close to other potential hosts, for example at a nursery or in a garden, enabling transfer to another host. Scale insects can also be difficult to detect.

Table 2: CSL records of *Pseudaulacaspis pentagona* identifications

Date received	Host	Plant part infested	Country of origin
27-Mar-96	*Plumeria rubra*	Leaves	Sri Lanka
12-Jul-96	*Codiaeum*	Leaves	Netherlands
24-Jul-98	*Prunus persica*	Fruit	unknown
10-May-00	unknown	Fruit	Italy
12-Nov-01	*Plumeria rubra*	Leaves	Netherlands
25-Apr-03	*Cycas*	Leaves	South Africa
12-Dec-03	*Actinidia*	Fruit	Greece
15-Nov-05	*Actinidia*	Fruit	Greece
13-Dec-05	*Actinidia*	Fruit	unknown
02-Mar-06	*Prunus persica*	Stems	Netherlands
31-Mar-06	*Prunus persica*	Stems	Netherlands
05-Jul-06	*Morus nigra*	Stems	unknown (*)
12-Sep-06	*Catalpa bignonioides*	Twig/branch	Italy (**)
17-Oct-06	*Actinidia sinensis*	Fruit	China

(*) A sample was taken from an infested *Morus nigra* growing abroad (Switzerland?) and brought back to the UK, where the sample was sent to CSL to identify the pest (C. Malumphy, pers. comm.).

(**) Detected after 4 or 5 years in the UK (see 2.).

13. How likely is the pest to establish outdoors in the PRA area?

very Unlikely		Unlikely		Moderate likelihood		Likely	✓	very Likely	

Hosts occur widely across the PRA area. Determining whether suitable environmental conditions, especially climate, occur within the PRA is a good indicator of whether establishment is likely.

Within its existing geographic range *P. pentagona* has from one to four generations per year, depending upon climate. In cold countries adult females overwinter and can survive temperatures as low as -20^{o}C although there is high mortality at such temperatures. Mild UK winters are not likely to be a barrier that inhibits establishment. Establishment success will depend upon whether sufficient thermal energy accumulates during the UK spring and summer.

Several workers have examined the thermal biology of *P. pentagona,* e.g. Ball (1980), Gurkan (1982), Park & Kim (1990), Erkilic & Uygun (1997), Mazzoni & Cravedi (1999), Kozar & Benedicty (2004) and Takeda (2004). Based on Ball (1980) the threshold temperature (T_0) for egg development is approximately 10^{o}C, with an accumulated temperature of 48 degree days (DD) above (T_0) required for egg hatch.

Erkilic & Uygun (1997) calculated the threshold temperature for development of larval stages as 9.8°C, close to the threshold of 10.3 °C calculated by Park & Kim (1990) although Park & Kim had used a simple linear regression technique whereas Erkilic & Uygun (1997) used a more sophisticated logarithmic technique. Erkilic & Uygun (1997) measured the development time required for all life stages, except the egg, at four fixed temperatures. From such data, the T_0 for each life stage can be determined. When combined with results from Ball (1980) a T_0 and accumulated temperature required for development from egg to oviposition can be determined (Annex 1).

Annex 1 calculates the threshold temperature for development from egg to adult females, capable of oviposition, as approximately 9.7°C, with 714 DD required to complete such development. Based on such requirements, one generation would be possible each year outdoors in the UK, with development occurring between mid-May and the end of September.

The infested hosts (*Catalpa bignonioides*) in Kent have been infested for between 4 or 5 years, since being supplied from Italy, providing further evidence that establishment in the UK is possible.

14. How likely is the pest to establish in protected environments in the PRA area?

very Unlikely		Unlikely		Moderate likelihood		Likely	✓	very Likely	

Pseudaulacaspis pentagona is known as a glasshouse pest in colder countries e.g. Sweden (CABI, 2006). Temperatures found in unheated UK glasshouses indicate that two generations would be possible each year, whilst in heated glasshouses, with temperatures typically between 10°C and 30°C, four generations would be possible (unpublished CSL data). Ornamental hosts maintained in glasshouses and conservatories could be at risk.
The occurrence of *P. pentagona* in a polytunnel in Oxfordshire, perhaps surviving for 4 or 5 years since the plants were brought from the Netherlands provides evidence for survival in protected environments.

15. How quickly could the pest spread within the PRA area?

very Slowly		Slowly		Moderate pace	✓	Quickly		very Quickly	

Like other diaspidids, the main dispersal stage of *P. pentagona* is the mobile first instar, which has legs. Crawlers can disperse up to 1 m, but can be distributed across much greater distances by wind, flying insects and birds (Watson, 2002). Ornamental plants can be important in facilitating the spread of this pest since they are not so well protected on nurseries, i.e. compared to the quantity of chemical sprays applied to cut flowers. A batch of infested ornamental shrubs from a single nursery can easily spread the pest widely since such hosts could be planted in private and public gardens.

16. What is the pest's potential to cause economic and/or environmental damage in the PRA area?

very Small		Small		Medium	✓	Large		very Large	

Pseudaulacaspis pentagona has caused major problems in areas where it was accidentally introduced in the absence of its natural enemies. The efficiency of natural enemies is reduced in urban areas by pollution; consequently, *P. pentagona* can cause severe damage to ornamental plants in towns and cities (Watson, 2002). *P. pentagona* is unusual as a scale insect in that it is known to be able to kill some of its hosts. In temperate regions, dense populations can form thick crusts of scales on tree trunks and older branches. Such populations can discolour leaves and lead to abnormal leaf fall and cause dieback on branches, eventually killing branches and sometimes the entire tree. In warmer parts of its existing range, for example in the south-eastern USA (Florida & Georgia) *P. pentagona* is a serious pest of *Prunus* spp. (especially peach) and *Pyrus* (pear) where infestation can become significant and thousands of dollars are spent each year on the control of the pest (Branscome, 1999).

P. pentagona was described as a very destructive pest in the north-eastern USA (Kosztarab, 1996) especially on flowering cherry, mulberry, peach and other deciduous fruit trees. Infested trees lose vigour and their lives are shortened, and young plants can die very quickly after infestation.

In Europe, heavy outbreaks have occurred on ornamental plants in Hungary (Kosztarab & Kozar, 1988) where infested *Morus* exhibits dieback and can be killed after a few years. Heavy outbreaks have also occurred in Switzerland (Kozar *et al*., 1994; Mani *et al*., 1997). Crop losses caused by *P. pentagona* are difficult to assess, but Williams & Watson (1988) describe it as a destructive species in the South Pacific, and Danzig & Pellizzari (1998) claim *P. pentagona* is a dangerous pest of fruit and ornamental plants. It is economically important in France (Foldi, 2001) and Greece (Argyriou & Kourmadas, 1981). This could suggest that control is difficult.

17. What is the pest's potential as a vector of plant pathogens?

Pseudaulacaspis pentagona is not known as a vector of plant pathogens.

STAGE 3: PEST RISK MANAGEMENT

18. How likely is the pest to continue to be excluded from the PRA area?

Outdoors:	very Likely		Likely		Moderate likelihood		Unlikely	✓	very Unlikely	

Pseudaulacaspis pentagona is spreading northwards in Europe and is present in northern France. It is likely to be transported to the UK either inadvertently via trade in plants or plant products, aerially via wind, birds or other flying insects, or mechanically with other goods or vehicles coming from Continental

Europe. As noted in 13., hosts occur widely outdoors across the UK. The presence of the pest in the UK may go undetected for several years (see 2.) during which time the organism may become more widespread.

In protection	very Likely		Likely		Moderate likelihood	✓	Unlikely		very Unlikely	

The pest is likely to be detected more quickly after its first arrival in protection than out of doors. As such there is a better chance of excluding it by treating outbreaks.

19. How likely are outbreaks to be eradicated?

very Likely		Likely		Moderate likelihood	✓	Unlikely		very Unlikely	

Infested hosts can be trimmed/ pruned to remove infested parts, which could then be burned. Chemical options are available but the waxy covering of the organism affords it some protection (see 20).

20. What management options are available for containment and control?

Repeated application of chemical insecticides over more than one season may be required. The mobile 1st instar crawler stages, that in the UK are most likely to be active in spring / early summer, are the most vulnerable to chemical treatments. Applications of "professional products" (cf. "home and garden products") are likely to have a higher efficacy but in a private garden these can only be applied by qualified contractors. Spay equipment such as a knapsack mist blower will be needed to achieve adequate coverage when treating trees.

Due to the waxy coat of the pest, chemical treatments are likely to include oils mixed with insecticides. The CSL Action Recommendations Team can provide advice to PHSI.

A pheromone trap is commercially available to monitor for this pest. It has been estimated that *P. pentagona* would be detected on a pheromone trap ten years before symptoms became clearly visible on hosts (Kozar, pers. comm., 2006).

Further work that would reduce uncertainties

Area of PRA	Uncertainties	Further work that would reduce uncertainty
Taxonomy	None. The taxonomy is now stable.	-
Pathway	Identify other potential sources.	Quantity of inspections carried out on traded/ imported hosts.
Distribution	Organism may be more widespread in Europe (possibly UK already, see spread)	Publicise pest and seek further information from industry and EU MS.

Establishment	Could the pest establish elsewhere in UK, outside of Kent?	Collect met data from the Kent area for the past 4/5 years and compare it with the rest of the UK.
Spread	The organism has probably been in the UK for 4 or 5 years already. Has it spread from the garden in Kent?	Survey hosts in the vicinity of the infested Kent garden to determine the extent of establishment.
Impact	Impacts in cooler regions of its existing distribution are not well described.	Contact northern EU MS and ask about impacts.
Management		

21. Summary

Pseudaulacaspis pentagona (the white peach scale) has been detected on *Catalpa bignonioides* trees in a Kent garden. The infested trees were sourced from Italy and arrived in the UK in approximately 2001 or 2002. The organism has previously been found on *Prunus* in a private polytunnel in Oxordshire. The plants had originated from the Netherlands in 2001 or 2002.

P. pentagona is a highly destructive polyphagous pest across much of the world. It occurs in several EU MS (France, Germany, Greece, Hungary, Italy, Malta, Netherlands, Portugal, Spain, Sweden).

Many hosts are grown in the UK, including several ornamental trees, shrubs and fruit such as *Pyrus*, *Ribes* and *Rubus*. *P. pentagona* is thought to originate from the Far East, China and Japan, where it is a particular pest of *Prunus* and *Morus*.

Pseudaulacaspis pentagona is likely to be able to establish outdoors in the UK with one generation per year. Within protected environments two or three generations may be possible each year. *Pseudaulacaspis pentagona* Is known to occur in glasshouses in Sweden.

In areas where *P. pentagona* has been accidentally introduced in the absence of its natural enemies, major damage has been caused to hosts.

22. Conclusion

Pseudaulacaspis pentagona is a potentially damaging pest to a number of hosts of economic importance in the UK.

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Name of Pest Risk Analyst: Alan MacLeod

Address: Central Science Laboratory, Sand Hutton, York, YO41 1LZ UK.

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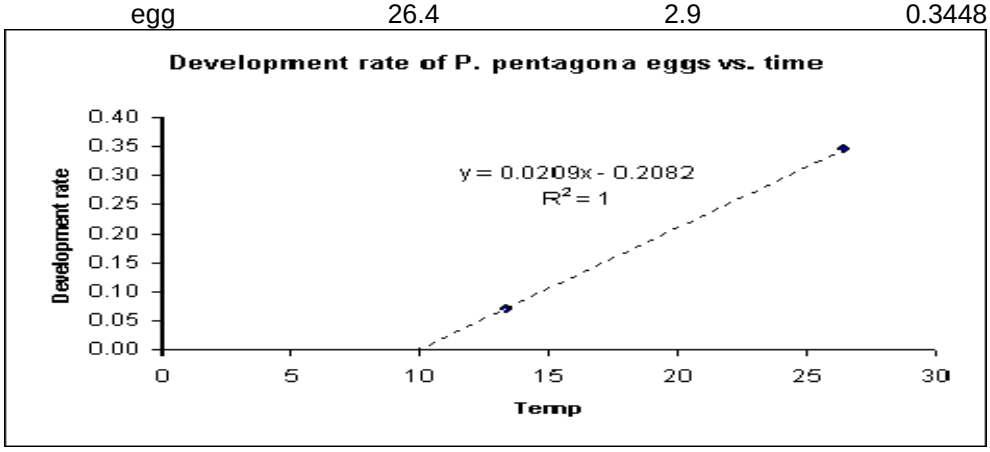
ANNEX 1

1) P. pentagona egg development from Ball (1980)

Life stage	Temp	development time (days)	1/days
egg	13.3	14.2	0.0704
egg	26.4	2.9	0.3448



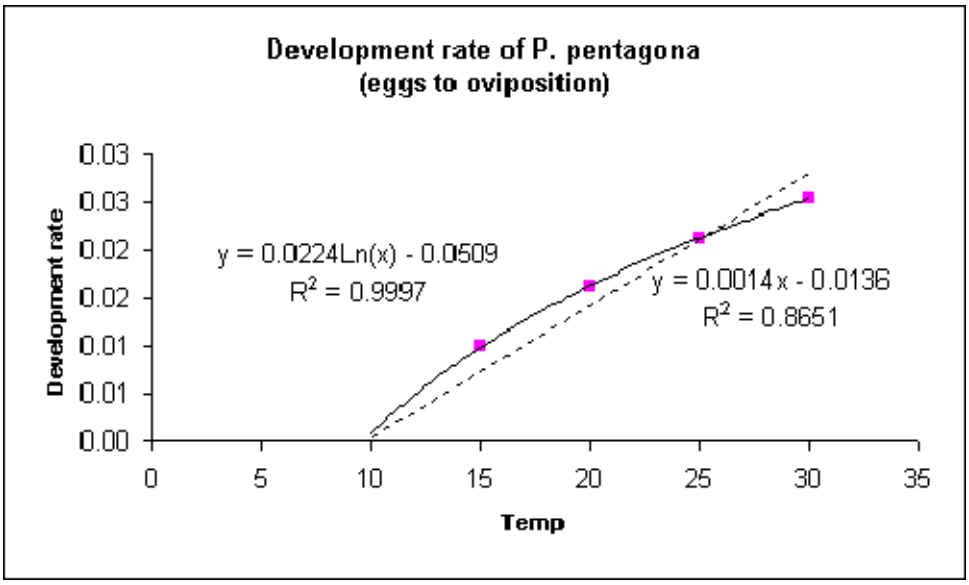
To = 0.2082/.0209 =	9.95
DD = 1/.0209	47.8

Based on above, days for development at 15, 20, 25 and 30C are shown below

Temp	rate	days (1/rate)
15	0.1053	9.5
20	0.2098	4.8
25	0.3143	3.2
30	0.4188	2.4

2) Add egg development at fixed temps to data from Erkilic & Uygun (1997) who examined development of instars and adult oviposition

Life stage	Temp	development time (days)	1/days
egg	15	9.5	0.1053
1st instar	15	21.5	0.0465
2nd instar	15	33.4	0.0299
preoviposition	15	36.1	0.0277
egg	20	4.8	0.2098
1st instar	20	11.8	0.0847
2nd instar	20	18.3	0.0546
preoviposition	20	27	0.0370
egg	25	3.2	0.3143
1st instar	25	9.5	0.1053
2nd instar	25	13.6	0.0735
preoviposition	25	20.8	0.0481
egg	30	2.4	0.4188
1st instar	30	7.3	0.1370
2nd instar	30	13.1	0.0763
preoviposition	30	16.5	0.0606
Sum egg to oviposition	15	100.5	0.0100
	20	61.9	0.0162
	25	47.1	0.0212
	30	39.3	0.0255



3) Threshold temp for development and Degree days

Based on LogN, eqn of line = Y=0.0224 * logN Temp - 0.0509

0.0509/0.0224 = log N temp

Log n 2.27 = 9.7

To = 9.7C

Forcing linear eqn through 9.7C gives DD required of 1/.0014

DD = 714

From egg laying to oviposition by female requires To of 9.7C and 714 DD