Pest Risk Analysis For *Cylas Formicarius* FABRICIUS

STAGE 1: PRA INITIATION

1. What is the name of the pest?

Cylas formicarius Fabricius Coleoptera
Curculionidae - sweet potato weevil

Synonyms
Cylas turcipennis Boheman
Cylas formicarius elegantulus Summers

Note on nomenclature:
Originally individuals of this species found in the New World were given the name *C. formicarius elegantulus* to separate them from those in the Old World. However, numerous studies have now shown that the Old and New World groups are the same species and not two sub-species (Wolfe, 1989; CABI, 2004). A conservative approach, i.e. the recognition of *Cylas formicarius,* should be adopted until the taxonomy of this species has been formally clarified (Ostoja-Starzewski, pers. comm.).

BAYER CODES: CYLAFO

2. What is the reason for the PRA?

On 16/05/00 three live adults and two dead larvae of *C. formicarius* were intercepted at a London airport in a consignment of *Ipomoea batatas* tubers from the Dominican Republic. Destruction of the infested plants was recommended.

3. What is the PRA area?

This PRA considers the whole EPPO region concentrating on the European and Mediterranean area, i.e. EPPO west of the Ural mountains.

STAGE 2: PEST RISK ASSESSMENT

4. Does the pest occur in the UK, EPPO or EU region or does it arrive regularly as a natural migrant?

There are no records of this species occurring anywhere in Europe, or of it arriving as a natural or regular migrant. However, interceptions of this pest in trade should be considered likely.

5. Is there any other reason to suspect that the pest is already established in the UK, EPPO or EU region?

No. See 4. above.

6. What is the pest's EU Plant Health Directive status?

Not listed.

7. What is the pest's EPPO Status?

Not listed. However *C. formicarius* is categorised as an A1 pest by the Caribbean Plant Protection Commission (CPPC) and as an A2 pest by both the Inter-African

Phytosanitary Council (IAPSC) and the Pacific Plant Protection Organisation (PPPO) (EPPO, 2004).

8. What are its host plants?

The major host plant of *C. formicarius* is *Ipomoea batatas* (sweet potato) (Chalfant *et al*, 1990; Janson *et al*., 1990; Austin *et al*, 1991). In addition to *I. batatas* at least forty nine other members of the Convolvulaceae have been recorded as hosts and *C. formicarius* has been recorded feeding on seven genera in six tribes within the family (Austin *et al.*, 1991). Based on this data, Austin *et al.* (1991) suggested that *C. formicarius* is an oligophagous species. However, this pest has also been recorded as feeding on members of the Acanthaceae (Sutherland, 1986; Chalfant *et al.*, 1990), Cruciferae (Muruvanda *et al.*, 1986.), Euphorbiaceae (Sutherland, 1986) and Umbelliferae (Muruvanda *et al.*, 1986; Sutherland, 1986), suggesting that it is actually a polyphagous pest. Appendix One provides a comprehensive list of host plants.

It is worth noting that the majority of plants on which *C. formicarius* feeds are considered to be weed species in at least one country where they occur (Randall, 2002; Website 1), although many are still sold as ornamentals in the PRA area.

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

Of the extensive host list of this pest, only five species are of either economic or environmental importance within the PRA area:

Table 1: Significant *C. formicarius* hosts in the UK

Host plant and family	Common name	Value in the UK per annum (£)	Notes
Daucus carota Umbelliferae	Carrot	£145 million in 2002 (Anon, 2003).	Crop plant (CABI, 2004)
Ipomoea batatas Convolvulaceae	Sweet potato	Estimate to be £3 million in 2002 (Jupe, 2002).	Crop plant (CABI, 2004). A trial conducted in 2001 showed that *I. batatas* can be successfully grown in the UK under cold glass (Website 2). *I. batatas* is now grown commercially on at least one farm in the UK (Website 3).
Calystegia soldanella Convolvulaceae	Sea bindweed	No direct value, see notes section.	Nationally scarce shoreline species, present in several RAMSAR sites within the UK (Anonymous, 2004a; Anonymous, 2004b and Anonymous, 1999).
Raphanus sativus Cruciferae	Radish	No value available.	Crop plant (CABI, 2004). The adults of *C. formicarius* can survive on *R. sativus* but are unable to reproduce on it (Muruvanda *et al.*, 1986).
Manihot esculenta Euphorbiaceae	Cassava	Imported only, not grown commercially in the UK.	Crop plant (CABI, 2004), although not grown within EPPO it is a staple part of West Indian and African diets and is imported regularly (Seaton, 2004).

Summary of main host:
Ipomoea batatas is the world's seventh most important food crop and ranks third in area planted (Wolfe, 1989; Chiranjeevi *et al*., 2002b). Although 92% of *Ipomoea batatas* is produced in Asia and the Pacific islands (Chalfont *et al.,* 1990), some is produced within the EPPO region (see Table 2).

Table 2: Sweet potato production within the EPPO region (Source: FAO, 2003).

Country	Production (MT)*	Area Harvested (Ha)*
Portugal	22,000	3,000
Italy	20,643	1,365
Morocco	9,700	645
Spain	9,612	491
Greece	2,000	100

I. batatas (cv. Red Skin) was first trialled in the UK in 2000 by Horticultural Research International (HRI). HRI found that yields of roughly 10kg per plant could be achieved provided young plants were given early protection (Website 2). Since then small scale commercial production of sweet potato has begun in the UK and the first commercial crop was produced in May 2000 from cuttings imported from the USA (website 3).

Sweet potato requires a minimum temperature of 12 °C for cultivation. In the UK it can be grown successfully in polytunnels or, in some areas, outdoors using a plastic mulch (Jupe, 2002).

With the UK sweet potato market estimated to be worth £3 million a year and to be growing by 10% per annum (Jupe, 2002) it seem likely that more UK and European growers will begin to view sweet potatoes as a viable commercial option in the future.

See Table 1 for details on the four other host species, including, *Daucus carota,* of 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?

Table 3: Current distribution of *C. formicarius*

North America:	USA (Alabama, Arkansas, Bermuda, Florida, Georgia, Louisiana, Mexico, Mississippi, New Mexico, New Orleans, North Carolina, South Carolina and Texas).
Central America & Caribbean:	Belize, Guatemala, Anguilla, Antigua and Barbuda, Bahamas, Cayman Islands, Cuba, Dominican Republic, Haiti, Jamaica, Netherlands Antilles, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Trinidad and Tobago and US Virgin Islands.
South America:	Guyana, Venezuela.
Europe:	Absent: Not known to occur.
Africa:	Cameroon, Chad, Congo Democratic Republic, Ethiopia, Ghana,

	Kenya, Liberia, Libya, Madagascar, Mauritius, Mozambique, Réunion, Senegal, Seychelles, Somalia, South Africa, Sudan, Swaziland, Tanzania, Uganda and Zimbabwe.
Asia:	Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Christmas Island, Cocos Islands, India, Indonesia (Java, Irian Java, Lesser Sunda Island, Moluccas, Nusa Tenggara and Sumatra), Japan (Honshu, Kyushu, South Islands; including; Amami, Amami-oshima, Ishigaki, Okinawa and the Ryukyu Archipelago), Laos, Malaysia, Myanmar, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand and Vietnam.
Oceania:	American Samoa, Australia (New South Wales and Queensland), Belau, Cook Islands, Federated states of Micronesia (Caroline Islands), Fiji, French Polynesia, Guam, Hawaii, Kiribati, Northern Mariana Islands, Papua New Guinea, Solomon Islands, Vanuatu and Wallis and Futuna.

(Data taken from CABI (2004) and other reference sources quoted throughout this document).

12. Could the pest enter the PRA area?
Yes. This PRA was initiated after finding several *C. formicarius* on *I. batatas* imported from the Dominican Republic.

13. Could the pest establish outdoors in the PRA area?
Possibly. Oviposition has been shown to occur at temperatures ranging from 10°C-27°C (Singh *et al*., 2001) and development has been shown to occur at temperatures ranging from 19.2°C to 39.1°C (Mullen, 1980; Sutherland, 1986; Chiranjeevi, *et al.*, 2003). Sutherland (1986) concluded that the optimum temperature range for development is between 27°C and 30°C and Mullen (1980) recorded the optimum temperature as 27°C.

Mullen (1980) notes that adults survived longest at 15°C and Yamaguchi, *et al.* (2000) reported that *C. formicarius* were found throughout winter in a sweet potato field on Amami-Oshima island, Japan. They also found that development, although delayed, of individuals continued throughout winter, suggesting that diapause does not occur. The weevils were found to stop moving at temperatures below 13°C and that mortality was increased by cold weather, but enough survived to cause problems the following spring.

From the data available it seems unlikely that *C. formicarius* could overwinter outdoors in the UK, however it does have the potential to overwinter in areas where its host plants are grown under protective cultivation.

14. Could the pest establish in protected environments in the PRA area?
Yes, see 13. Sweet potatoes are grown in polytunnels and under plastic mulch (Jupe, 2002). Carrots, the most important alternative host in the UK, are grown year round and are protected in the winter months by either a think layer of straw or by polythene sheeting (Website 4).

15. How quickly could the pest spread within the PRA area?
Unclear. This is difficult to predict as there is little documented evidence on the dispersal of this species. Sutherland (1986) reports that individuals can fly at temperatures between 23-27°C, and there is unsupported evidence that weevils are capable of flying distances of up to 2km. Sutherland (1986) also discusses a paper by Sherman & Tamashiro (1954) in which they conclude that mechanical transmission on planting material is the most important means of dispersal for this species. Movement of larvae via infected tubers is also suggested by Wolfe (1989) and this would seem the most likely route of dispersal and spread for this weevil.

There is anecdotal evidence to suggest that once established this pest is able to disperse across great distances; for example *C. formicarius* was first introduced into North America in New Orleans in 1857 and has since spread throughout the southern USA from Texas to South Carolina (Mullen, 1980; Wolfe, 1989).

16. What is the pest's potential to cause economic and/or environmental damage?
Substantial. *C. formicarius* is recognised as the most important pest of sweet potato worldwide (Jansson *et al.*, 1987; Chalfant *et al.*, 1990) and damage caused by it can be considerable, with losses ranging from 5-100% reported (Sutherland, 1986; Chiranjeevi *et al*., 2003). Damage occurs to vines, leaves and tubers, although it is the damage to tubers which is most significant (Sutherland, 1986). Sweet potato tubers release terpene phytoalexins in response to even low level feeding damage and these compounds render the tubers unpalatable and hence unmarketable (Jansson *et al*., 1987; Sutherland, 1986; Jansson *et al*., 1990).

17. What is the pest's potential as a vector of plant pathogens?
There is no record of *C. formicarius* acting as a vector for any plant pathogen.

STAGE 3: PEST RISK MANAGEMENT

18. What are the prospects for continued exclusion?
Good, this pest does not occur in the PRA region and there is no evidence to suggest that it is a regular migrant. However, there is the potential for this species to arrive in the UK on host species imported from countries where *C. formicarius* is present. Mullen (1980) notes that the suggested storage temperature for sweet potatoes of 15°C is within the range that *C. formicarius* can survive. Instead, Mullen (1980) suggests that sweet potatoes be held at 40°C for 14 days as this has been shown to be effective in ensuring pest freedom.

19. What are the prospects of eradication?
Most countries where *C. formicarius* is present seem to be adopting campaigns to control this pest rather than eradicate it, suggesting that eradication is not feasible. However, there have been successful eradication campaigns against *C. formicarius* in several Japanese provinces, although reinvasion has been common in most cases. The method adopted by the Japanese was the continuous removal of all host plant material from within the eradication area; where this was not possible herbicides and insecticides were used. In addition to these measures, growers were encouraged to switch from sweet potato production to alternative crops (Komi, 2000; Anonymous, 2001).

20. What management options are available for containment and control?
Chemical control in the field has been shown to reduce *C. formicarius* numbers but with varying degrees of success (Jansson *et al*., 1987; Yasuda, 1999; Chiranjeevi *et al.*, 2002a). The cryptic nature of the larvae, developing within the vines and tubers, limits the effectiveness of chemical treatments (Sutherland, 1986; Chalfant *et al*., 1990; CABI, 2004). Chalfant *et al*., (1990) details a range of hormones, insect growth regulators and pheromones which have been shown to have varying effects on *C. formicarius*, however further guidance on chemical control should be sought from the CSL action recommendations team. Cultural controls, such as the use of *C. formicarius* resistant cultivars of *I. batatas*, non-infested planting material and crop rotation, along with various management regimes have also been shown to reduce pest numbers (Sutherland, 1986; Bhat, 1987; Jansson *et al*., 1987; Chalfant *et al*., 1990).

From the available data it would appear that an integrated pest management approach would be the most effective way of controlling *C. formicarius* were it to become established within the PRA area.

<u>CONCLUSION OF THE PEST RISK ANALYSIS</u>
Cylas formicarius is recognised as the most important pest of sweet potato worldwide. Sweet potatoes are grown in EPPO and have recently begun to be grown in the UK. The area of sweet potatoes grown in the UK is likely to increase. As evidenced by interception, there is a pathway for *C. formicarius* to arrive in the PRA area. Although primarily a tropical and sub-tropical pest, it can overwinter in Japan. Within its current range losses range from 5-100%. In the PRA area sweet potatoes and carrots are at risk, especially in warmer southern MS. Once here it has the potential to become established and become a pest. In the event of this happening, eradication may be a viable option only in the early stages of invasion although it is more likely that containment and control measures would be the only course of action available. Given the value of the crops at risk every effort should be made to prevent this species from becoming established in the PRA area.

<u>UNCERTAINTIES AND FURTHER WORK</u>

Section of PRA	**Uncertainties**	**Further work that would reduce uncertainty**
Taxonomy	Is this a species complex?	More work on the taxonomy of this species is needed
Pathway	Volume of sweet potatoes imported into the EU	Collect import data
Distribution	None	None
Hosts	None	None
Establishment	Suitability of climate in the UK/ EU for establishment.	Given its ability to overwinter in parts of Japan further experimental data is needed to determine the thermal biology of the pest.
Spread	Rate of spread if moved in trade.	Ask countries where *C. formicarius* is a pest

Impact	Impact on carrots.	Collect quantitative data from where this pest is present.
Management	None	None

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Website 4: British Carrot Growers association. Available on line at: www.bcga.info

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APPENDIX 1

***CYLAS FORMICARIUS* HOST LIST**		
Host Family	**Host Genus and species**	**Reference**
Acanthaceae	*Thunbergia* spp.	Chalfant *et al.*, (1990); Sutherland (1986).
Convolvulaceae	*Calystegia sepium*	Austin *et al.*, 1991; CABI, 2004.
	Calystegia soldanella	CABI, 2004; Sutherland, 1986.
	Calystegia spp.	Chalfant *et al.*, 1990.
	Cuscuta spp.	Austin *et al.*, 1991; CABI, 2004 Chalfant *et al.*, 1990.
	Dichondra carolinensis	Austin *et al.*, 1991; CABI, 2004.
	Dichondra spp.	Chalfant *et al.*, 1990.
	Ipomoea alba	Austin *et al.*, 1991; CABI, 2004.
	Ipomoea aquatica	Austin *et al.*, 1991; CABI, 2004.
	Ipomoea barleirioides	CABI, 2004; Sutherland, 1986.
	Ipomoea batatas	Ahire *et al.*, 2000; Austin *et al.*, 1991, Bhat, 1987; Braun *et al.*, 1999; CABI, 2004, Chalfant *et al.*, 1990; Chiranjeevi *et al.*, 2002a; Chiranjeevi *et al.*, 2003; Hartemink *et al.*, 2000; Jansson *et al.*, 1987; Jansson *et al.*, 1989; Jansson *et al.*, 1992; Jayaramaiah, 1975; Masaki *et al.*, 2002; Miyaji and Tanaka, 1998; Mullen, 1981; Muruvanda *et al.*, 1986; Ohara *et al.*, 2000; Parker *et al.*, 1992; Pillai and Lal, 1976, Ramirez, 1991; Reyes and Notz, 1992; Sakuratani *et al.*, 2001; Singh *et al.*, 2001; Suenaga *et al.* 1987; Sutherland, 1986; Yamaguchi *et al.*, 2000;Yasuda, 1999.
	Ipomoea bona-nox x *hederacea*	Sutherland, 1986.
	Ipomoea cordato-triloba	Austin *et al.*, 1991; CABI, 2004; Sutherland, 1986.
	Ipomoea hederacea	Austin *et al.*, 1991; CABI, 2004; Sutherland, 1986.
	Ipomoea hederacea x intergriuscula	Sutherland, 1986.
	Ipomoea hederifolia	Austin *et al.*, 1991; CABI, 2004; Jansson, *et. al*, 1989.
	Ipomoea heptaphylla	Sutherland, 1986.
	Ipomoea horsfalliae	Austin *et al.*, 1991, CABI, 2004; uruvanda *et al.*, 1986
	Ipomoea imperati	Austin *et al.*, 1991 ;CABI, 2004.
	Ipomoea indica	Austin *et al.*, 1991; CABI, 2004 ;Sutherland, 1986.
	Ipomoea lacunosa	Austin *et al.*, 1991; CABI, 2004 and Sutherland, 1986.
	Ipomoea lateralis	Sutherland, 1986.
	Ipomoea learii	Sutherland, 1986.
	Ipomoea littoralis	Pillai and Lal, 1976; Sutherland, 1986.

	Ipomoea macrorhiza	Austin *et al.*, 1991; CABI, 2004;Sutherland, 1986
	Ipomoea obscura	Austin *et al.*, 1991, CABI, 2004 ;Muruvanda *et al.*, 1986
	Ipomoea palmata	Sutherland, 1986.
	Ipomoea pandurata	Austin *et al.*, 1991; CABI, 2004; Sutherland, 1986.
	Ipomoea pes-caprae	Austin *et al.*, 1991; Pillai & Lal, 1976;Sutherland, 1986.
	Ipomoea quamoclit	Austin *et al.*, 1991.
	Ipomoea sagittata	Austin *et al.*, 1991; CABI, 2004; Sutherland, 1986.
	Ipomoea sepiaria	Austin *et al.*, 1991.
	Ipomoea setosa	Austin *et al.*, 1991; CABI, 2004; Sutherland, 1986.
	Ipomoea sinensis	Austin *et al.*, 1991; CABI, 2004.
	Ipomoea trichocarpa	Pillai and Lal, 1976; Sutherland, 1986.
	Ipomoea triloba	Austin *et al.*, 1991; CABI, 2004; Sutherland, 1986.
	Ipomoea tuboides	Austin *et al.*, 1991.
	Ipomoea turbinata	Austin *et al.*, 1991; CABI, 2004; Sutherland, 1986.
	Ipomoea wrightii	Austin *et al.*, 1991;CABI, 2004.
	Jacquemontia curtissii	Austin *et al.*, 1991; CABI, 2004.
	Jacquemontia spp.	Chalfant *et al.*, 1990.
	Jacquemontia tamnifolia	Austin *et al.*, 1991; CABI, 2004; Sutherland, 1986
	Merremia dissecta	Austin *et al.*, 1991; CABI, 2004; Sutherland, 1986
	Merremia spp.	Chalfant *et al.*, 1990; Pillai & Lal, 1976.
	Merremia umbellata	CABI, 2004; Sutherland, 1986.
	Pharbitis nil	CABI, 2004.
	Pharbitis purpurea	CABI, 2004 ; Sutherland, 1986.
	Stictocardia barlerioides	Austin *et al.*, 1991.
	Stictocardia spp.	Chalfant *et al.*, 1990.
	Stictocardia tiliifolia	Austin *et al.*, 1991; CABI, 2004.
Cruciferae	*Raphanus sativus*	Muruvanda *et al.*, 1986.
Euphorbiaceae	*Manihot esculenta*	Sutherland, 1986.
Umbelliferae	*Daucus carota*	Muruvanda *et al.*, 1986; Sutherland, 1986.