RISK ASSESSMENT SUMMARY SHEET

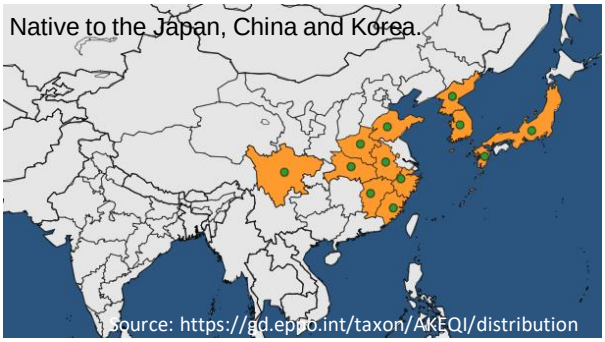
Chocolate Vine (*Akebia quinata*)

- A climbing evergreen shrub, native to Japan, China and Korea, that grows up to 10m or more with woody stems and purple, chocolate scented flowers.
- A popular garden ornamental recorded in the wild, but not yet thought to be established in GB.
- Does not set seed in GB, spreads vegetatively.
- Highly invasive in the US and New Zealand, where it grows rapidly and smothers native vegetation.
- Currently limited by cold climate, but with climate change may be able to establish in south-east England (prefers warm springs and long, hot summers).

History in GB

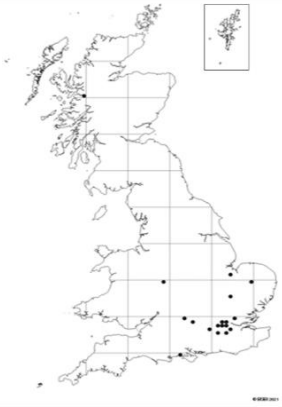
A popular ornamental plant, present in the trade since the 1800s, probably since 1807. By the 1990s it was described as a persistent garden escape; however, not yet known to have established a sustained population in the wild in GB.

Native Range



GB Distribution

46 records on the BSBI Database, of which 28 are confirmed (BSBI, 2021). Mostly from urban habitats or arboreta, and therefore unlikely to be from the wild.



Impacts

Environmental: (minor, medium confidence)

- Where it has become invasive it can grow densely, blocking light, displacing native flora (including understory shrubs and young trees) and ultimately altering ecosystems.
- Has the potential to impact on native species and ecosystems in GB in the future, but this is limited by slow rate of spread.

Economic: (minor, medium confidence)

- Little data on economic impact in areas where it is invasive.
- If it were to become invasive in GB there would be some management costs associated with keeping it under control

Societal: (minimal, very high confidence)

- None known.

Introduction pathway

A popular ornamental plant in the horticultural trade, widely available in GB.

Spread pathway

Natural: (minor, high confidence) – spreads vegetatively over short distances, not known to set seed in GB.

Human: (major, medium confidence) – the main means of spread with plants escape gardens or dumped in wild.

Summary	Response	Confidence
Entry	LIKELY	HIGH
Establishment	MODERATELY LIKELY	MEDIUM
Spread	VERY SLOWLY	MEDIUM
Impact	MINOR	MEDIUM
Overall risk	MEDIUM	MEDIUM

GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

Name of organism: *Akebia quinata*, Chocolate Vine
Author: Tomos Jones, Reading University
Risk Assessment Area: Great Britain
Version: Draft 1 (Feb 2021), Peer Review (July 2021), NNRAP 1 (May 21), Draft 2 (August 2021), NNRAP 2 (Nov 2021), Draft 3 (Feb 2022), NNRAF (Dec 2022)
Signed off by NNRAF: December 2022
Approved by GB Committee: January 2024
Placed on NNSS website: January 2024

What is the principal reason for performing the Risk Assessment?

The GB Committee for non-native species is considering whether to add this species to the list of species of special concern. This assessment will form part of the evidence used to inform the Committee's decision. This species was selected for consideration following horizon scanning[1], in which *Akebia quinata* was ranked in the top 10 threats to biodiversity because of its potential to arrive, establish and cause negative biodiversity impact.

[1] Roy et al 2019. Horizon-scanning for invasive alien species with the potential to threaten biodiversity and ecosystems, human health and economies in Britain. https://www.nonnativespecies.org/assets/Document-repository/Horizon_scanning_short_report_2019-2.pdf

SECTION A – Organism Information		
Stage 1. Organism Information	**RESPONSE**	**COMMENT**
1. Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	Yes Scientific name: *Akebia quinata* (Thunb. ex Houtt.) Decne. Common names: Chocolate vine, five-leaf Akebia, raisin vine (CABI, 2019). Synonyms: *A. quinata* was initially named *Rajania quinata* in 1779 (CABI, 2019). Plants of the World Online (2021) also list *Akebia quinata* f. *albiflora* Y.N.Lee and *Akebia micrantha* Nakai as synonyms.	
2. If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)	There are several ornamental varieties (Li et al., 2010; Christenhusz & Rix, 2012). Named cultivars include: 'Amethyst Glow', 'Shirobana', 'Silver Bells' and 'White Chocolate' AGM (RHS, 2018; Cubey, 2018). There is also a clone (collection number B&SWJ 4425) available and a selection under the designation "cream flowered" that is offered by 27 nurseries (Cubey, 2020).	
3. Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	Not a full risk assessment but it was considered during the GB horizon scanning workshop held in 2019. It was also considered by Baus et al. (2009) for Belgium.	
4. If there is an earlier risk assessment is it still entirely valid, or only partly valid?	As a result of the horizon scanning workshop in 2019, *A. quinata* was ranked within the top ten species with a high likelihood of arrival, establishment and impacts on **biodiversity** within GB (Roy et al., 2019). The evidence considered for this current risk assessment suggests lower risk summaries. It did not feature in the horizon scanning list for human health or economic impact, nor in the combined list. The combined list included species which could have the highest risk when considering all three impact categories of 'biodiversity and ecosystems', 'human health' and 'economies' (Roy et al., 2019).	

5. Where is the organism native?	This climbing vine is widely distributed in east Asia (Li et al., 2010) including eastern central China, Japan and Korea (RHS 2008; CABI, 2019).
6. What is the global distribution of the organism (excluding the risk assessment area)?	Introduced in North America, Australia (CABI, 2019) and New Zealand (New Zealand Government, 2020). Also introduced in Europe including Belgium (Baus et al., 2009) and Slovenia (Glasnović & Pecnikar, 2010). CABI (2019) also lists France (EPPO, 2020) and the United Kingdom (GISD, 2005; EPPO, 2020) but see section 8.
7. What is the distribution of the organism in the risk assessment area?	Its introduction date is often given as 1845 (e.g. Christenhusz & Rix (2012)), but it is listed in Martyn (1807) as *R. quinata* suggesting that it had been introduced into cultivation by 1807. *A. quinata* is described in Clement & Foster (1994:27) as "a persistent garden escape or relic at Sandling (E Kent)" which might be the earliest record. See Coleman & O'Reilly (2004) for a brief discussion on early records. There are 46 records on the BSBI Database, of which 28 are confirmed records (BSBI, 2021). 27 of these are from urban habitats or arboreta, including the confirmed record in western Scotland, and therefore might not represent plants which are established in the wild. The remaining record was said to be well established in a hedge but this again might not be in the wild. This suggests that *A. quinata* is not established in GB. 

8. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems) anywhere in the world?	Yes, CABI (2019) describes it as "a highly invasive, aggressive vine" which "poses a dangerous risk to ecosystems by readily naturalizing in suitable climates".  *A. quinata* invading woodland in the USA. © Steve Manning, Invasive Plant Control, Bugwood.org It was apparently introduced into the USA in 1845 (Invasive Plant Atlas of the United States, 2018). This date is likely to be the introduction date for GB (see section 7), although they are expected to be similar (see section 7). It is considered invasive in North America (Weber, 2003; CABI, 2019). It is described as an "invasive vine" in eastern states, where the climate matches that of most of its native range (Beck et al., 2018). For example, in Virginia where it is invasive in forest habitats (Master Gardeners of Northern Virginia, 2020). Also, in North Carolina (NC Invasive Plant Council, n.d.) and Maryland (Maryland Invasive Species Council, 2010) among other eastern states.

	It is also considered invasive in New Zealand (CABI, 2019), and listed in their National Pest Plant Accord (New Zealand Government, 2020). In New Zealand, it is found on roadsides, forest margins, scrub and hedgerows (Auckland Council, 2021). It is present in France (Centre de Ressources Especes Exotiques Envahissantes, 2016) and listed in Brunel et al. (2010) as a species "to be observed in the Mediterranean Basin" but not as a priority species due to the lack of information available. *A. quinata* was added to the EPPO Alert List in 2008 and transferred to the Observation List in 2012 (EPPO, 2021). The Observation List is for plant species (present or absent in the EPPO region) "which present a medium risk or for which information currently available is not sufficient to make an accurate assessment" (EPPO, 2020).
9. Describe any known socio-economic benefits of the organism in the risk assessment area.	A popular ornamental, which has been widely available for many years (Cubey, 2014; 2018; Lord, 1994).

SECTION B – Detailed assessment

PROBABILITY OF ENTRY

Important instructions:

- Entry is the introduction of an organism into the risk assessment area. Not to be confused with spread, the movement of an organism within the risk assessment area.
- For organisms which are already present in the risk assessment area, only complete the entry section for current active pathways of entry or if relevant potential future pathways. The entry section need not be completed for organisms which have entered in the past and have no current pathways of entry.

QUESTION	RESPONSE	CONFIDENCE	COMMENT
1.1. How many active pathways are relevant to the potential entry of this organism? (If there are no active pathways or potential future pathways respond N/A and move to the Establishment section)	very few	very high	
1.2. List relevant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways. For each pathway answer questions 1.3 to 1.10 (copy and paste additional rows at the end of this section as necessary).	Ornamental and horticulture		This includes trade of *A. quinata* online through retailers such as Amazon and ebay etc.
Pathway name:	Ornamental and horticulture (considered as one but see Pergl et al. (2020) for distinction)		

1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)	intentional	very high	
1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place.	very likely	very high	In the absence of sales figures for *A. quinata*, it is listed in the RHS *Plant Finder* (Cubey, 2014; 2018) as widely available meaning that it is stocked by more than 30 suppliers with 67 nurseries listed online (RHS, 2021a). There is no measure of how much is sold online through non-specialist suppliers such as Amazon and ebay.
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	likely	high	It has transferred (escaped) from gardens into suitable habitat in New Zealand (New Zealand Government, 2020).
1.10. Estimate the overall likelihood of entry into the risk assessment area based on this pathway?	likely	high	Based on it being a widely available ornamental in GB (Cubey, 2014; 2018), and having entered the wild from gardens in conditions similar to GB such as in New Zealand (Beck et al., 2018). See section A.7 for comments on GB records.
End of pathway assessment, repeat as necessary.			
1.11. Estimate the overall likelihood of entry into the risk assessment area based on all pathways (comment on the key issues that lead to this conclusion).	likely	high	Refer to comment in response to 1.10. Entry into GB via natural means (i.e. seed dispersed by birds from continental Europe) is not deemed likely enough to be considered here.

PROBABILITY OF ESTABLISHMENT

Important instructions:

- For organisms which are already well established in the risk assessment area, only complete questions 1.15, 1.21 and 1.28 then move onto the spread section. If uncertain, check with the Non-native Species Secretariat.

QUESTION	RESPONSE	CONFIDENCE	COMMENT
1.12. How likely is it that the organism will be able to establish in the risk assessment area based on the similarity between climatic conditions in the risk assessment area and the organism's current distribution?	moderately likely	high	Climatic similarity is based on the Köppen-Geiger climate classification of Beck et al. (2018), in which most of GB is currently classified as having a Cfb climate (temperate, no dry season, warm summer). There are also areas of Cfc (temperate, no dry season, cold summer) and Dfc climates (cold, no dry season, cold summer) mostly in northern Scotland (Beck et al., 2018). According to CABI (2019), *A. quinata* prefers a Cf climate (Warm temperate, wet all year) or Cw (Warm temperate with dry winter). Current climate in GB (Cfb or Cfc) are not found in its native range which is mostly Cfa (temperate, no dry season, hot summer (Beck et al., 2018). It is moderately likely however because it has established - and considered invasive - in New Zealand (Ministry of Primary Industries, 2019; New Zealand Government, 2020), which is also mostly classified as having a Cfb climate (Beck et al., 2018).
1.13. How likely is it that the organism will be able to establish in the risk assessment area based on the similarity between other abiotic conditions in the risk assessment area and	likely	medium	There seems to be disagreement on the soil preferences for *Akebia* spp, with Walters et al. (1989:398) stating it prefers "rich, loamy soil" but the preference in Li et al. (2010) given as "moist, fertile, well-drained, and slightly acid soils (i.e., pH 4.89 to 6.62)". However, Guo et al. (2005) and EPPO (2021) suggest that they will tolerate a variety of soils and it would appear that there are suitable abiotic conditions in much of GB.

the organism's current distribution?			
1.14. How likely is it that the organism will become established in protected conditions (in which the environment is artificially maintained, such as wildlife parks, glasshouses, aquaculture facilities, terraria, zoological gardens) in the risk assessment area? Subnote: gardens are not considered protected conditions.	very likely	low	It could establish in protected conditions because it establishes in gardens in GB. Gardens are similar to wildlife parks and zoological gardens in being 'artificially maintained'. This is why it is ranked as 'very likely'. *A. quinata* does not need any particular maintenance (e.g. protection from frost) in order to establish in gardens. This is probably why it has never been seen growing in glasshouses (personal observation). However, the higher temperatures provided in glasshouses could facilitate increased fruiting (see 1.22.). Confidence is low here because *A. quinata* is only known to be grown as an ornamental in gardens, but it is possible that it is also grown in protected conditions *sensu stricto*.
1.15. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in the risk assessment area?	widespread	high	It has a "wide range of adaptability in different habitats" (Li et al., 2010:4). In its native range it is "often found along forest edges, in mixed scrub forests, along roadsides, and on rocky slopes by streams and rivers" (Li et al., 2010:4). CABI (2019) also lists several principal habitats for it: riverbanks, natural forests, urban or semi-urban areas, rail or roadsides, disturbed areas and cultivated or agricultural land. In Auckland, New Zealand, where it is invasive its habitats are also listed as roadsides, forest margins, scrub, hedgerows (Auckland Council, 2021). These habitats are widely distributed in GB.
1.16. If the organism requires another species for critical stages in its life cycle then how likely is the organism to become	NA	high	It does not seem to have any specialist pollinators. Observed pollinators are hoverflies (Syrphidae), honeybees (*Apis* spp.) and small solitary bees but wind pollination is also suspected (Qin, 1997; Kawagoe & Suzuki, 2002; 2003; Li et al, 2010; CABI, 2019).

associated with such species in the risk assessment area?			
1.17. How likely is it that establishment will occur despite competition from existing species in the risk assessment area?	moderately likely	high	Vigorous growth and tolerance to shade and drought. It is known to out-compete native plants in its introduced range (e.g. GISD, 2005). According to Jordan et al. (2008) it possesses two or more characteristics, namely shade tolerance and quick growth, which increases its competitive advantage. There are very few native climbers that might compete, perhaps only *Hedera helix* and *Clematis vitalba*.
1.18. How likely is it that establishment will occur despite predators, parasites or pathogens already present in the risk assessment area?	moderately likely	high	Brickell (2008:92) describe it as "trouble free" in GB and no serious pests or diseases are reported for it (Missouri Botanical Garden, 2013; CABI, 2019). *Akebia* spp. are also "notably resistant to honey fungus" (*Armillaria* spp.) (GISD, 2005), which is the most destructive fungal disease in garden in GB. It is a fungus that attacks and kills the roots of woody and perennial plants (RHS, 2021b). CABI (2019) lists seven natural enemies of *A. quinata* in its native range in Asia, four pathogens and three herbivores. There is no evidence these species are present in GB. There is also evidence that it is susceptible to powdery mildew (Garibaldi et al., 2014) including in GB (Ellingham, 2017). This should not have a significant impact on establishment. Any generalist organisms that may feed or attack the plant in the RA area are unlikely to have any impact on the establishment of the species.
1.19. How likely is the organism to establish despite existing management practices in the risk assessment area?	moderately likely	high	No known existing management practices in the risk assessment area.

1.20. How likely are management practices in the risk assessment area to facilitate establishment?	very unlikely	high	No known existing management practices in the risk assessment area.
1.21. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in the risk assessment area?	unlikely	medium	It does not produce fruit often (see comments in 1.22.) and mainly spreads vegetatively over short distances (CABI, 2019). This should make it easier to eradicate, with both manual and chemical methods being effective for control, although repeated attempts might be necessary for eradication Swearingen et al. (2006).
1.22. How likely are the biological characteristics of the organism to facilitate its establishment?	likely	high	*Akebia* spp. are monoecious with male and female flowers on the same inflorescence (Qin, 1997; Li et al., 2020). Individual plants are self-incompatible and require cross-pollination (Li et al., 2010). To ensure cross-pollination there needs to be two plants which are not of the same clone (thus cultivar) (Brickell, 2008; Christenhusz & Rix, 2012). See section A.2. for cultivars available in GB. Fruit set in its native range is usually low (Li et al., 2010). There is evidence of increased fruiting in *A. trifoliata* under cultivation in China (Xiong et al., 1996; Zhong et al., 2006; Li et al., 2010) although the Flora of North America (n.d.) states that "fruits are apparently uncommon in cultivation". In GB, *Akebia* spp. in cultivation do not produce abundant fruit (Waters et al., 1989) and need "warm springs and long, hot summers to fruit well" (Brickell, 2008: 92). When seeds are produced, they might not germinate easily; a period of cold (5°C for fourteen days) is recommended to overcome dormancy in *Akebia* spp. (Xiong et al., 2006). Such conditions would be met during winter in GB. Li et al. (2010) also suggests stratifying or pre-germinating seeds for propagation in cultivation but no such guidance is given from in Brickell (2008).

			Establishment by sexual means is therefore considered 'unlikely' but establishment by vegetative means is considered 'likely' because of its ability to grow quickly (see following section on probability of spread). This would be its main means of establishing in GB. Confidence is scored as 'high' here because of agreement in well-documented evidence of its ability to establish by vegetative means in conditions similar to GB, namely north America and New Zealand. See following section on probability of spread for further discussion.
1.23. How likely is the capacity to spread of the organism to facilitate its establishment?	moderately likely	high	The spread of the species is mainly vegetatively and is "normally found in patches" (Li et al., 2010:4) in its native range but it can grow quickly, 6-12m/yr (Weber, 2003; EPPO, 2021) or even 14m within a single growing season (Northland Regional Council, 2017). Therefore, once a seedling or vegetative propagule has taken root, the potential for establishment by vegetative means is 'moderately likely'.
1.24. How likely is the adaptability of the organism to facilitate its establishment?	likely	high	It is found in different habitats, with good tolerance to heat (Wang et al., 2005) and is fully hardy, meaning it can withstand average minimum temperatures of -15°C (Brickell, 2008). The RHS (2021a) give it a hardiness rating of H6 meaning it is hardy in GB and northern Europe (-20°C to -15°C). It is also tolerant of drought (Weber, 2003; Wang et al., 2005) and shade (Weber, 2003). This adaptability should facilitate establishment.
1.25. How likely is it that the organism could establish despite low genetic diversity in the founder population?	moderately likely	high	There is evidence of considerable genetic variation within *A. quinata* (Li et al., 2010), at least within its native range. This genetic diversity might not be represented within the horticultural stock in GB, due to the practise of vegetative propagation, but there are several cultivars available (which are different genotypes). The fact that it does occasionally form fruit also suggests there are different genotypes (clones) grown in GB.

1.26. Based on the history of invasion by this organism elsewhere in the world, how likely is to establish in the risk assessment area? (If possible, specify the instances in the comments box.)	moderately likely	medium	Invasive in New Zealand, which mostly has the same climate classification of Cfb as GB (Beck et al., 2018) but summer temperatures might be too low in GB. Where it is invasive in North America, the climate is classified as Cfa (hot summers) compared to Cfb (warm summers) in GB (Beck et al., 2018). Despite this, it can grow vigorously in gardens (personal observation). Jordan et al. (2008) claim that it requires anthropogenic disturbance to establish.
1.27. If the organism does not establish, then how likely is it that transient populations will continue to occur? Subnote: Red-eared Terrapin, a species which cannot re-produce in the risk assessment area but is established because of continual release, is an example of a transient species.	very likely	High	As a popular ornamental and widely available (Cubey 2014; 2018), it will almost certainly have a transient population within gardens as a source of possible establishment. It has been listed as widely available in the RHS *Plant Finder* since at least 1994 (Lord, 1994).
1.28. Estimate the overall likelihood of establishment (mention any key issues in the comment box).	moderately likely	medium	*A. quinata* seems adaptable, is widely available and the GB climate is potentially suitable for establishment. However, it is important to consider that the plant has been introduced since the 19th century (Martyn, 1807) and not yet established (see section A.7.) but such a time-lag is often evident between the introduction and establishment of non-native species. Furthermore, it is considered absent in the wild in Belgium, where its establishment potential is considered to be ‘medium’ (Baus et al., 2009).

PROBABILITY OF SPREAD

Important notes:

- Spread is defined as the expansion of the geographical distribution of a pest within an area.

QUESTION	RESPONSE	CONFIDENCE	COMMENT
2.1. How important is the expected spread of this organism in the risk assessment area by natural means? (Please list and comment on the mechanisms for natural spread.)	minor	high	It mainly spreads vegetatively and over short distances (CABI, 2019) but it can grow quickly, 6-12m/yr (Weber, 2003; EPPO, 2021) or even 14m within a growing season (Northland Regional Council, 2017). Fruits (if produced) are known to be dispersed by animals including birds (Li et al., 2010; EPPO, 2021) but not by wind or insects (EPPO, 2021). There is no known evidence of seed dispersal by natural means in GB but seed is dispersed by birds in New Zealand (Waikato Regional Council, 2015). For Long Island in New York, Jordan et al. (2008) ranked its potential for long-distance dispersal (e.g. by birds) as infrequent or inefficient but it occurs occasionally.
2.2. How important is the expected spread of this organism in the risk assessment area by human assistance? (Please list and comment on the mechanisms for human-assisted spread.)	major	medium	Human activity is the primary method of spread, as is the case in its introduced range, e.g. in New Zealand (New Zealand Government, 2020). This could be because of planting in the wild (it is not known if this occurs in GB) or 'dumping' of waste plant material in the wild. This could be problematic because spreading stems can root. Soil contamination with vegetative fragments is also an issue (Northland Regional Council, 2017; Weedbusters, n.d.) because roots can sprout (Jordan et al., 2008). However, Jordan et al. (2008: 5) consider its potential to be spread in New York by human activities to be low, meaning that dispersal by humans to new areas is "almost exclusively by direct means and is infrequent or inefficient".

2.3. Within the risk assessment area, how difficult would it be to contain the organism?	easy	low	Its limited spread by natural means should make containment efforts easier, especially if it only establishes in - or near - urban habitats.
2.4. Based on the answers to questions on the potential for establishment and spread in the risk assessment area, define the area endangered by the organism.	See comment	high	According to EPPO (2021), *A. quinata* thrives in many habitats particularly wetlands and riparian habitats, and urban areas. CABI (2019) also lists several principal habitats (see section 1.15). In New Zealand, it grows in open or semi-shaded locations along the edges of forests or along roads (Northland Regional Council, 2017) and in scrub and hedgerows (Auckland Council, 2021). The record of it growing in Kent in 2003 was also in a semi-shaded location (Coleman & O'Reilly, 2004). In New York, Jordan et al. (2008) list forests and forested wetlands/riparian habitats along with managed habitats such as ditches, roadsides and cultivated ground. Based on its potential for establishment and spread, those principal habitats in (or near) urban areas are most endangered. The urban 'heat island' effect could also provide the hot summers needed to fruit well (Brickell, 2008). Baus et al. (2009) however consider it likely to spread to natural habitats in Belgium. This could be a concern if seed is dispersed by birds within GB, as is the case in New Zealand (Waikato Regional Council, 2015). It is more likely to establish and/or spread in southern England because of its preference for long hot summers which also increase fruiting (Brickell, 2008). However, it does spread mostly due to human activity (see 2.2.) so climate might not be as important. See section 7 for its current distribution and 2.16. on it establishing in Kent.
2.5. What proportion (%) of the area/habitat suitable for establishment (i.e. those parts of the risk assessment area	0-10	high	See map of current distribution in GB (BSBI, 2021) and notes on records (section A.7.).

were the species could establish), if any, has already been colonised by the organism?			
2.6. What proportion (%) of the area/habitat suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)?	0-10	high	Primarily spreads (relatively) short distances (CABI, 2019) and therefore unlikely to spread far in the next five years.
2.7. What other timeframe (in years) would be appropriate to estimate any significant further spread of the organism in the risk assessment area? (Please comment on why this timeframe is chosen.)	80	medium	See section on climate change, specifically projections from Beck et al. (2018) for the end of the century.
2.8. In this timeframe what proportion (%) of the endangered area/habitat (including any currently occupied areas/habitats) is likely to have been invaded by this organism?	0-10	low	Only London is projected to have a climate (Cfa) which matches that currently in most of its native range (especially eastern central China) and invasive range in North America. It is however considered invasive in New Zealand which (mostly) has the same classification as GB (Cfb).
2.9. Estimate the overall potential for future spread for this organism in the risk assessment area (using the	very slowly	medium	The potential to spread - similar to establishment - is reduced given it rarely fruits in GB under current climate. It is also important to considering that it has been introduced to GB since at least 1807 (Martyn, 1807) and not yet established or spread.

comment box to indicate any key issues).			Baus et al. (2009) rank its 'dispersion potential' as 'medium' in Belgium, but comment that this typically depends on human assistance. A medium ranking in Baus et al. (2009) means a species will not colonise remote areas except with human assistance and natural dispersal is rarely more than 1km/yr (Branquart, 2009). Although it can potentially grow quickly, its potential for future spread is considered to be 'very slowly', because it is defined as a 0-10% relative increase in the occupancy of potentially habitable area. Although localised spread can be significant, the expansion of geographic range is relatively slow (National Regional Council, 2017). Seed dispersal by birds could increase the potential for future spread. This is reflected in the medium confidence level.

PROBABILITY OF IMPACT

Important instructions:

- When assessing potential future impacts, climate change should not be taken into account. This is done in later questions at the end of the assessment.
- Where one type of impact may affect another (e.g. disease may also cause economic impact) the assessor should try to separate the effects (e.g. in this case note the economic impact of disease in the response and comments of the disease question, but do not include them in the economic section).
- Note questions 2.10-2.14 relate to economic impact and 2.15-2.21 to environmental impact. Each set of questions starts with the impact elsewhere in the world, then considers impacts in the risk assessment area separating known impacts to date (i.e. past and current impacts) from potential future impacts. Key words are in bold for emphasis.

QUESTION	RESPONSE	CONFIDENCE	COMMENTS
2.10. How great is the economic loss caused by the organism within its existing geographic range **excluding the risk assessment area**, including the cost of any current management?	moderate	low	Although it is listed as invasive in north America and New Zealand, there is no economic cost readily available. It is considered 'moderate' because impact is suspected to be confined to certain areas with little spread, but could be considered 'major' given its inclusion in New Zealand's National Pest Plant Accord (New Zealand Government, 2020) for example. In the Northland region of New Zealand, its potential socio-cultural impact is considered 'moderate' because of potential aesthetic impacts and negative effects on recreation (Northland Regional Council, 2017). A low confidence reflects the lack of direct documented evidence of economic costs.
2.11. How great is the economic cost of the organism **currently** in the risk assessment area **excluding management** costs	minimal	high	There is no evidence of economic impact from *A. quinata* in GB.

(include any past costs in your response)?			
2.12. How great is the economic cost of the organism likely to be **in the future** in the risk assessment area **excluding management** costs?	minimal	medium	There is no evidence of economic impact from *A. quinata* in GB or in its introduced range with similar conditions. It is possible it could cause economic cost if it were to become invasive within commercial forestry. This potential impact is considered 'low' in the Northland region of New Zealand (Northland Regional Council, 2017).
2.13. How great are the economic costs **associated with managing** this organism **currently** in the risk assessment area (include any past costs in your response)?	minimal	high	There are no known instances of this plant causing economic cost in GB, other than to gardeners who want to remove it from their garden. This can be achieved by manual lifting for small areas with as many roots as possible removed. This should be repeated for several years for long-term control (Jordan et al., 2008; Centre de Ressources Especes Exotiques Envahissantes, 2016). Plant material should not be composted as they might root (Waikato Regional Council, 2015).
2.14. How great are the economic costs **associated with managing** this organism likely to be **in the future** in the risk assessment area?	minor	medium	If it succeeds in establishing, its limited spreading ability (by natural means) suggests that any invasive impact is likely to be localised and short term (with effective management) and probably in urban habitats or 'just beyond' gardens. It can be controlled mechanically by cutting, repeatedly for several years for long-term control (Jordan et al., 2008) preferably to ground level, or by digging and removing as much root material as possible. Stems can be left in tree canopies to die (Northland Regional Council, 2017). Chemical control options are the use of systemic herbicide (e.g. GISD, 2005; Swearingen et al., 2009; Waikato Regional Council, 2015; CABI, 2019).
2.15. How important is environmental harm caused by	moderate	medium	According to CABI (2019) "it poses a dangerous risk to ecosystems by readily naturalizing in suitable climates. [It] grows quickly by

the organism within its existing geographic range **excluding the risk assessment area**?			vegetative means where it can outcompete and replace existing flora including understory shrubs and young trees. Its dense growth shades out sunlight preventing seed germination and establishment of seedlings of native plants. The dense shade created by [it] can kill existing species". It can grow as a vine or as groundcover (Swearingen et al., 2006). There is general agreement on its environmental impact (e.g. EPPO, 2021; Weber, 2003; GISD, 2005). In New Zealand and New York, it grows very quickly to form a dense carpet which smothers native species (Jordan et al., 2008; Waikato Regional Council, 2015; Weedbusters, n.d.). Jordan et al. (2008) consider it to have significant impact on at least one layer of community structure. It is listed in New Zealand's National Pest Plant Accord (New Zealand Government, 2020). In the Northland region of New Zealand, its potential impact on species diversity is considered to be 'high' and impact on threatened species 'moderate'. This is because it can out-compete native species (Northland Regional Council, 2017). According to Jordan et al. (2008), it possesses two or more characteristics, such as shade tolerance and fast growth, which increases its competitive advantage. However, Jordan et al. (2008) only rank its impact on other species as 'minor'. This is because although *A. quinata* can displace native plants (and associated species) it is mostly limited to gardens. Jordan et al. (2008) give *A. quinata* an overall 'invasiveness ranking' of 'moderate' for Long Island in New York. It is also ranked as 'moderate' here because its impact is assumed to be relatively localised (i.e. that it won't spread beyond the local area) which would give a 'major' ranking (see section on probability of spread). This explains the medium confidence.

2.16. How important is the impact of the organism on biodiversity (e.g. decline in native species, changes in native species communities, hybridisation) **currently** in the risk assessment area (include any past impact in your response)?	minimal	high	There is one unconfirmed record on the BSBI Database of it "established in wild for at least five years and spreading" and "sprawling over trees" (BSBI, 2021). Similarly, it was found in 2003 in Kent growing over scrub along a railway embankment (Coleman & O'Reilly, 2004).
2.17. How important is the impact of the organism on biodiversity likely to be in the **future** in the risk assessment area?	minor	medium	Impact on biodiversity would be a decline in native species especially understory species and establishment of seedlings (Waikato Regional Council, 2015). Baus et al. (2009) ranks potential impact on species in Belgium through competition as 'high'. However, it is considered 'minor' here because it has not established (see section A.7.) and its 'very slow' potential for future spread (see 2.9.) which means that any impact is likely to be localised. The impact ranking is increased to 'minor' in future because projected increases in temperatures are expected to be favourable for the species (see section on climate change).
2.18. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism **currently** in the risk assessment area (include any past impact in your response)?	minimal	very high	No evidence of alteration of ecosystem functioning currently in GB. Its impact on ecosystem function in New York is unknown (Jordan et al., 2008).

2.19. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism likely to be in the risk assessment area in the **future**?	moderate	medium	Impact on biodiversity (2.17) would eventually alter ecosystem function and habitat through competition for resources such as light, water, nutrients (GISD, 2005) and inevitably impact on trophic interactions. Once established, the dense growth of *A. quinata* prevents seed germination and the establishment of native species (Northland Regional Council, 2017). Considered 'moderate' due to limited potential to spread. Baus et al. (2009) rank the potential impact on ecosystems; on physical alterations as 'high', on nutrient cycling as 'likely', on food web alterations as 'low' and natural successions as 'likely'.
2.20. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism **currently** in the risk assessment area?	minimal	high	There are no known instances of this plant causing environmental impact in sites of conservation value in GB.
2.21. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism likely to be in the **future** in the risk assessment area?	minor	high	Although it can grow in many different habitats the strongest evidence of it as an invasive species is in forests or forest edges (Weber, 2003), as in North America (e.g. Invasive Plant Atlas of the United States (2018)). Given its limited potential for spread (by natural means), any potential impact in the future is likely to be in forest or forest edges in (or near) urban areas, or 'just beyond' gardens. If the climate becomes suitable (see climate section) for increased fruiting, it would have the potential to spread further and invade into sites of conservation value.

2.22. How important is it that genetic traits of the organism could be carried to other species, modifying their genetic nature and making their economic, environmental or social effects more serious?	minimal	very high	*A. quinata* is known to hybridise with *A. trifoliata* (Thunb.) Koidz. (syn. *A. lobata*) (Krüssmann, 1984; CABI, 2019), both of which are available as ornamentals, to give *Akebia* × *pentaphylla* (Mak.) Mak.. There are no native (to GB) or non-native members of Lardizabalaceae listed in Stace (2010; 2019) nor in Stace & Crawley (2015). Baus et al. (2009) rank potential impact on species through genetic effects as 'low'.
2.23. How important is social, human health or other harm (not directly included in economic and environmental categories) caused by the organism within its existing geographic range?	minimal	high	There is no known documented evidence of social or human health impacts in its introduced range.
2.24. How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	minor	high	*A. quinata* is not known to have serious pests or diseases (CABI, 2019) and in Brickell (2008:92) it is described as "trouble free" in GB. However, powdery mildew (*Oidium* sp.) has been reported on it in Italy (Garibaldi et al., 2004; CABI, 2019) and *Erysiphe akebiae* in GB (Ellingham, 2017). *E. akebiae* is listed as a natural enemy of *A. quinata* (CABI, 2017) but this would not transfer to a native species. Baus et al. (2009) rank potential impact on species through disease transmission as 'low'.
2.25. How important might other impacts not already covered by previous questions be resulting from introduction of the organism? (specify in the comment box)	NA	high	

2.26. How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in the risk assessment area?	moderate	low	See section 2.24, and it is not known if its natural enemies from its native range (CABI, 2019) are present in GB.
2.27. Indicate any parts of the risk assessment area where economic, environmental and social impacts are particularly likely to occur (provide as much detail as possible).	See comment	medium	Impacts are particularly likely in, or near, urban areas where there is higher propagule pressure but it can invade many types of habitats in the eastern states of the USA (Swearingen, 2006).
2.28. Estimate the overall impact of this organism in the risk assessment area (using the comment box to indicate any key issues).	minor	medium	Although its environmental impact globally is considered ‘moderate’ (see 2.15.), it is considered ‘minor’ here due to its limited potential to spread. Any environmental impact(s) are thus expected to be in urban - or near urban - habitats and localised.

RISK SUMMARIES			
	RESPONSE	**CONFIDENCE**	**COMMENT**
Summarise Entry	likely	high	Based on it being a widely available ornamental in GB (Cubey, 2014; 2018), and available online through retailers such as Amazon and ebay etc. It has also entered the wild from gardens in conditions similar to GB such as in New Zealand (Beck et al., 2018). Entry into GB via natural means (i.e. seed dispersed by birds from continental Europe) is not deemed likely enough to be considered here.
Summarise Establishment	moderately likely	medium	*A. quinata* seems adaptable, is widely available and the GB climate is potentially suitable for establishment. However, it is important to consider that the plant has been introduced since the 19th century and not yet established. Furthermore, it is considered absent in the wild in Belgium, where its establishment potential is considered to be 'medium' (Baus et al., 2009).
Summarise Spread	very slowly	medium	Considered 'very slowly' because of its limited spreading potential, especially by natural means.
Summarise Impact	minor	medium	Although its environmental impact globally can be considered 'moderate' (see 2.15.), it is considered 'minor' here due to its limited potential to spread. Any environmental impact(s) are thus expected to be in urban - or near urban - habitats and localised.
Conclusion of the risk assessment	moderate	medium	See the comments for each risk summaries above.

Additional questions are on the following page ...

ADDITIONAL QUESTIONS - CLIMATE CHANGE			
3.1. What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?	Temperature	high	Based on projections in Beck et al. (2018) most of GB will still be classified as Cfb (temperate, no dry season, warm summer) but with the south coast expected to become Csb (temperate, dry summer, warm summer). This does not match the current climate in the native range. However, London is projected to be classified as Cfa (temperate, no dry season, hot summer) which matches with most of the native range (especially eastern central China). This is supported by the plant needing "warm springs and long, hot summers" to fruit well Brickell, 2008:92). A hot summer is defined as having the average temperature of the warmest month greater than 22°C. Currently, the warmest parts of the UK are not reaching a mean monthly temperature of 20°C during the warmest month (July). However, hot summers are expected to become more common with an increase in the frequency of hot summer days (> 30°C) by 2070s, especially SE of England. This is under the high emission scenario (RCP8.5) (Met Office, 2018). This may have some influence on fruit set.
3.2. What is the likely timeframe for such changes?		high	Based on climate classification projections for 2071-2100 in Beck et al. (2020) who used an ensemble of 32 climate model projections under Representative Concentration Pathway (RCP) 8.5 for the future Köppen-Geiger maps. This RCP is the worst-case scenario but the only one considered in this study.
3.3. What aspects of the risk assessment are most likely to change as a result of climate change?	See comments	medium	If it succeeds in establishing due to climate change and fruits more often, then the projected climate in London (Beck et al., 2018) could increase its potential to spread and invade natural habitats. Urban habitats beyond London might also become suitable because of the

			'heat island' effect. Increasing fruiting would also increase genetic diversity.

ADDITIONAL QUESTIONS – RESEARCH			
4.1. If there is any research that would significantly strengthen confidence in the risk assessment please summarise this here.	See comment	high	It would be worth investigating what has inhibited its entry into the wild in GB. For example, how often does it set viable seed in gardens? It is also important to consider the invasive potential of cultivars (Jordan et al., 2008).

Please provide a reference list on the following page ...

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