Department for Environment Food & Rural Affairs

Rapid Pest Risk Analysis (PRA) for:

Euzophera bigella

June 2018

Summary and conclusions of the rapid PRA

Euzophera bigella is a moth found in much of Europe and parts of Asia, whose larvae (caterpillars) feed inside a variety of fruit and under the bark of a number of species of tree. Though there have been several adults caught in light traps in the UK, such records are very scarce and there is no evidence this species is established in any part of this country. Following the rapid screening of *E. bigella* via the UK Plant Health Risk Register, this PRA was requested to further assess the potential risk to the UK.

This rapid PRA shows:

Risk of entry

The pathway of fruit (and nuts) is considered moderately likely, with medium confidence. Larvae have previously been found in imported fruit in the UK. If larvae were able to complete development inside the fruit, emerging adults would be capable of flying off and locating new hosts.

The pathway of larvae under the bark of older trees for planting is considered moderately likely, with medium confidence. Larvae under the bark of younger, smaller trees is assessed as unlikely with medium confidence, as infestations produce swellings and cracks in the bark which are more likely to be seen in smaller trees.

The pathway of wood with bark is considered unlikely with low confidence. Confidence is low because a different species of *Euzophera* has recently travelled from the USA to Italy on this pathway.

The pathway of natural spread is considered very unlikely with low confidence. It is unclear if records of adults from outside the known breeding range are true migrants, or if adults which have been imported inside plant material, and have subsequently emerged, but there is no evidence *E. bigella* routinely undergoes long-distance migration.

Risk of establishment

Establishment outdoors is considered likely with medium confidence. Suitable hosts will be present throughout most of the UK. A record was found of a larva in the wider environment in Germany, just south of Berlin. This suggests that at least part of the UK may be warm enough for *E. bigella* to establish outdoors. Establishment in semi-protected cultivation, such as that used for dwarfed fruit trees, is assessed as moderately likely with medium confidence. Establishment in fully protected cultivation is considered very unlikely with medium confidence as, other than in botanical gardens, suitable hosts are not usually grown in such environments.

Economic, environmental and social impact

In warmer parts of the native range, the impact of *E. bigella* are apparently variable, but overall the assessment is that impacts are medium, but this judgement is made with low confidence as data can be scarce and quite dated.

Potential economic impacts in the UK are assessed as small with medium confidence, as recorded impacts of *E. bigella* have all occurred in countries with much warmer summers than in this country. Even if some impacts were to occur in fruit orchards, it is unclear if *E. bigella* would be any more damaging than those of fruit pests already present, for example codling moth (*Cydia pomonella*). Potential environmental and social impacts in the UK are both considered to be very small, with medium confidence.

Endangered area

It is unclear if any part of the UK would be endangered, but the areas most likely to see impacts from this pest are likely to be semi-protected fruit cultivation.

Risk management options

Exclusion is unlikely to be completely successful, due to the variety of hosts which could be imported and the cryptic larval feeding habits. The early stages of any incursion may go undetected as *E. bigella* could be confused with native species, both as adults and larvae. As any incursion is likely to be in the wider environment, with concealed larvae feeding on a wide range of hosts, eradication or containment would be very challenging. In orchard crops, chemical, cultural or some biological controls currently used against codling moth may also have some effect against *E. bigella*. However, the main biological control against codling moth (codling moth granulovirus) will not have any affect against *E. bigella*.

Key uncertainties and topics that would benefit from further investigation

- The full host range of *E. bigella*.
- What causes this pest to show high levels of damage on some hosts in some years, and not in others, and whether these are linked to climate or some other variable.
- Whether perceived shifts in host range (e.g. onto olive in the Mediterranean area in the early 2010s) is real, or if the pest has actually been present on such hosts for some years at very low levels.

Images of the pest

Images of *E. bigella*, both live and museum set specimens, can be seen at http://www.lepiforum.de/lepiwiki.pl?Euzophera_Bigella. Images of live adults and a larva can be seen at http://www.biodiversidadvirtual.org/insectarium/Euzophera-bigella-(Zeller-1848)-cat15502.html (both links last accessed 23 April 2018).

Is there a need for a detailed PRA or for a more detailed analysis of particular sections of the PRA? If yes, select the PRA area (UK or EU) and the PRA scheme (UK or EPPO) to be used.

No	✓				
Yes		PRA area: UK or EU		PRA scheme: UK or EPPO	

While data are still lacking on some aspects of the biology of *E. bigella*, all the available evidence suggests this species is not a high risk to UK trees or orchards as impacts are only seen in countries with much warmer summers. While it can cause damage in warmer countries, it is already present in southern EU member states, and therefore an EU-level PRA is not appropriate, either.

Given the information assembled within the time scale required, is statutory action considered appropriate / justified?

Yes Statutory action	✓	No Statutory action	

While *E. bigella* is a damaging pest in parts of its range, it is likely that the UK is too cool for major impacts to occur. Action against findings in the wider environment is likely to be very challenging, and the chances of success are not high. Given the very wide host range, it would be difficult to justify introducing measures on fruit and growing trees from Europe which would be proportionate to the risk *E. bigella* poses to the UK, but statutory action will be taken against interceptions on a precautionary basis.

Stage 1: Initiation

1. What is the name of the pest?

Euzophera bigella (Lepidoptera, Pyralidae).

Euzophera punicaeella is a synonym which is sometimes used, especially in older literature. There are a number of other synonyms, but none are commonly used.

Common names include peach knot-horn moth (in Britain) and quince moth (which is more widely used in continental Europe and beyond).

2. What initiated this rapid PRA?

Euzophera bigella was added to the UK Plant Health Risk Register[1] in the spring of 2015, following a commodity PRA by the USA, identifying this species as a potential threat. Several uncertainties were identified during the process of adding this moth to the Risk Register, principally concerning the host range and northern limits of the species breeding distribution. During discussions prompted by the Risk Register entry, this PRA was requested to try to help resolve these uncertainties and enable the potential risk to the UK to be more fully assessed.

3. What is the PRA area?

The PRA area is the United Kingdom of Great Britain and Northern Ireland.

Stage 2: Risk Assessment

4. What is the pest's status in the EC Plant Health Directive (Council Directive 2000/29/EC[2]) and in the lists of EPPO[3]?

Euzophera bigella is not listed in the EC Plant Health Directive, it is not recommended for regulation as a quarantine pest by EPPO, and it is not on the EPPO Alert List.

[1] https://secure.fera.defra.gov.uk/phiw/riskRegister/

[2] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2000L0029:20100113:EN:PDF

[3] https://www.eppo.int/QUARANTINE/quarantine.htm

5. What is the pest's current geographical distribution?

Euzophera bigella is found through much of Europe, parts of central Asia and North Africa. Country-level records are provided in Table 1 and summarised in Fig. 1. It should be noted that details of sub-national distributions were almost entirely unavailable, and so it was not determined if the pest was present in all parts of each country where records were found.

Table 1: Distribution of *Euzophera bigella*	
North America:	No records.
Central America:	No records.
South America:	No records.
Europe:	Countries with larval records, or where it is more likely that *E. bigella* has a breeding population in at least some parts, include: Austria (Kasy, 1955; Pagitz & Huemer, 2016); Bulgaria (Soffner, 1967); Croatia (Klimesch, 1942); Czech Republic (Šumpich, 2010); France (www.lepinet.fr); Germany (Rämisch & Graf, 2011); Greece (Simoglou *et al.*, 2012); Hungary (Gabor, 2012); Italy (Espinosa *et al.*, 2013); Macedonia (Matevski, 2010); Montenegro (photo caption credit in www.lepinet.fr); Romania (Szekely, 2011); parts of Russia (Cherkezova, 2012; Popova, 2017); Slovakia (Richter, 2005); Slovenia (Lesar & Habeler, 2005); Spain (Ortiz *et al.*, 2016) and Ukraine (www.lepidoptera.crimea.ua). Records which may be linked to imports or migrants, rather than breeding populations, include: Belgium (De Prins & Steeman, 2016); Denmark (island of Bornholm) (Buhl *et al.*, 2016; Buhl *et al.*, 2011); Poland (http://baza.biomap.pl); Switzerland (Billen, 1988) and the UK (see question 6 for further details of UK findings).
Africa:	Libya to Morocco (Palmoni, 1969); Morocco (Nuss *et al.*, 2017).
Asia:	Afghanistan (Gerstberger, 1981); Armenia (Sevumyan & Aslanyan, 1988); Azerbaijan (Kuliyeva & Hasanova, 2016); Iran (Kermani *et al.*, 2014); Israel, Lebanon (Palmoni, 1969); Pakistan (Baluchistan) (Janjua & Samuel, 1941); Syria (Palmoni, 1969); Turkey (Hantas *et al.*, 2014); Turkmenistan (Krasil'nikova, 1981); Uzbekistan (Gerasimov, 1930).
Oceania:	No records.

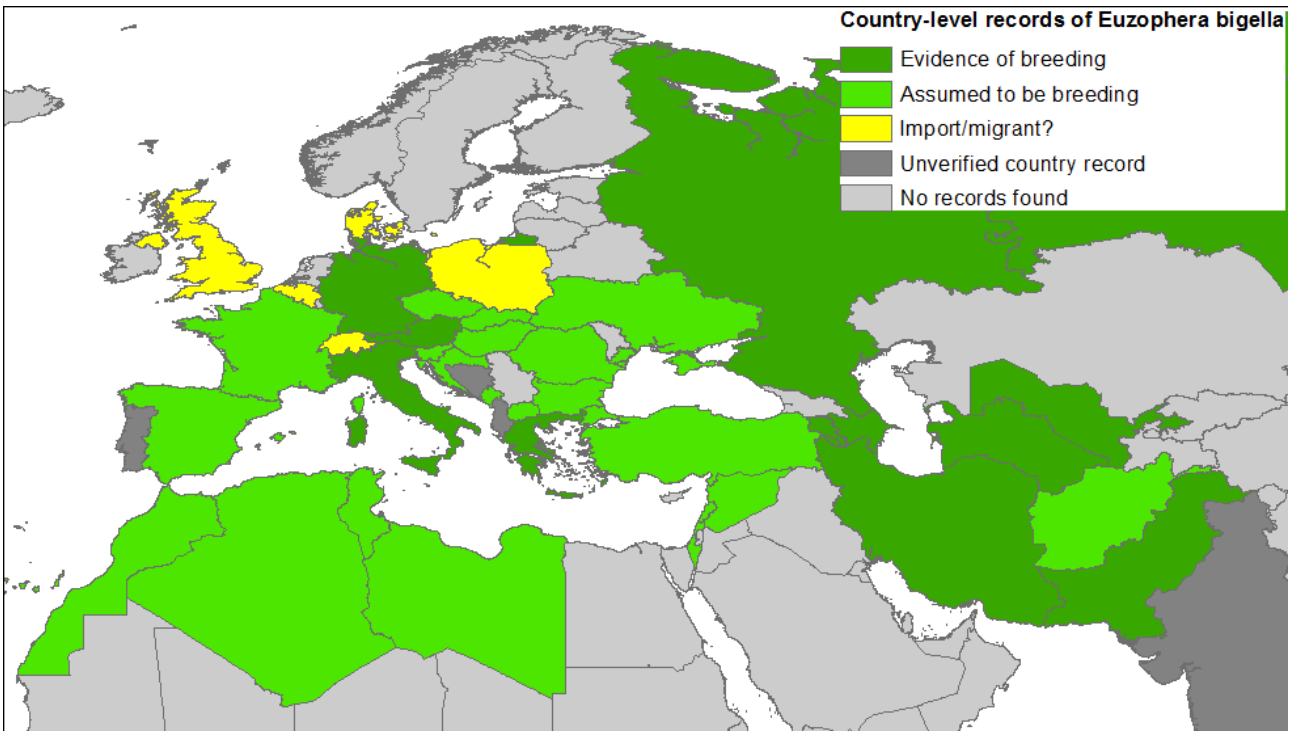

Figure 1. Country-level records for *Euzophera bigella*. The species may not be present in all parts of every country where its presence is noted in this map (for example, northern Russia or the Russian region of Kaliningrad in the Baltics). As far as can be determined from the available literature, the breeding status, again at country level, is also indicated.

Europe

Within Europe, van Nieukerken and Karsholt (2016) state *E. bigella* is also present in Albania, Bosnia and Herzegovina, Malta and Portugal, but no additional sources (other than those which only cite this reference) could be located. The records from the Balkans, at least, would appear to tie in with the other distribution records in this region (such as those from Montenegro and Macedonia). Roesler (1980) provides a map of the European distribution of *E. bigella* (as two subspecies), which shows the northern range limit including England and Wales and the Low Countries, which does not match up with actual records of specimens located during the research for this PRA. Further east, the map's northerly distribution limits do not include Denmark, and then dip slightly to the south, approximately including Ukraine but not Belarus (Roesler, 1980).

No records of *E. bigella* could be found from Luxembourg and the Netherlands, the Baltic States (Belarus, Estonia, Latvia, Lithuania) or Scandinavia (Finland, Norway, Sweden), other than Denmark where it is rare enough for the finding of occasional adults to be listed on the list of unusual Microlepidoptera recorded from Denmark (Buhl *et al.*, 2016; Buhl *et al.*, 2011). Additionally, no records were found for Moldova or Serbia but for these two countries, it is possible that *E. bigella* is present as several neighbouring countries to the north and south do have records of *E. bigella*.

A number of records from northern European countries are definitively associated with imported produce (e.g., Beaumont, 1986; McCormick, 2000; Parsons, 1986), and do not

represent breeding populations. The origin of other specimens from more northern locations is less clear. It is mainly adults which are recorded in light traps, and so it is usually not possible to determine where *E. bigella* is breeding, and where incidental adults have been caught. Additionally, it is seldom possible to determine if the adults are natural migrants which have flown long distances, or if they have emerged locally from immature stages imported with fruit. For example, Billen (1988), reporting on *E. bigella* in Switzerland, notes that it may have been imported, or, at a minimum, is outside the usual range for this species. The most northerly record found for a larva unambiguously present in the wider environment was from Brandenburg in Germany, about 20 km south of Berlin. In an internet forum post, Rämisch and Graf (2011) found, reared and identified a larva of *E. bigella* in detritus associated with frass from a wood-boring sessiid caterpillar, mistletoe wood (*Viscum album*) and wood from *Acer* (the mistletoe host tree).

North Africa

The type of *Euzopherodes angulella* was collected from Morocco: as *E. angulella* is now considered synonymous with *E. bigella* (Nuss *et al.*, 2017), then *E. bigella* is present in Morocco. Palmoni (1969) states it is present from Libya to Morocco, but no individual country records could be located during this PRA.

Asia

In the Middle East, Palmoni (1969) records *E. bigella* larvae from apples in the region around the Sea of Galilee, and in a table of species distributions, Syria and Lebanon are also included. However, the latter two country records are without details and no further records could be located. *Euzophera bigella* has also been recorded in Asia Minor, as far east as Pakistan (as Baluchistan) (Janjua & Samuel, 1941), and Gerstberger (1981) states he has examined specimens from Afghanistan. Some literature states *E. bigella* is also present in India, but the original sources could not be located, nor could any recent literature.

There are a small number of records of *E. bigella* in the literature from East Asia: Korea (Shibuya, 1927) and Japan (Kimura & Uchida, 1964). However, these may refer to another species of *Euzophera* which is very similar in external appearance and present in parts of the Far East of Asia, *Euzophera batangensis*, or other moths in the same subfamily. Known mis-identifications of east Asian "*E. bigella*" have occurred. Yoshimatsu *et al.* (2015) re-identified a specimen of *"E. bigella*" captured in Japan in 1978, and stated that the specimen was, in fact, another species from the same subfamily, *Glyptoteles leucacrinella*. Based on the available evidence, for the remainder of this PRA, *E. bigella* will not be considered to be present in the far eastern parts of Asia.

6. Is the pest established or transient, or suspected to be established/transient in the UK/PRA area?

There have been a number of findings of *E. bigella* in the UK, though it has never been intercepted by the Plant Health authorities in England and Wales. The UK records are instead from amateur entomologists who have found very occasional specimens at various locations. Many of these records have had a clear association with imported produce, often with larvae being reared to adult from fruit. The first British record was from a larva associated with an Italian peach in 1955 in Edinburgh (Shaffer, 1968). Subsequent records include larvae in peach from Yorkshire (Beaumont, 1986), peach from southern England (Parsons, 1986), or in pomegranate from Devon (McCormick, 2000). However, at least four records may conceivably be of true migrants, as they were of adults in light traps (Clancy, 2016). At least two of the records are from southern coastal regions: Teignmouth, Devon in 2003 (Clancy & Skinner, 2007) and St Marys, Isles of Scilly in 2004 (Clancy, 2007). The alternative explanation of larvae imported inside fruit, which were able to emerge as adults in the wider environment before being caught in light traps, is also valid.

No evidence of *E. bigella* breeding in the UK has been found. Larval records have all been associated with imported fruit (the larvae continuing to develop upon arrival in the UK). Adult records are scarce and scattered, and provide no evidence for a resident population.

7. What are the pest's natural and experimental host plants; of these, which are of economic and/or environmental importance in the UK/PRA area?

Larvae have been recorded feeding both within fruit and under the bark in wood of a number of fruit trees, as well as on the nuts of *Juglans regia* (walnut) (Table 2). More recently, larvae have been recorded feeding under the bark of *Olea europaea* (olive) trees in the Mediterranean, first in Greece (Simoglou *et al.*, 2012) and a year later in Italy (Espinosa *et al.*, 2013).

It should be noted that nearly all host records refer to crop species. It seems likely that other wild or cultivated fruit hosts, particularly stone fruit, may be suitable for development of this species, and it is also possible that *E. bigella* will be able to feed under the bark of additional tree genera/species. For example, the larva in Germany was associated with either *Acer* or *Viscum* wood (Rämisch & Graf, 2011), neither of which has been recorded as a host elsewhere. *Ulmus* as a host is cited in Kasy (1955) but the original 1904 paper could not be located during this PRA.

Cedrus libani (cedar of Lebanon) is recorded as a host by Janjua and Samuel (1941). However, this is the only record of a coniferous host which could be found, and it is very dated. Therefore, until further evidence becomes available, *Cedrus* will not be considered further as a host for the purposes of this PRA.

Table 2: Recorded hosts of *Euzophera bigella*, including the location of the reported damage on the host plant.

Host	Common name	Fruit attacked?	Bark/wood attacked?	Reference(s)
Cydonia oblonga	Quince	✓	✓	Radjabi *et al.* (1986); Robinson *et al.* (2010); Kermani *et al.* (2014)
Juglans regia	Common or English walnut	✓		Deseo *et al.* (1981); Robinson *et al.* (2010); Simoglou *et al.* (2012)
Malus pumila	Apple	✓	✓	Radjabi *et al.* (1986); Monta (1985); Robinson *et al.* (2010); Simoglou *et al.* (2012)
Olea europaea	Olive		✓	Simoglou *et al.* (2012); Espinosa *et al.* (2013)
Prunus armenaica	Apricot	✓	✓	Deseo (1980a); Radjabi *et al.* (1986); Simoglou *et al.* (2012)
P. avium	Sweet cherry		✓	Radjabi *et al.* (1986)
P. domestica	Plum		✓	Radjabi *et al.* (1986)
P. persica	Peach	✓		Robinson *et al.* (2010); Simoglou *et al.* (2012)
Punica granatum	Pomegranate	✓	✓	Robinson *et al.* (2010); Simoglou *et al.* (2012); Naserian *et al.* (2012); Cocuzza *et al.* (2016)
Pyrus sp.	Pear	✓	✓	Radjabi *et al.* (1986); Simoglou *et al.* (2012)
Salix alba, *S. purpurea*	Willow		✓	Kasy (1955)
Vitis sp.	Grapevine	✓		Deseo (1980b); Robinson *et al.* (2010)

While the UK grows a smaller variety of fruit than continental Europe, certain fruit crops are economically important. *Prunus* spp. (stone fruit), especially plums, have an average yearly value of over £10 million, *Malus* (apples) have an average yearly value of over £100 million, for both dessert and cooking fruit and *Pyrus* (pears) have an average yearly value of over £12 million (Defra, 2016: all data 2006-2015 inclusive). The value of cider apples and perry pears was over £11 million in 2006 and 2007; after that time, the statistics are collected differently, and no comparable figures are available (Defra, 2016). Cherries are an increasingly important fruit crop, with a yearly value of only £2 million in 2006, but rising

to over £13 million by 2014 (Defra, 2016). Vineyards are also widely planted: in 2015 there were 502 commercial vineyards in England and Wales with a total productive area of around 1839 ha (Food Standards Agency, 2016). *Olea* (olive) trees are commonly sold as ornamentals, though so far only one site in southern UK is attempting commercial production of olives[4].

Environmentally, there are many wild fruit trees growing throughout the UK, especially of various *Prunus* species such as *P. avium* (BSBI, 2017). Given the known host range, other wild *Prunus* species in the UK, such as *P. spinosa,* may also be attacked, though they have not been formally recorded as hosts. *Juglans regia* is also widely distributed, especially in England (BSBI, 2017).

8. What pathways provide opportunities for the pest to enter and transfer to a suitable host and what is the likelihood of entering the UK/PRA area?

Fruit (and nuts)

Larvae feed inside several different species of fruit (Table 2). Where there are multiple generations in the year, summer generations will also pupate inside the fruit (Janjua & Samuel, 1941). Therefore, both larvae and pupae could be associated with imports of several kinds of fruit, and these would be cryptic as the larvae feed internally. However, fruit attacked by larvae is less likely to be moved in trade, as it will be of poorer quality. Younger larvae are unlikely to be able to complete development before the fruit is eaten or disposed of, and would have difficulty in finding a new host to complete development on, as they are not especially mobile. Older larvae or pupae inside the fruit may be able to complete development with adults successfully emerging. Several larvae can develop in one piece of fruit (Cherkezova, 2012), and two of the UK records of *E. bigella* were of multiple larvae. Three larvae were found in one peach, from which one adult was reared (Beaumont, 1986), and another three larvae were in one pomegranate, from which two adults emerged (McCormick, 2000). In Italy, up to eight larvae have been found in a single peach fruit (Deseo, 1980a). If multiple larvae are all around the same age, it is possible that several adults will emerge together and be able to locate a mate. Adults have wings, and, given the reasonably broad host range, are likely to be able to locate a suitable host for oviposition. Refrigeration of fruit during transport of storage is unlikely to affect the viability of *E. bigella* larvae, at least in the short term: larvae have been recorded in stored fruit, continuing to develop at 6-7°C and causing noticeable damage (Deseo, 1980a).

For fruit originating in the EU, there are no import controls on any of the fruit species known to be a host for *E. bigella*. Fruit of *Cydonia, Malus, Prunus* and *Pyrus* from outside the EU must have had a plant health inspection before they can enter the EU. *Punica granatum* fruit from Africa or Israel must meet requirements targeted against another

[4] http://www.olioofoxney.co.uk/page-4/british-olive-grove.html (last accessed 11 April 2018)

lepidopteran pest, *Thaumatotibia leucotreta*. *Vitis* fruit and *Juglans* nuts are not subject to specific regulation when entering the UK. It is possible that other fruit and nut species may be occasional hosts, but without knowing what these might be, it is not possible to state if any controls may apply on these species. The USA includes *E. bigella* on their pest list for fresh fruit of *Malus domestica* or *Pyrus communis* from certain countries in mainland Europe.

Though larvae are known to have entered the UK inside fruit (see question 6), only a few larvae or adults have ever been recorded in this country. This greatly reduces the chances of a newly emerged adult moth locating another of the opposite sex to mate with, especially given the fruit will either be rapidly processed or widely dispersed as they are sold for consumption. While several larvae may occur in one fruit, these fruit are unlikely to pass pre-export quality checks, especially given the very high cosmetic standards for produce in the UK. Therefore it seems likely that very little infested fruit will reach the UK, and of that, only a proportion will contain multiple larvae. While entry of a number of individuals has occurred in the past and is likely to continue to do so in the future, the overall numbers are likely to be very small. Additionally, no evidence was found of incursions or establishments of *E. bigella* in any part of the world outside its native range, suggesting that this species, though capable of moving in trade, has had some difficulty in transferring from infested fruit to new hosts. This may be due to many infested fruits failing quality checks, with those containing multiple larvae most likely to be rejected at harvest, meaning the number of infested fruit moving in trade is, overall, quite low. Overall, the pathway of **fruit (and nuts)** is considered **moderately likely** with **medium confidence**, as larvae have entered the UK in the past, adults are reasonably mobile, and there are records of multiple larvae in a single fruit. The medium confidence reflects that transfer to a suitable host does not seem to have occurred either here or elsewhere the pest may have been moved in trade.

Trees for planting

Larvae are the overwintering stage, and form a cocoon under loose bark in which they spend the winter in a quiescent state before pupating in the spring (Janjua & Samuel, 1941). Deciduous trees are usually moved in winter, while dormant, but larvae under loose bark are cryptic and may not be detected. Younger trees, which are more likely to be moved in trade, will have smaller quantities of fruit, and so the number of larvae emerging from fruit and seeking overwintering sites under the bark of their host will also be smaller. As well as overwintering under loose bark, larvae may also feed in the cambium of the wood at other times of the year. Images of damaged trees (e.g. those in Cherkezova, 2012; Espinosa *et al.*, 2013; Simoglou *et al.*, 2012) show substantial damage, frass and deformation of the affected trunk or branch, which is likely to be noticed pre-export.

Cydonia, *Malus, Prunus* (other than *P. laurocerasus* and *P. lusitanica*) and *Pyrus* plants for planting originating within the EU must have had a plant health inspection at the place of production and be accompanied by a plant passport. The UK has an additional pre-notification scheme for *Prunus*, but this will only help with trace-back in the event of an outbreak, and will not reduce the chances of *E. bigella* larvae entering the UK under the

bark of a dormant tree. From third countries, *Vitis* plants cannot be imported, other than from Switzerland, while other species of deciduous trees and shrubs must be imported dormant and free from leaves.

The UK imports the majority of its fruit- or nut-bearing trees from Europe. Of the imports of "Trees, shrubs and bushes, grafted or not, of kinds which bear edible fruit or nuts (excl. vine slips)", most UK trees come from the Netherlands (Eurostat data, extracted 24 May 2017), but the Netherlands are a major plant trading hub and some of the plants sold in the Netherlands are likely to have been grown in other countries. Within Europe, available data suggests that large populations of *E. bigella* are only likely to be found in southern countries. The UK imports significant numbers of trees directly from some southern EU countries, e.g. Italy (Table 3).

Table 3. Imports to the UK (in tonnes) of trees and shrubs which have edible fruit and nuts, from countries where *Euzophera bigella* is likely or known to be breeding outdoors. Countries sorted in descending order of the total volume of imports Data from Eurostat (extracted May 2017).

Exporter	Average tonnes/year 1997-2001	Average tonnes/year 2002-2006	Average tonnes/year 2007-2011	Average tonnes/year 2012-2016	Total tonnes imported 1997-2016
Italy	43.4	251.6	461.8	442.8	**5,998**
France	139.5	93.9	183.9	106.7	**2,620**
Spain	0.0	1.4	55.9	136.6	**970**
Portugal	25.7	24.5	2.6	2.7	**278**
Hungary	18.7	0.0	3.6	0.0	**111**
Serbia	0.0	0.0	0.0	19.8	**99**
Greece	0.8	0.1	5.5	0.0	**32**
Romania	2.1	0.0	0.0	0.0	**11**
Slovakia	0.0	0.0	0.0	1.6	**8**
Bosnia and Herzegovina	0.0	0.0	0.0	1.6	**8**
Malta	0.0	0.0	1.4	0.0	**7**

Data on forestry imports show that thousands of bareroot *Prunus avium* (wild cherry, or gean tree) were imported to the UK between 2003 and 2013, the majority from Germany but also over 90,000 trees from Hungary, 10,000 from Slovenia and 5,000 from Slovakia (unpublished data from the Forest Reproductive Material Database). Though large numbers of hosts (or at least potential hosts) are imported to the UK, many of the trees are likely to be young, and less likely to have loose bark or other places for larvae to hide, while damage to branches is likely to be readily apparent on smaller trees. The main risk

to the UK is considered to be from the import of large trees, for example those used for instant landscaping. These are likely to have more places for larvae to hide, and a small amount of damage from larvae tunnelling in the wood may be overlooked in a large tree. Larger trees are also more likely to contain multiple larvae.

Overall, the pathway of **trees for planting of mature or semi-mature trees** is considered to be **moderately likely**, with **medium confidence**.

The risk for **trees for planting of young trees** will be less and has been assessed as **unlikely** with **medium confidence**.

Wood with bark

As noted under the pathway of plants for planting, larvae overwinter under loose bark, and in addition, some larvae feed under the bark and in the cambium throughout their lives. As larvae can feed on wood, it is possible that development could continue and adults could successfully emerge from the felled trees. As adults can fly and have a reasonably wide host range, it seems likely that they would be capable of locating suitable hosts to lay eggs on. However, fresh-cut wood is likely to be dried before it is transported. If this is done by natural seasoning, this takes time and it is likely that all larvae will have completed development, and no viable insects will be associated with the wood and bark. If faster alternatives (such as kiln-drying) are used, this is likely to kill the larvae or pupae. In contradiction to the above, however, is evidence that wood with bark has been a viable pathway for a different species in the genus. In 2017, Italy intercepted the North American species *Euzophera semifuneralis*, which was associated with the import of *Prunus* wood with bark from the USA (Europhyt, unpublished interception records). Overall, the pathway of **wood with bark** is considered **unlikely** but with **low confidence** as a different species of *Euzophera* has moved in trade on this pathway.

Natural spread

Adults have been trapped some distance outside their normal range, e.g. records from Denmark or the UK. Some micromoths do migrate long distances, e.g. *Plutella xylostella* (Yponomeutidae) (diamondback moth) (Chapman *et al.*, 2002), but it is unclear if *E. bigella* is capable of long-distance migration or whether it is even capable of sustained periods of flight sufficient to cross the English Channel. There are no records of any species of *Euzophera* being a long-distance migrant. When an adult *E. bigella* is caught in the wider environment some distance from its known breeding range, it is never clear if it is a true migrant or if the larva was transported via the trade in plants or plant products, and an adult subsequently emerged. The pathway of **natural spread** is assessed as **very unlikely** (as only a few adults have been trapped in the UK to date), with **low confidence** as it is unclear if these adults are true migrants, or if larvae were associated with imported produce and adults emerged locally. The long-distance flight capacity of *E. bigella* remains unclear, as are details of its distribution in northern Europe.

Fruit (and nuts)	Very unlikely	☐	Unlikely	☐	Moderately likely	☑	Likely	☐	Very likely ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			
Trees for planting (semi mature or mature)	Very unlikely	☐	Unlikely	☐	Moderately likely	☑	Likely	☐	Very likely ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			
Trees for planting (young)	Very unlikely	☐	Unlikely	☑	Moderately likely	☐	Likely	☐	Very likely ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			
Wood with bark	Very unlikely	☐	Unlikely	☑	Moderately likely	☐	Likely	☐	Very likely ☐
Confidence	High Confidence	☐	Medium Confidence	☐	Low Confidence	☑			
Natural spread	Very unlikely	☑	Unlikely	☐	Moderately likely	☐	Likely	☐	Very likely ☐
Confidence	High Confidence	☐	Medium Confidence	☐	Low Confidence	☑			

9. If the pest needs a vector, is it present in the UK/PRA area?

This is a free-living insect which does not require a vector.

10. How likely is the pest to establish outdoors or under protection in the UK/PRA area?

As the pest is polyphagous, suitable hosts are likely to be present in most of the UK.

Outdoors

As previously noted, though *E. bigella* has been recorded in parts of northern Europe, it is unclear how far north it breeds naturally. The most northerly record of a larva in the wider environment was found on a German Lepidoptera online forum: at a site 20 km south of Berlin in 2010, a larva was reared from some *Viscum album* (mistletoe) and/or a small piece of *Acer* host bark attached to the mistletoe (Rämisch & Graf, 2011). This suggests that it would be possible for *E. bigella* to develop outdoors in the warmer parts of the UK, at least. However, *E. bigella* is not common in Germany, and the UK is no more likely to prove suitable for development of large populations of the pest than Germany. However, establishment as such may prove possible in the UK, at least in warmer or more sheltered parts of the country. Overall, establishment outdoors is considered **likely** with **medium confidence**.

Semi-protected cultivation

Some fruit trees (notably cherries) are grown in "semi-protected" cultivation in the UK. These are typically trees on a dwarf rootstock, grown under a roof of polythene, but with the sides of the polytunnel open to the environment[5]. These systems provide some extra warmth, and may encourage the development of *E. bigella*. However, such environments will be limited in area, and the moths may have difficulty moving from one location to another, so any establishment may only be localised to a particular production site. Additionally, trees grown in such environments will be actively managed to maximise crop yields, and pests which affect the fruit are likely to be spotted quickly and populations controlled. Establishment in semi-protected cultivation is considered **moderately likely**, with **medium confidence**.

Fully protected cultivation

Other than specialist botanical collections or specialist fruit stock growers with glasshouses large enough to house mature trees, few hosts of *E. bigella* will be grown throughout their lives under glass or full cover from polytunnels. Establishment in enclosed protected cultivation is considered **very unlikely** with **high confidence**.

Outdoors	Very unlikely	☐	Unlikely	☐	Moderately likely	☐	Likely	☑	Very likely ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			
Semi-protected cultivation	Very unlikely	☐	Unlikely	☐	Moderately likely	☑	Likely	☐	Very likely ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			

[5] http://www.fruitforum.net/english-cherry-production.htm (last accessed 23 April 2018)

Fully protected cultivation	Very unlikely	✓	Unlikely	☐	Moderately likely	☐	Likely	☐	Very likely ☐
Confidence	High Confidence	✓	Medium Confidence	☐	Low Confidence	☐			

11. How quickly could the pest spread in the UK/PRA area?

Natural spread

It is unclear if *E. bigella* is a natural migrant, capable of sustained long distance flight, or if the records of this species from outside the main range are due to movement of larvae or pupae in traded commodities. No data on the flight capacity of *E. bigella* could be located, nor any other details of natural spread (for example, whether it can spread long distances by the effects of many cumulative short flights over the lifespan of an adult moth). No data on the spread of other species of *Euzophera* could be found either, which suggests that in general, species in this genus do not commonly move long distances naturally. Without definitive evidence of long-distance migration or spread, the rate of natural spread was considered to be **moderate**, but given the lack of information, this assessment only has **low confidence**.

Spread with trade

Individual specimens of *E. bigella* have been explicitly associated with imported fruit: for example, several of the UK records have been from larvae reared from fruit bought by entomologists. In Edinburgh, Yorkshire and southern England, peaches were infested (Beaumont, 1986; Parsons, 1986; Shaffer, 1968), while in Devon, it was a pomegranate fruit which contained larvae (McCormick, 2000). However, as a means of spread within the UK, movement of infested fruit was not considered to be a major factor, unless populations of *E. bigella* were to become very high in fruit-growing regions of the UK. It is also unlikely to be moved with trees for planting: as discussed under that pathway in section 8, only older trees are likely to contain high numbers of larvae under the bark, and such older trees are less likely to be moved in trade. Rather, the risk of spread with trade is judged to be far higher from new introductions (as covered under entry pathways). The risk of spread with trade within the UK was therefore assessed as **slowly**, with **medium** confidence.

Natural Spread	Very slowly	☐	Slowly	☐	Moderate pace	✓	Quickly	☐	Very quickly ☐
Confidence	High Confidence	☐	Medium Confidence	☐	Low Confidence	✓			

With trade	Very slowly	☐	Slowly	☑	Moderate pace	☐	Quickly	☐	Very quickly ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			

12. What is the pest's economic, environmental and social impact within its existing distribution?

Damage can occur both to fruit and to wood and bark, depending on host (Table 2). In fruit, *E. bigella* larvae are often found with the tortricid *Cydia pomonella* (codling moth), a damaging fruit pest found in the UK. One difference noted by Deseo (1980a) in the damage caused to fruit, is that the fruit hardens around the feeding sites of *E. bigella*, but not *C. pomonella*. In Italy, damage seems to vary, with a number of reports of damage to various fruit in the late 1970s/early 1980s (e.g. Deseo, 1980a). The next reports of damage in Italy which could be found were from 2003, on fruit crops including peach, noting the damage was unusually high and included damage to fruit as well as wood (Cravedi & Galassi).

Where available, further details of recorded damage by host follows.

Cydonia oblonga (quince)

Together with *C. pomonella*, *E. bigella* is a major pest of quince in Iran. Larvae tunnel through fruit and render them unmarketable (Radjabi & Beheshti, 1979). In early July, *C. pomonella* larvae were found in the fruit, but *E. bigella* larvae were not detected until two weeks later, and they only accounted for a small percentage of overall infestations. As the season developed, *E. bigella* became more important: by the start of August, over half the larvae in the quince fruit were *E. bigella*; and at the time of harvest in early September, they accounted for almost 90% of the larvae in infested fruit (Radjabi & Beheshti, 1979). The increase in the numbers of *E. bigella* over the growing season is attributed to their diverse feeding habits. Some larvae feed on the wood all year round, while others switch their feeding site in mid to late summer, from wood to fruit (Radjabi *et al.*, 1986). The overall damage rate of quince fruit at the time of harvest, having been attacked by either *E. bigella* or *C. pomonella*, was around 95% (Radjabi & Beheshti, 1979).

Juglans regia (walnut)

In the north-east of Italy, *E. bigella* occurs with populations of *C. pomonella* and both affect walnuts. In an experiment using mating disruption for *C. pomonella* as a means of control, damage by *E. bigella* to walnut kernels in the control (untreated) plots ranged from 5.4-17.1% in the three years studied (Angeli *et al.*, 2000). In comparison, damage by *C. pomonella* ranged from 22.9-30.6% over the same time period. Control methods used against *C. pomonella* were also effective against *E. bigella*, with damage levels reduced under both experimental treatments (mating disruption and insecticides), compared to the control, for all three years (Angeli *et al.*, 2000). Again in Italy, Deseo *et al.* (1981) observed

damage to the walnut husks, but (in laboratory experiments), *E. bigella* larvae did not feed on the kernel.

Malus pumila (apple)

As far as can be determined from the available literature, *E. bigella* is usually a relatively minor pest of apples. In Iran, *C. pomonella* is considered the dominant pest of *Malus*, with *E. bigella* only forming a small proportion of total larvae in infested fruit (under 20%) (Radjabi *et al.*, 1986). In very dated reports from Baluchistan (an area mostly encompassing Pakistan, but also including areas of neighbouring countries), *C. pomonella* larvae often occurred with *E. bigella* inside fruit, but *E. bigella* was apparently only able to attack fruit which was already damaged (Anonymous, 1939). However, in Italy, Deseo (1980a) state that in autumn, *E. bigella* is of some importance even in apple orchards, and a very dated report from Uzbekistan states that around 70-80% of the apples believed to have been damaged by *C. pomonella* actually contained *E. bigella* larvae (Gerasimov, 1930).

Olea europaea (olive)

Damage to olive is recorded in branches and trunks and not the fruit. Reports of damage to this host are relatively recent. In Greece, Simoglou *et al.* (2012) noted damage that included bark cracking and limb swelling, with necrosis of the internal bark. If this girdled the branch, dieback resulted. The death of mature trees was even reported, though mortality was recorded in less than 4% of trees surveyed. In 4/6 orchards included in the survey, extensive swellings and other distortion accompanied by bark cracks were reported from 30-80% of trees, though other orchards had less severe damage (Simoglou *et al.*, 2012). Similar damage to olive trees was reported from southern Italy, with large areas of bark becoming detached; young trees were particularly badly affected (Espinosa *et al.*, 2013).

Prunus persica (peach)

Damage in Italian peach orchards caused by *E. bigella* was occasionally equal to the damage caused by *C. pomonella* (Deseo, 1980a). Larvae usually tunnel in near the peduncle, and are only visible by ejected frass (excrement) on the surface of the fruit. They may attack the peach stone as well as the fruit (Deseo, 1980a).

Punica granatum (pomegranate)

In the pomegranate orchards in western Iran, *E. bigella* is “one of the important fruit pests” along with another pyralid, *Ectomyelois ceratoniae* (Naserian *et al.*, 2012). In Azerbaijan, Cherkezova (2017) states that larvae overwinter inside the damaged fruit, either on the tree or in wind-fallen fruit. In Baluchistan, fruit is filled with frass and secondary mould (Janjua & Samuel, 1941). Cocuzza *et al.* (2016) state that *E. bigella* develops mostly in wood (entering via existing damage), and regard fruit damage as secondary.

Pyrus (pear)

Similarly to apple, *E. bigella* appears to be a relatively minor pest of pears. In Iran, *C. pomonella* is considered the dominant pest of *Pyrus*, with the proportion of *E. bigella* larvae in infested fruit always under 5% (Radjabi *et al.*, 1986).

Vitis (grapes)

Deseo (1980b), reporting on vineyards around Bologna in Italy, is the only source found who details damage to grapes (fruit). Damage is compared to the tortricid *Lobesia botrana* (a species which is not resident in the UK, though occasional adults have been found), though *E. bigella* do not spin webbing around the fruit. During the time studied (1978-9), *E. bigella* was only regarded as a pest of secondary importance on grapes (Deseo, 1980b). No more recent reports of damage to grapes have been located.

Summary of impacts

It is quite difficult to come to an overall assessment of the impact of *E. bigella* in its native range. While undoubtedly a pest in some regions on some crops, quantified data on impacts are almost entirely lacking. Further difficulties include the fact that larvae are cryptic in their habits, and, at least in fruit, frequently occur in association with other lepidopteran pests. This means that damage to fruit may be misattributed, or the importance of one species over another overestimated. *Euzophera bigella* also appears to be capable of exploiting new resources such as olive wood in Greece in the early 2010s, or fruit crops in Italy in the late 1970s, causing high levels of damage at least initially, and coming to the attention of growers and scientists as a result. It is probable that the moth has been present in the "newly affected" areas for many years, just at low population levels and/or exploiting other hosts. In parts of its range and/or in certain years, *E. bigella* can cause impacts to a variety of crops, and the assessment is that **impacts in certain parts of its native range are medium**. However, impacts do vary over time and with geography. Additionally, many reports of damage are very dated, so this assessment is made with **low confidence**.

Impacts	Very small	☐	Small	☐	Medium	☑	Large	☐	Very large ☐
Confidence	High Confidence	☐	Medium Confidence	☐	Low Confidence	☑			

13. What is the pest's potential to cause economic, environmental and social impacts in the UK/PRA area?

While *E. bigella* can be a serious pest in some parts of its range, all countries where impacts have been recorded have much warmer summers. The northern breeding limits of *E. bigella* are uncertain, but all cases of impacts have been reported from the more southerly parts of its distribution. Though this pest may be capable of establishment in the

UK, it is considered unlikely to be capable of building up to population levels which can cause impacts, except perhaps in the very warmest years in the most sheltered locations. There may, however, be a potential for some damage in semi-protected environments which will be slightly warmer than the surrounding environment. In potential mitigation, there are a number of native Lepidoptera which are pests of fruit orchards (such as *C. pomonella*), and it is possible that control measures against these species will also serve to limit any damage from *E. bigella*, though as most insecticides require precise timing, this is uncertain. Overall, potential **economic impacts** are assessed as **small** with **medium confidence**, while potential **environmental** and **social impacts** are both assessed as **very small** with **medium confidence.**

Economic Impacts	Very small	☐	Small	☑	Medium	☐	Large	☐	Very large ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			
Environ - mental Impacts	Very small	☑	Small	☐	Medium	☐	Large	☐	Very large ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			
Social Impacts	Very small	☑	Small	☐	Medium	☐	Large	☐	Very large ☐
Confidence	High Confidence	☐	Medium Confidence	☑	Low Confidence	☐			

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

Euzophera bigella is not known to vector plant pathogens.

15. What is the area endangered by the pest?

From the available evidence, damaging populations of *E. bigella* are unlikely to build up outdoors, and so only sites with semi-protected (or protected) cultivation in the UK might perhaps be endangered, thought even this is uncertain.

Stage 3: Pest Risk Management

16. What are the risk management options for the UK/PRA area?

Exclusion

It is unlikely that entry of larvae to the UK could be entirely prevented. The species is present in most of southern Europe, with scattered records from more northern countries. Larvae are cryptic, hiding inside fruit or under bark of trees, and while heavily infested fruit or trees may be detected, low levels of infestation may not be seen even if import inspections are carried out.

Under the EU Plant Health Directive 2000/29, there are some requirements for inspection and/or plant passports or phytosanitary certificates for several of the major hosts of *E. bigella* as growing trees. Additionally, a small number of records were found of non-fruit tree hosts (*Salix, Ulmus* and possibly *Acer*), and larvae may well be associated with yet more additional hosts.

There are no controls on the movement of known host fruit from the EU to the UK, and larvae are known to have entered this country in association with imported fruit in the past. Some fruit require a phytosanitary certificate if imported from outside the EU, but it is still possible that a small number of larvae could enter inside infested fruit.

Given the variety of recorded hosts, diversity of larval feeding habits, and likelihood of additional hosts (at least for larvae associated with wood or bark), it would be very difficult to design additional measures to entirely mitigate against the risk of entry of *E. bigella*.

Eradication or containment

Either eradication or containment would be highly challenging, as this is a polyphagous pest with cryptic feeding habits, and an incursion is likely to be in the wider environment. Detecting early infestations of *E. bigella* (which is when eradication would be most feasible) could be difficult. While *E. bigella* adults have previously been recorded in the UK (see question 6), demonstrating that the species can be identified by lepidopterists in the UK, it is a rather undistinguished little brown moth, superficially rather similar to a number of native UK species such as *Euzophera cinerosella*. Unless examined by a specialist, there is a possibility that early infestations would not be correctly identified and/or there would be a significant delay in the identification of specimens as further opinions on their identity were sought. Additionally, in native parts of its range, *E. bigella* may be found in the same pieces of fruit as *C. pomonella*, a species which is found in the UK and which causes similar damage to UK orchard crops. Therefore, in orchards, *E. bigella* damage may be misidentified as damage caused by *C. pomonella*. As there is a potential for a delay in accurate identification of both adults and larvae, this may allow populations of *E. bigella* to spread in the wider environment before any incursion is detected.

The pheromones of *E. bigella* have been identified (Bestmann *et al.*, 1993), and are available commercially[6]. This would enable detection of *E. bigella* adults in the wider environment and probably allow a reasonably accurate determination of the infested area, though it is likely that trap catches would need to be examined by a specialist to determine which species were caught with certainty. Control would be challenging, as larvae can be found under bark of a range of tree species, where it will be difficult to apply effective control measures against them.

Therefore, there would be significant practical difficulties in trying to eradicate or contain infestations of *E. bigella* in the UK.

Non-statutory controls

It is likely that UK orchard pest management regimes used to keep populations of native caterpillars under control will have at least some effect on *E. bigella*. There is detailed guidance available on the management of *C. pomonella* in UK orchards on the websites of the Agriculture and Horticulture Development Board (AHDB), or the Royal Horticultural Society (RHS) for gardeners (links to the relevant web pages are provided in the reference list). Though existing biological control using the codling moth granulovirus will not have any effect on *E. bigella*, more generalised biological control options such as entomopathogenic nematodes may be effective. Chemical control against *C. pomonella* is likely to have at least some impact on populations of *E. bigella*. There is evidence from Italy that *C. pomonella* pheromone traps also attract *E. bigella* (Angeli et al., 2000), though it is unclear what proportion of *E. bigella* are trapped using *C. pomonella* pheromones. The female sex pheromones of *E. bigella* have been identified (Bestmann *et al.*, 1993), and so specific traps could be deployed against *E. bigella*. Several of the cultural control methods recommended for *C. pomonella* are also likely to reduce numbers of *E. bigella*, for example removing infested fruit and disposing of them securely, or the use of trunk bands to provide artificial pupating sites for overwintering larvae, from which they can be gathered up and killed.

17. References

AHDB Agricultural and Horticultural Development Board: Apple best practice guide - codling moth (*Cydia pomonella* L.) & codling moth - additional information. Available at: http://apples.ahdb.org.uk/codling-moth.asp (accessed 25 May 2018).

Angeli G, Bellinazzo S, Monta LD, Rizzi C & Rama F (2000): Control of *Cydia pomonella* L. in walnuts (*Juglans regia* L.) with mating disruption technique. *GF 2000. Atti, Giornate Fitopatologiche, Perugia, 16-20 aprile, 2000, volume primo* 361-366 [Italian with English abstract].

[6] For example, http://www.evergreengrowers.com/quince-moth-lure.html or http://russellipm-agriculture.com/pheromones-new/ (both websites last accessed 30 May 2018).

Anonymous (1939): Short Notes and Exhibits. *Indian Journal of Entomology* **1** (pt. 1-2), 107-114.

Beaumont H (1986): *Euzophera bigella* (Zell.) and *Euchromius ocellea* (Haw.) (Lep.: Pyralidae) in Yorkshire. *Entomologist's Record and Journal of Variation* **98** 212.

Bestmann HJ, Kern F, Melikyan GG, Schafer D, Babayan EV, Badanyan SO & Vostrowsky O (1993): Pheromones, 88 1 . Sex pheromone components of female *Euzophera punicaeella* M. (Lepidoptera, Pyralidae). *Zeitschrift fur Naturforschung. Section C, Biosciences* **48** (1-2), 110-112.

Billen W (1988): Tropical insects in Basle, II. *Mitteilungen der Entomologischen Gesellschaft Basel* **38** (2-3), 53-57.

BSBI (2017) Botanical Society of Britain and Ireland: plant distribution maps. Available at: http://bsbi.org/maps (accessed 17 February 2017).

Buhl O, Falck P, Karsholt O, Larsen K & Vilhelmsen F (2016): Fund af småsommerfugle fra Danmark i 2015 (Lepidoptera). *Entomologiske Meddelelser* **84** (1-2), 69-86.

Buhl O, Falck P, Karssholt O, Knud L & Vilhelmsen F (2011): Fund af småsommerfugle fra Danmark i 2010 (Lepidoptera). *Entomologiske Meddelelser* **79** 117-140 [Danish with English abstract].

Chapman JW, Reynolds DR, Smith AD, Riley JR, Pedgley DE & Woiwod IP (2002): High-altitude migration of the diamondback moth *Plutella xylostella* to the U.K.: a study using radar, aerial netting, and ground trapping. *Ecological Entomology* **27** (6), 641-650.

Cherkezova S (2012): The new wreckers of fruit orchards in the south of Russia. *Плодоводство и виноградарство Юга России* **17.09.2012** 1-10 [Russian with English abstract].

Cherkezova S (2017): Development features of two-lined pyralid moth *Euzophera bigella* Zell. in the Krasnodar redion and measures of plant protection. *Плодоводство и виноградарство Юга России* **44** (2), 1-14.

Clancy SP (2007): The immigration of Lepidoptera to the British Isles in 2004. *Entomologist's Record and Journal of Variation* **119** 145-184.

Clancy SP (2016) Atropos website: migrant totals. Available at: http://www.atropos.info (accessed 22 June 2016).

Clancy SP & Skinner B (2007): The immigration of Lepidoptera to the British Isles in 2003. *Entomologist's Record and Journal of Variation* **119** 1-41.

Cocuzza GEM, Mazzeo G, Russo A, Giudice VL & Bella S (2016): Pomegranate arthropod pests and their management in the Mediterranean area. *Phytoparasitica* **44** (3), 393-409.

Cravedi P & Galassi T (date unknown) Come si interviene contro fitofagi e fitomizi. Centro Ricerche Produzioni Vegetali. Available at: http://www.crpv.it/doc/5184/agricoltura2dic03.pdf (accessed 2 June 2016).

De Prins W & Steeman C (2016) Catalogue of the Lepidoptera of Belgium. Available at: http://webh01.ua.ac.be/vve/Checklists/Lepidoptera/Lepmain.htm (accessed 22 June 2016).

Defra (2016) Horticulture statistics 2015. Available at: https://www.gov.uk/government/statistics/horticulture-statistics-2015 (accessed 17 February 2017).

Deseo K (1980a): La piralide della frutta (*Euzophera bigella* Zell. Lepidopt. Pyral.) in Emilia-Romagna. *Informatore Fitopatologico* **30** (4), 13-19 [Italian with English abstract].

Deseo KV (1980b): Due fitofagi di secondaria importanza nei vigneti emiliani: *Euzophera bigella* Zell. ed *Ephestia parasitella* ssp. *unicolorella* Staud. (Lepidoptera, Pyralidae). *Informatore Fitopatologico* **30** (6), 7-9 [Italian with English abstract].

Deseo KV, Briolini G & Bruno P (1981): Osservazioni sui fitofagi delle noci. *Informatore Fitopatologico* **31** (6), 3-6 [Italian with English abstract].

Espinosa B, Sannino L & Maria Sd (2013): Insoliti attacchi di *Euzophera bigella* all'olivo nel foggiano. *Protezione delle Colture* (3), 30-33 [Italian with English abstract].

Food Standards Agency (2016) UK Vineyard Register. Available at: https://www.food.gov.uk/business-industry/winestandards/ukvineyards (accessed 24 May 2017).

Gabor P (2012): A Magyarországon előforduló molylepkefajok jegyzéke, 2012. *Moicrolepidoptera.hu* **5** 51-146.

Gerasimov AM (1930): *Euzophera bigella* Zell., ennemi du pommier en Asie Centrale. *Russkoe entomologicheskoe obozrenie* **24** (3-4), 179-181.

Gerstberger M (1981): *Glyptoteles leucacrinella* Z. und *Euzophera bigella* Z. Zwei verwechselte Arten (Pyralidae: Phycitinae). *Nota Lepidopterologica* **4** (4), 151-154 [German].

Hantas C, Cetin G & Akcay ME (2014): Marmara Bölgesi Ayva Bahçelerinde Zararlı Böcek ve Akar Türleri ile Doğal DüÇmanlarının Saptanması ve Önemli Zararlı Türlerin Popülasyon DeğiÇimi. *Bitki Koruma Bulteni* **54** (3), 283-302 [Turkish with English abstract].

http://baza.biomap.pl (2018). Available at: http://baza.biomap.pl/en/taxon/species-euzophera_bigella/mapb/letter/E (accessed 13 April 2018).

Janjua NA & Samuel CK (1941): Fruit pests of Baluchistan. *The Imperial Council of Agricultural Research - Miscellaneious Bulletin* **42** 41pp.

Kasy F (1955): Kleinschmetterlingsraupen als Bewohner der von der Weidenholzgallmücke (*Helicomyia saliciperda* Duf.) befallenen Weidenäste und -stämmchen. *Entomologisches Nachrichtenblatt österr. u. Schweizer Entomologen* **6** 1-4.

Kermani P, Farazmand H, J K & Avand Faghih A (2014): The population fluctuations of *Euzophera bigella* (Zeller) and *Cydia pomonella* (L.) at quince orchards. *Journal of Entomological Research* **6** (2), 161-171 [Iranian].

Kimura Y & Uchida K (1964): クリ樹幹の病害虫について (Diseases of trunks of chestnut trees caused by insect pests). *Proceedings of the Kanto-Tosan Plant Protection Society* **1964** (11), 85-86.

Klimesch J (1942): Über Microlepidopteren- Ausbeuten aus der Gegend von Zaton bei Gravosa (Süddalmatien). *Mitteilungen der Münchner Entomologischen Gesellschaft* **32** 347-399.

Krasil'nikova GA (1981): Topographical distribution of Microlepidoptera in south-western Turkmenia. *Trudy Vsesoyuznogo Entomologicheskogo Obshchestva* **63** 99-102.

Kuliyeva H & Hasanova L (2016): Biology of development and physiology of the Apsheron population of pomegranate *Euzophera punicaella* Moore (Lepidoptera, Pyralididae). *GISAP: Biology, Veterinary Medicine and Agricultural Sciences* (9), 21-24.

Lesar T & Habeler H (2005): Beitrag zur Kenntnis der Kleinschmetterlinge (Microlepidoptera) von Štajersko und Koroško in Slowenien *Natura Sloveniae* **7** (2), 3-127.

Matevski V (2010) Студија за ревалоризација на природните вредности на заштитеното подрачје споменик на природата "Кањон Матка". Available at: http://www.moepp.gov.mk/wp-content/uploads/2015/01/Studija-za-MATKA.pdf (accessed 23 April 2018).

McCormick R (2000): *Euzophera bigella* Zell. (Lep.: Pyralidae) new to Devon. *Entomologist's Record and Journal of Variation* **112** 114.

Monta Ld (1985): The apple clearwing, *Synanthedon myopaeformis* Borkh.: bio-ethological observations and control prospects. *Atti XIV Congresso Nazionale Italiano di Entomologia sotto gli auspici dell'Accademia Nazionale Italiana di Entomologia, della Societa Entomologica Italiana e della International Union of Biological Sciences. Palermo - Erice - Bagheria, 28 maggio-1 giugno 1985.* 391-399.

Naserian N, Farazmand H, Vafaei Shoushtari R, Avand-Faghih A & Azadbakht N (2012): The seasonal population fluctuations of pomegranate fruit moth, *Ectomyelois ceratoniae* Zeller and quince moth, *Euzophera bigella* Zeller in pomegranate orchards. *Journal of Entomological Research* **5** (2), 161-170 [Iranian with English abstract].

Nuss M, Landry, B. , Mally R, Vegliante F, Tränkner A, Bauer F, Hayden J, Segerer A, Schouten R, Li H, Trofimova T, Solis MA, De Prins J & Speidel W (2017) Global Information System on Pyraloidea: *Euzophera bigella* species page. Available at: http://www.pyraloidea.org/ (accessed 24 May 2017).

Ortiz JG, Ullastre JY & Vila RM (2016): *Apomyelois bistriatella* (Hulst, 1887), un nuevo pirálido para la fauna de la Península Ibérica (Lepidoptera: Pyralidae, Phycitinae). *Arquivos Entomologicos* **15** 107-113.

Pagitz K & Huemer P (2016) Geo-Tag der Artenvielfalt 2016. Available at: http://www.arten-vielfalt.at/fileadmin/data/pdf/Bericht_GEO_Tag_2016.pdf (accessed 17 April 2018).

Palmoni Y (1969): The Pyralidae of the Lake Tiberias region. *Israeli Journal of Entomology* **4** (2), 293-321.

Parsons M (1986): *Euzophora bigella* (Zeller) (Lepidoptera: Pyralidae): a second British record. *Entomologist's Gazette* **37** (1), 40-40.

Popova T (2017) New pest of apple in the Krasnodar region (Новый вредитель яблони в Краснодарском крае). Available at: http://agroprogress.org/zashhita-rastenij//novij-vreditel-jabloni-v-krasnodarskom-krae (accessed 10 April 2018).

Radjabi G & Beheshti ND (1979): Supplementary studies on quince moth (*Euzophera bigella* Zell.) in Iran during 1975, 1976 and 1977. *Entomologie et Phytopathologie Appliquees* **47** (1), 53-67; en 68-69 [Iranian with English abstract].

Radjabi G, Pazuki A & Rezwani A (1986): Supplementary studies on *Euzophera bigella* Zell. in Iran (1975-1984). *Entomologie et Phytopathologie Appliquees* **53** (1-2), 57-74; en 11-13 [Iranian with English abstract].

Rämisch F & Graf F (2011) Lepiforum.de archive forum. Available at: http://www.lepiforum.de/forum2010.pl?md=read;id=73651 (accessed 26 May 2017).

RHS Royal Horticultural Society: pest page on codling moth. Available at: https://www.rhs.org.uk/advice/profile?PID=489 (accessed 25 May 2018).

Richter I (2005) Motýle južného Zemplína. In *XXIX. Východoslovenského TOP – HATFA* pp. 44-54.

Robinson GS, Ackery PR, Kitching IJ, Beccaloni GW & Hernández LM (2010) HOSTS - A database of the world's lepidopteran hostplants. Natural History Museum, London. Available at: http://www.nhm.ac.uk/our-science/data/hostplants/ (accessed 7 September 2016).

Roesler R (1980): Neue Resultate zur Taxonomie von *Euzophera* Zeller Phycitinen-Studien XVII. *Nachrichtenblatt der Bayerischen Entomologen* **29** (5), 81-89.

Sevumyan AA & Aslanyan AA (1988): Pests of a walnut crop in the Megri region of the Armenian SSR. *Biologicheskii Zhurnal Armenii* **41** (9), 784-785.

Shaffer M (1968): Illustrated notes on *Synclita obliteralis* (Walker) and *Euzophera bigella* (Zeller), two species new to the British list (Lepidoptera: Pyralidae). *Entomologist's Gazette* **19** 155-158.

Shibuya J (1927): Some new and unrecorded species of Pyralidae from Corea (Lepid.). *Insecta Matsumurana* **2** (2), 87-102.

Simoglou KB, Karataraki A, Roditakis NE & Roditakis E (2012): *Euzophera bigella* (Zeller) (Lepidoptera: Pyralidae) and *Dasineura oleae* (F. Low) (Diptera: Cecidomyiidae): Emerging olive crop pests in the Mediterranean? *Journal of Pest Science* **85** (2), 169-177.

Soffner VJ (1967): Kleinschmetterlinge aus Bulgarien (Lep.). *Mitteilungen der Münchner Entomologischen Gesellschaft* **57** 102-122.

Šumpich J (2010) Synekologické hodnocení motýlí fauny (Lepidoptera) na území kraje Vysočina: PR Údolí Brtnice ekologie, diverzita, ochrana, p. 61.

Szekely L (2011): The Lepidoptera of Bucharest and its surroundings. *Travaux du Muséum National d'Histoire Naturelle* **54** (2), 461-512.

van Nieukerken E & Karsholt O (2016) Fauna Europaea: *Euzophera bigella*. Fauna Europaea version 2.6. Available at: http://www.fauna-eu.org/ (accessed 22 June 2016).

www.lepidoptera.crimea.ua (2018). Available at: http://www.lepidoptera.crimea.ua/2000_Pyralidae/Euzophera_bigella.htm (accessed 13 April 2018).

www.lepinet.fr (2018). Available at: https://www.lepinet.fr/especes/nation/lep/?e=l&id=27610 (accessed 13 April 2018).

Yoshimatsu S-i, Nakatani Y & Yoshitake H (2015): A list of specimens of Pyraloidea (Insecta: Lepidoptera) of Dr. Hiroshi Inoue preserved in the National Institute for Agro-Environmental Sciences. *Bulletin of the National Institute of Agro-Environmental Sciences* **34** 101-142.

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