DCA - NATIONALT CENTER FOR FØDEVARER OG JORDBRUG
AARHUS UNIVERSITET

NaturErhvervstyrelsen

DCA – Nationalt Center for Fødevarer og Jordbrug

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Vedrørende Pest Risk Analysis på *Epitrix* sp.

NaturErhvervstyrelsen, Center for Jordbrug, har den 19. april 2012 anmodet DCA - Nationalt Center for Fødevarer og Jordbrug om at bedømme anvendelighed af et nyt skema til udarbejdelse af hurtige risikoanalyser for planteskadegørere ("ekspres-PRA-skema") samt foretage ekspres-PRA på *Epitrix* sp. ved anvendelse af skemaet.

Første del af besvarelsen blev fremsendt 15. maj, anden del følger herunder.

Vurdering på *Epitrix* sp. er foretaget af seniorforsker Annie Enkegaard, Institut for Agroøkologi.

Med venlig hilsen

Susanne Elmholt

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Summary[1] ***Epitrix* sp.**		
PRA area: Denmark		
Describe the endangered area: Denmark		
Main conclusions: *Overall assessment of risk:* ***Likelihood of entry*** Prior to the new EU emergency measures (EU 2012) it was moderately likely that *Epitrix* sp. could enter Denmark through import of seed potatoes in spite the fact that Denmark at present only has a minor import from EPPO-countries where the pests occur (Danmarks Statistik 2012). This is because the pest in a foreseeable future could be expected to spread to EPPO-countries from which Denmark has a larger import (e.g. France, 766.000 tons in 2011, Danmarks Statistik (2012)). Similarly it was highly likely that *Epitrix* sp. could enter Denmark through import of ware potatoes from Spain (not from North America or Portugal due to present zero-import, Danmarks Statistik (2012)), from North America should import be resumed or from EPPO-countries that in the future would have the pests established. With the new EU emergency measures (EU 2012) the likelihood of entry of *Epitrix* species into Denmark is greatly reduced and is classified as low. ***Likelihood of establishment*** Once entered into Denmark, the likelihood of establishment is high ***Likelihood of spread*** Once entered into Denmark, the likelihood of rapid spread (mainly by human assistance) is high ***Likelihood of impact*** Once entered into Denmark, the likelihood of serious impacts is high Phytosanitary measures should be applied. *Phytosanitary Measures:* The pest is recommended for immediate action. The following measures which already apply (EU 2012) will help prevent entry of *Epitrix* species into Denmark: 1) any import to Denmark of potatoes from non-EU countries where the pest occurs should either be prohibited or restricted according to the specifications in the new emergency EU measures (EU 2012), i.e. subjected to requirements of production in pest free areas or washing/brushing, with either option accompanied by a phytosanitary certificate; 2) any import to Denmark from EU countries where the pest occurs (demarcated areas) (EU 2012) must according to the new emergency EU measures (EU 2012) only take place if accompanied by plant passport		
Phytosanitary risk for *endangered area* prior to EU emergency measures	High **x**	
Phytosanitary risk for *endangered area* after EU emergency measures in place		Low **x**
Level of uncertainty of assessment		Low **x**
Other recommendations:		

Pest Risk Analysis: *Epitrix* sp.

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Date: 14th June 2012

Stage 1 Initiation

Reason for performing the PRA: request by the Danish AgriFish Agency
PRA area: Denmark
Note: the majority of the information in this PRA comes from the PRA-analysis on *Epitrix* sp. done for the EPPO region in 2010 (Conceiçao et al. 2011 – see this for detailed references).

Stage 2 Pest risk assessment

1. Taxonomy

This PRA addresses the *Epitrix*-complex (Chrysomelidae, Coleoptera, Insecta) which damage potato tubers – the species in the complex are *Epitrix tuberis* Gentner 1944 (tuber flea beetle), *Epitrix cucumeris* (Harris, 1851); (potato flea beetle), *Epitrix similaris* Gentner, 1944 (no common name) and *Epitrix subcrinita* LeConte 1857 (western potato flea beetle) (Conceiçao et al. 2011). *E. cucumeris* and *E. similaris* have recently established in Portugal, and damage to potato tubers (*Solanum tuberosum*) has been observed since 2004 with lots of consumption potatoes being rejected (Conceiçao et al. 2011). In 2010, *E. similaris* was detected causing damage in Northern Spain (Malumphy et al. 2011).

2. Pest overview

Life cycle

Overwintering adult beetles emerge from the soil in spring. Eggs are deposited in batches near the base of a host plant. After eggs hatch, the larvae feed on roots and/or tubers. Pupation takes place in the soil. The number of generations for the different *Epitrix* species is still debated but at least one species has 2-3 generations per year. 4-5° C is suitable for survival of adults and possibly of pupae; pupae cannot evolve at 5°C. The flight ability of the species is debated – some note the species as strong flyers able to cover long distances while other state that the beetles seldom fly (Anon. 1989; Anon. 2005; Anon. 2012; Conceiçao et al. 2011).

Host plants

Epitrix species are very similar in their external morphology and difficult to distinguish in the field even by specialists. Data on host range is therefore not fully reliable. In general, *Epitrix* spp. are associated with Solanaceae, the adults feeding on the foliage and the larvae on the roots and/or tubers. Foliage feeding does not necessarily imply egg laying and larval survival – completion of the life cycle on potato is well documented but there is little data for other host plant species (Anon. 2012; Conceiçao et al. 2011).

<u>*E. tuberis*</u>: Potato is the preferred host plant. *E. tuberis* is also reported to attack other Solanaceae, such as tomato (*Lycopersicon esculentum*), aubergine (*S. melongena*), tobacco (*Nicotiana tabacum*), pepper (*Capsicum* sp.) and weeds (thorn apple (*Datura stramonium*), black nightshade (*S. nigrum*)). Adults can occasionally feed on leaves of other plant families (Chenopodiaceae, Cucurbitaceae, Fabaceae). Experimental work mentions that adults can feed on a wide range of species: horseradish (*Armoracia rusticana*), beetroot (*Beta vulgaris*), cabbage/cauliflower (*Brassica oleracea*), chilli (*Capsicum frutescens*), cucumber (*Cucumis sativus*), pinnate tansymustard (*Descurainia pinnata*), lettuce (*Lactuca sativa*), lucerne (*Medicago sativa*), common bean (*Phaseolus vulgaris*), groundcherry (*Physalis*), radish (*Raphanus sativus*), red currant (*Ribes rubrum*) and spinach (*Spinacia oleracea*). Several wild hosts are mentioned, including species of nightshade. There is field evidence demonstrating that *E. tuberis* can establish and reproduce on wild Solanaceous plants growing in the margin of fields (Conceiçao et al. 2011).

<u>*E. cucumeris*</u>: The most significant host of *E. cucumeris* is potato but the pest has also been reported on other Solanaceae, such as aubergine, pepper, tomato and tobacco. Adult beetles may feed on a great variety of hosts, even non-solanaceous species: cabbage, beetroot, cucumber, sunflower (*Helianthus annuus*), lettuce, bean, maize (*Zea mays*) and various weeds including goosefoots (*Chenopodium* spp.) and thorn apple (Conceiçao et al. 2011).

E. similaris: In North America, foliar damage is reported on potato and other Solanaceae, such as tomato. According to recent experience in Portugal, foliar and tuber damage was observed coincident with *E. similaris* populations in potato fields. Foliar damage was observed in aubergine, and weeds (thorn apple, nightshades) and on potato vine (*S. jasminoides*), an ornamental Solanaceae. In experimental conditions, *E. similaris* can complete its life cycle on aubergine (Conceiçao et al. 2011).

E. subcrinita: Potato, sweet potato (*Ipomoea batatae*), quinoa (*Chenopodium quinoa*), aubergine, pepper, beetroot. Very little information is available on this species (Conceiçao et al. 2011).

Symptoms

Adults may be found on all above-ground parts of the plant as well as on the soil surface. They feed mainly on the upper surfaces of leaves, and less often on the lower surfaces. Adult beetles cut characteristic shot-like holes (1.0–1.5 mm diameter) in the leaves (Anon. 2011). Larvae of *Epitrix* species inhabit the soil around the potato roots on which they feed. Larvae of some *Epitrix* species enter the tubers to feed below the epidermis digging galleries that usually remain superficial and do not affect the flesh of the tuber (Anon. 2011). The tubers will show longs sinuous corky lesions and small holes. The tunneling may result in deep cracks, rough and pimply skin and distortion of the tuber (Anon. 2012). For pictures of damage symptoms, see the links provided in Appendix 1.

Detection, identification

Egg: minute, whitish, spherical. Larva: whitish, slender, cylindrical, 5-12 mm long with a brown head. Adult: small black beetle, 1.5-2.0 mm long, jumping like fleas, with yellow antennae. Morphological identification is only possible for adults but requires both binocular and light microscopy of female spermatheca and male aedeagous. A guide to differentiation between *E. tuberis, E. cucumeris* and *E. similaris* exists, see Anon. (2011). For pictures of *Epitrix* stages, see the links provided in Appendix 1.

Trapping

No trapping methods are available (Conceiçao et al. 2011).

3. Is the pest a vector? **Yes** **X**

Epitrix spp. are vectors of pathogens causing potato blight (*Phytophthora infestans*), potato brown rot (*Ralstonia solanacearum*), potato scab (*Streptomyces scabiei*), potato spindle tuber viroid (CAB 2012), Andean potato latent virus and Physalis mottle virus PhyMV on tomatillo (*Physalis ixocarpa*) (Conceiçao et al. 2011). In addition, feeding wounds can also serve as entry points for other potato pathogens (CAB 2012) such as soft rot bacteria or *Fusarium* dry rot fungi (Conceiçao et al. 2011). Of the vectored pathogens potato blight and potato scab occur commonly in Denmark. Potato brown rot, potato spindle tuber viroid and Andean potato latent virus are quarantine pests for Denmark. Of the secondary pathogens both soft rot bacteria and *Fusarium* dry rot fungi occur commonly in Denmark. *Physalis mottle virus* PhyMV has never been observed in Denmark and is not a quarantine pest.

4. Is a vector needed for pest entry or spread? **No** **X**

5. Regulatory status of the pest

E. tuberis is categorized as an EPPO A1 action list pest (EPPO/CABI, 1997), as is *E. cucumeris* (Anon. 2005). *E. similaris* is on the EPPO alert list at present (May 2012) (EPPO, 2012). *E. tuberis* is a quarantine pest in a number of EPPO countries (e.g. Israel, Jordan, Morocco, Russia, Serbia, Turkey, and Ukraine) as well as in Peru but not for countries in the EU (Conceiçao et al. 2011).

EU emergency measures to prevent the introduction and spread of *Epitrix* spp. was published in May 2012 (EU 2012). The new measures are aimed at preventing the introduction of *Epitrix* spp. into the EU and spread from areas of the EU already infested (parts of Spain and Portugal) (Malumphy et al. 2011)

6. Distribution

Many records only mention *Epitrix* sp., which makes it difficult to reliably establish the geographical distribution worldwide for each species. Difficulties in species identification have meant that *Epitrix* species have often been considered together as a pest complex. The data below on distribution of individual species is therefore not fully reliable (Conceiçao et al. 2011).

Conti-nent	Distribution	Provide comments on the pest status in the different countries where it occurs	Reference
Africa	*E. tuberis:* absent *E. cucumeris:* reported on *Solanum macrocarpon* *E. similaris:* absent *E. subcrinita:* absent	*E. cucumeris:* no data available	Conceiçao et al. 2011
North America	*E. tuberis:* believed to be native to Colorado (USA); spread to California, Nebraska, New Mexico, Oregon, South Dakota, Washington and Wyoming and to Canada (British Columbia and Alberta) *E. cucumeris:* USA (at least California, Florida, Indiana, Kansas, Maine, Manitoba, New Hampshire, New Mexico, Nebraska, North Carolina, North Dakota, South Dakota, Vermont, Virginia, New York); Canada (Alberta, Manitoba, New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan); Mexico (Durango, Guerrero, Morelos, Puebla, Veracruz) *E. similaris:* is considered to have originated from North America, but very little data is available. Occurs in USA (at least California) *E. subcrinita:* Canada (British Columbia), USA (Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming)	*E. tuberis:* Widespread and spreading *E. cucumeris:* no data available *E. similaris:* no data available *E. subcrinita:* no data available	Anon. 2012 Conceiçao et al. 2011
Central and South America	*E. tuberis:* Ecuador *E. cucumeris:* Costa Rica, Dominican Republic, Guadeloupe, Guatemala, Jamaica, Nicaragua, Puerto Rico, Bolivia, Colombia, Ecuador, Venezuela *E. similaris:* absent *E. subcrinita:* Peru	*E. tuberis:* restricted distribution *E. cucumeris:* no data available *E. subcrinita:* no data available	CAB 2012 Conceiçao et al. 2011
Asia	Absent		Conceiçao et al. 2011
EPPO	*E. tuberis:* absent *E. cucumeris:* Azores Islands and Northern mainland Portugal *E. similaris:* Portugal (mainly in the North and centre), Northern Spain *E. subcrinita:* absent	*E. cucumeris:* no data available *E. similaris:* widespread in the main potato-growing areas in Portugal	Conceiçao et al. 2011
Oceania	Absent		Conceiçao et al. 2011

7. Host plant/habitats distribution

Below only outdoor host plants are considered (not in greenhouses in view of the statements made under point 10). Only host plants which are commercially grown in Denmark are specifically mentioned. Host plants grown exclusively in Danish private gardens are mentioned in just one entry. Of wild hosts only wild Solanaceae of relevance to Denmark are considered. Here only common names are stated. The original headings of the table are marked in light brown.

Main host – for Latin names see under host plants, point 2 **Host Scientific name (common name)**	**Presence in PRA area**	**Comments (the area stated relates only to commercial production)** (e.g. total area, major/minor crop in the PRA area)	**Reference**
Potato	Crop. Private gardens	40.532 ha	Danmarks Statistik 2012
Beetroot	Crop	approx. 44.000 ha	Danmarks Statistik 2012
Cabbage	Crop. Private gardens	approx. 2.500 ha	Nielsen 2011
Lettuce	Crop. Private gardens	approx. 700 ha	Nielsen 2011
Lucerne	Crop	approx. 7.000 ha	Danmarks Statistik 2012
Bean	Crop. Private gardens	minor	Nielsen 2011
Radish	Crop. Private gardens	minor	Nielsen 2011
Red currant	Crop. Private gardens	approx. 300 ha	Danmarks Statistik 2011
Spinach	Crop. Private gardens	minor	Nielsen 2011
Maize	Crop	approx. 174.000 ha	Danmarks Statistik 2012
Host plants grown outdoor in private gardens (e.g. tomato, tobacco, lettuce, radish, red currant, ornamental Solanaceae)		common	
Wild plants (Solanaceous and others), e.g. nightshades		fairly common (weed, wild habitats)	

8. Pathways for entry

The pathways described below are valid for all species of *Epitrix* species. Except otherwise stated the references is Conceiçao et al. (2011) which can be consulted for details. Please note that the headings of the two rightmost columns have been changed according to my comments made to part I of the task (the original headings are marked in light brown).

The most probable means of entry or spread is considered to be as pupae or dormant adults in soil associated to potato tubers and the attached soil (i.e. tubers that have not been brushed and/or washed). The other pathways are considered to present lower risk, and Conceiçao et al. (2011) recommended that they should not be considered for risk management at this stage but might be reconsidered if necessary.

Possible pathways	**Short description explaining why it is considered as a pathway**	**Probability of spread of pest through pathway with brief outline of reason** Prohibited: Yes/No	**Likelihood for detecting pest on the pathway** Pest intercepted on the pathway? Yes/No
Potato tubers for planting with soil attached originating from areas where the pests occur	Soil may contain dormant adults or pupae. Potato tubers may contain larvae although larvae probably leave tubers immediately after they are lifted (Anon. 2012)	Import of seed potatoes to Denmark from countries outside the EPPO region is prohibited. Prior to the new EU emergency measures (EU 2012) it was moderately likely that *Epitrix* sp. could enter Denmark through import of seed potatoes from Portugal (although no import to Denmark at present) or Spain (200 tons in 2011), or from EPPO-countries that in the future would have the pests established. Likelihood of entry now is greatly reduced	Likely to remain undetected unless close inspections are made

Possible pathways	**Short description explaining why it is considered as a pathway**	**Probability of spread of pest through pathway with brief outline of reason** Prohibited: Yes/No	**Likelihood for detecting pest on the pathway** Pest intercepted on the pathway? Yes/No
Potato for consumption with soil and/or plant debris attached originating from areas where the pests occur	Soil may contain dormant adults or pupae. Potato tubers may contain larvae although larvae probably leave tubers immediately after they are lifted (Anon. 2012)	Import of potato tubers for consumption to Denmark from countries outside the EPPO region is prohibited. Under derogations, import may occur from Canada and USA, however Denmark does not import seed potatoes from North America at present (Danmarks Statistik 2012) Prior to the new EU emergency measures (EU 2012) it was highly likely that *Epitrix* sp. could enter Denmark through import of ware potatoes from North America or Portugal (although no import to Denmark at present), from Spain (2.900 tons in 2011), or from EPPO-countries that in the future would have the pests established. Likelihood of entry now is greatly reduced	Moderately likely to remain undetected – depends on storage temperature and closeness of inspection
Natural spread from countries where the pests occur	Adult beetles can actively fly to potato fields - other stages are sedentary (Anon. 2012)	No strong evidence for long distance natural spread; therefore highly unlikely at present where *Epitrix* sp. only occur in Portugal and Spain	Highly unlikely that naturally spreading *Epitrix* individuals will be discovered
Soil or growing medium attached to rooted host plants for planting from areas where the pests occur	Soil attached to rooted host plants may contain dormant adults or pupae. Rooted plants produced in soil and/or in outdoor conditions are likely to pose a greater risk than rooted plants produced in artificial growing media or grown under protection. In the case of potatoes, only microplants (for seed potato production) are marketed as rooted plants; they are normally produced in axenic conditions so should pose no risk	In Denmark, import of Solanaceous plants is prohibited from third countries (except European and Mediterranean countries) but spread may occur through import from countries within EU where the pests are present May occur – more data needed to determine which host plants besides potato allow completion of the pest life cycle	Highly likely to remain undetected unless close inspections are made
Soil or growing medium attached to rooted non-host plants for planting from areas where the pests occur	Soil attached may contain dormant adults or pupae. Plants may be grown in fields where potatoes or other hosts had been grown previously and consequently soil attached to rooted non-host plants may contain dormant adults or pupae.	May occur – more data needed on survival in soil without host plants	Highly likely to remain undetected unless close inspections are made

Possible pathways	**Short description explaining why it is considered as a pathway**	**Probability of spread of pest through pathway with brief outline of reason** Prohibited: Yes/No	**Likelihood for detecting pest on the pathway** Pest intercepted on the pathway? Yes/No
Soil attached to machinery from countries where the pests occur	Soil attached may contain dormant adults or pupae	Highly unlikely at present where the pests are only present in Portugal and Spain	Highly likely to remain undetected unless close inspections are made
Soil or growing medium as such from countries where the pests occur	Soil may contain dormant adults or pupae.	Denmark prohibits the import of soil from countries outside the EU Highly unlikely at present where the pests are only present in Portugal and Spain from which no movement of soil to Denmark is known to occur	Highly likely to remain undetected unless close inspections are made
Washed ware potato tubers	Potato tubers may contain larvae although larvae probably leave tubers immediately after they are lifted (Anon. 2012)	Unlikely. Presence of larvae in potato tubers is not reported in the literature and has never been observed. In addition, it seems that the larvae are active and leave tubers immediately after they are lifted (Anon. 2012)	Highly likely to remain undetected unless close inspections are made

Rating of the likelihood of entry, prior to EU emergency measures			*High* **x**
Rating of the likelihood of entry, after EU emergency measures	*Low* **x**		
Rating of uncertainty	*Low* **x**		

9. Likelihood of establishment outdoors in the PRA area

Host plants are abundantly available since the main host, potato, is grown extensively in Denmark by professional growers on an area about 40.500 ha (Danmarks Statistik, 2012). In addition, potatoes are grown in private gardens and wild host plants are common.

Epitrix species are present in the north western part of North America, from California to British Columbia (Conceiçao et al. 2011). Based on the climate matching done by Conceiçao et al. (2011) (Appendix 2), the climate in Denmark can be considered similar to zones where at least some of the species of *Epitrix* occur.

Rating of the likelihood of establishment outdoors			*High* **x**
Rating of uncertainty	*Low* **x**		

10. Likelihood of establishment in protected conditions in the PRA area

Epitrix species have never been recorded as pests under protected conditions. They are reported as secondary pests of tomato in California but not in tomato under protected cultivation. In British Colombia, there is extensive protected cultivation of tomato but no *Epitrix* species have ever been recorded (Conceiçao et al. 2011)

Rating of the likelihood of establishment in protected conditions	*Low* **x**		
Rating of uncertainty	*Low* **x**		

11. Spread in the PRA area

Adult beetles can actively fly – other stages are sedentary (Anon. 2012). Dispersal distances are not mentioned in scientific literature. Although no strong evidence exists of long distance natural spread, it is considered moderately likely that the pest can spread by natural means (Conceiçao et al. 2011).

In addition, it is considered likely that the pest can spread rapidly by human assistance through movement of plant or plant products with soil attached (e.g. plants for planting, potato tubers) – i.e. with dormant adults or pupae (and, less likely, with tubers containing larvae). This judgment, however, is based solely from the experience with the outbreak in Portugal where spread occurred in the absence of phytosanitary measures: over a 4-year period damage was observed in areas up to 300 km from the place where the pests are presumed to have been introduced. It is difficult to know which part of this spread is due to natural spread or to human-mediated spread (Conceiçao et al. 2011).

Rating of the magnitude of spread			*High* **x**
Rating of uncertainty		*Moderate* **x**	

12. Impact in the current area of distribution

Economic impacts

Epitrix species are considered as important pests in the area of origin and have resulted in economic damages to potato in Portugal since 2004 (Conceiçao et al. 2011). The feeding damage caused by *Epitrix* larvae to potato tubers results in downgrading of potatoes and heavy infestations may result in complete crop loss (Conceiçao et al. 2011). The feeding by adults, causing shot-like holes in potato leaves may, at least for some *Epitrix* species, result in yield losses of economic importance, especially in cases of stress due to drought or infestations with diseases or other pests, although of less importance than the tuber damage (Conceiçao et al. 2011; Anon. 2012). All *Epitrix* species can transmit or favour pathogen entry which may have an additional negative impact on yield (Conceiçao et al. 2011).

Ecological/environmental impacts

No direct environmental damage is reported in the literature (Conceiçao et al. 2011). The use of insecticides to control *Epitrix* species will have ecological impacts (see below, point 13).

Social impacts

No social impacts are reported in the literature (Conceiçao et al. 2011).

Control measures

Insecticide treatments are generally applied against *Epitrix* sp., targeting the first generation. When the first generation is not correctly controlled, up to 7 insecticide treatments may be required during the growing season (Conceiçao et al. 2011). Resistance to DDT appeared rapidly in the USA after 5-6 generations, so similar problems may arise with the more modern insecticides (Anon. 1989).

Rating of the magnitude of impact in the current areas of distribution			*High* **x**
Rating of uncertainty	*Low* **x**		

The rating is based on the highest type of impact

13. Potential impact in the PRA area

Impact similarity

Based on the fact that establishment has occurred in Portugal, it is likely that existing Danish management practices combined with the existing diversity of Danish natural enemies and competitors will fail to prevent establishment (Conceiçao et al. 2011). Should establishment occur in Denmark, it may be possible to keep the pest under control but probably only with some difficulties – in Portugal, once the farmers were made aware of possible treatments, management measures were implemented (e.g. an additional early spray) and damage appeared to be less severe in 2009 than in previous years. In Denmark the following active ingredients that have an effect against *Epitrix* sp. (Conceiçao et al. 2011) are presently approved for use in potato: acetamiprid, esfenvalerate, imidacloprid (coating) and lambda-cyhalothrin (Videncentret for Landbrug 2012). Research may be needed to determine the most effective insecticides and best time of treatment under Danish conditions.

In spite of the present availability of insecticides, the economic impacts as well as the ecological impacts associated with an increased insecticide use in Denmark are considered to be of similar magnitude as in areas already infested.

Pest management options currently available in organic farms will fail to prevent establishment (Conceiçao et al. 2011) and most likely to control the pests.

Consequences

Export loss

Denmark's export of potatoes amounted to approx. 67.000 tons seed potato and 118.000 tons other potato in 2011 with main destinations within Europe, Russia, North Africa and the Middle East (Danmarks Statistik 2012). One or more of the *Epitrix* species are quarantine pests in several of these destination countries (Conceiçao et al. 2011). Establishment of *Epitrix* sp. in Denmark is very likely to cause losses in the export market.

Increased use of pesticides

It is very likely that an establishment of *Epitrix* sp. in Denmark will necessitate an increased used of insecticides, e.g. through increased frequency of application (Anon. 2012). In addition, *Epitrix* species may through transmission or favouring of pathogen entry increase the need for application of fungicides. The increased pesticide use may disrupt ongoing biological or integrated management programs against other pests and/or have negative influence on the environment (Conceiçao et al. 2011) as the especially the required insecticides, but also some of the fungicides, generally are moderately to highly toxic to a range of natural enemies (Biobest, 2012).

Increased production costs

Major increases in production costs can be foreseen if *Epitrix* sp. establishes in Denmark – growers will probably apply insecticides at high frequency at least in the first years, to be sure not to have quality problems, as growers might not be ready to accept the risk of IPM. Routine spray schedules at short intervals (one week or less) might be needed. Time and money will be needed before action thresholds and IPM programs adapted to Danish conditions are developed, and will, upon implementation, presumably imply additional costs for scouting and advice. Extending crop rotation is an effective measure for preventing infestations with *Epitrix* sp. but for some growers, the need to rotate fields more frequently would have an economic impact. To be truly effective, rotation should be applied over a large area and volunteer potatoes would have to be removed (Conceiçao et al. 2011).

Reduced consumer demand

Moderate reduction in consumer demand for potatoes produced in Denmark if *Epitrix* sp. becomes established can be foreseen. It is likely that demand for Danish exported seed potatoes will decrease or that seed exporters will be asked to justify and give the proof of seed freedom from *Epitrix* sp. Likewise it is expected that supermarkets and the processing industry will refrain from buying Danish potatoes with symptoms. In addition, increased production costs for Danish potatoes as a consequence of establishment of *Epitrix* sp. may increase prices which can result in consumer reduction. Finally, consumer awareness of an increase in the use of pesticides in Danish potatoes may result in consumer reduction (Conceiçao et al. 2011). Organic production of Danish potatoes may be affected – it is likely to become more difficult and thereby more costly to produce quality organic potatoes resulting in increased prices and consumer reduction, perhaps leading to a shift in consumer preference for organic potatoes originating outside Denmark.

Other costs

Moderate additional costs include the cost for research to find appropriate control methods (e.g. IPM, biological control), for extension (advice to producers), for monitoring of the pests to target treatments and evaluate its spread and for increasing public awareness (Conceiçao et al. 2011).

Will impacts be largely the same as in the current area of distribution? **Yes**

14. Identification of the endangered area

The endangered area is the entire Denmark for at least one of the *Epitrix* species. Of the 4 species, *E. cucumeris, E. subcrinita* and *E. tuberis* are the most likely to be able to establish in Denmark, based on their present distribution (Eastern North America for the first species and north western part of North America for the other two) (see Appendix 2) (Conceiçao et al. 2011).

15. Overall assessment of risk

Likelihood of entry

Prior to the new EU emergency measures (EU 2012) it was moderately likely that *Epitrix* sp. could enter Denmark through import of seed potatoes in spite the fact that Denmark at present only has a minor import from EPPO-countries where the pests occur (Danmarks Statistik 2012). This is because the pest in a foreseeable future could be expected to spread to EPPO-countries from which Denmark has a larger import (e.g. France, 766.000 tons in 2011, Danmarks Statistik (2012)). Similarly it was highly likely that *Epitrix* sp. could enter Denmark through import of ware potatoes from Spain (not from North America or Portugal due to present zero-import, Danmarks Statistik (2012)), from North America should import be resumed or from EPPO-countries that in the future would have the pests established. With the new EU emergency measures (EU 2012) the likelihood of entry of *Epitrix* species into Denmark is greatly reduced and is classified as low.

Likelihood of establishment

Once entered into Denmark, the likelihood of establishment is high

Likelihood of spread

Once entered into Denmark, the likelihood of rapid spread (mainly by human assistance) is high

Likelihood of impact

Once entered into Denmark, the likelihood of serious impacts is high

Phytosanitary measures should be applied.

Stage 3 Pest risk management

16. Phytosanitary measures

Options at the place of production

Infestation of a commodity can not be prevented by 1) treating the crop prior to harvest / 2) growing resistant cultivars / 3) growing in special conditions / 4) harvesting only at certain times / 5) harvesting only certain plant parts / 6) producing under certified systems. The reasons are as follows (Conceiçao et al. 2011):

1) Chemical treatments are not fully reliable in ensuring crop freedom from *Epitrix* sp. In addition, in spite of various cultural and chemical control measures applied to the crop, there is always a risk that adult *Epitrix* sp. may reinfest fields from neighbouring areas and establish between treatments
2) Although some cultivars show less damage than others, the number of pupae or dormant adults in the soil is not necessarily reduced. Transgenic potatoes with resistance to *E. cucumeris* have been explored without success
3) Both seed and ware potatoes are mostly produced outdoors. It is not economically practical to produce potatoes in greenhouses, neither in infested countries (to prevent introduction) nor in Denmark (to prevent spread if entry has occurred in Denmark)
4) Potatoes are usually harvested when *Epitrix* stages are present in the soil
5) The pests are present in the soil attached to the tubers – they do not occur on plant parts that can be removed
6) Certification schemes are usually established to address viruses/pathogens that are transmitted by the mother plant. They do not address insect pests specifically, but general inspections required in this framework may allow the pest to be detected. This approach is considered below under "pest freedom" below

Pest freedom

It is considered likely that pest free areas can be established to ensure freedom from *Epitrix* sp. in potatoes imported to Denmark from such areas. Establishment of a pest free area would for at least 2 years normally include monitoring at harvest for *Epitrix* damage symptoms on tubers, monitoring of the growing crop for characteristic *Epitrix* shot-like holes on leaves, visual scouting of young potato crops and sweeping larger-sized potato plants for adults during the growing season, monitoring of alternative hosts for foliage damage in commercial fields and backyard gardens (Conceiçao et al. 2011). Establishment of pest free areas will result in additional costs resulting in increased prices for imported potatoes.

It will not be possible to establish and uphold pest free places of production (i.e. on specified premises) because it will not be possible to define an adequate size for a buffer zone around such premises due to the lack of reliable information on capacity of natural spread of the pests by walking or flying combined with the presence of potential wild hosts. Since no trapping methods are available, extensive monitoring of all fields and field margins at the premises would be necessary (Conceiçao et al. 2011).

Options after harvest, at pre-clearance or during transport

Brushing and/or washing tubers to remove practically all of the soil (and thus all live stages of *Epitrix* sp.) is possible but the effect under commercial conditions is yet unknown. However, washing is known to increase the risk of soft rot so careful management of the seed will be needed. Quarantine treatments against other potato pests may be applied post-harvest for instance by use of insecticides, steam treatment, hot water dipping treatment or irradiation but investigations on the effect against *Epitrix* sp. are required. Only insecticide use will be appropriate for seed potatoes as they are damaged by the other treatments. Containers/bags for transportation should be new or cleaned and disinfected to prevent infestation of the consignment with pests that might remain in containers/bags from their previous use (Conceiçao et al. 2011).

Options that can be implemented after entry of consignments

The pest can not be reliably detected by visual inspection at the time of export / import / storage / transport / post-entry quarantine. Adults may be detected but not larvae and pupae. Adults are small (less than 2 mm) and black so they will not be easily observed because of the presence of soil, but they are visible if they are looked for specifically. Adults are not active at 5°C which is the usual temperature for storage of certified seed potatoes, and detection will therefore be more difficult. In addition, seed potatoes are not washed, so symptoms are more difficult to detect. Potato tubers for consumption may be transported and stored at a warmer temperature, and adults may not be dormant which makes detection easier, but it is likely that there will be more soil attached to tubers for consumption than to seed potatoes, and tubers for consumption are often transported in bulk. Therefore detection will be more problematic. Absence of damage symptoms or non-detection of the pest is not sufficient to ensure that the consignment is free from the pest (Conceiçao et al. 2011).

Infested consignments can not be accepted without risk for specific end uses / limited distribution in Denmark / limited periods of entry: 1) seed potatoes are imported for planting and will thus enter at times where conditions are favourable for spread to and survival on host plants; 2) pests may escape from imported potatoes for consumption and spread to and survive on host plants – host plants will be present in Denmark most of the year (March-September) and even if no host plants are available the risk, albeit minor, exists that dormant adults may end up in suitable places for continued dormancy or may survive in storage.

Prohibition

Existing regulations already stipulate prohibition of import of seed and ware potatoes to Denmark from countries outside the EPPO region with exemptions for import of ware potatoes from Canada and USA (Conceiçao et al. 2011). Additional emergency measures have recently been set up to prevent entry to and spread within EU (EU 2012).

Surveillance, eradication

It is very unlikely that the pest can be eradicated from Denmark through eradication programs for the following reasons: 1) Although the number of generations exhibited by the 4 *Epitrix* species is still debated, it seems that at least one species has the potential to have more than one generation, 2) *Epitrix* species have a high reproductive capacity with a long period of oviposition; beetles can reinvade fields which makes chemical control against the pest difficult if the first generation is not correctly controlled, 3) *Epitrix* species are polyphagous, which will help survival of adults; host plants are very widely distributed in Denmark, 4) Symptoms are visible on tubers but the recognition of this is too late for effective treatment, therefore a population can establish before its presence is noticed; the presence of adults is difficult to spot by inexperienced people; adults have a dormancy period in the soil or plant debris during which they can not be detected, 5) efficient plant protection products for the control of *Epitrix* are available in Denmark, but it will not be possible to treat some host plants (e.g. in the wild); the risk of resistance development exists (Conceiçao et al. 2011).

Conclusion
Epitrix species present a risk to Denmark because 1) they can have high economic impact on potato, 2) economic impact has been noted in Portugal on potato, 3) at least some of the species in the pest complex can find suitable ecoclimatic conditions in Denmark and 4) potato is widely grown in Denmark both commercially and in private gardens.

The main pathways are potato tubers for planting, as well as potato tubers for consumption, with soil and plant debris attached coming from areas where the pests are present. The pests are likely to be moved undetected in soil attached to plants or plant products. The probability of entry through these pathways was prior to the new EU emergency measures (EU 2012) considered to be high with a low uncertainty but is now greatly reduced. The other pathways are considered to present lower risk.

The overall probability of establishment in Denmark is high with a low uncertainty because hosts are abundant, environment is favourable for establishment, and current management practices are not expected to prevent establishment. Of the 4 species of the pest complex it is most likely that *E. cucumeris, E. subcrinita* and *E. tuberis* can establish in Denmark.

The overall probability of spread within Denmark, should establishment occur, is high with a moderate uncertainty based on the experience from Portugal with 300 km distances covered within 4 years.

Control of *Epitrix* sp. populations that may establish in Denmark in the future is possible but will increase production costs in commercial production. Control in non-commercial production will be problematic and will maintain a certain level of pests. As *Epitrix* sp. is quarantine pest in numerous countries worldwide, an establishment of *Epitrix* sp. In Denmark is likely to affect export markets. The economic impact if introduced in Denmark is evaluated as high and phytosanitary measures should therefore be applied to prevent establishment.

The following measures which already apply (EU 2012) will help prevent entry of *Epitrix* species into Denmark: 1) any import to Denmark of potatoes from non-EU countries where the pest occurs should either be prohibited or restricted according to the specifications in the new emergency EU measures (EU 2012), i.e. subjected to requirements of production in pest free areas or washing/brushing, with either option accompanied by a phytosanitary certificate; 2) any import to Denmark from EU countries where the pest occurs (demarcated areas) (EU 2012) must according to the new emergency EU measures (EU 2012) only take place if accompanied by plant passport.

17. Uncertainty
The following matter are uncertain (Conceiçao et al. 2011): origin of the Portuguese outbreak; species distribution and pest status (presence of *E. similaris* in North America, pest status of *E. cucumeris*); biology and population dynamics of *Epitrix* sp. (number of generations, capacity of dispersal, adaptability, building of small population); host range, in particular impact in tomato; the ability of *Epitrix* species complete life cycle on other host plants besides potato. The uncertainties are due to lack of information in the literature and a detailed PRA (already existing for the EPPO region (Conceiçao et al. 2011)) will not solve this.

18. Remarks
No additional remarks.

19. References

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Nielsen SF (2011) Arealet med frilandsgrønsager steget markant. Frugt og Grønt, Februar 2011, 78-79.

Videncentret for Landbrug 2012. Middeldatabasen. http://planteapp.dlbr.dk/middeldatabasen [accessed May 2012].

Appendix 1 Relevant illustrative pictures (for information)

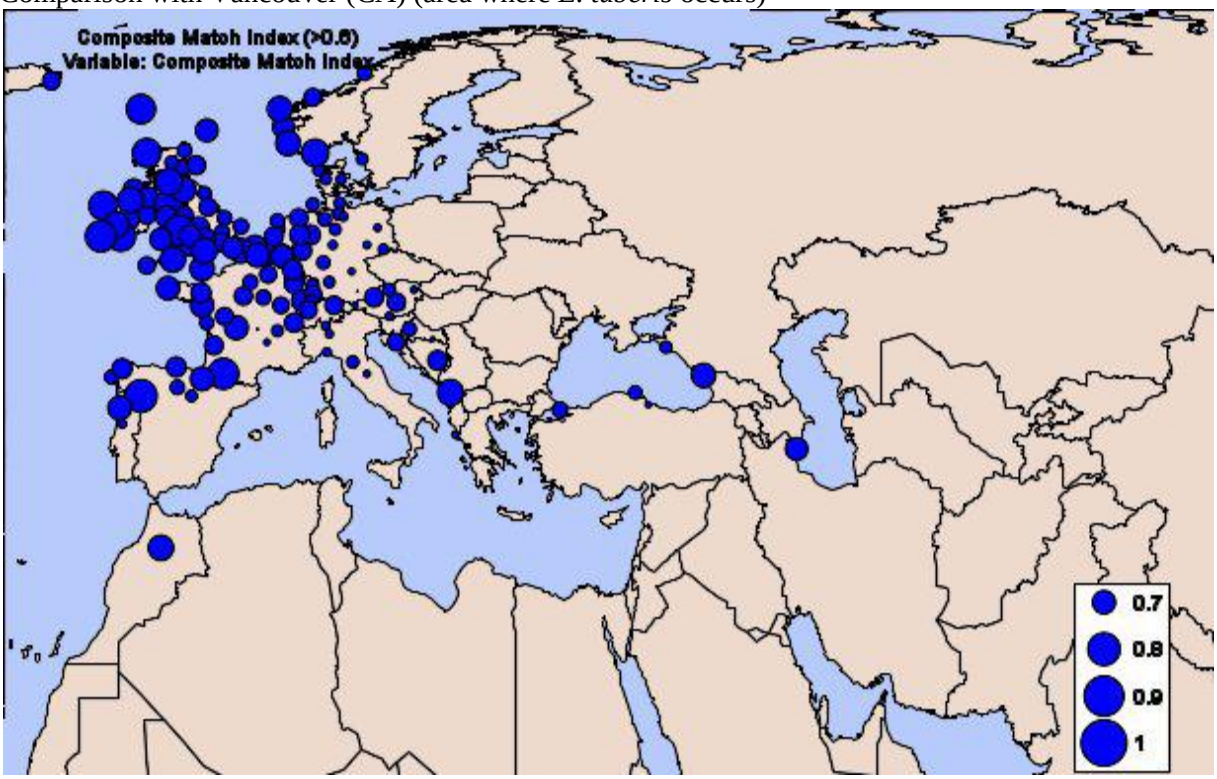
See the following websites:

http://photos.eppo.int/index.php/album/176-epitrix-tuberis-epixtu
http://www.eppo.int/QUARANTINE/insects/Epitrix_tuberis/EPIXTU_images.htm?utm_source=www.eppo.org&utm_medium=int_redirect

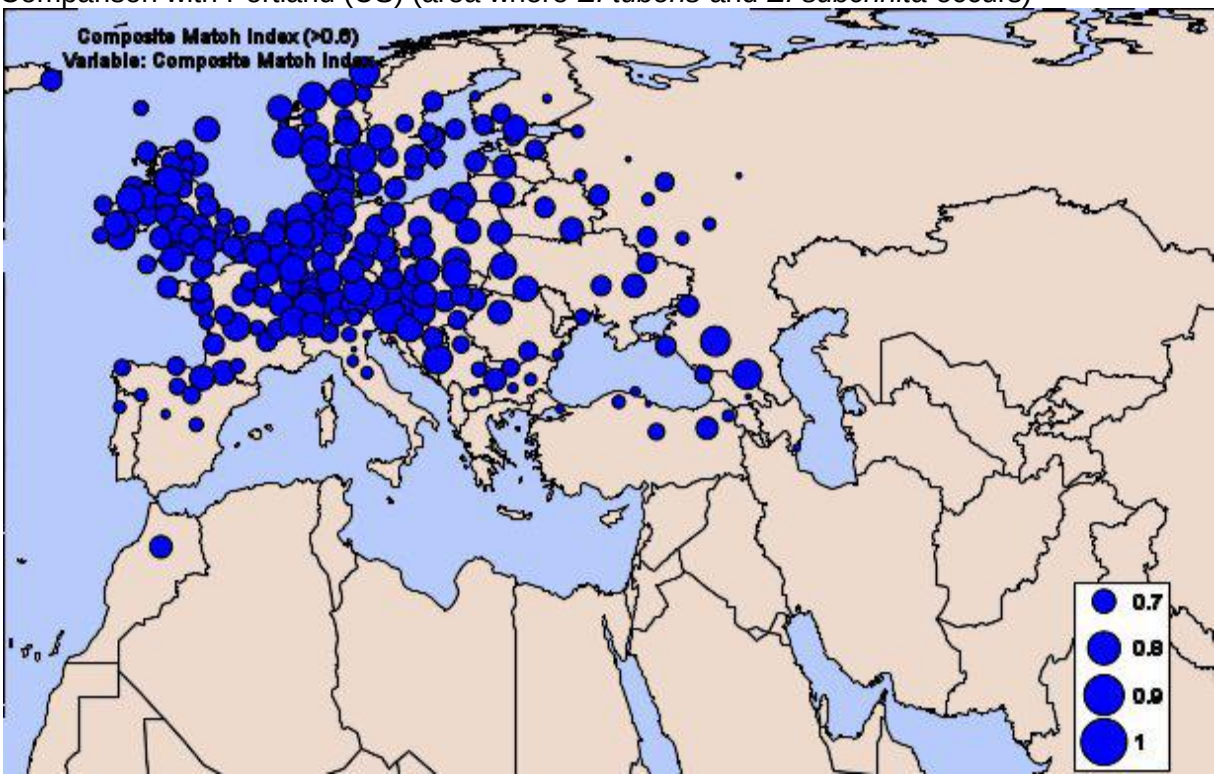
Appendix 2

Comparison of climate between zones where *Epitrix* spp. are present and the EPPO region. This comparison was performed by Conceiçao et al. (2011) using CLIMEX software, with a match index of 0.6. CLIMEX compares the weekly maximum, minimum or average temperatures, rainfall and relative humidity. This comparison is not based on the biology of the pest.

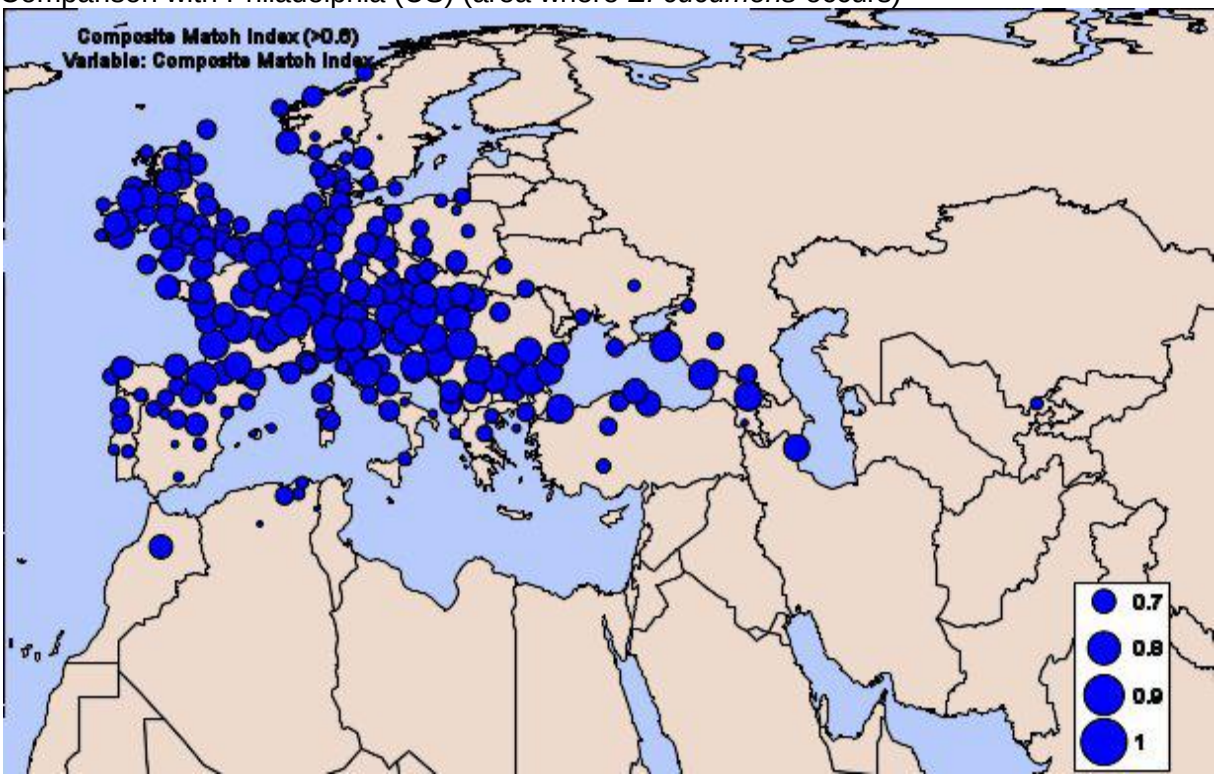
Comparison with Vancouver (CA) (area where *E. tuberis* occurs)



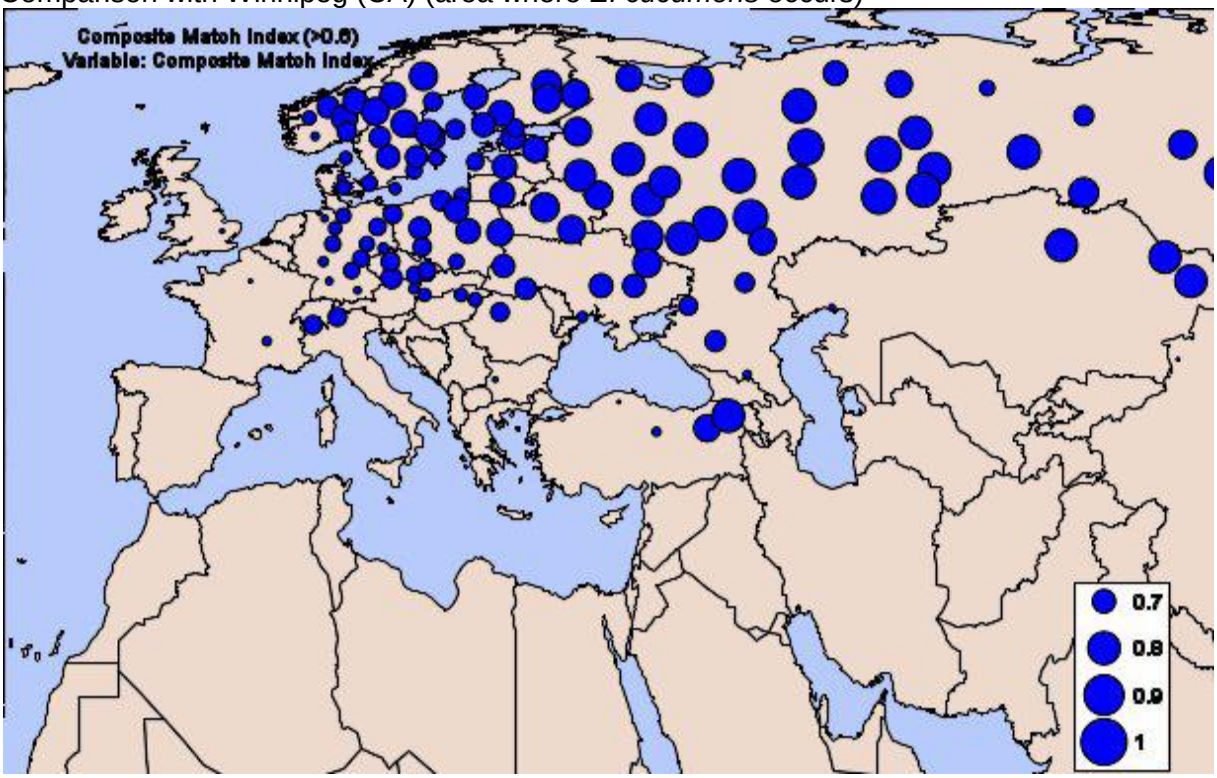
Comparison with Portland (US) (area where *E. tuberis* and *E. subcrinita* occurs)



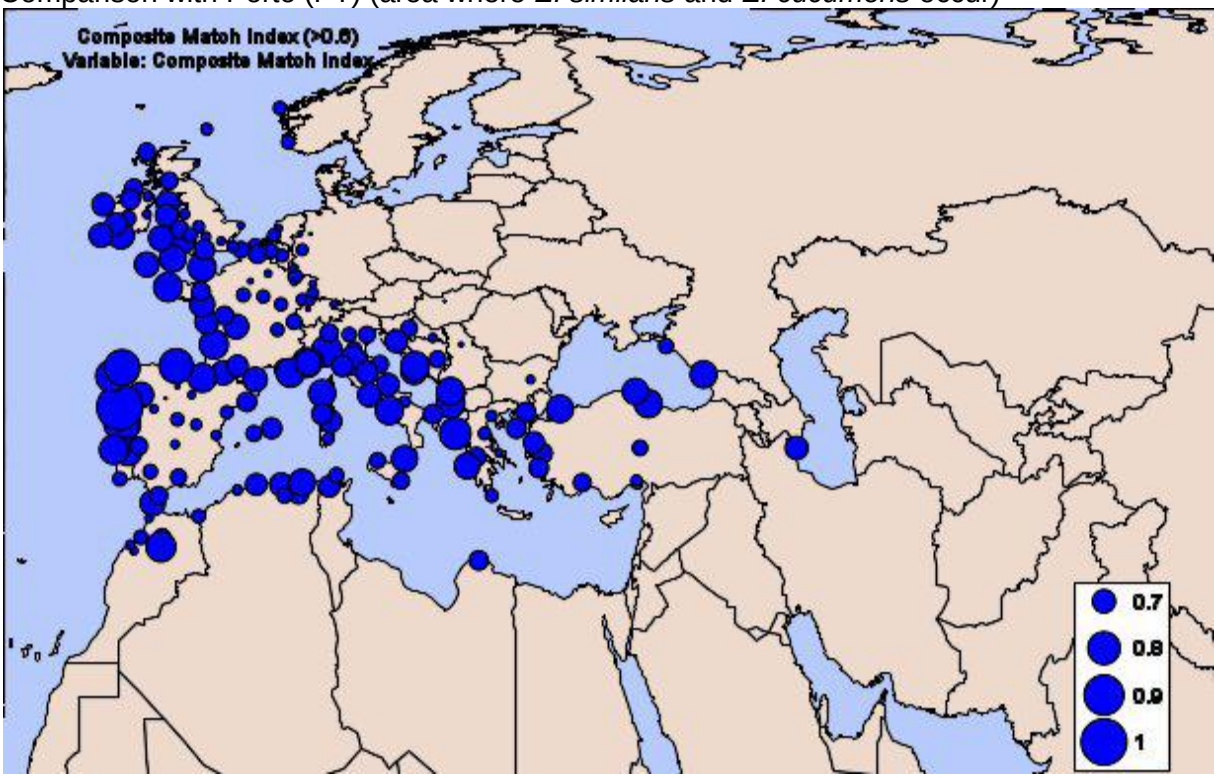
Comparison with Philadelphia (US) (area where *E. cucumeris* occurs)



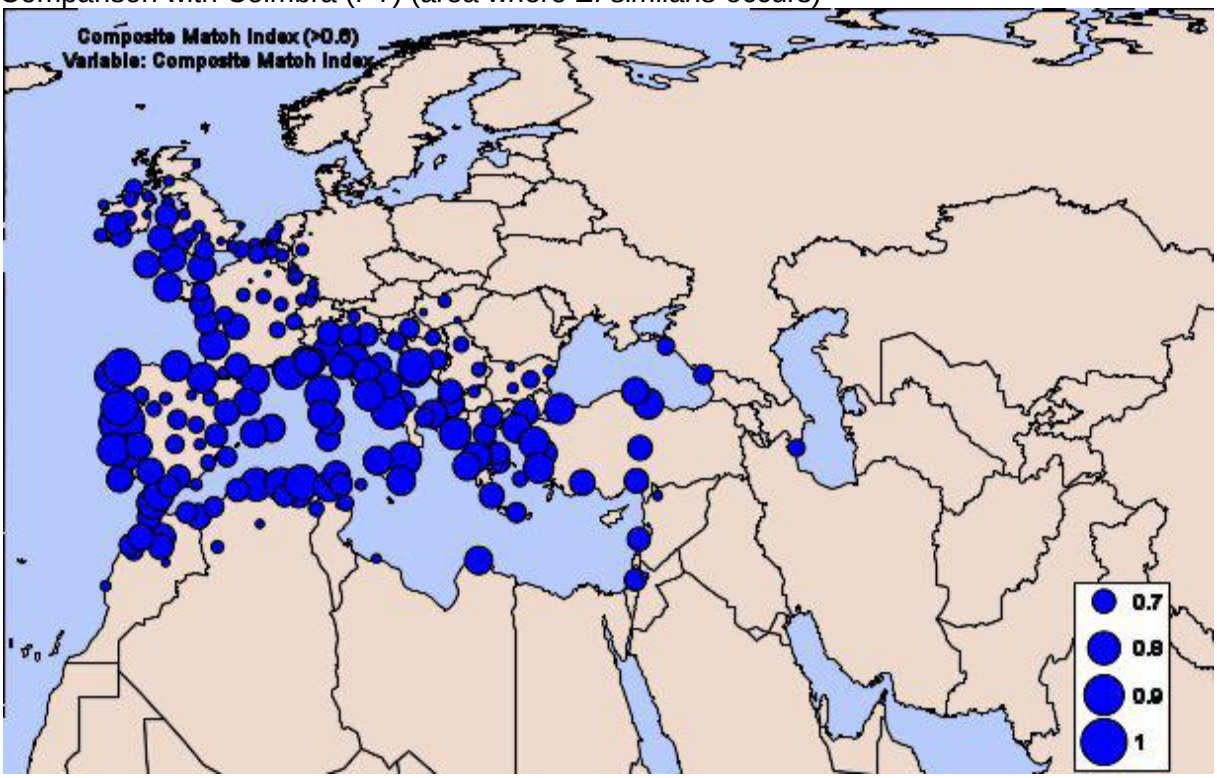
Comparison with Winnipeg (CA) (area where *E. cucumeris* occurs)



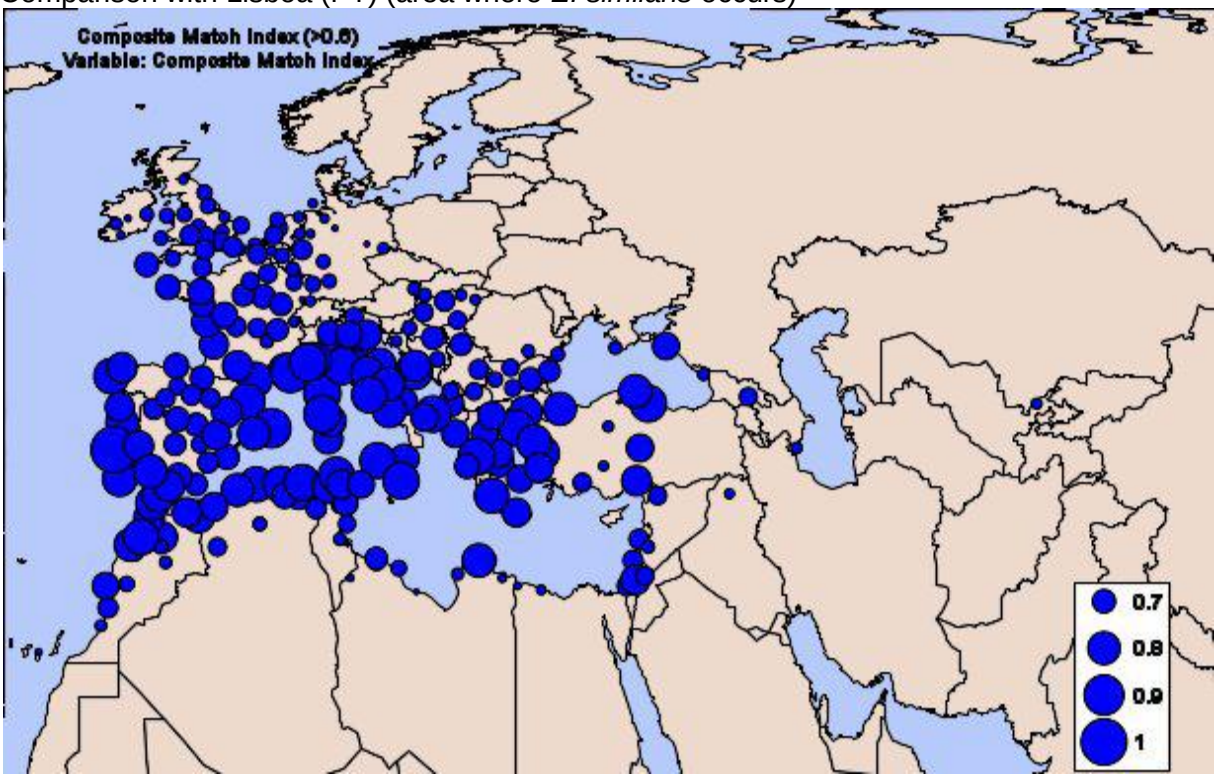
Comparison with Porto (PT) (area where *E. similaris* and *E. cucumeris* occur)



Comparison with Coimbra (PT) (area where *E. similaris* occurs)



Comparison with Lisboa (PT) (area where *E. similaris* occurs)



Comparison with Los Angeles (USA) (area where *E. similaris* and *E. subcrinita* occur)