Department for Environment Food & Rural Affairs

The potential for small hive beetle, *Aethina tumida*, to be associated with produce and other plant products from Italy

1. Background

The small hive beetle belongs to the family Nitidulidae. Nitidulids have a diverse range of feeding habits, but many feed on a variety of rotting food and fungi, including ripe and fermenting fruit. The small hive beetle is primarily a serious pest of hives, both for honey bees and bumble bees, but it has also been recorded feeding on fruit. No evidence could be found as to whether the beetle is a primary pest able to attack healthy fruit, or if it is a secondary pest that requires existing damage before it can feed on fruit. The small hive beetle additionally carries a yeast strain which induces fermentation of its food, adding to the damage it causes.

Given the findings of small hive beetle in Italy, the potential risks of introducing the beetle to the UK on imported Italian plants and plant products are considered here. A literature search was carried out exploring non-hive sources of food for *A. tumida*, and relevant documents are summarised below.

2. Pathway: Produce

Research into alternative (non-bee-related) sources of food was carried out by Ellis *et al.* (2002). In the laboratory, the complete life cycle could be completed on fresh and rotten Kei apples, but the ratio of emerging adults per larvae was only about half that of beetles raised on hive products. Adults fed on honey could live for over 5 months, while those feeding on fruit could live for over 2 months (Ellis *et al.* 2002).

Neumann and Elzen (2004) carried out a review of the biology, focussing on aspects that (may) contribute to the invasive potential of this species. They note that, while breeding on a variety of fruit is possible, this has never been observed in South Africa (their native

range). Additionally, they note that research on alternative field hosts has not been carried out, with the conclusion that “We cannot completely exclude that the presence of an abundant food source other than honeybee colonies may serve as a refuge for the small hive beetle and as a source of further infestations” (Neumann & Elzen 2004).

Undertaking laboratory research into feeding habits, Buchholz *et al.* (2008) investigated whether small hive beetles would use alternative food sources (including fruit and meat) when bee colonies were also available for food. While brood, honey and pollen were always a preferred food in choice tests for egg laying and larval feeding, bananas were also frequently chosen, and when only honey and pollen were available (not brood), bananas were chosen most often. This was the case for both experiments on larval food choice and adult oviposition choice, i.e. in the absence of brood, eggs were frequently laid in banana fruit, as well as larvae choosing to feed on bananas. While survival to adult was higher on honey and pollen than fruit, development could be completed on all the fruit tested: bananas, grapes, and mango. Buchholz *et al.* (2008) also examined the role of flowers (Asteraceae) as a food source for adults. In no-choice flower tests, some adults could survive on flowers for over 10 days, but so did adults in the negative control, which were only given water. Larvae were not found in any of the flowers. Thus, it seems that small hive beetle may be associated with fruit, notably banana, with some frequency even when bee hives are available, but flowers (at least in the Asteraceae) appear to be less favoured as an adult food, and larvae are unlikely to be associated with them (Buchholz *et al.* 2008).

While larvae may choose to feed on fruit, a smaller percentage may survive to adult if they do so. Arbogast *et al.* (2009) reared larvae (in experimental no-choice conditions) on a substrate containing pollen and on a variety of fruit. They also investigated the effect of inoculating the food with the yeast the beetle carries naturally. The total progeny was highest on the inoculated oranges and the inoculated pollen substrate, then on cantaloupe, followed by oranges and grapes, with the fewest progeny on the plain pollen substrate (Arbogast *et al.* 2009). In further work, Arbogast *et al.* (2010) found that, while larvae developed faster on oranges, the larvae were much less likely to survive when compared to the pollen diet.

The UK imports a wide range of plants and produce from Italy. EUROSTAT data from 2011 to 2013 indicate we import a variety of fruit, as well as growing plants. As well as fruit such as citrus, melons and grapes, imports from Italy also include a small amount of bananas (in the last ten years the amount has varied from around 22 to over 1000 tonnes per year) (Table 1 in Appendix shows data from the last three years). Buchholz *et al.* (2008) found that banana was a host that larvae and adults of the small hive beetle choose with some frequency, even when there were hive products available as food.

While England and Wales have not intercepted small hive beetle on plants and plant produce to date, other nitidulid species are found reasonably often on a variety of plant products, with most years between 1996 and 2014 having at least one nitidulid interception (Table 2 in Appendix). The beetles originated from Asia, Africa, North and South America,

and hosts range from growing plants such as *Butia* (palms) and *Chrysanthemum*, to fruit including mango, *Citrus* and *Zea mays*.

Overall, therefore, the literature suggests a weak association between the small hive beetle and fruit. The exception to this is the preference shown for bananas. However the quantities of imports of these from Italy are very small. The ability of the organism to transfer from the pathway to a suitable habitat or host is also considered unlikely with this pathway. The life stage being imported with fruit is likely to be larvae, which will then need to find a suitable place to pupate for the lifecycle to continue. Rejected fruit which is thrown onto landfill, or rotting fruit thrown into garden compost would provide such a situation, but it is unlikely that infested fruit, that may already be rotting to start with, would make it this far along the pathway.

3. Pathway: Plants for planting with soil

Another potential pathway is the association with soil or compost. The beetles pupate in the soil, in 80% of cases at a depth of no more than 10cm, and although beetles tend to pupate close to the hive they are known to travel some distances to find a sandy substrate (Pettis & Shimanuki, 2000; Frake & Tubbs, 2009). Larvae are capable of crawling over 200m in search of suitable pupation substrate (Somerville, 2003). Small hive beetle will stay as pupae within the soil for between 15 – 78 days (Steadman, 2006; Bernier *et al*., 2014), with the length of this period having being linked to temperature and soil water content (Meikle & Patt, 2011; Bernier *et al*., 2014). These last two studies both extrapolated findings to estimate a minimal pupal development temperature of between 10 and 13.2ºC, depending on soil water content.

Soil is therefore considered to be a higher risk pathway than fruit, although the quantity of soil that is imported with plants for planting is related to the size of the plant. Large numbers of plants for planting are imported from Italy (see Table 1 in the Appendix), particularly from the area west of Florence, but data on the numbers and varieties from different regions of Italy, such as Calabria, are not available. Plant imports are likely to come from nurseries that are not associated with bee hives, however the proximity of these nurseries to infected apiaries is unknown. It is possible that some fruit trees, e.g. specialist varieties, may come from orchards that use managed pollinators – but such numbers are likely to be very small.

4. Summary

In conclusion, although the pathways related to fruit and soil associated with plants for planting cannot be completely discounted, the evidence suggests that they pose a much lower risk compared to the movement of bees, bee keeping equipment and bee related products.

References

Arbogast RT, Tort B & Teal PEA (2010): Potential for population growth of the small hive beetle *Aethina tumida* (Coleoptera: Nitidulidae) on diets of pollen dough and oranges. *Florida Entomologist* **93**, 224-230.

Arbogast RT, Torto B, Willms S & Teal PEA (2009): Trophic Habits of *Aethina tumida* (Coleoptera: Nitidulidae): Their Adaptive Significance and Relevance to Dispersal. *Environmental Entomology* **38**, 561-568.

Bernier M, Fournier V, & Giovenazzo P (2014) Pupal development of *Aethina tumida* (Coleoptera: Nitidulidae) in thermo-hygrometric soil conditions encountered in temperate climates. *Apiculture and Social Insects* **107 (2)**, 531-537

Buchholz S, Schaefer MO, Spiewok S, Pettis JS, Duncan M, Ritter W, Spooner-Hart R & Neumann P (2008): Alternative food sources of *Aethina tumida* (Coleoptera : Nitidulidae). *Journal of Apicultural Research* **47**, 202-209.

Ellis JD, Neumann P, Hepburn R & Elzen PJ (2002): Longevity and reproductive success of *Aethina tumida* (Coleoptera : Nitidulidae) fed different natural diets. *Journal of Economic Entomology* **95**, 902-907.

Frake AM & Tubbs H (2009) Population of small hive beetles (*Aethina tumida* Murray) in two apiaries having different soil textures in Mississippi. *Science of Bee Culture*, **1,** 4-8.

Meikle WG & Patt JM (2011) The effects of temperature, diet and other factors on development, survivorship and oviposition of *Aethina tumida* (Coleoptera: Nitidulidae). *Apiculture and Social Insects*, **104(3)**, 753-763

Neumann P & Elzen PJ (2004): The biology of the small hive beetle (*Aethina tumida*, Coleoptera: Nitidulidae): Gaps in our knowledge of an invasive species. *Apidologie* **35**, 229-247.

Pettis JS & Shimanuki H (2000) Observations on the small hive beetle, *Aethina tumida* Murray, in the United States. *American Bee Journal* **140 (2),** 152-155.

Somerville D (2003) Study of the small hive beetle in the USA. A report for the Rural Industries Research and Development Corporation. Pub. No. 03/050: 57.

Stedman M (2006) Small Hive Beetle (SHB): *Aethina tumida* Murray (Coleoptera: Nitidulidae). Primary Industries and Resources for South Australia. Factsheet 03/06: 13 pp.

Appendix

Table 1: Fruit and Plant imports from Italy to the UK 2011 – 2013. Values are in 100 kg (data from EUROSTAT)

Product (by customs code)	Year		
	2011	2012	2013
Bananas, incl. plantains, fresh or dried	3957	10659	1018
Dates, figs, pineapples, avocados, guavas, mangoes and mangosteens, fresh or dried	24389	2425	2998
Citrus fruit, fresh or dried:	31016	30361	36792
Grapes, fresh or dried	90009	108366	116236
Melons, incl. watermelons, and papaws "papayas", fresh	24661	34867	29348
Apples, pears and quinces, fresh	260309	304991	259620
Apricots, cherries, peaches incl. nectarines, plums and sloes, fresh	215412	249212	207963

Product (by customs code)	Year 2011	2012	2013
Fresh strawberries, raspberries, blackberries, back, white or red currants, gooseberries and other edible fruits	166728	145279	134912
Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage	152880	182682	154244
Live Forest trees	7526	1988	380
Edible fruit or nut trees, shrubs and bushes, whether or not grafted	3277	7364	2899

Table 2: Origin and host of Nitidulidae interceptions in England and Wales between 1996 and September 2014, excluding samples from the UK, or where the origin is unknown.

Country	Host	Number of interceptions
Argentina	*Butia yatay*	1
Belize	*Citrus*	1
	Citrus paradisi	2
	Citrus sinensis	2
China	*Capsicum annuum*	1
	Chrysanthemum x morifolium	1
Egypt	*Allium*	1
	Mangifera	1
	Mangifera indica	1
Ghana	*Carica papaya*	1
	Dioscorea	1
	Unknown	3
	Zea mays	1
Grenada	*Syzygium jambos*	1
Guatemala	*Arachis*	1
India	*Achras sapota*	1
	Mangifera	1
	Punica	1
Israel	*Diospyros*	1
Jamaica	*Citrus*	1
Morocco	*Helianthus annuus*	1
Mozambique	*Citrus limon*	1
Nigeria	*Chrysophyllum*	1
	Manilkara zapota	1
	Unknown	1
Pakistan	*Mangifera indica*	3
	Syzygium jambos	1
Saudi Arabia	*Phoenix dactylifera*	2
South Africa	*Protea*	1
Sri Lanka	*Feronia limonia*	1
Thailand	*Malus domestica*	1
United Arab Emirates	*Phoenix*	1
	Phoenix dactylifera	4
United States of America	*Zea mays*	1
Zambia	*Solidago*	1

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