CHAPTER NINE

THE DRAFT PEST CATEGORISATION

Introduction

9.1 This chapter initially identifies the 17 pests of quarantine concern analysed in the draft IRA as associated with the importation of apples from New Zealand.

9.2 Subsequently, the chapter specifically examines the biology and distribution of *Erwinia amylovora*. In particular, it addresses the survival of the bacterium in cankers and the environment, and notes confusion regarding the fragility of the bacterium. It also notes the worldwide spread of *Erwinia amylovora* since its discovery in North America around 1780, including its recent detection and eradication in Australia.

9.3 In turn, the chapter also examines the biology and distribution of the 16 other pests of quarantine concern associated with the importation of apples from New Zealand.

Pests of Potential Quarantine Concern

9.4 Based on the pest categorisation methodology outlined in Chapter Seven, AQIS initially identified 26 quarantine pests (16 insects, one mite, one bacterium and eight fungi) associated with pome fruit from New Zealand and either absent from Australia, or present but not widely distributed and under official control.[1]

9.5 Subsequently, again as outlined in Chapter Seven, BA narrowed those 26 identified pests to 17 pests of potential quarantine concern (14 insects, one mite, one bacterium and one fungus). That is to say that it is 'feasible' that those 17 pests could become established in Australia, and the economic consequences of that happening would be 'significant'. Those 17 pests are listed below in Table 9.1.

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1 Biosecurity Australia, *Draft Import Risk Analysis on the Importation of Apples from New Zealand,* October 2000, pp 54-56

Table 9.1: Quarantine Pests for Detailed Assessment

Category	**Scientific Name**	**Common Name**
Insects	*Carpophilus* spp.	Dried fruit beetle
	'Cnephasia' jactatana	Black lyre leaf-roller
	Ctenopseustis herana	Brown-headed leaf-roller
	Ctenopseustis obliquana	Brown-headed leaf-roller
	Dasineura mali Kieffer	Apple leaf-curling midge
	Graphania mutans	Cutworm
	Graphania specificity	Cutworm
	Planotortix excessana	Green-headed leaf-roller
	Planotortix octo	Green-headed leaf-roller
	Pseudococcidae species	Mealy bugs
	Pyrgotis plagiatana	Native leaf-roller
	Stathmopoda horticola	Oecophorid moth
	Thrips obscuratus	New Zealand flower thrips
	Torticinae species	Leaf-rollers
Mites	*Eriophyes mali*	Apple blister mite
Bacterium	*Erwinia amylovora*	Fire blight
Fungi	*Nectria galligena*	European canker

Source: Biosecurity Australia, *Draft Import Risk Analysis on the Importation of Apples from New Zealand*, October 2000, p 57

9.6 Of the 17 pests identified above by BA for further study, the most significant and destructive is *Erwinia amylovora*. The biology and distribution of *Erwinia amylovora* is discussed below.

The Biology of *Erwinia Amylovora*

9.7 Fire Blight is generally accepted to be 'the most dangerous disease of pome fruits – the Pomoideae sub-family which includes pear, quince, apple and loquat.[2] It may also cause damage to members of the Rosaceae family including quince, crabapple, mountain ash, spirea, hawthorn, pyracantha, and cotoneaster.[3]

9.8 The disease is so named because during an outbreak, infected leaves will turn brown or black, appearing as though they have been scorched by fire. Blighted leaves remain attached to dead branches through the summer, however the end of the branch may bend over, resembling a shepherd's crook or an upside down "J". This is shown below in Figure 9.1.

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2 H.Saygili, H.Turkusay, S.Hepaksoy, A.Unal & H.Z.Can, 'Investigation of Determining some Pear Varieties Resistant to Fire Blight' in M.T.Momol & H Saygili, *Proceedings of the Eighth International Workshop on Fire Blight*, (Acta Horticulturae No 489, International Society of Horticultural Science, 1999), p 225

3 Ohio State University Extension Fact Sheet, 'Fire Blight of Apples, Crabapples and Pears', http://www.ag.ohio-state.edu/~ohioline/hyg-fact/3000/3002.html, p 1

Figure 9.1: The "Shepherd's Crook"

Fire blight on apple twigs. Note the curved "Sheperd's Crook" at the tip of infected twigs.

9.9 The Committee notes some confusion as to the fragility of the *Erwinia amylovora* bacterium, the causal bacterium of fire blight. It is generally accepted that the individual bacterial cells are, like most other bacteria cells, vulnerable to desiccation, heat competition, solar radiation and competition from other micro-organisms.

9.10 However, the disease itself can be robust and persistent, due to the ability of individual cells to overwinter in protected environments, notably the margins of cankers formed during previous seasons on the trunk and main branches of trees. A diseased canker is shown in Figure 9.2 below.

Figure 9.2: A Diseased Canker

Fire blight canker on apple trunk.

9.11 Under warm conditions in spring, active cankers exude bacteria-laden ooze that acts as the primary source of inoculum of *Erwinia amylovora.* Rain, heavy dews and high humidity favour the growth of the bacterium. While relatively few over-wintering cankers become active and produce bacteria-laden ooze in the spring, a single active canker may produce millions of bacteria, enough to infect an entire orchard.[4]

9.12 Subsequently, the bacterium in droplets of ooze may be spread by splashing rain or pollinating insects (mostly bees, flies, and ants) to open blossoms, fruitlets, young leaves and growing shoots. The five stigmas in the centre and top of each apple blossom have a moist, nutrient-rich surface that supports their selective colonisation by the bacterium to high levels.[5]

9.13 Special note should be made of the role of foraging bees, which are important agents in the transmission of *Erwinia amylovora* from flower to flower, although not from cankers to flowers. In particular, BA notes research that bees can visit up to 400 blossoms per hour, and can range up to 4km from their hive. By contrast, over longer ranges, dissemination is primarily by contaminated propagative material, transport in air currents or by birds.[6]

Infestation

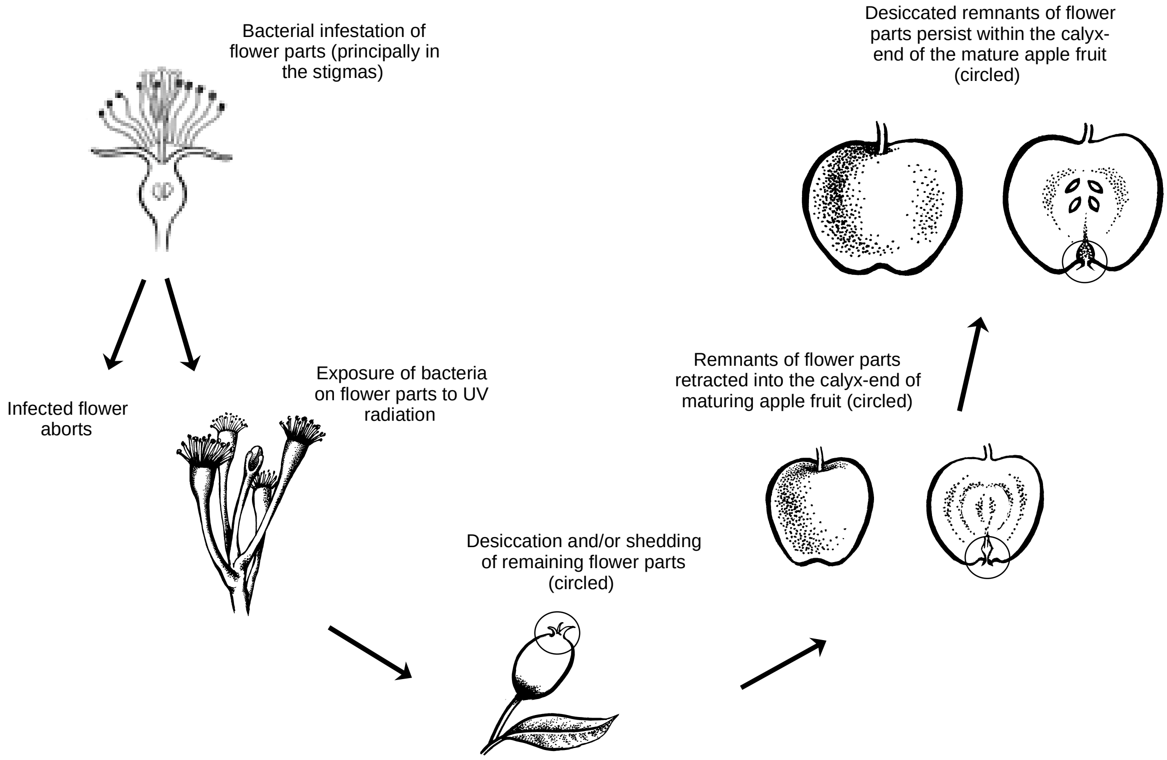
9.14 Bacteria deposited on the stigmatic surfaces of blossoms usually do not cause the fire blight disease, but remain in the calyx of the developing fruit, in some cases until it reaches maturity. This is called infestation of the fruit. Key steps in the infestation of the calyx-end of mature apple fruit are shown in Figure 9.3 below.

4 Ohio State University Extension Fact Sheet, 'Fire Blight of Apples, Crabapples and Pears', http://www.ag.ohio-state.edu/~ohioline/hyg-fact/3000/3002.html, p 1

5 P.W.Steiner, 'The Biology and Epidemiology of Fire Blight', http://www.caf.wvu.edu/kearneysville/articles/FB-BIOLOGY00.html (2000)

6 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 207

Figure 9.3: Infestation of the Calyx-end of Mature Apple Fruit



Source: BA, *Draft Import Risk Analysis on the Importation of Apples from New Zealand*, October 2000, p 78

Infection

9.15 Following from infestation of a blossom, it is also possible that the host plant may be infected with *Erwinia amylovora.* This occurs where *Erwinia amylovora* is washed from the stigmas in the blossoms to the hypanthia of blossoms, where the bacterium can gain entry to the plant through nectarthodes. In contrast with infested flowers and young fruitlets, infected flowers and young fruitlets generally abort.[7]

9.16 Infection of flowers and fruitlets may lead to the movement of bacteria through the xylem and phloem of the host plant, such that the bacteria spread to other parts of the apple plant. As the bacteria move through blighted twigs and into the main branches, the bark sometimes cracks along the margin of the infected area causing a distinct canker. These cankers can subsequently form the basis for further spread of the *Erwinia amylovora* bacterium to other parts of the tree and other trees.[8]

9.17 In the draft IRA, BA also noted evidence that *Erwinia amylovora* may also establish latent colonies within shoots, but without forming cankers. The bacterium

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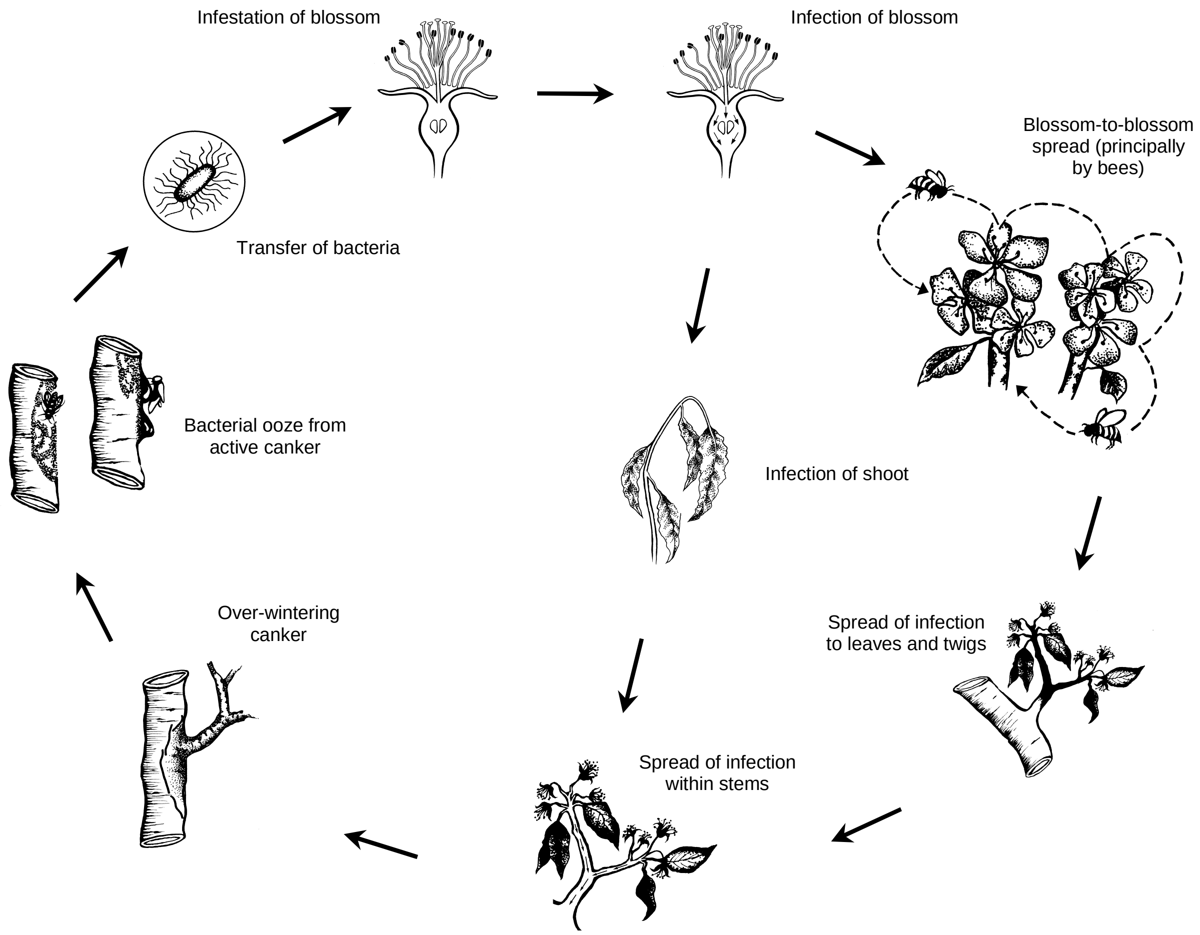
7 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 78

8 Ohio State University Extension Fact Sheet, 'Fire Blight of Apples, Crabapples and Pears', http://www.ag.ohio-state.edu/~ohioline/hyg-fact/3000/3002.html, p 1

may survive in this state during winter, then subsequently multiply in spring and continue the disease cycle by exuding bacterial ooze.[9]

9.18 Key steps in the fire blight disease cycle are illustrated in Figure 9.4 below.

Figure 9.4: Steps in the Disease Cycle of Fire Blight



Source: Biosecurity Australia, *Draft Import Risk Analysis on the Importation of Apples from New Zealand,* October 2000, p 80

The Distribution of *Erwinia Amylovora*

9.19 Fire blight was first recognised in North America around 1780, and probably originated as a disease of native species such as crab apple, hawthorn and mountain ash. Over the ensuing 220 odd years, it has spread to Canada, Central America, parts of the Carribean, Europe, Scandinavia, the Middle East, and New Zealand. It is notably absent from Australia, South Africa and South America.

9.20 The initial impact of the disease in the USA was severe. For example, between 1800 and 1810 there was a 28% decline in the number of pear trees in

9 Biosecurity Australia, *Draft Import Risk Analysis on the Importation of Apples from New Zealand,* October 2000, p 79

California, followed by a smaller decline between 1820 and 1824 and a severe decline between 1830 and 1835. By 1840, the disease had also spread to Canada.[10]

9.21 *Erwinia amylovora* became established in New Zealand in 1919. The bacterium is reported to have entered the New Zealand north island on infected nursery stock from North America. During the 1920s, fire blight is reported to have done severe damage to cultivars in the Hawke's Bay region.[11]

9.22 *Erwinia amylovora* reached the New Zealand south island in 1929, despite several quarantine regulations concerning shipments of bees and plant material from infected areas designed to prevent the spread of *Erwinia amylovora*. The bacterium reached the Otago growing region in 1936.[12]

9.23 In 1957, *Erwinia amylovora* reached England on crates from North America. Once the bacterium became established in southern England it caused serious losses. In 1966, considered to be the worst year for fire blight in England, many trees became infected in orchards and in nurseries. Large numbers of hawthorn, cotoneaster and poyracantha shrubs were also affected.[13]

9.24 From England, *Erwinia amylovora* is reported to have jumped the English Channel around 1965. The numerous occurrences of *Erwinia amylovora* in hawthorns along the coastline from England and France to Northern Poland, Denmark and along the coast of Germany and the Netherlands provides very strong evidence that migratory birds were initially responsible for spreading the bacterium.[14]

9.25 During conduct of this inquiry, the Committee took evidence from Mr Veens who formerly worked in the apple industry in the Netherlands, but migrated to Australia 10 years ago. He indicated that the arrival of the disease in the Netherlands in 1966 had a dramatic and ongoing effect on the industry.[15]

9.26 Once established in Europe, *Erwinia amylovora* spread throughout the continent, including the Scandinavian countries and Eastern Europe, and into the Middle East, most likely through incremental transport by insects. Most recently, the bacterium has been reported in Greece, Israel and Spain.

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10 US Department of Agriculture, *Fire Blight – a Bacterial Disease of Rosaceous Plants*, Agricultural Handbook 510, 1979

11 S.Wimalajeewa, *Fire blight: A Technical Report*, 1989

12 US Department of Agriculture, *Fire Blight – a Bacterial Disease of Rosaceous Plants*, Agricultural Handbook 510, 1979

13 T.van der Zwet, 'The Various Means of Dissemination of the Fire Blight Bacterium *Erwinia Amylovora*', EPPO Bulletin, (NO 24, 1994), p 212

14 *Ibid*

15 Evidence, RRAT, 12 February 2001, p 52

9.27 In 1995, there were reports of the presence of fire blight in Japan. The following year, a team lead by Dr Beer reported that:

> the tree fruit disease that the Japanese call "bacterial shoot blight of pear" is caused by *Erwinia amylovora*, the bacteria that causes fire blight and should be called fire blight.[16]

9.28 Subsequently, Dr Roberts, research leader with the US Department of Agriculture in Washington, confirmed that the symptoms of the so-called "bacterial shoot blight" and fire blight were identical, and that to distinguish between the two was a misnomer. That said, it appears that the variety of *Erwinia amylovora* present in Japan is less aggressive and damaging than that found in other countries.[17]

9.29 In April 1997, during the preparation of the 1998 IRA on the importation of apples into Australia from New Zealand, officers of MAFNZ reported the presence of *Erwinia amylovora* in the Royal Botanic Gardens in Melbourne.[18]

9.30 AQIS subsequently implemented a program to eradicate the bacterium, including the following measures:

a) Removal of trees suspected of being infected, together with all host plants within a 250m radius of the boundaries of the Royal Botanic Gardens;

b) The institution of a 15km special surveillance zone;

c) Restrictions on the movement of fruit grown within a 5km radius of the outbreak, together with an interim ban on interstate movement of apples and pears from Victoria;

d) The eradication of all feral bee colonies within the Royal Botanic Gardens; and

e) A comprehensive inspection of all Victorian apple and pear orchards over the next two years to ensure the absence of fire blight.[19]

9.31 Subsequently, in Autumn 1997, surveys were undertaken of every commercial pome fruit orchard and nursery throughout Victoria, including 7500ha of orchards, 130 nurseries and all host plants on arterial roads 30km from the Melbourne CBD.

16 Geraldine Warner, 'Study Shows Disease in Japan is Fire Blight', *Good Fruit Grower*, July 1996

17 *Ibid*

18 Biosecurity Australia, *Draft Import Risk Analysis on the Importation of Apples from New Zealand*, October 2000, p 17

19 Submission 33, p 21

Similar surveys were conducted nation-wide, together with follow-up surveys in spring 1997-98. No traces of *Erwinia amylovora* were detected.[20]

9.32 The Committee was also presented with evidence of a possible outbreak of *Erwinia amylovora* in the Adelaide Botanic Gardens in 1997. Once again, the authorities carried out a detailed inspection of all potential hosts within a 1km area, and a 15km surveillance zone was established.[21]

9.33 The Committee notes, however, research by Jock, Kim, Geilder, Rodoni and Merriman entitled 'Isolation and Characterization of *Erwinia Amylovora* from Australian Wood Samples', in which the authors studied wood samples from the Melbourne and Adelaide Botanic Gardens for the presence of *Erwinia amylovora.* They isolated *Erwinia amylovora* in three of the four samples taken from the Melbourne Botanic Gardens, but indicated that the bacterium was not present in any samples taken from plants in the Botanic Gardens in Adelaide.[22]

9.34 The Committee also notes research by Kim, Garr, Bauer, Beer, Gustafson and Momol who analysed the virulence of the *Erwinia amylovora* strains isolated in the Melbourne Botanic Gardens. They indicated that:

> Our results support reports that fire blight occurred in Australia, and indicate that the Australian strains are similar to Maloideae-infecting strains of *Erwinia amylovora* analysed previously from North America, Europe and the Middle East.[23]

9.35 Given the spread of *Erwinia amylovora* worldwide, the Committee notes that there have been two notable recent fire blight outbreaks internationally that have led to severe production and plant losses. One was in the Po Valley in Italy in 1998 and the other in south-west Michigan in spring 2000.

9.36 In particular, the outbreak in south-west Michigan destroyed between 350,000 and 450,000 trees, with 1,550 to 2,300 acres of apple orchards lost, reducing yield from the region by 35 per cent. The outbreak was caused by a combination of heavy rains, often with hail which damaged the fruit, and unusually warm and humid

20 T.van der Zwet & W.G.Bonn, 'Recent Spread and Current Worldwide Distribution of Fire Blight' in M.T.Momol & H Saygili, *Proceedings of the Eighth International Workshop on Fire Blight*, (Acta Horticulturae No 489, International Society of Horticultural Science, 1999), p170

21 AQIS, Information Paper on Detection and Eradication of Fire Blight Disease, March 1998. See also evidence, RRAT, 12 February 2001, p 74

22 S.Jock, W.S.Kim, K.Geilder, R.Rodoni and P.Merriman, 'Isolation and Characterization of *Erwinia Amylovora* from Australian Wood Samples' in M.T.Momol & H Saygili, *Proceedings of the Eighth International Workshop on Fire Blight*, (Acta Horticulturae No 489, International Society of Horticultural Science, 1999), p 61

23 J.F.Kim, E.R.Garr, D.W.Bauer, S.V.Beer, H.L.Gustafson & E.A.Momol, 'Analysis of Three Bacterial Strains Isolated from Symptomatic Plants in Australia' in M.T.Momol & H Saygili, *Proceedings of the Eighth International Workshop on Fire Blight*, (Acta Horticulturae No 489, International Society of Horticultural Science, 1999), p 149

conditions, leading to the rapid dispersal of *Erwinia amylovora* throughout the region. The region's total economic loss was estimated to be around $42 million.[24]

9.37 To summarise the evidence of the international spread of *Erwinia amylovora*, the Committee cites the opening address of Dr Gordon Bonn, Chairman of the Fire Blight Working Group of the International Society for Horticultural Science, to the 8th International Workshop on Fire Blight held in Turkey from 12 –15 October 1998:

> Fire blight continues to cause major loss for growers in many parts of the world. In 1998 alone, serious losses have been reported in Italy and fruit growing regions of north-west USA where the loss may be greater than $68 million. A scare that the disease might have spread to Australia was reported in 1997, but was fortunately not confirmed as a threat to the fruit industry. This suggests that authorities in countries where the disease is not present must be ever vigilant in order to prevent the introduction of Fire Blight. The disease continues to spread in the Middle East and Europe where it has recently been reported from Iran and Spain respectively.
>
> The disease is notably absent from Australia, South Africa and South America at the moment. Fortunately, these countries have the additional arsenal to maintain the vigilance and fight the disease through the efforts of those who have attended past workshops … [25]

9.38 Given the evidence on the international spread of *Erwinia amylovora*, the Gippsland Fruitgrowers' Association argued in its written submission that BA erred when compiling the draft IRA by failing to undertake research into fire blight in countries other than NZ. The *IRA Handbook* states at page 48:

> Biological information and the potential economic impact of a pest on a pest free area should be assessed using information obtained from areas where the pest currently occurs.

9.39 The Committee acknowledges this argument, and notes that there is considerable room for speculation as to the possible role of alternative vectors in the worldwide spread of the *Erwinia amylovora*.

The Biology and Distribution of Other Pests

Insects

<u>*Carpophilus* spp</u>

9.40 *Carpophilus* spp (dried fruit beetle) are flying insects of 2-5 mm in length which are attracted to ripe fruit in orchards. Two other species of *Carpophilus* are

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24 M.Lonstroth, The Fire Blight Epidemic in Southwest Michigan', http://www.msue.msu.edu/vanburen/fb2000.htm.

25 M.T.Momol & H Saygili, *Proceedings of the Eighth International Workshop on Fire Blight*, (Acta Horticulturae No 489, International Society of Horticultural Science, 1999)

present in Australia, however *Carpophilus* spp have not been specifically identified in Australia.[26]

'Cnephasia' jactatana

9.41 *Cnephasia' jactatana* (black lyre leaf-roller) feeds on the leaves of host plants, but may also attack the surface of fruit. Larvae grow up to 15cm long, and live in a leaf-edge folded down with silk.[27]

Ctenopseustis herana

9.42 *Ctenopseustis herana* (brown-headed leaf-roller) has only recently been differentiated from *Ctenopseustis obliquana* (next entry), and as such, little biological information is available.[28]

Ctenopseustis obliquana

9.43 Ctenopseustis obliquana (brown-headed leaf-roller) larvae feed between leaves spun together with silk, but also on shoots, buds, stems or the surface of fruit. Full grown larvae are about 20mm long, with two to four generations each year.[29]

Dasineura mali (Keiffer)

9.44 *Dasineura mali* (apple leaf-curling midge) larvae grow up to 4mm, with up to 250 larvae found on an individual leaf. The dominant symptoms of infestation are tightly rolled leaves, caused by early instar larval feeding. Leaves subsequently become brown and brittle and drop from the tree.[30]

Graphania mutans

9.45 *Graphania mutans* (cutworm) feed on leaves, and occasionally buds and young fruit. Occasionally when eggs are laid on young fruit they may damage the surface of the fruit.[31]

Graphania specificity

9.46 *Graphania* specificity (cutworm) is presumed by BA to be similar to *Graphania mutans.*[32]

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26 Biosecurity Australia, *Draft Import Risk Analysis on the Importation of Apples from New Zealand,* October 2000, p 191

27 *Ibid* p 192

28 *Ibid*

29 *Ibid,* p 193

30 *Ibid,* p 194

31 *Ibid,* p 195

32 *Ibid*

Planotortix excessana

9.47 *Planotortix excessana* (green-headed leaf-roller) larvae generally feed between leaves spun together with silk, but may also graze on the surface of fruit. Young larvae may invade the calyx of various fruits. There are two or three generations per year.[33]

Planotortix octo

9.48 *Planotortix octo* (green headed leaf-roller) has only recently been differentiated from *Planotortix excessana*, and as such, is assumed to be similar in biology.[34]

Pseudococcidae species

9.49 Pseudococcidae species (mealy bug) is characterised by a covering of white, mealy wax. About 2000 species have been described worldwide. They generally feed on aerial plant parts, but also occur on roots and under bark.[35]

Pyrgotis plagiatana

9.50 There is no detailed information on *Pyrgotis plagiatana* (native leaf-roller).[36]

Stathmopoda horticola

9.51 *Stathmopoda horticola* (oecophorid moth) larvae are known to feed on the surface of fruit from a silken shelter under the dying calyx. They grow to about 8mm long, and form a white silken cocoon.[37]

Thrips obscuratus

9.52 *Thrips obscuratus* (New Zealand flower thrips) is noted for its ecological and physiological elasticity. Teulon and Penmann list 51 species of breeding hosts in the Canterbury region alone, while over 3000 adults have been found in a single small *Hebe* flower. Adults and immatures are found throughout the year in flowers and in leaves on introduced and native plants.[38]

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33 *Ibid*, p 196

34 *Ibid*

35 *Ibid*, p 197

36 *Ibid*

37 *Ibid*, p 198

38 *Ibid*, p 199

<u>Torticinae species</u>

9.53 Torticinae species (leaf-roller moths) is an important insect family containing some 6500 species in 650 genera. Larvae display many lifestyles, but are best known as leaf-rollers. They may also bore into shoots, stems, fruit or roots of plants.[39]

Mites

<u>Eriophyes mali</u>

9.54 Eriophyes mali (apple blister mite) females over-winter in the scales of buds, laying eggs in spring. Young mites subsequently feed on leaves and blossoms, causing blisters to develop. Adults of the first generation then enter the blisters between full bloom and petal fall, leading to the development of several generations within blisters during late spring and summer. Most mites in the blister move to buds to over-winter from July to September, however some individuals remain to over-winter in the blister.[40]

Fungi

<u>Nectria galligena</u>

9.55 *Nectria galligena* (European canker) infects pome fruit trees through freshly exposed leaf scar or wounds. Fruit may be infected through the open calyx, lenticels or wounds caused by insects.

9.56 The fungi are disseminated primarily by rain run-off and rain-splash. The probable maximum distance for dispersal is 10m, although this may be extended to up to 125m in storm conditions. Field infections of *Nectria galligena* occur between 5-16^{0}C, although primarily at 10-16^{0}C, and in areas where the mean annual rainfall is greater than 1000mm.

9.57 Under the right conditions, *Nectria galligena* may cause fruit rot at the calyx-end or the stem-end of the fruit. Where this occurs, the skin over the rotted area becomes dark brown and as the flesh beneath shrinks, a pronounced depression may develop.

9.58 It is possible for fruit infected with *Nectria galligena* to remain symptomless until after harvest, with symptoms only expressed in storage.

9.59 It should be noted that *Nectria galligena* has been eradicated from Tasmania.[41]

39 *Ibid*, p 200

40 *Ibid*, pp 200-201

41 *Ibid*, pp 213-215