Tuberolachnus salignus the giant willow aphid

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Photo: CM Collins

Tuberolachnus salignus has recently become noteworthy because it is increasingly found on commercially grown willows used in bioenergy production. Most information in the scientific literature is relatively recent (less than 20 years with several papers since 2012) and from Europe. Earliest reports from Australasia were in November, 2013 in Kohukohu, North Hokianga, and in December, 2013 from Auckland, New Zealand where they were recognised as a species new to New Zealand. As of March 2014 this aphid can be found throughout the North Island and, in the South Island, as far south as Clyde (in the east) and Greymouth (in the west).

Identifying features

Tuberolachnus salignus is a very large aphid with a body length of 5.0-5.8 mm. Wingless individuals (Apterae) are mid-brown to dark brown with several rows of black sclerotic patches. The body is covered with numerous fine hairs, which give a greyish-golden sheen to the abdomen. There is a large dark brown tubercle in the centre of the back, just in front of the siphunculi which are on large dark cones. The antennae are less than half the body length. Winged individuals (Alates) have the forewing membrane unpigmented but the pterostigma (wing markings) and costal margin are dark brown. Rubbing against an aphid colony releases a red stain.

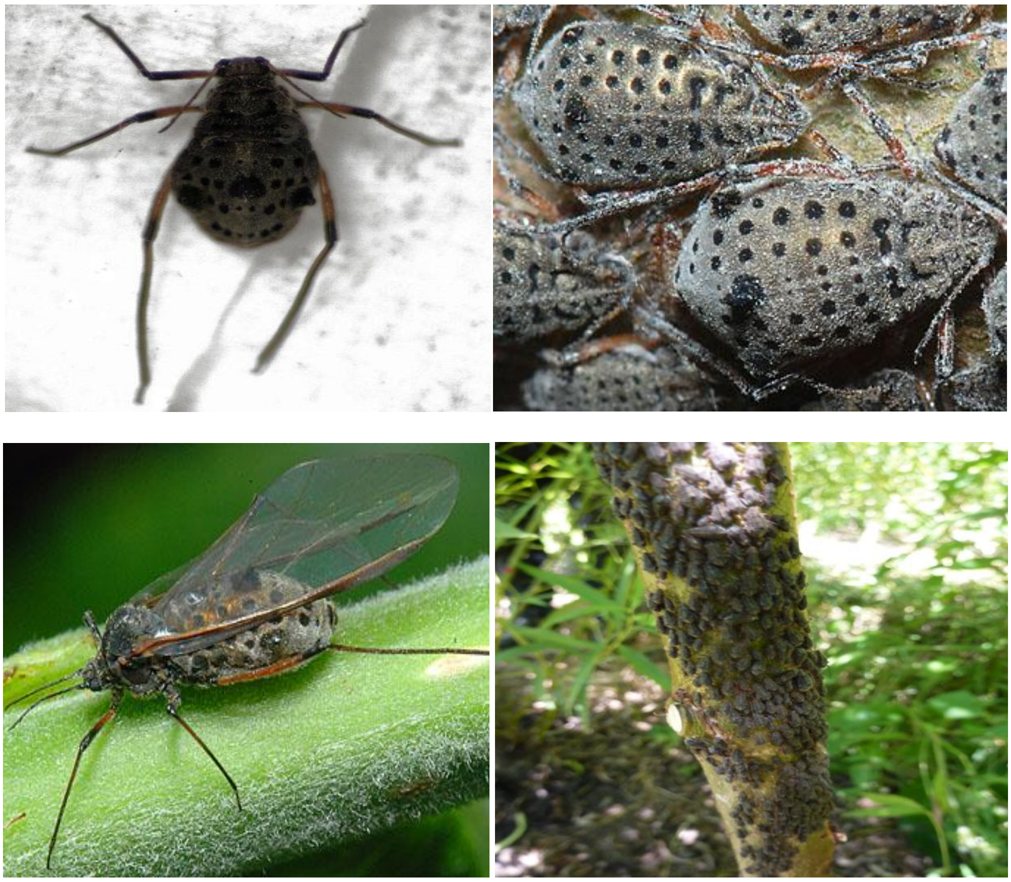
Life Cycle

Adults give birth to miniature adults called nymphs. Each adult alate (winged adult) weighs over 5 mg, and is reported to produce 34.3 nymphs on average, each surviving nymph capable of doing the same at maturity (see below for maturation times). Both adult forms continue to survive post-breeding.

The early season colonies appear in summer and are situated at the base of the willow trees, moving up the stems with increasing numbers. In summer, colonies formed by alatae dispersing from other infestations start higher on the stem, some up to 3.5 m from the ground. By late summer colonies can contain tens of thousands of individuals.

Colonies persist through the autumn and, although they decline in late autumn, continue to feed on the stems after leaf fall and into late winter. In their first season in New Zealand colony decline appears to have happened rapidly with very few sightings of the aphid from the second week in April. Reports from Hawke's Bay, Wairarapa and Manawatu (Peter Manson, Stan Braaksma, Ian McIvor) in the period 15-16 April indicate an absence or very low numbers of the aphid. David Aires in Marlborough reported a definite decline in population size in the previous three weeks (from ~24 March) though their effects were evident in stressed willows. Wayne Teal from Whangarei in Northland reported there had been a slight decline in numbers of aphids at the nursery as at 11 April. Clusters or colonies of aphids were smaller and individual sizes were smaller overall, but still present. Willows are still in full leaf at this stage of the year though senescence has started. Eastern regions had experienced two weeks of rain prior to these reports, though only very light rain had fallen in the Manawatu.

Continuing growth and reproduction on leafless and dormant trees is unusual for aphids. Where they go from winter to early summer is not yet known.



Photos: Stephen Thorpe, Kevin Cash, Wayne Teal

Development times

The development time, survivorship and reproduction of *T. salignus* were studied on *S. babylonica*, *S. matsudana* and *S. alba* at constant temperatures (17.5, 20, 22.5, 25 and 27.5°C). Development time of immature stages ranged from 14.6 days at 17.5°C to 12.5 days at 25°C on *S. babylonica*, 16.5 days at 20°C and 12.3 days at 25°C on *S. matsudana*, and from 17.0 days at 17.5°C to 12.2 days at 25°C on *S. alba*. Total survivorship of immature stages of *T. salignus* varied from 28% to 85% at 22.5 °C and 17.5 °C, respectively, on *S. babylonica*, and from 13% to 63%, respectively, at 17.5°C and 25°C on *S. matsudana* and varied from 50 to 70% at 17.5 to 20°C on *S. alba*.

The optimal temperature for *S. babylonica* growth, development time, reproduction and percent survival was 25°C, and on S. alba was 20°C. The mean generation time of the aphid population ranged from 14.2 days at 25°C to 16.2 days at 17.5°C on *S. babylonica*, from 14.3 days at 25°C to 19.9 days at 20°C on *S. matsudana* and from 13.6 days at 22.5°C to 19.6 days at 17.5°C on *S. alba*.

At lower temperatures such as experienced in early winter generation times will be much longer. It was estimated that 19.6 +/- 4 degree-days above a threshold temperature of 5.5 +/- 0.3 °C were required for apterae to complete development from birth to final ecdysis. The alate morph was significantly less fecund than the apterous morph and its fecundity did not vary with temperature.

Effects on the host willows

Tuberolachnus salignus has an adverse impact on the growth of the host trees and should be considered as a potential pest species in the context of willow as a production crop. Responses measured in the host plant are both quantitative and qualitative; 1 increase in photosynthetic rate, 2 increase in leaf N, 3 increase in tree water use, 4 reduction in shoot and root biomass, 5 reduction in growth in the following year.

Tree death has not been observed in Short Rotation Coppice (SRC) willows, but the implications for production willows are clear. Large scale tree willow mortality in Himachal Pradesh State, North India in 2001-2002 was attributed to high *T. salignus* populations, aphid infestation ranging from 40% to 100% of willow plantations. The age of the trees (150 years) was thought to have increased their vulnerability.

The increase in tree water use in response to aphid colonisation may exacerbate the effects of summer drought stress of the trees. The honeydew attracts wasps, though bees are reported to be infrequent feeders. Honeydew is sugar that is not reaching the roots which reduces the capacity of the tree to explore soil and absorb water and nutrients. Deposition of sugar on to the ground has been shown to induce tree branching in SRC willow. Wasps are likely indicators of aphid infestation.

Biological control agents

Colony reduction from predation is low, possibly because they taste strongly of salicin and tannins. Some colonies overseas have been decimated by a pathogenic fungus that attacks the aphid internally, but the identity and ecology of the pathogen is not yet known. No parasitoid of the species has been recorded in Europe. In Japan, *Tuberolachnus salignus* is parasitized by the braconid wasp *Aphidius salignae* (Watanabe, 1939) and by a specific hyperparasitoid *Pauesia salignae,* which might indicate that this is where it is endemic. *Pauesia salignae* is predated on by the hyperparasites *Dendrocerus carpenteri* and *D. ramicornis* in Japan (Takada, 1973). The hyperparasite *Dendrocerus carpenteri* is present in New Zealand, but it appears that *D. ramicornis* is not present. As Jonathan Swift wrote ‘So

Photo: Wayne Teal

nat'ralists observe, a flea hath smaller fleas that on him prey; and these have smaller fleas to bite 'em, and so proceeds *Ad infinitum*'.

Chemical control

Systemic insecticides that are friendly to bees provide the best chemical control approach. It may be difficult to effectively use contact insecticides from a boom.

Population Genetics

Tuberolachnus salignus shows very low clonal diversity; only 16 genotypes were found in 660 specimens from 27 populations in five countries. There was limited geographical structuring in the samples, although the two most common genotypes, which comprised more than half of the specimens collected, had a very wide distribution. Furthermore, recent studies (published 2012) showed colonies of these aphids can consist of more than one genotype, suggesting aggregation of colonizing *T. salignus*.

This aphid reproduces parthenogenically all year round. No males are known. Though colonies of *T. salignus* can contain different genotypes, it is highly likely that a single genotype colonised New Zealand.

It colonises most willow species but colonies grow faster on some willows than on others. It has been reported overseas and in New Zealand on *Salix alba, S. fragilis, S. viminalis, S. schwerinii, S. miyabeana, S. matsudana* and their hybrids amongst others. It colonises both tree willows and non-tree willows (shrub and osier).

Economic Impacts

1. Honey production. Following one season where the aphid has been identified as present in New Zealand it has already had a measurable impact. Apiarists have reported the willow honeydew collected from the aphids has altered the properties of the honey. There is a real problem already associated with taste (increased phenol levels contribute bitterness) and the non-extractable melezitose sugar that stays in the honey frames during extraction with this late summer honeydew honey. The bees are unable to fully utilise this sugar and if a hive box contains too much melezitose, bees may actually starve (John McLean National Beekeepers Association). In Europe the honey is referred to as "cement" honey. The honey crystallises

more readily in the comb leading to increased costs for extraction because the comb needs to be heated to make the honey flow (hence ‘cement’ honey). Willows are the major quality pollen producers in the spring. Apiarists rely heavily on them to feed the bees and increase hive numbers in most areas of the country.

2. Tree health. At this stage the consequences to willow tree health are speculative but the extraction of large quantities of sap will reduce root resources and consequent growth in the following season. It will take targeted research to quantify the effects on tree health.

3. Wasp populations. The prolific flow of honeydew has provided an equally significant food supply for wasps. This season has been noted for higher than normal numbers of wasps and large numbers of wasps feeding on honeydew. The wasps potentially can reduce bee populations and possibly other beneficial insects. This impact is also difficult to quantify.

4. Erosion control and soil stabilisation. Weakened tree willows compromise river protection systems and most river systems are dependent on willow protection. Successive defoliations by the willow sawfly *Nematus oligospilus* contributed to willow deaths and weakened river protection just ten years ago, and this insect has the potential to have the same effect. A recurrence of defoliated willows was reported in 2014 after 9-10 years of noticeable low sawfly activity. The synergistic adverse effect of these two insect pests on willow health is alarming.

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