BEECH HONEYDEW: FOREST PRODUCE

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ABSTRACT

New Zealand beech honeydew is a viscous, sugary substance excreted by a soft scale insect (Ultracoelostoma assimile), which commonly feeds on the sap of the New Zealand beeches (Nothofagus spp.). Honeydew nourishes sooty mould fungi, insects, and nectar feeding birds, and is the source of honeydew honey, a readily saleable export commodity. Heavy infestations of scale insects occur on beech trees in the northern half of the South Island and have been shown to decline with increasing altitude and to be lower on the southern aspect of trees. Honeydew honey can be distinguished from floral honey by its darker colour, distinctive flavour and composition. There appears to be considerable potential for an increase in the production of honeydew honey which would enable the present level of export to Europe to be raised.

INTRODUCTION

New Zealand beech honeydew is a colourless syrup excreted by a soft scale insect (Ultracoelostoma assimile). This insect characteristically occurs on the trunk and branches of the four endemic species of Nothofagus, mainly in low to moderate rainfall areas in the northern half of the South Island. It feeds on phloem sap and in Canterbury high infestations occur on mountain beech (N. solandri var. cliffortioides) and black beech (N. solandri var. solandri). Sooty moulds, insects, and nectar feeding birds are nourished by the honeydew; in particular honeybees (Apis mellifer) collect the honeydew and transform it into honey. Observations suggest that the infestations of the soft scale insect do not harm the host beech, although the sap drain by a large population must be considerable.

Beekeepers in New Zealand have traditionally utilised beech honeydew for feeding bees outside nectar flow periods. Extensive use of beech honeydew for this purpose was made in Canterbury from the early days of commercial beekeeping (Smellie, *N.Z. Forest Service, P.O. Box 25-022, Victoria, Christchurch.*
1949). However, prejudice prevented its early use as a human food because it was considered to be derived from the excrement of an insect and has a stronger flavour than most floral honey. Nevertheless, since 1968 the honeydew honey has gradually become accepted as a human food comparable to floral honey.

The first trial shipment to Europe in 1970 was a success, and the possibility of a large export market was realised (Cook, 1971). Growing interest in this commodity led to a seminar in 1978 which brought together and disseminated the information available at that time (Ministry of Agriculture and Fisheries, 1978). The export of New Zealand beech honeydew honey has grown from a few trial shipments to an annual export market of 300 tonnes in the 1980-1 year.

In extensive areas of Central Europe honeydew is produced by aphids and scale insects, principally from the leaves and branches of trees such as conifers, oaks (*Quercus* spp.), poplars (*Populus* spp.), elms (*Ulmus* spp.), and maples (*Acer* spp.). The European honeydew honey is very similar to that of New Zealand, and is often more highly regarded than floral honeys.

**BEECH SCALE INSECT**

The endemic insect *Ultracoelostoma assimile* Maskelli belongs to the family Margarodidae in the order Homoptera. The genus *Ultracoelostoma* was established by Cockerell in 1902 to receive the species described by Maskell as *Coelostoma assimile* (Maskell, 1889) on the basis of the stated absence of legs in the adult female. Brittin (1935) considered, however, that, as the legs (though still rudimentary) are still retained in the adult stage, there was little to justify the change, particularly as there is a great similarity between all the other stages of *U. assimile* and *Coelostoma* spp. Apart from a note on the genus by Dumbleton (1967), little further study has been made of this insect.

While the female *U. assimile* has four distinct stages in her life-cycle, the presence of males is disputed and females are thought to be parthenogenic (Dumbleton, 1967). Reddish oval eggs are laid within many hard, waxy capsules in the bark of beech trees. At a later stage innumerable tiny first stage nymphs emerge from hatched eggs, to be dispersed by the wind. If the nymph lands on a favourable host, a suitable feeding site such as a fissure or pit in the bark is located. Alignment with bark striation or scar tissue is therefore common. The stylet is inserted in the phloem tissue of the host plant to obtain sap. This supplies the insect's complete food requirements.
The nymph, or crawler as it is also called, mouls at this stage to form a second stage immobile nymph with much reduced legs, which is approximately 5 mm long, globular in shape and protected by a hard waxy capsule. The second stage nymph is connected anteriorly to a phloem cell from which it extracts sap and excretes excess sugars to the exterior of the tree by way of a waxy tubular thread, approximately 2 to 3 cm in length, which projects from the surface of the tree and reveals the position of the otherwise inconspicuous insect. Droplets of honeydew are suspended at the end of these silvery filaments, and are a prominent feature within some South Island beech forests.

Honeydew is produced only by the second stage nymph which continues excreting until it mouls, forming the adult stage within
the same hard cast. Sucking mouth parts are absent in the adult insect, suggesting it does not feed and that death follows oviposition.

The duration of the life cycle is not known, although scale insects generally have one to four generations a year (Litchwark, 1978).

HOST PLANT

*U. assimile* appears to be limited to a small number of host plants, notably the four species of *Nothofagus*. Mountain and black beeches are most conspicuously affected.

Limited numbers of *U. assimile* have also been noted on some other woody plant species within New Zealand. Only one recording has been made in the North Island from Ngatea, in the Thames district, where it was found on *Laurelia novae-zelandiae* (Litchwark, 1978). Maskell (1891) recorded the scale insect on tanekaha (*Phyllocladus trichomanoides*) from the Reefton district, but as this plant does not naturally occur in this area it was most likely mistaken for *P. alpinus*. Dumbleton (1967) recorded *U. assimile* on *Dracophyllum paludosum* on the Chatham Islands and on *D. longifolium* on the Auckland Islands and at Arthur's Pass.

DISTRIBUTION OF SCALE INSECT

Honeydew producing *U. assimile* is widespread on *Nothofagus* spp. in the South Island on the West Coast north of Greymouth and east of the main ranges north of Mt Somers (although absent in the Wilberforce and Harper-Avoca catchments).

Crozier (1978) carried out studies in the Eyre catchment of Oxford State Forest in Canterbury to determine the variables affecting the intra-forest distribution of *U. assimile*. Within twenty-four 400 m² plots 862 trees were sampled by counting honeydew threads within a fixed grid at breast height (1.4 m) on the north and south aspect of each tree. The density of threads (number of threads per unit area), and thus density of scale insects, was found to be significantly reduced with increasing altitude. For every 100 metre increase in altitude there was an average of 100 fewer threads per square metre of bark, suggesting that altitude is a major limiting factor. The critical altitude at which the beech scale insect becomes uncommon was found to be approximately 800 m. This was confirmed in a resource survey of Canterbury beech forests (Belton and Crozier, 1979).
At lowland altitudes of 400 to 800 m, the density of threads at breast height was found to be significantly higher on the north aspect (932 per square metre) compared with the south aspect (690 per square metre) of beech trees. This could be attributed to the warm sunny conditions on the northerly aspect producing a more favourable environment for the scale insect.

Observations also suggest that there is a greater density of scale insects on trees exposed to a higher intensity of sunlight for

**Fig. 2:** Exposed *U. assimile* second stage nymph with protruding thread and droplet of honeydew. (Magnification approximately × 3.)
longer periods than those within the forest itself, such as solitary trees, those at the forest edge, on open ridges, stream banks or in areas with an open canopy. The distribution of scale insects seems to be highly localised — some trees support lichen communities or are bare, while neighbouring trees which seem equally healthy are heavily infested with scale insects and have a thick covering of sooty mould.

Seasonal variation in the scale insect populations and honeydew production was observed, based on monthly readings for 70 sample sites over a year. A distinct peak in populations and production was obtained in the autumn with correspondingly low figures recorded in mid-summer (Crozier, 1978).

SOOTY MOULDS

Honeydew excreted by the scale insect provides one of the ecological niches occupied by sooty moulds which are often found in close association with some scale insects. Some of the honey-
dew washed down the tree trunks and branches by dew and rain is caught in the web of the fungal mycelium where it provides nourishment for sooty mould fungi. A layer of black fungus, up to approximately 5 cm thick, commonly covers beech trees infested by the scale insect, giving them a fire-blackened appearance. It is not uncommon to find plants and the ground within the splash zone of the exuded honeydew covered with the black fungus.

Cockayne (1926) named the fungus on beech trees *Hyphosoma hypoxyloides* and explained its association with the scale insect. However, for a long time the picture seemed confused, as Smellie (1949) stated that the globules of honeydew fall from the threads to the bark, solidify and turn into black smuts, gradually forming a thick sooty covering over the surface of the tree.

Dumbleton (1967) referred to the sooty mould as being *Capnodi um* spp., pyrenomycetes which are generally classified in the Capnodia ceae family. However, the taxonomy is confusing and not well defined, as little research has been carried out in this area. Hughes (1972) provides some background information and states that up to six species could grow together in apparent harmony.

**INSECT AND BIRD HONEYDEW FEEDERS**

Honeydew excreted by *U. assimile* is consumed by a wide range of insects, including various species of wasp, bee, fly, beetle and ant. Hives placed near or within infested beech forest enable honeybees to collect the honeydew, which they treat in the same way as nectar.

Honeydew is also an important food source for nectar feeding birds, such as bellbirds (*Anthornis melanura*), and silvereyes (*Zosterops lateralis*), particularly in winter months when other nectar sources are unavailable.

**COMPOSITION OF BEECH HONEYDEW**

Honeydew is produced in copious amounts in relation to the size of the scale insect. No study has been made of its composition in New Zealand. In America, Ewart and Metcalf (1956) have shown that water-soluble carbohydrates, mainly oligosaccharides, may exceed 80% of the total weight of freshly excreted honeydew. The remaining portion is principally water, nitrogenous compounds, and traces of minerals. European honeydew always contains organic acids, especially citric, more rarely malic, succinic and fumaric acids. In certain cases the sugars in honeydew are replaced or accompanied by sugar alcohols. These are not,
however, likely to be present on New Zealand beeches, as honeydew rich in sugar alcohols is disregarded by many insects, among them the honey bee (Maurizio, 1975). Orzhevskii (1966) has also found that in Europe honeydew contains more dextrin, mineral salts and acid than nectar.

HONEYDEW HONEY

New Zealand beech honeydew honey, or Bush honey as it is known locally, is a unique product with delicious flavour and light amber colour. Detailed analyses have shown that, as well as its darker colour and distinctive flavour, honeydew honey can be distinguished from floral honey by its higher content of ash, dextrin, sucrose, reducing sugars, higher pH, and greater free acidity (Kirkwood et al., 1960). Presence of microscopic sooty mould particles, however, appears to be a more reliable indicator of difference (Crane, 1975).

Since the early days of commercial beekeeping, hives have been moved to beech forests in early autumn to allow bees to gather honeydew for winter stores. Since about 1968, however, some apiaries have been kept in or near beech forests throughout the year to produce surplus honeydew honey, particularly for export.

The honeydew honeys (or Forest honeys as they are known) from the coniferous forests of Germany, Austria, Switzerland, Bulgaria, Greece, and Poland are generally darker in colour, sometimes almost black. Their flavour and aroma vary, depending on the plant source.

HONEYDEW HONEY EXPORT POTENTIAL

Although some beech honeydew honey is marketed locally, it has become established as an export commodity, having grown from a few trial shipments to 300 tonnes in 1980-1 in 10 years. At present practically all of this honey is sent to Germany where it is blended with local Forest honey, as New Zealand honeydew honey is bought at a relatively low price but is not dark enough in colour to be sold alongside the European product. The proportion of New Zealand Bush honey to European Forest honey is not known. Previously it was sold in both England and Japan, and there appears to be considerable room for export expansion to Germany.

The present price received for honeydew honey is equal to or slightly greater than that of top quality clover honey, but this
bears little relation to the retail prices being charged in Germany. A higher input of labour and skill is required to produce good honeydew honey yields because an apiarist could probably look after 40% more hives feeding on clover. Honeydew honey yields of 50 kg or more per hive have been obtained.

The fact that beech honeydew honey does not granulate makes it very suitable for export in the comb. Since honey has been sold successfully in this way for several years, it may also be possible to market packs of liquid honeydew honey on the European market as a unique New Zealand product, instead of blending it with local Forest honey.

A study of the beech honeydew resource undertaken in 1978-9 throughout Canterbury beech forests showed that great scope exists within the restrictions of available apiary sites, access, and pollen sources (Belton and Crozier, 1979). In Canterbury there are at present 4,850 hives licensed in Ashley and Mt Thomas State Forests alone — the principal area used for the production of honeydew honey. There are lesser numbers of hives in Mt Hutt and Alford State Forests and Hanmer and Craigieburn Forest Parks. Although the potential is extensive, little is known of the carrying capacity of forests, the effect of carbon loss from the beech forest ecosystem, and the competition with other honeydew feeders.

Because of its intrinsic biological interest and its growing economic importance, honeydew honey deserves to be studied more intensively.

REFERENCES


Note added in proof:

The presence of *U. assimile* male slides held by the Entomology Division, DSIR, Auckland, has been drawn to my attention. The samples were collected at the bottom of beech trees in pits and on totara (*Podocarpus* sp.) and manuka (*Leptospermum scoparium*), and identified by Miss J. de Boer and G. Brittin. The males have a reddish body dusted with wax and two large wings with a thickened front edge and only one faint vein.

Many coccids, especially the more primitive ones such as Margarodididae, have males which emerge on the same day and hour over a short period of time. It is likely that *U. assimile* has a similar reproductive strategy to *Icerya purchasi*, the cottony cushion scale (also a margarodid). The female can reproduce hemaphroditically. If she fertilises herself she produces more hemaphrodites; if she mates with a male the fertilised egg can be either male or female. Males of *I. purchasi* are also rarely found. This reproductive strategy is common in insects where the female is inactive and the presence of males seems to be retained to produce genetic variation.

Two distinct stages of the intermediate female may also exist as two separate sizes have been observed in the DSIR slides. The smaller specimens do not have a definite rim around the sclerotised anal tube area as do the larger specimens (C. Butcher, pers. comm.).