SESSION 2: Chairman: Mr. K. E. Lee

An Example of Winter Injury to Silver Beech at Moderate Altitude

G. T. S. Baylis

To judge by published records winter injury to native plants in their natural habitats is a rare phenomenon, but it might be nearer the truth to say merely that it is rarely recorded. In either case it seems worthwhile to draw attention to damage recently observed in silver beech on Maungatua near Dunedin since it is our chief timberline species.

The distribution of silver beech on Maungatua is not readily understood. The Range is scarcely 3,000 ft. high and only ten miles from the coast. A survey of rainfall and evaporation rates over the whole mountain has indicated that the entire upland is wet enough for beech forest (Wardle & Mark 1956). But silver beech, which is the only beech species present, is virtually restricted to the seaward face of the mountain and even there it is almost confined below the 2,000 ft. contour. Its extreme upper limit is however, 2,400 ft. At this altitude there is a small clump of about a dozen trees up to 30 ft. in height. They occupy a steep shallow cleft that faces south-east. It was here that conspicuous winter injury was observed.

In August 1957 when these trees were approached from their southern side their entire canopy appeared brown and desiccated. Only branches within a few feet of the ground were uninjured. Far less damage was apparent when the trees were viewed from their northern side. In due course some of the trees became almost leafless but their buds proved undamaged and were in active growth by December.

At lower altitudes only traces of injury were seen on mature trees but damage to saplings was apparent down to an altitude of 1,800 ft. Moreover the leaders of saplings were susceptible as well as the foliage, and in some cases were killed back for as much as two feet. Other woody species injured were *Dracophyllum longifolium, Leptospermum scoparium* and gorse. *L. ericoides, Cassinia fulvida* and *Hebe buxifolia* were undamaged. The unlignified capsules of *L. scoparium* were induced to shed their seed prematurely even on plants devoid of foliage injury. It thus appears that the seeding habit of this species can be upset even when it is not obviously harmed vegetatively.

Beech seedlings planted on the summit of Maungatua survived the winter undamaged, and *Dracophyllum* showed less injury here than on the flanks of the mountain. Greater protection by snow probably accounts for this; the beech seedlings were completely covered for at least three weeks.

The field evidence indicates that a southerly air stream was the cause of the injury. Its desiccating effects may have been produced by excessive transpiration or by freezing. It is generally accepted that frost injury is a form of dehydration injury associated with withdrawal of water from the cells by ice crystals forming between them (Levitt, 1956 p. 637). As to the possibility of excessive transpiration it is well established (Kramer, 1949) that when the rooting zone of a plant is chilled or frozen absorption of water is greatly reduced. In such circumstances quite low transpiration rates may prove excessive and lead to "winter drought injury" or "parch blight" as it is sometimes called.

The Director of the New Zealand Meteorological Service has kindly provided and commented upon the most relevant of the available weather records. These are the air temperatures and wind measurements taken daily about noon over Invercargill at an altitude of 2,000 ft., and the humidities recorded at noon at Taieri airport. It appears that the whole week, July 27th–August 2nd was exceptionally cold, but the orientation of the injury towards the south

points to July 27th and 28th as the damaging period, since only on those days did the wind blow strongly from a southerly quarter. It was on July 27th that its speed was greatest (about 50 knots) and it was on this day also that the noon air temperature at 2,000 ft. over Invercargill was the lowest recorded for the period. This was, however, only one degree below freezing point (31° F.) and substantially lower figures at other times of day should not be inferred since only a very small daily range is to be expected in the circumstances. Despite snow showers the air was possibly somewhat unsaturated (the relative humidity at noon at Taieri was 81%) but because of the temperature it seems unlikely that injury would have been through excessive transpiration. According to one Canadian investigation the winter water-loss from twigs of deciduous species only becomes pronounced at temperatures exceeding 41° F. (Wilner, 1952). The noon air temperature over Invercargill remained below 36° F. until August 2nd when it rose to 42° F. At the same time relative humidity was rather low (63% at Taieri at noon). Since the soil must by now have been well chilled the warm dry atmosphere of August 2nd seems to have offered the most suitable conditions in this period for winter drought injury. The wind, however, was from the north. This would seem to eliminate August 2nd as the day on which injury occurred, and add to the probability that the damage was caused by direct freezing of foliage and young stems on July 27th.

While we have no definite information about the minimum temperatures on Maungatua at this time, the severity of the cold period can be judged by Dunedin records. These show six comparable periods of sustained low temperature since 1901 and three particularly cold years (1899, 1900 and 1901) at the turn of the century. There is thus a suggestion that the type of injury observed in 1957 should recur erratically but with an average interval of eight years. But the high wind may have differentiated 1957 critically from several winters that seem comparable with it on the basis of mean daily temperatures.

Though mature trees were not permanently damaged at 2,400 ft. it seems likely that seedlings or saplings fully exposed to the weather about this altitude would have been partially or completely killed. But it is difficult to suggest that 2,400 ft. sets a thermal limit to silver beech on Maungatua since the species commonly exceeds 3,000 ft. in Otago. An isolated range might of course lack cold-resistant ecotypes that are present in most mountain districts. A graver objection is that spring or summer temperatures are usually considered to control timberlines (Tansley 1921; Griggs 1946; Zotov 1953). In New Zealand however, our timberline species are broadleaved evergreens; elsewhere they are usually conifers or deciduous dicotyledons. This may complicate the situation particularly in relation to winter drought injury. It has been shown that per unit of transpiring surface winter transpiration is about the same in conifers as in the leafless branches of deciduous trees, but is higher in broadleaved evergreens. If our beeches conform with the broadleaved evergreens that have been tested both in America and in Japan their winter transpiration rates will substantially exceed those of conifers (Weaver and Mogenson, 1919; Kozlowski, 1943). In a paper which is unfortunately not available in New Zealand, Michaelis has suggested that winter transpiration may be an important factor in determining the timberline (Kozlowski, 1943).

These observations on Maungatua do not however seem open to interpretation as a case of winter drought injury. They seem instead to reveal an unexpected vulnerability to damage by freezing. I do not think they warrant abandoning the explanation that grass fires are primarily responsible for the absence of forest from the upper slopes of the mountain (Wardle and Mark, 1956), but they suggest that the mutual shelter may be an important factor in enabling beech forests to grow at these altitudes.

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