EUCALYPTUS SPP. POLLEN TRANSPORT ACROSS LIAWENEE MOOR, ON THE CENTRAL PLATEAU OF TASMANIA

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(with one table, three text-figures and one plate)

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Investigation of *Eucalyptus* spp. pollen transport modes on Liawenee Moor in Tasmania revealed that it is possible to separate woodland areas from areas of moor and heath vegetation. While most *Eucalyptus* spp. pollen is deposited locally, a relatively small component is distributed across treeless areas, where it behaves in a manner similar to the long-distance transported (LDT) pollen of rainforest and alpine conifer taxa. When deposited into lakes, the *Eucalyptus* spp. component of the terrestrial pollen is increased compared with local pollen. Knowledge of the percentage *Eucalyptus* spp. pollen values from extant vegetation communities and the LDT components of *Eucalyptus* spp. and rainforest–alpine conifer taxa is useful for palaeoecological interpretation of vegetation history from lake sediment cores.

Applied to the 8000-year-long Camerons Lagoon record, the study confirms the treeless character of Liawenee Moor during the Holocene. The evidence indicates that the moorland has altered from grassy to heath, due to the impacts of grazing and burning associated with European pastoral practices, but that the boundaries between the moor and adjacent woodlands have remained stable.

Key Words. *Eucalyptus*, pollen transport, pollen deposition, Holocene, Tasmania.

INTRODUCTION

This paper reports the results of a study of the surface distribution of *Eucalyptus* spp. pollen at a site on the eastern Central Plateau of Tasmania (fig. 1). The purpose is to examine the transport of pollen from woodland/forest sources into non-forested areas. The results from this study were then applied to the core studied by Thomas & Hope (1994) at Camerons Lagoon on the southern part of the moor.

Liawenee Moor, west of Great Lake, forms an extensive part of the eastern Central Plateau of Tasmania (fig. 2). It is situated between 1000 and 1100 m altitude, and slopes gently towards Great Lake. The moor coincides with the outcrop of Tertiary basalts. The basalt-derived soils are nutrient-rich but poorly drained. It is surrounded to the north, west and south by Jurassic dolerite, which forms the higher parts of the eastern Central Plateau (Tasmanian Department of Mines 1956). Climatically, the moor lies within the drier parts of the Central Plateau. It has a mean annual precipitation of 985 mm and a mean annual temperature of 10.3°C. The dryness is caused by the maritime westerly airflows being stripped of their moisture by the transversely-oriented ranges of western Tasmania and the high areas of the western parts of the Central Plateau. The dominant westerly airflows descending to Liawenee Moor and Great Lake are adiabatically warmed and dried by a foëhn effect.

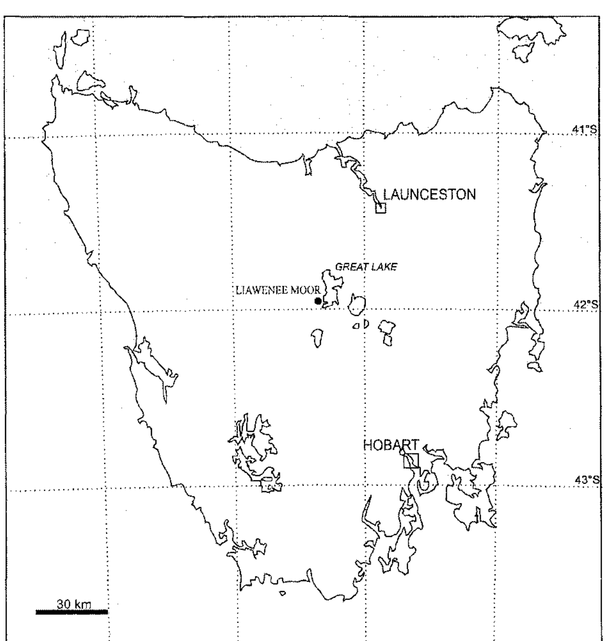

FIG. 1 — Location of Liawenee Moor, Tasmania.

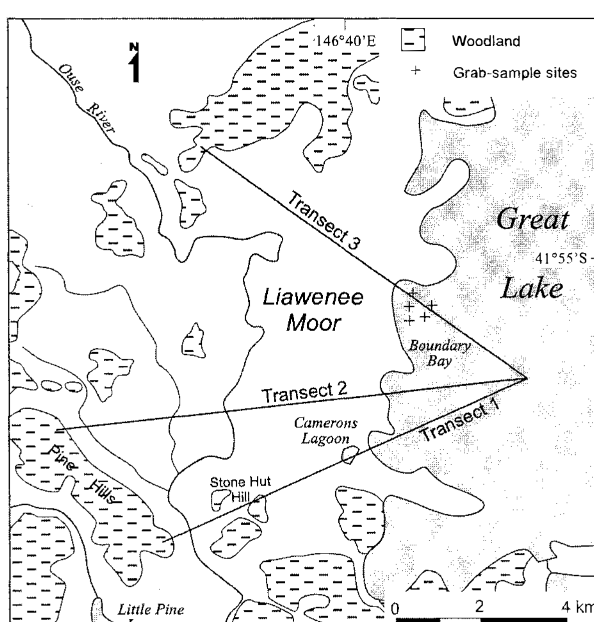

FIG. 2 — Liawenee Moor site map.

The moor is at present treeless. The predominant vegetation consists almost entirely of shrub-steppe dominated by *Helichrysum hookerii* with *Olearia algida, Orites revoluta,* Epacridaceae, *Danthonia* spp. and herbs. The ridges of dolerite surrounding the moor have a cover of *Eucalyptus* woodland with a shrub/grass understorey. The eucalypt species are predominantly *E. delegatensis, E. coccifera* and *E. gunnii* (Thomas & Hope 1994).

Beyond the woodland on the dolerite ridges, the western Central Plateau surface consists of alpine shrub and herb vegetation. There are substantial quantities of the coniferous shrub *Podocarpus lawrenceii,* whose pollen has been transported across Liawenee Moor by westerly winds. These winds also transport pollen of *Nothofagus cunninghami, Phyllocladus asplenifolius* and other rainforest taxa from the valleys to the west. These taxa form the most important components of the discretely identifiable long-distance transported (LDT) component on the moor.

Thomas & Hope (1994) concluded, from studies of pollen taken from Camerons Lagoon near the southern margin (fig. 2), that Liawenee Moor had been treeless throughout most of the middle and late Holocene, and was probably a grassland relic from the last glaciation. The treeless character has been attributed primarily to climatic dryness and poor soil drainage, with modification of the herb and shrub vegetation by Aboriginal burning during the Holocene, and a severe burning and grazing impact with the advent of European settlement (Jackson 1965, 1973, Thomas & Hope 1994).

In this study the pollen rain is separated into three components: pollen produced from local plants on the moorland; pollen from the *Eucalyptus* spp. growing on the dolerite ridges; and the LDT pollen component from the Central Plateau and valleys to the west. By separating these components it is possible to identify what percentages of modern tree pollen are deposited across the moorland and in the bottom sediments of the adjacent parts of Great Lake. Some *Eucalyptus* spp. pollen transport dynamics may then be deduced. These results are applied to the pollen record of Thomas & Hope (1994) to assess the stability of the woodland/moor boundaries and the claim that the moor has remained treeless throughout most of the Holocene.

METHOD

Three transects, focussed on a Mackereth Core site in Great Lake (GR 55GDP774575) (fig. 2), were laid out across Liawenee Moor. These extended into the *Eucalyptus* woodlands on the dolerite ridges (pl. 1). Transect 1 was chosen to intersect Camerons Lagoon, so that surface pollen samples could be compared with the sediment pollen record of Thomas & Hope (1994). It also impinged on Stone Hut Hill and terminated on the southern end of Pine Hills. Transect 2 crossed the south-central part of the moor to the northern end of Pine Hills. Transect 3 crossed the northern part of the moor and terminated on the steep scarp-edge to the northwest.

Sampling frequency along the transects was designed
(a) to examine the distance *Eucalyptus* spp. pollen were transported from the woodlands onto the moor, and
(b) to determine the ratio between the pollen deposited within and adjacent to the source vegetation and that which entered the long-distance pollen rain and was transported across the moor.

PLATE 1

The sharp boundary on the northern margin of Liawenee Moor with the open Eucalyptus *spp. woodlands on the Jurassic dolerite ridge.*

The study is similar to that of Dodson (1983), which concluded that most pollen of insect-pollinated native plants is deposited within 10 m of the source plant. The 0 m sample points on transects were located at the base of the first tree trunks on the sharp woodland–moor boundaries, and the distance between subsequent samples increased exponentially in both directions. Approximately 30 gm-samples of moss were taken at each transect-sample point by integrating nine regularly spaced subsamples within a 4 m^2 plot. Five bottom-sediment grab-samples taken from Boundary Bay in Great Lake represent modern unconsolidated lake sediments (fig. 2).

The moss samples collected from the transects were thoroughly mixed and subsamples of 1 gm were processed for pollen using KOH treatment, sieving at 100 µm, Erdtman's acetolysis and mounting in glycerol following procedures described in Fægri *et al.* (1992). The lake sediments were not sieved but received HF treatment to remove clays.

At least 300 pollen grains of terrestrial taxa were counted for each sample from Liawenee Moor and 150 grains from the Great Lake bottom sediment samples. The pollen was identified using the Tasmanian pollen reference collection (http://www.newcastle.edu.au/department/gg/pol/0Intro.html) in the School of Geosciences, University of Newcastle.

RESULTS AND DISCUSSION

On Liawenee Moor, the pollen analysis revealed that there is a very sharp decrease in the ratio of *Eucalyptus* spp. to total terrestrial pollen from the well-defined woodland edge to the moor. A sharp fall-off in pollen occurs within 6 m, the first inter-sample distance (fig. 3A, C). The effect of a tree 13 m beyond the woodland boundary on Transect 2 (fig. 3B) is clearly visible. On all transects woodland may be defined by >11% *Eucalyptus* to terrestrial pollen, to a high of 70%. Low values within the woodland reflect an outcrop area of bare rock (fig. 3A) and a small block stream (fig. 3C). Samples from the moor give ratios of *Eucalyptus* to terrestrial pollen of <11%, except adjacent to Stone Hut Hill which is an area of open woodland (fig. 3A).

The samples also contain LDT pollen from the alpine and forested regions of the higher parts of the Central Plateau and ranges to the west. Given that these pollen taxa are derived from distant sources, values for this component would be expected to be constant across the study area. The major LDT taxa include the rainforest species *Nothofagus cumminghamii, Phyllocladus aspleniifolius, Lagarostrobos franklinii* and the alpine taxon *Podocarpus lawrencii.* In addition, spores of the treeferns *Dicksonia antarctica* and *Cyathea australis,* and pollen of *Pinus* are included in the LDT sum, these taxa not being present on the moor or adjacent ridges. Percentages of LDT terrestrial pollen and spores average 3.1 ± 0.6% for the woodland and 4.5 ± 1.7% for the moor.

The ratio of total *Eucalyptus* spp. pollen to the LDT counts allows the comparison of pollen signatures between the woodland, moor and lake. Within the woodland this ratio varies between 4 and 34:1, but on the moor the ratio is very low and stable, not exceeding 3:1.

The grab samples from Boundary Bay (figs 2, 3D, table 1) show that the percentage of *Eucalyptus* spp. pollen and the LDT component are about twice the moor values. This

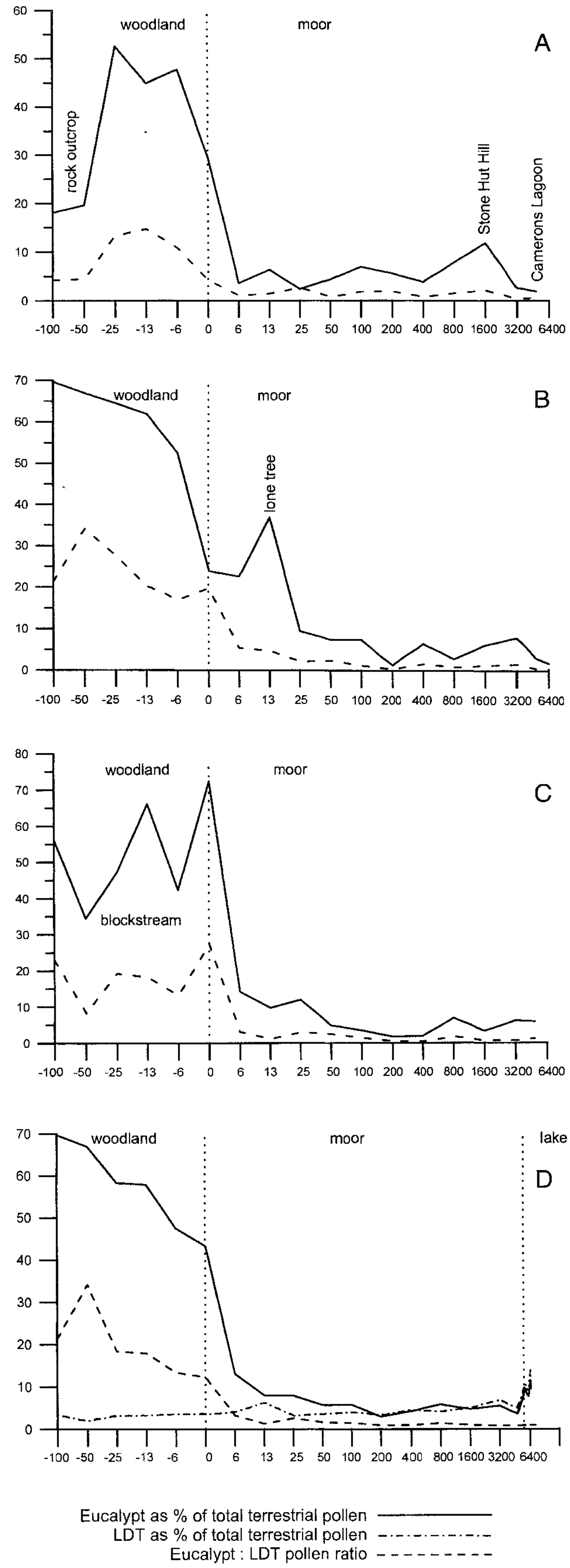

FIG. 3 — Liawenee Moor pollen transport: distance (m) from woodland–moor boundary. (A) transect 1. (B) transect 2. (C) transect 3. (D) averaged transects.

TABLE 1
Summary of environments for Liawenee Moor and Great Lake*

	n	% Eucalyptus ± 1σ	% LDT ± 1σ	Eucalyptus: LDT ± 1σ
Woodland/ forest [†]	10	60.0 ± 6.4	3.1 ± 0.6	20.5 ± 6.2
Moor [‡]	29	5.2 ± 2.8	4.5 ± 1.7	1.3 ± 0.7
Lake bottom	5	9.3 ± 1.5	10.7 ± 2.1	0.9± 0.1

* All transition samples (0–13 m) have been excluded (see figs 3A–D).
† Excluding rock outcrop and open woodland samples.
‡ Excluding Stone Hut Hill sample.

indicates a gross reduction in transport of pollen from local moorland taxa to the lake and a through-carriage of low quantities of both *Eucalyptus* spp. and LDT pollen across the moor. The *Eucalyptus* spp. pollen on the moor and lake have similar concentration patterns to the other LDT pollen taxa. This is also shown by the similar *Eucalyptus*:LDT ratios for the moor and lake.

The increase in *Eucalyptus* spp. pollen to 9.3 ± 1.5% in the Boundary Bay samples compared with the values on Liawenee Moor suggests that if *Eucalyptus* spp. pollen in lake sediments does not exceed this value, then *Eucalyptus* woodland was probably not present as part of the local vegetation. This result is in accord with the conclusion of Thomas & Hope (1994) that values of <15% of fossil *Eucalyptus* spp. pollen in the terrestrial sums at Camerons Lagoon do not substantiate the presence of local *Eucalyptus* woodlands on the moor throughout the mid- to late Holocene.

Results from this study indicate that the <15% of *Eucalyptus* spp. pollen in the sediments of Camerons Lagoon is consistent with treelessness and up to 39% for Poaceae indicates that the moor was very grassy. This suggests that the moor remained a treeless plain after melting of glaciers to the west. Its survival is probably attributable to a combination of factors including reduced rainfall, poor drainage, cold air drainage from the Central Plateau into the upper Ouse Valley, high-nutrient status of the basalt soils and possibly Aboriginal burning (Thomas & Hope 1994, Jackson 1973, Kirkpatrick 1983, Kirkpatrick & Dickinson 1984). Aborigines are known to have occupied the Mersey Valley, 40 km to the northwest, throughout the Holocene (Lourandos 1983).

The uniformity of representation of pollen percentage values for *Eucalyptus* spp. and Poaceae throughout the last 8000 years shows stability of the vegetation not only on the Moor but also of the woodland on the surrounding dolerite ridges. The change to higher values for Asteraceae tubuliflorae, Epacridaceae and Restionaceae at 100 mm depth in the Camerons Lagoon record is consistent with the moor becoming more heathy as a result of the impact of grazing and burning of the mountain grasslands, as indicated by Jackson (1965, 1973).

CONCLUSIONS

Study of pollen transport across Liawenee Moor shows that *Eucalyptus* spp. pollen dominates the total pollen recovered from moss polsters within 6 m (being the first inter-sample distance) of the source vegetation. Beyond 6 m this taxon is a minor component of the total pollen sum. This supports Dodson's (1983) conclusions that the pollen of most native insect-pollinated species is deposited within a few metres of source plants. However, this paper shows that there is also a significant LDT component that can be associated with *Eucalyptus* spp., and it is likely that similar patterns exist for other native species.

Approximately 90% of the pollen deposited in moss samples on Liawenee Moor is derived locally from heath, grass and herb plants. About 5% is LDT pollen from rainforest and alpine taxa west of the study site, and around 5% is *Eucalyptus* spp. pollen derived from the bounding forested dolerite ridges, also transported across the moor as a LDT component.

The doubling in percentages of pollen from both *Eucalyptus* spp. and the LDT rainforest and conifer species in the lake-floor sediments represents reduction in transport of local pollen taxa from the moor. Thus, in this region, values for *Eucalyptus* spp. below about12% (i.e. 9.3 + 2σ, table 1) do not indicate the presence of local woodland or forest.

When the results of this study are applied to the 8000-year Camerons Lagoon record, the treeless character of Liawenee Moor throughout the Holocene, as interpreted by Thomas & Hope (1994), is confirmed. The results also indicate that the boundaries between the forest/woodland vegetation and the moor remained stable during the Holocene. The moor was probably much richer in grassland than at present, the alteration to heathland being a product of European settlement involving grazing and burning, as suggested by Jackson (1973).

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