Available online at www.sciencedirect.com
ScienceDirect
Review of Palaeobotany and Palynology 146 (2007) 146–168
Review of Palaeobotany & Palynology
www.elsevier.com/locate/revpalbo

Modern pollen–vegetation relationships in western Tasmania, Australia

Michael-Shawn Fletcher*, Ian Thomas

School of Anthropology, Geography and Environmental Studies, University of Melbourne, Parkville, 3010, Australia

Received 24 November 2006; received in revised form 16 March 2007; accepted 21 March 2007
Available online 1 April 2007

Abstract

This paper describes the results of a modern pollen survey of plant communities in western Tasmania, Australia. Sampled communities occur in the main vegetation types: alpine/subalpine, rainforest and moorland. We show that despite the over-representation of rainforest trees in the regional pollen rain, vegetation type and some communities can be distinguished using pollen analysis. Temperature (altitude) and fire frequency are significantly correlated with the ordination axes, consistent with the ecology of the region, indicating that pollen composition is a good reflection of vegetation and that pollen spectra can be effectively used to reconstruct changes in these environmental parameters. Moorland communities are clearly distinguished by ordination analysis. Seasonality is significantly correlated with moorland community type. Although percentage cover of the major plant taxa correlates significantly in most cases with pollen percentages, the high variability means that quantitative estimates of vegetation cover from pollen data alone are not possible.

Keywords: Australia; western Tasmania; Palynology; modern pollen rain; modern pollen–vegetation relationships; moorland; fire

1. Introduction

Pollen analysis is the most widely used tool for reconstructing past vegetation. Central to the employment of pollen analysis as a palaeoecological tool is the assumption that relative pollen abundance in sediments is in some way proportional to the relative abundance of plants in a given landscape (Erdtman, 1943). Plants employ various means of dispersing pollen and, as such, pollen production and dispersal varies greatly between species (Tauber, 1965; Faegri, 1966). It follows that an understanding of the relationship between vegetation and modern pollen rain is a vital and necessary first step before attempting to interpret fossil pollen spectra (Janssen, 1973). There is a considerable body of research concerning modern (surface) pollen and its relationship to vegetation for northern hemisphere plant communities (*e.g.* Wright, 1967; Gaillard et al., 1984; Prentice, 1985; Gaillard et al., 1992; Sugita et al., 1999; Bunting, 2003). The forests of Europe and North America have received particular attention (*e.g.* Janssen, 1984; Bartlein et al., 1986; Prentice, 1986; Prentice and Webb, 1986; Seppa et al., 2004) and a good understanding of regional and local scale pollen–vegetation relationships has been garnered for these regions using both intuitive and objective means (*e.g.* Prentice, 1980; Birks and Gordon, 1985; Overpeck et al., 1985; Bartlein et al., 1986; Birks, 1994; Seppa et al., 2004).

Australia, on the other hand, has a comparatively sparse coverage of published modern pollen literature

* Corresponding author.
E-mail address: msfl@unimelb.edu.au (M.-S. Fletcher).

0034-6667/$ - see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.revpalbo.2007.03.002

(Dodson, 1977, 1982, 1983; Dodson and Myers, 1986; Kershaw, 1993a,b; Crowley et al., 1994; Kershaw and Bulman, 1994; D'costa and Kershaw, 1997; Luly, 1997; Shimeld and Colhoun, 2001; Pickett et al., 2004) with even fewer making use of objective numerical analyses (Dodson, 1983; Dodson and Myers, 1986; Kershaw and Bulman, 1994). Dodson (1983) provided a regional scale qualitative assessment of pollen representation for a number of southeast Australian pollen types (compiled from a variety of sources), identifying three classes of pollen representation: over-, well-, and under-represented, and presenting a means to differentiate vegetation type using numerical analyses. Since then, there have been a number of attempts to use modern pollen representation, calibrated against the bioclimatic envelopes of single (*e.g.* Markgraf et al., 1986; McKenzie and Busby, 1992; Kershaw, 1993a,b; Thomas, 1998) and multiple (Kershaw and Nix, 1988) plant taxa, to derive palaeoclimatic estimates from pollen diagrams. In addition, a number of regional indicator pollen types for temperature and precipitation have been identified for southeast Australia using large modern pollen datasets plotted along major climatic gradients (Kershaw et al., 1994; D'costa and Kershaw, 1997).

Many publications provide information on modern pollen composition around fossil sites (*e.g.* Hope, 1974; Ladd, 1979; Macphail, 1979; Colhoun and van de Geer, 1986; Harle et al., 1999), but there is a lack of synthetic studies aimed at identifying regional pollen–vegetation relationships (Dodson, 1983; Crowley et al., 1994; Kershaw et al., 1994; D'costa and Kershaw, 1997; Pickett et al., 2004) and the reliability of pollen spectra for predicting Australian vegetation communities is largely untested. In a recent paper we (Fletcher and Thomas, 2007) used multivariate analysis of a limited modern pollen dataset from western Tasmania, in southeast Australia, to accurately predict the occurrence of plant communities and applied these results to the interpretation of Holocene vegetation change. We were prompted by a lack of modern pollen literature for the region and by the failure of a recent regional synthesis to scry the dominant lowland vegetation type in western Tasmania: treeless buttongrass moorland (Pickett et al., 2004). We demonstrated a clear potential for the use of objective numerical analyses to correctly predict vegetation type from pollen, despite the over-representation of a few key tree species in the pollen rain and the abundance of pollen types with poor taxonomic resolution (Fletcher and Thomas, 2007).

In this paper we: (1) expand upon our earlier analysis, strengthening its predictive power; (2) quantitatively assess the representativeness of important pollen types; (3) compare vegetation data with pollen representation; (4) identify the dominant environmental correlates determining modern pollen composition; and (5) discuss the implications of the results for Quaternary research in western Tasmania.

2. The study area

2.1. Environment

Tasmania is a large island located to the south of mainland Australia between 41° and 43°S. Western Tasmania is a mountainous and perennially wet region where orographic rain deposits 1500–3500 mm rain annually and average annual temperatures range between 5 and 7 °C in winter and between 14 and 16 °C in summer (Nunez, 1979). Precipitation exceeds evaporation for most of the year and the climate is classed as superhumid (Fig. 1, Gentilli, 1972). Two main climatic gradients operate in western Tasmania, a precipitation gradient from west (wet) to east (drier) and a latitudinal gradient manifest in temperature and seasonality differences between the north (warmer-seasonal) and south (cooler-aseasonal) (see Fig. 1).

Precipitation in the study region is dictated by orography with the west coast rarely experiencing long periods of moisture deficit, while water stress is common in the rain-shadows cast over the midlands and eastern Tasmania (Gentilli, 1972). Latitudinally, Tasmania lies near the boundary of two major weather systems: the mid- to high-latitude low pressure (cyclonic) and the subtropical high pressure (anticyclonic) systems. Annual migration of these systems relieves the northwest from the maritime westerlies for longer periods than the southwest, and incursions of hot and dry continental air in to the northwest are common in summer (Nunez, 1979).

Soils in western Tasmania are usually highly infertile and acidic. Large areas of predominantly quartzitic bedrock are overlain by moor and forest peats on which are developed the whole spectrum of plant communities found in the region. Except in rare situations, and in the most general sense of open versus forest vegetation, soil type is not a useful predictor of plant community type (Bowman et al., 1986; Pemberton, 1989).

2.2. Vegetation

The main determinants of vegetation type in western Tasmania are altitude and fire frequency (Jackson, 1968; Bowman and Jackson, 1981; Kirkpatrick, 1982). Lowland vegetation (excluding coastal vegetation)