CHAPTER 2

MARION LAKE STRATIGRAPHY[1]

As a first exploratory look at the chironomid stratigraphy in a British Columbia lake, Marion Lake in the University of British Columbia Research Forest was selected for study. This initial investigation would allow a comparison of chironomid successional patterns in British Columbia with those documented elsewhere in North America and Europe.

Extensive ecological (Efford and Hall, 1975; Hall and Hyatt, 1974) and palaeoecological (Mathewes, 1973; Mathewes and Heusser, 1981; Wainman and Mathewes, 1987) research has been conducted at Marion Lake. The extant chironomid fauna is well documented (Hamilton, 1965), and the lake is of comparable size to other North American sites from which detailed postglacial chironomid stratigraphic records have been obtained (Lawrenz, 1975; Walker and Paterson, 1983). The faunas of small lakes are likely to be most responsive to climatic changes. Also, a complete postglacial sediment core was available for study. The lake is unusual in having large stream and spring-water inputs.

Study Area

Located about 50 km east of Vancouver, British Columbia, in the University of British Columbia Research Forest (Fig. 2.1), Marion Lake (49° 19'N, 122° 33'W) occupies a valley depression in the Coast Mountains at 304 m above sea level. The area is exposed to a mediterranean type climate. Although summer precipitation is similar to that in much of southern Canada, summer temperatures are slightly cooler, and winter is

[1] This chapter is largely adapted from a previously published account (Walker and Mathewes, 1987a).

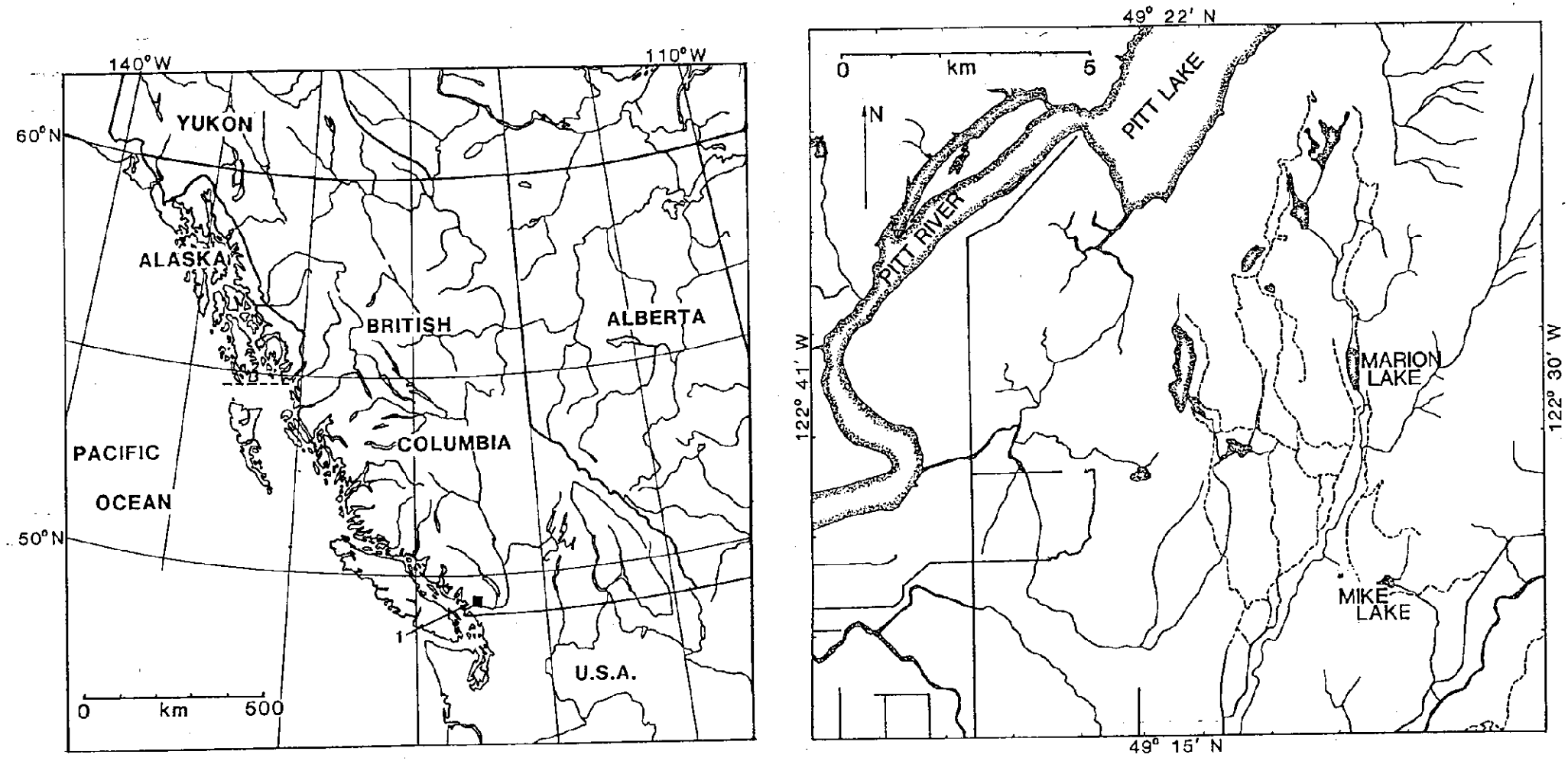

Figure 2.1 Location of Marion Lake in the University of British Columbia Research Forest, near Maple Ridge, British Columbia, Canada.

comparatively warm and wet (Table 2.1). The lake has an area of 13.3 ha and maximum depth of approximately 6 m (Hamilton, 1965). The catchment encompasses 15 km^2, with tributary streams extending to at least 500 m above lake level. Perhaps owing to the rapid flushing of Marion Lake following frequent rains, little stratification of the water column is apparent. Temperatures at 5.0 m depth can exceed 17°C during summer, whereas winter temperatures approach 2°C (Hamilton, 1965). Efford (1967) notes, however, that water as cold as 9.5°C can be found during summer over one large spring in the lake bottom. As a result of the high precipitation (2500 mm) and base-poor plutonic bedrock (Roddick, 1965), Marion Lake is a weakly-acidic to circum-neutral (pH 5.9 to 7.4), oligotrophic, softwater lake, typical of those along British Columbia's mainland coast.

The conifer-dominated forests of the (wetter) coastal Western Hemlock Zone (Krajina, 1969) that surround the lake have been extensively disturbed by fires and logging. The present forest consists primarily of western hemlock (*Tsuga heterophylla* (Raf.) Sarg.), western red cedar (*Thuja plicata* Donn.), Douglas-fir (*Pseudotsuga menziesii* (Mirbel) Franco), and red alder (*Alnus rubra* Bong.).

Palynological investigations (Fig. 2.2) reveal the postglacial forest history of Marion Lake's catchment (Mathewes, 1973). Climatic interpretations are available as established by pollen/climate transfer functions (Mathewes and Heusser, 1981). The earliest sediment (≥12,000 yr B.P.; ≥8.85 m) is dominated by clay and contains a significant non-arboreal pollen component including willow (*Salix* L.) and soapberry (*Shepherdia canadensis* (L.) Nutt.). Forests were then rapidly established at the site. All subsequent sediments, excluding the Mazama volcanic ash layer (6800 yr B.P.: Bacon, 1983), are highly organic, containing much allochthonous plant debris. Early forests (12,000 - 10,000 yr B.P.) included lodgepole pine (*Pinus contorta* Dougl.), balsam fir (*Abies* Mill.), spruce (*Picea* A.Dietr.), mountain hemlock (*Tsuga mertensiana* (Bong.) Carr.) and alder, suggesting a

Table 2.1. Climatic summary (1951-1980) for Loon Lake (49°18'N, 122°35'W; 354 m elev.), University of British Columbia Research Forest, Haney, British Columbia.

Mean Daily Temperature	
Coldest Month (Jan)	0.5°C
Warmest Month (Jul)	16.3
Precipitation	
Rain: Annual	2459.1 mm
Wettest Month (Dec)	343.3
Driest Month (Jul)	86.7
Snow: Annual	195.2 cm
Frost-free Period	199 d
Degree-days	
Above 0°C	3092.7°C·d
Above 5°C	1633.7

(Environment Canada, 1982)

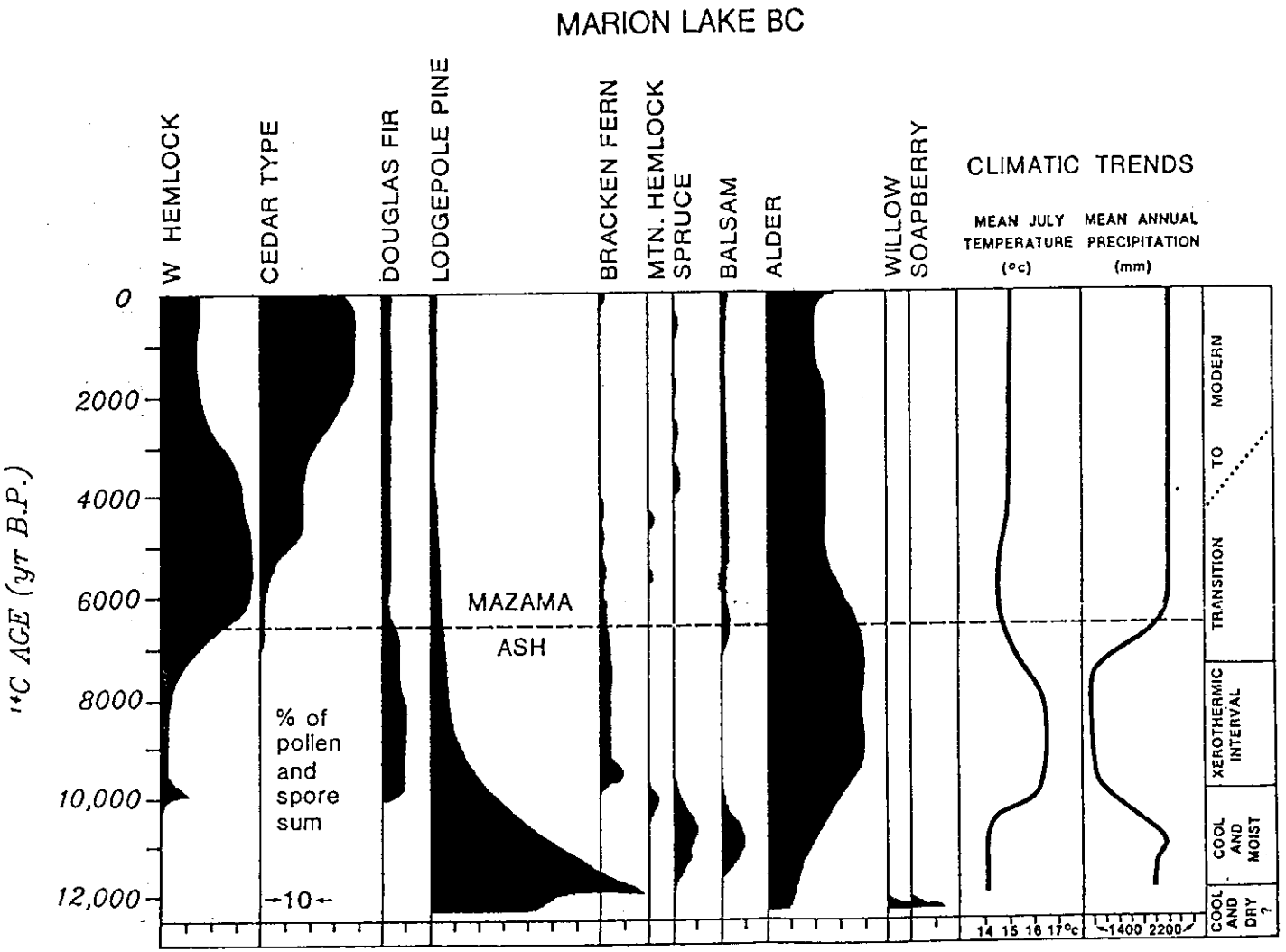

Figure 2.2 Summary diagram of postglacial pollen stratigraphy at Marion Lake, B.C. (adapted from Mathewes, 1985).

cool moist climate. Maximum proportions of Douglas-fir, alder, and bracken (*Pteridium aquilinum* (L.) Kuhn.) palynomorphs between 10,000 and 7000 yr B.P. imply a warm dry climate, described as a xerothermic interval (Mathewes and Heusser, 1981) with increased fire frequency (Mathewes, 1985). Post-Mazama maximum frequencies of western hemlock and western red cedar indicate a shift towards the present cooler and wetter climate. These patterns of forest development and the climatic inferences accord well with evidence from other sites in the same region (Mathewes, 1985).

Methods

A 5-cm-diameter sediment core was collected at the point of maximum depth (*ca.* 6 m) in Marion Lake using those methods described by Mathewes (1973). Because this core was taken close to one previously studied palynologically (Mathewes, 1973) the stratigraphy of this 8.95-m core is identical to that described by Mathewes (1973). A reliable stratigraphic correlation of the two records is therefore possible.

One millilitre samples of sediment were normally used for chironomid analysis. Larger samples (≤30 mL) were occasionally necessary, especially for the basal clay (≥8.85 m). The samples were spaced at approximately 1.0 m intervals, except in sediments below 8.0 m and near the Mazama ash (6.1 m) where rapid faunal changes were expected. In these instances, samples were more closely spaced. Samples were deflocculated in hot 10% KOH and sieved through a .075 mm mesh. The sediment retained in the sieve was washed into a beaker and later examined in a Bogorov counting tray (Gannon, 1971) at a magnification of 50X for fossil chironomids. All fossil Chironomidae were mounted on microscope slides in Permount® and retained for identification. Counts per sample averaged 91.6 ±12.2 (S.E.) chironomid head capsules, with a minimum of 25.5 and maximum of 203.5.

Head capsules were identified principally with reference to the work of Hamilton (1965), Oliver and Roussel (1983a) and Wiederholm (1983). Nomenclature follows Wiederholm (1983). Because most appendages were separated from the head capsules, it was not possible to provide all identifications at the generic level and few at the species level. Thus, several broader taxonomic categories (e.g. *Corynoneura* Winnertz/*Thienemanniella* Kieffer, *Cricotopus* v.d.Wulp/*Orthocladius* v.d.Wulp/*Paratrichocladius* Santos Abreu, *Tanytarsus* s.lat.) have been designated. Details regarding the identification of individual taxa, including diagnostic characters, illustrations, and species likely to be included in each group are provided as an appendix to this thesis.

The chironomid diagrams were been plotted using the pollen-plotting package MICHIGRANA developed by R. Futyma and C. Meachum. Head capsule influx estimates were calculated assuming constant sedimentation rates between radiocarbon-dated levels. Zonation of the diagrams is subjective.

Results

The counts of head capsules are presented as percentages[2] (Fig. 2.3), as well as total influx[3] (Fig. 2.4). Although ideally representing the abundance of individual taxa, interpretation of influx data is limited by the possibility of sediment focusing (Davis *et al.*, 1984) concentrating littoral head capsules in the less turbulent sublittoral region (Iovino, 1975). Thus total influx values are presented, but not influx estimates for individual chironomid taxa.

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[2] For individual samples, the proportion of each taxon has been calculated as a percentage, of the total number of chironomid head capsules.

[3] Total influx refers to the rate at which head capsules of all chironomid species are being deposited and preserved in the sediments. Influx is reported as the number of head capsules deposited per cm^2 per year ($hc \cdot cm^{-2} \cdot yr^{-1}$).

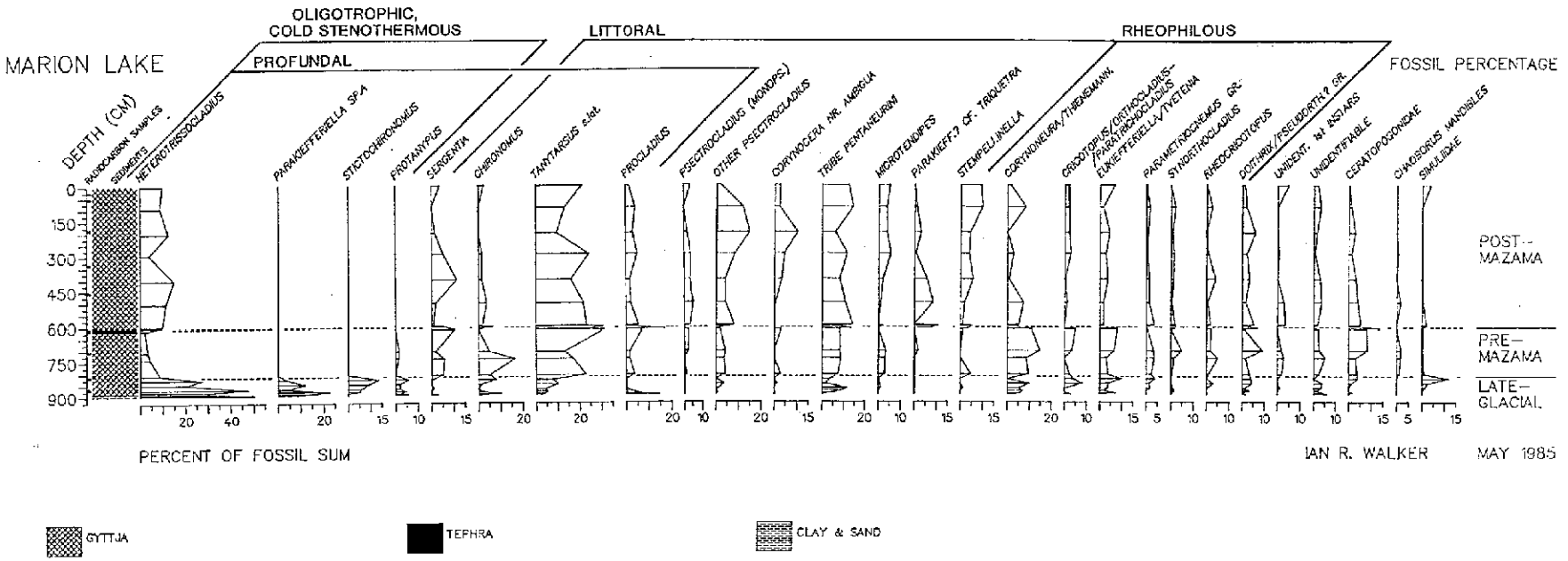

Figure 2.3 Percentage (of total number of chironomid head capsules at each sample level) diagram representing stratigraphy of common Chironomidae at Marion Lake, B.C. (Several rare taxa, including *Pseudodiamesa* Goetghebuer have been excluded.)