

HOW MANY LOGS MAKE A FOREST?†

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The nature of ice-margin conditions is a durable problem in paleoecology. In a recent contribution Goldthwait (1958) and Burns (1958) provide a valuable stratigraphic account of wood from Wisconsin and post-Wisconsin age deposits in Ohio. From glacial till they report abundant records of spruce logs, less often of larch and white cedar, that indicate relatively short distance of transport by the Wisconsin glacier near its margin. Seventeen radiocarbon dates of this wood from 27,500 to 16,560 years ago bracket the last Wisconsin glacial maximum. Goldthwait (p. 213) concludes that, locally, the ice sheet pushed into extensive patches of living forest climatologically akin to those of north central Ontario. Burns (p. 223) interprets this as a relatively narrow band of coniferous forest, mainly spruce. To support the concept of a narrow coniferous zone, he cites Braun's postulate of deciduous forest fifty miles south of the drift border (Braun, 1951).

The query raised by my title now emerges. Are abundant broken logs embedded in till prima-facie evidence that ice moved through and buried a closed canopy *forest*? Or was it an open woodland of a savanna type, with dense tree growth only along drainage systems? Or was it a wooded-tundra (lyesotundra) resembling the subarctic treeline?

To the paleoecologist and paleoclimatologist the distinction is crucial. If a narrow zone of periglacial boreal forest bordered the ice sheet, it is reasonable to assume that a temperate climate and deciduous forest biota lay slightly beyond. Braun's concept of an ice margin refugium for such plants would be supported. If, however, the ice margin were occupied by *woodland* or wooded tundra, both boreal and deciduous forest zones would have suffered a greater displacement (cf. Martin, 1958).

To consider a hypothetical illustration, an ice sheet advancing southward into northern Quebec at 58° north latitude would encounter pole-sized spruce and larch in dense groves along rivers. This is the northern limit of tree growth in eastern Canada (fig. 1). Farther south, in the boreal woodland or taiga, "... tall and well-developed spruce . . . stand several yards apart in a sea of *Cladonia*" (Hare 1950: 624). Here an ice sheet might bury the following: white and black spruce at a density of 400 trees per acre, white spruce on the best sites up to 59 feet tall, 28 inches in diameter, and over 158 years in age. In such terms Hustich (1954) described "forests" at Knob Lake, 55° north. By comparison with closed-canopy boreal forests of southern Canada, this is slow growth and low stature. By comparison with the growth of trees at their limit in northern Quebec, it is luxuriant. In each case the ice sheet could have covered, locally at least, abundant logs. What type of trees were buried in Ohio?

Although distortion or compression may have altered the ring width, it is of interest to compare Hustich's Knob Lake data with those of the fossil logs studied by Burns. With one exception, the annual ring growth measurements of 1.4 mm or less on Wisconsin-age trees in Ohio (Burns, p. 225-226) are matched and frequently exceeded by ring measurements of black and white spruce from good sites in the Knob Lake woodland. The single exception is log 272 from Anderson Run, in which Burns recorded a maximum annual ring increment of over 4.2 mm, twice the maximum Hustich reported at Knob Lake. Perhaps it is not a coincidence that the Anderson Run locality also included wood of white cedar (*Thuja*).

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Although *Thuja* reaches the subarctic lowlands of James Bay (Hustich, 1957, map 8), it is more commonly found within true boreal forest to the south. On these grounds the Anderson Run locality might be considered representative of *boreal forest* rather than *boreal woodland*.

On the other hand the description of wood from other Ohio sites, with diameters and ring growth features equivalent to those recorded at Knob Lake, does not invite the strict generalization of forest. To me it indicates that the advancing Wisconsin sheet swept through a zone of scattered trees, relatively dense along drainage ways, but perhaps enclosing patches of tundra on hilltops (fig. 1). Farther south closed canopy coniferous, rather than deciduous forest, occupied the Appalachian Plateaus in southern Ohio and Kentucky.



FIGURE 1. Lyesotundra at the subarctic tree line, Fort Chimo, Quebec, 58° N. Lat. Lichen-heath tundra occupies the foreground and horizon, while a dense wood of larch and black spruce grows along drainage only. Did Ohio glacial forests resemble this?

As stressed by Hare (1950), Hustich (1949), and Rousseau (1952), there are three distinct vegetation zones, wooded tundra, boreal woodland, and boreal forest, south of the tundra in eastern Canada. Spruce (*Picea*) is common in each. By careful comparison of growth features, as Burns' data allow, it may be possible to relate fossil logs to a narrow segment of the modern vegetation gradient. While we lack sufficient information on subarctic tree growth to attempt a detailed comparison, it is notable that rings of most fossil Ohio logs do not exceed in width those of trees from the boreal woodland.

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