Late Cenozoic wood from Washington Land, North Greenland

Ole Bennike

The arctic regions are north of the tree line, but nevertheless wood is quite plentiful. Most of this wood in Greenland is driftwood that has floated across the Arctic Ocean, to be eventually deposited on beaches. Following previous deglaciations and isostatic rebound, raised beaches are common, and driftwood may be common below the marine limit. Most driftwood is of postglacial age, but pre-Holocene driftwood has been reported from Greenland and elsewhere in the Arctic.

Some of the pre-Holocene wood derives from trees that grew in the Arctic in the past, when climates were warmer than at the present. Best known are the Late Cretaceous and Early Tertiary diverse floras that comprise many warmth-demanding species including vines, but the wood from these time periods is more or less fossilised. Trees also grew in the Arctic much later, and some of this wood is remarkably well preserved and looks much like postglacial driftwood. Thus when the geologist Lauge Koch observed tree trunks up to 165 m above sea level in the hills of the Kap København area in eastern Peary Land (Fig. 1), he interpreted this as postglacial driftwood (Koch 1926). However, the Kap København Formation is now dated to the Plio-Pleistocene (Bennike 1990). Although no trees have been found in growth position in the Kap København area, it is obvious that the trees grew locally, since leaves, needles, seeds and cones are common, and the rich fossil insect fauna also comprises numerous species that are dependent on trees (Böcher 1995). At two other sites in Peary Land concentrations of pre-Holocene wood are present, namely at Jørgen Brønlund Fjord and at Baggården. The occurrence at Jørgen Brønlund Fjord is situated below the marine limit, and the wood could be driftwood, but the concentration of wood fragments is more indicative of local tree growth (Bennike 1990). At Baggården, wood is found along the shore of the lake and along Sydpaselv that drains into Øvre Midsommersø (Bennike 1990; E. Knuth, National Museum, Copenhagen, archive). A few specimens from this locality archived in the National Museum in Copenhagen (NM VIII A 4512M) are small, abraded and fragmented pieces that do not show the size of the trees.

From Washington Land, pre-Holocene wood has previously been reported from the pre-glacial Bjørnehiet Formation (GGU 211926 and 211929; Jepsen 1982), and from a gravel river bed north of Humboldt Gletscher (GGU 206054). At the latter site many wood pieces were reported at an altitude of 245–260 m above sea

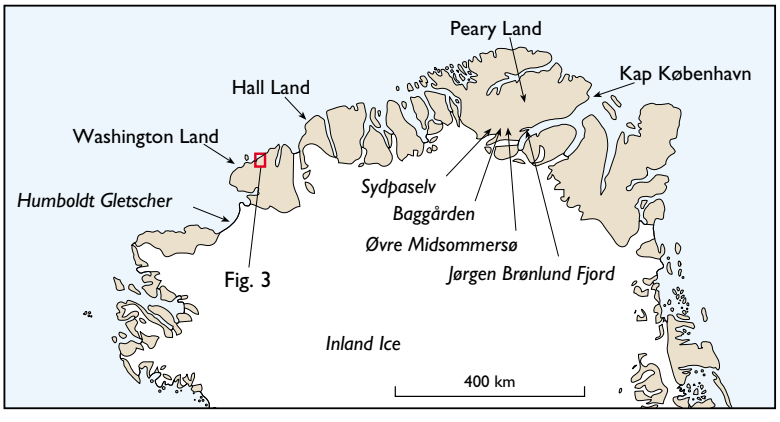

Fig. 1. Map of northern Greenland showing the locations of place names mentioned in the text.

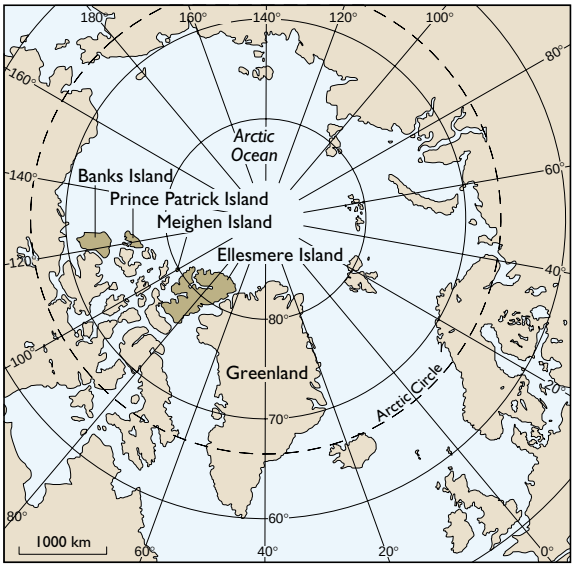

Fig. 2. Circumpolar map showing the locations of place names in northern Canada mentioned in the text.

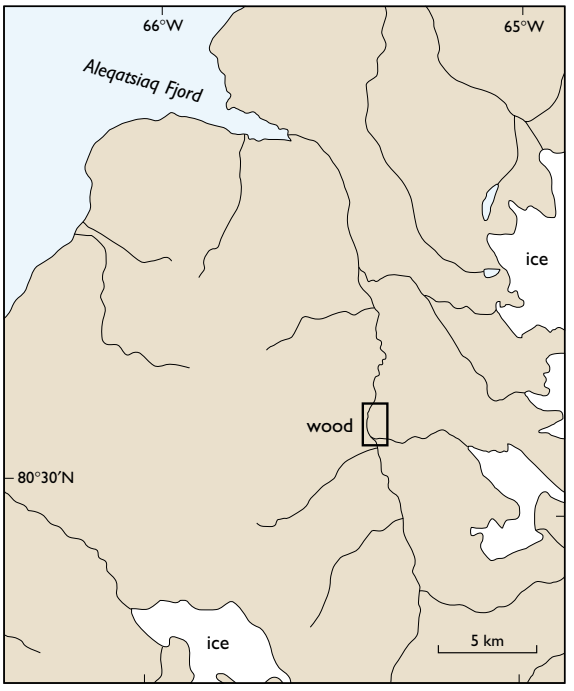

Fig. 3. Map of the Aleqatsiaq Fjord region in Washington Land, showing where the wood pieces described in this report were collected.

level (Blake 1987), which is far above the marine limit of the area. Weidick (1978) suggested that the wood is interglacial driftwood that was redeposited by glaciers, but again the concentration of wood fragments is hard to understand, so a source from local tree growth seems more likely.

The wood in North Greenland bears resemblance to wood from the Beaufort Formation and related deposits in northern Canada (e.g., Matthews & Ovenden 1990; Matthews *et al.* 1990; Fyles *et al.* 1994). The Beaufort Formation is assigned to the Miocene and Pliocene. On western Ellesmere Island (Fig. 2), so-called high-level alluvium is fairly widespread. A notable occurrence here, at an elevation of approximately 400 m, is the Mid or Late Pliocene Beaver Pond peat that also contains a rich mammalian fauna, including the extinct rabbit *Hypolagus* that is also present in the Kap København Formation (Matthews & Ovenden 1990; C.R. Harington, personal communication 1994).

During field work in Washington Land in the summer of 1997 a new locality with abundant wood was located along the river that drains into Aleqatsiaq Fjord, at *c.* 80°31.9′N, 65°25′W (Fig. 3), and the purpose of this note is to describe some samples of wood that were brought to Copenhagen. The collection site is *c.* 70 m above sea level. Although no information is available on the height of the marine limit in Washington Land, this is probably below the marine limit, since the marine limit on Hall Land to the east of Washington Land is 100–120 m above sea level (Kelly & Bennike 1992). However, postglacial driftwood is exceedingly rare in Hall Land, and the highest reported comes from an altitude of 56 m (England 1985). Furthermore, the wood from Washington Land does not look like driftwood, since all logs represent very small trees. In spite of a search in the vicinity in 1997, it was not possible to locate the source of the wood (M. Sønderholm, personal communication 1997).

Material and methods

A total of 20 samples of wood, mostly trunks of trees but also a few branches and a few small wood fragments, were available for analysis (Fig. 4). Most samples were cut and polished for growth ring analysis using a dissecting microscope. The wood samples were identified by their anatomical structure as studied in tangential, radial and cross sections, using a light microscope. *Larix* and *Picea* wood were distinguished by the features listed by Bennike (1990).

Fig. 4. Some of the wood pieces. From left to right, GGU 442933, 442936, 442935 and 442943.

Table 1. Data on wood pieces from North Greenland

GGU No.	Length (cm)	Diameter* (mm)	Number of rings	Mean ring width† (mm)	Taxon
442933	98	60	150	0.20	*Larix* sp.
442934	92	56	194	0.14	*Larix* sp.
442935	57	36	210	0.09	*Larix* sp.
442936	70	61	*c.* 200	0.15	*Pinus* sp.
442937	64	105	*c.* 320	0.21	*Thuja* sp.
442938	50	115	42	1.10	*Picea* sp.
442939	56	80	40	0.45	*Larix* sp.
442940	34	60	*c.* 100	0.28	*?Larix* sp.
442941	42	48	*c.* 150	0.14	Gymnospermae
442942	50	68	150	0.25	-
442943	34	33	*c.* 240	0.09	*Pinus* sp.
442944	35	-	-	-	*?Larix* sp.
442945	33	59	130	0.23	*Larix* sp.
442946	50	30	220	0.08	*Thuja* sp.
442947	48	55	146	0.17	*Larix* sp.
442948	51	30	?	0.10	*Pinus* sp.
442949	18	32	80	0.18	*Larix* sp.
442950	53	65	152	0.22	*Larix* sp.
442951	33	13	-	-	?
442952	stub	-	-	-	*Pinus* sp.

* Measured midway between root and top where present.
† Often measured along only part of the cross section.

Results

The specimens are small; the longest piece measured 98 cm in length, and the thickest stem measured 115 mm in diameter (Table 1). The diameter of the longest stems with some roots still attached decreases rapidly from base to top, a conical growth form that characterises tree trunks near the tree line. Stems are distinguished from branches by the morphology of the samples and from the distribution of compression wood. The specimens are strongly abraded, and no bark or branches are preserved. The structure of the wood is well preserved, but the wood is slightly carbonised. Fly holes, presumably from cerabycid beetles, are present in some of the pieces, and borings of bark beetles are also observed.

The growth rings are extremely narrow, and many growth rings are only a few cell layers thick. The mean ring width ranges from 0.08 to 1.10 mm (Table 1), which shows that radial growth was extremely slow. It is suggested that the plants were growing at or near the tree line, mostly under pronounced thermal stress during the summer, and probably at the lower limit of tree growth. The widths of the individual growth rings are highly variable, suggesting great variability in summer temperatures during the period of time of the formation of the wood. Another common phenomenon among the samples is the presence of asymmetrical growth rings formed as a result of tilting, indicating growth on unstable soils.

All samples represent conifers; 10 were identified as *Larix* sp., four as *Pinus* sp., two as *Thuja* sp. and one as *Picae* sp. (Table 1).

Comparisons

Information that can provide a basis for comparison with the wood from Washington Land is available from a few sites in North Greenland and northern Canada. Of the tree trunks from the Kap København Formation, only a few measured more than 10 cm in diameter, and the largest sample had a diameter of 18 cm. The two longest trunks were respectively 460 and 335 cm long. The

growth rings were extremely narrow, although rather variable; mean ring width was 0.20 to 0.78 mm. Of 119 wood samples identified, 76 were *Larix* sp., 22 *Picea* sp., and a few *Thuja* sp., *Taxus* sp., *Betula* sp. and *Salix* sp. (Bennike 1990). The lack of pines in the Kap København Formation distinguishes that flora from most Late Cenozoic floras from northern Canada.

In Canada, a few of the tree trunks from the Beaufort Formation on Meighen Island (Mid or Late Pliocene) exceed 18 cm in diameter. On Banks Island logs up to 60 cm in diameter are found (Late Miocene and Pliocene), and on Prince Patrick Island some logs exceed 40 cm in diameter (Mid Pliocene). From the Worth Point Formation on Banks Island trunks of *Larix* up to 26 cm in diameter have been reported. *Laric laricina* is the only conifer reported from the Worth Point Formation; this sequence is considered to be around 1.5 Ma old (Matthews & Ovenden 1990).

The floristic composition and the size of the wood fragments from Washington Land bear strongest resemblance to that of the Beaufort Formation on Meighen Island and the high-level alluvium on Ellesmere Island, for which a Mid or Late Pliocene age is suggested, perhaps around 3 Ma.

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Author's address:
Geological Survey of Denmark and Greenland, Thoravej 8, DK-2400 Copenhagen NV, Denmark.