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THE FOREST EDGE AT NORTON BAY, ALASKA

J. L. Giddings, Jr.

Air passengers en route from Fairbanks to Nome are sometimes surprised to find, after leaving the broad, timbered valley of the Yukon River and passing over the bare and rugged Ingalik Range, that forests of spruce cover the slopes and shorelines of a part of the north Bering Sea. These forests, distributed approximately as shown by the stippled areas of Figure 1,[1] represent the westernmost coniferous trees in America, and thus are of interest as an extreme timberline reaching towards arctic cold.

The collection of increment cores that afford the body of measures reported herewith is derived from the spruces growing on a 15° east-facing slope about 100 feet above sea level on Cape Darby. This collection (designated DA in Figures 1 and 2) was made during early July of 1950, while the author was carrying on an archaeological reconnaissance of the Norton Sound region.* Trees selected for boring were those that appeared to be the oldest individuals bordering an old sled trail. No determined effort was made to find the oldest trees in the area nor to estimate the forest in terms of permanence. Our intent was to obtain a sample of the forest for crossdating and climatic reference to other timberline collections in the Arctic area.

As might have been anticipated from collections made in other western Alaska timberline areas, the trees thus selected proved to range in age between 150 and 400 years. As the author has previously pointed out for the Mackenzie River delta,[2] the presence of unusually old trees at these forest edges seems to be somehow related to a minimum of "age curve"—the predictable decrease in ring size with age so often seen in far-inland, river-bottom trees — and to signify in no appreciable way a limit to the length of time that forests have characterized the area, since factors such as center rot, brush fires, and other hazards to tree growth are constantly at work.

Although age curve is prominent in none of the nine measured samples, all but one curve of original measures have been standardized, in per cent of growth departure from an estimated mean line, for convenience of presentation. Specimens DA 2-9 are shown in Figure 2 in standardized curves as representing the degree of agreement to be expected between individual trees of various ages in the same timber stand. These eight trees are averaged as standardized measures (Table II) and shown at double weight as the mean curve DA.

*The Bering Strait Expedition, of which this was a part, was financed by the Wenner-Gren Foundation for Anthropological Research, the University of Alaska, the University of Pennsylvania, and the Danish National Museum. These studies were aided by a contract between the Office of Naval Research, Department of the Navy, and the University of Pennsylvania (NR 160-903).

[1]After P. S. Smith and H. M. Eakin, A Geologic Reconnaissance in Southeastern Seward Peninsula and the Norton Bay—Nulato Region, *U.S. Geol. Surv. Bull.* 449, 1911, Pl. 4, opp. p. 32.

[2]Mackenzie River Delta Chronology, *Tree-Ring Bull.* 13: 26-29, 1947.

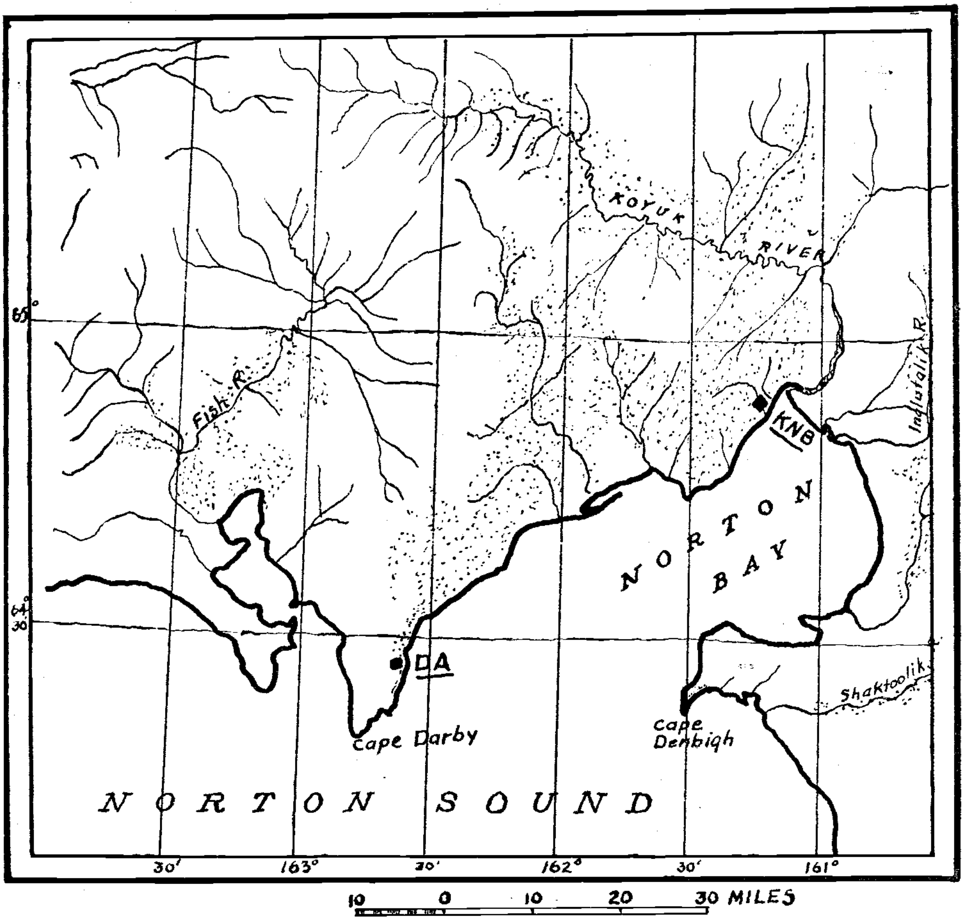

Fig. 1. Map of the Norton Bay region of western Alaska, showing distribution of spruce forest (stippled) and collecting stations.

Contrasted with the DA mean curve is a curve (KNB) of an unstandardized average of the actual measures (slightly weighted) of 25 trees from a collecting point at the shore of Norton Bay, 50 miles east of Cape Darby, near the village of Koyuk (Figure 1).[3] The close agreement between these two mean curves reveals two sorts of information. First, the factors that control annual variation in ring-widths are nearly identical between one end and the other of Norton Bay. These factors are presumably climatic. Secondly, long-range trends in tree-growth are essentially the same in the two areas, even though one series of data has been subjected to artificial treatment (standardizing) while the other probably includes some cumulative age curve from the individual trees incorporated in its average.

The oldest tree in the DA series (DA-1, Table I) is presented as a direct average of two opposed radii because its long life span includes several long-term maxima and minima that may be climatic in the main and thus subject to partial concealment through standardizing. One notes that its last 140 years of growth remarkably duplicate in trend the KNB mean.

[3]The measures are recorded in Dendrochronology in Northern Alaska, *Univ. Arizona Bull.* 12(4); *Univ. Alaska Pub.* 4, 1941, p. 93.

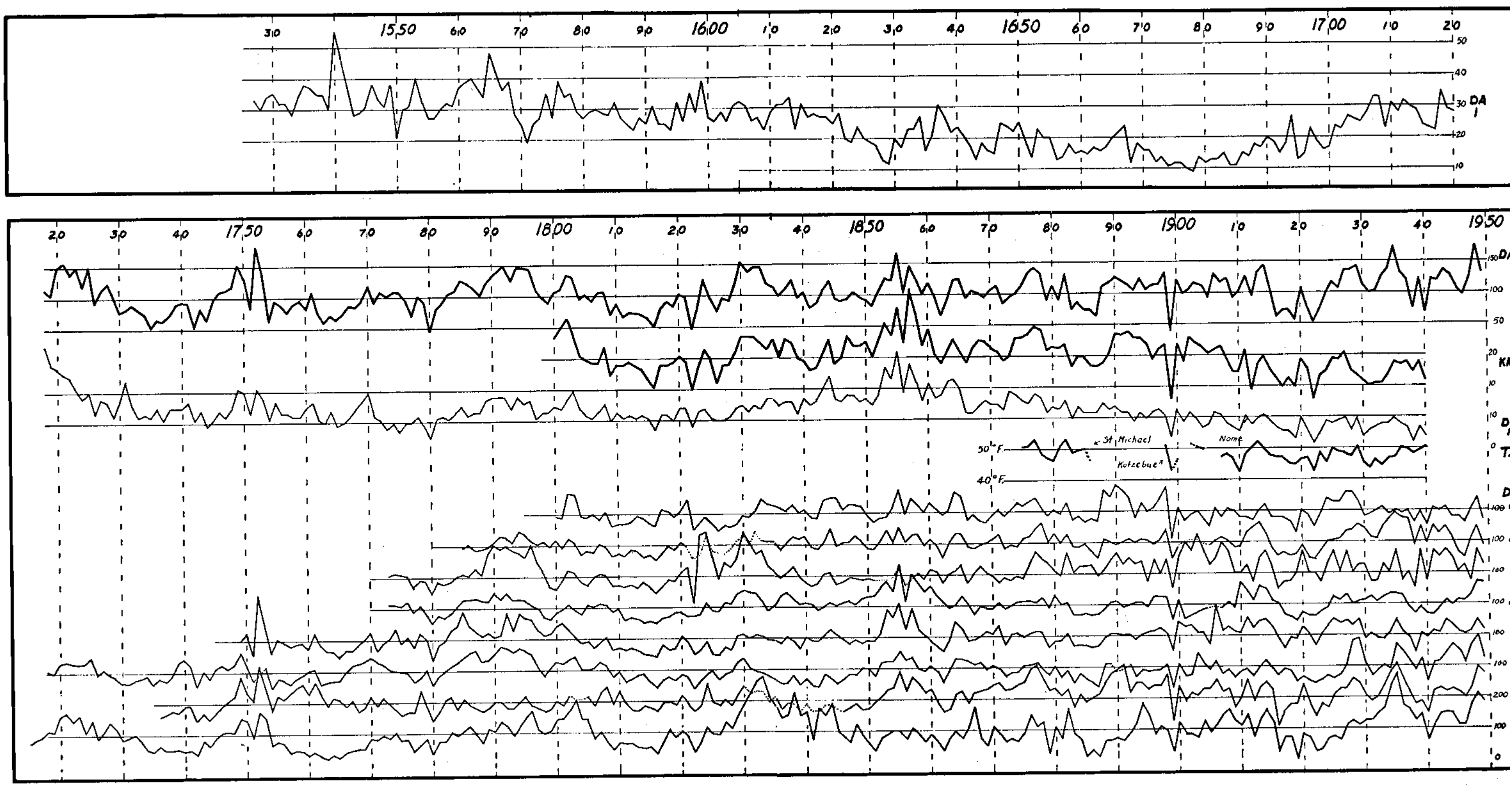

Fig. 2. Curves of individual tree-ring measures (lightly inked) from Cape Darby, group means of Cape Darby and Koyuk tree growth, and a curve of mean June-July temperature from neighboring weather stations. KNB in 100ths millimeter; DA-1 in approx. 90th mm., a convenient unit during measurement; others in departures from a mean line (100).

As to the climatic meaning of these Norton Bay records, we have previously shown that an average of KNB and Noatak River trees, spaced 200 miles apart, and a mean of June-July temperature for twelve stations spaced along the Yukon River as far east as the Canadian border, agree closely in year-to-year variation.[4] Attempts to localize the growth of trees of one stand to the climatic records of a single nearby weather station have met with less striking success although the correlation of tree-growth at tree-line with June-July, or July, temperature is always strong. In the present instance it is found that available June-July mean temperature figures for the nearest stations are of interest even though they do not represent averages over a wide area. The temperature curve (T) in Figure 2 is broken because of the erratic recording of weather in the coastal region. The mean June-July temperatures for the years 1875-85 are drawn from St. Michael, 110 miles south of Cape Darby; those for years between 1898-

[4]Some Climatic Aspects of Tree Growth in Alaska, *Tree-Ring Bull.* 9:26-32, 1943.

Table I. Ring-widths of a standing dead tree, DA-1, on Cape Darby; mean of two opposite radii. Unit .01 mm.

A.D.	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1520								37	33	38
1530	39	36	36	31	38	42	41	39	39	33
1540	61	52	42	31	32	34	42	37	34	42
1550	23	33	34	44	36	30	30	33	36	34
1560	41	43	44	41	38	53	47	40	43	31
1570	28	21	28	30	39	30	43	38	39	32
1580	30	32	33	32	31	36	30	28	26	30
1590	28	34	28	28	26	36	29	39	32	43
1600	30	29	32	29	34	36	34	29	30	26
1610	32	34	34	37	26	34	30	31	30	30
1620	28	31	22	21	27	22	21	20	14	13
1630	22	19	26	26	30	18	23	34	30	24
1640	27	23	20	14	21	18	17	28	27	24
1650	28	21	16	26	22	22	14	16	20	17
1660	18	17	19	18	19	22	24	27	13	20
1670	18	18	13	16	12	13	13	11	10	16
1680	13	14	14	17	12	12	17	16	20	19
1690	22	21	17	20	30	14	17	26	21	18
1700	19	27	26	30	29	28	31	37	37	26
1710	34	31	36	33	32	27	26	24	39	32
1720	31	29	28	23	20	22	14	20	19	13
1730	19	27	18	13	14	13	17	12	17	17
1740	17	19	12	16	10	12	16	13	17	23
1750	22	14	23	20	12	19	14	14	13	13
1760	17	19	12	11	16	10	11	13	17	19
1770	22	13	12	09	11	08	11	11	13	10
1780	06	12	13	12	14	17	13	14	14	19
1790	20	20	20	16	20	18	19	12	14	14
1800	17	16	19	22	16	13	12	14	18	11
1810	14	12	13	12	13	12	08	13	13	11
1820	16	16	09	14	16	12	11	11	12	16
1830	17	14	17	16	19	19	17	18	18	13
1840	19	17	18	22	27	19	18	20	20	18
1850	19	17	20	30	26	36	21	31	24	18
1860	24	19	20	24	26	22	13	13	16	18
1870	17	17	14	21	20	18	17	20	19	13
1880	16	14	18	11	16	13	13	13	17	14
1890	16	13	13	10	13	11	13	14	12	04
1900	14	10	13	11	08	09	13	12	09	08
1910	07	12	09	11	12	10	08	07	07	03
1920	11	07	02	06	10	09	10	11	07	11
1930	04	07	08	09	09	11	09	08	02	08
1940	04									

Table II. Tree-ring indices for spruce at Cape Darby, Alaska: ring-widths in per cent of the growth trend.

A.D.	0	1	2	3	4	5	6	7	8	9
1710									113	107
1720	151	159	139	150	120	151	93	114	122	104
1730	79	82	90	82	76	55	69	65	75	90
1740	94	92	54	86	66	94	109	112	119	153
1750	132	83	185	140	64	96	90	79	91	97
1760	84	112	76	61	73	67	76	89	87	96
1770	120	92	110	103	110	110	98	72	103	94
1780	46	80	90	107	110	128	122	118	101	122
1790	134	142	150	127	148	148	147	112	99	91
1800	109	111	137	132	98	104	92	108	109	71
1810	89	69	74	72	72	67	51	81	91	82
1820	104	100	49	80	129	94	75	99	94	122
1830	153	139	146	146	120	115	100	110	125	97
1840	106	80	89	109	125	95	91	94	105	98
1850	92	84	106	128	123	167	104	146	126	101
1860	120	98	69	90	125	126	95	106	102	96
1870	108	112	87	97	103	111	134	141	132	90
1880	114	92	131	77	89	76	76	65	113	120
1890	128	121	117	107	127	107	115	117	136	40
1900	123	100	108	118	114	93	131	119	126	94
1910	104	130	95	134	147	111	61	72	75	58
1920	108	77	54	75	98	117	107	136	138	141
1930	112	100	103	127	139	176	133	121	74	124
1940	69	121	120	138	129	108	97	124	174	133

1904 are from Kotzebue, 160 miles to the north; and the remainder are from Nome, 80 miles to the west. It seems probable from these indications that if a long series of weather records were available from a single station near which trees grow under timberline conditions a much closer correlation could be obtained.

In summary, the forests bordering Norton Bay appear to be controlled in their growth largely by the stress of temperature of the growing season and to offer a laboratory for the refinement of data towards a better understanding of climatic change and forest stability throughout several centuries.

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THE ORIGIN OF DRIFTWOOD AT HOOPER BAY, ALASKA

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The purpose of this study is to determine the origin of spruce logs which have drifted ashore along a three-mile section of the Bering Sea coast opposite Hooper Bay Village (ca. 61°30′N.) and adjacent to Hooper Bay.* By crossdating driftwood with living trees it is possible to isolate the origin of spruce trees that have been undercut by a river and drifted hundreds or thousands of miles from their source, finally to be deposited upon a beach.

*As an Arctic Institute Grantee, the author carried out this study in conjunction with an archaeological survey of the Hooper Bay area, sponsored by the Arctic Institute of North America with funds from the United States Government and supported also by the Bering Strait Expedition with funds from the Univ. of Alaska, the Danish National Museum, the Univ. of Pennsylvania, and the Wenner-Gren Foundation.

The writer wishes to express his gratitude to Mr. and Mrs. Olin Pruitt, ANS teachers at Hooper Bay, Alaska, for their fine cooperation during the field season at Hooper Bay. The writer also wishes to express his thanks to Dr. J. L. Giddings, Jr., for his advice and criticism of this paper.

The first work done in northern Alaska on the origin of driftwood was by Giddings[1]; although his primary interest was cross-dating the various driftwood structures along the Bering Sea coast and the Arctic Ocean, he noted at the same time that the source of some driftwood can be determined. For example, many of the logs used in constructing the Point Hope reindeer corral contained what have been termed "Series A Dating" records; others were "Series B Dating".[2] Distribution of the former ring sequence is widespread in timberline trees of northern Alaska; the Series B ring record is restricted to the Yukon flats region. Thus, a Series B log now at Point Hope must have drifted down the Yukon River, into the Bering Sea and then north through Bering Strait into the Arctic Ocean.

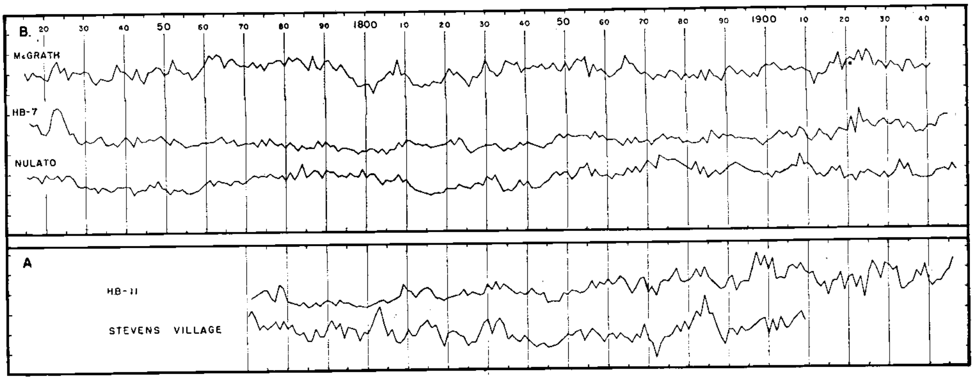
The Hooper Bay driftwood study was begun in the summer of 1950, at which time thirty samples were selected from among hundreds of logs lining the beach. The presence of compression wood, complacent ring records, or too few rings made it necessary to eliminate nine borings from the series. The remaining twenty-one samples were skeleton-plotted and then compared with Giddings' Series A driftwood master plot and the Series B master plot.[3] Fourteen dated as follows:

Hooper Bay Driftwood Number	Number of Rings	End Date	1783 Faint Latewood
1	207	1933	X
3	186	1948	X
5	141	1945	
7	231	1945	X
8	188	1943	X
9	247	1947	X
10	191	1937	X
11	176	1947	
12	209	1945	X
15	141	1901	X
16	159	1940	X
18	202	1947	
20	191	1939	X
21	132	1949	

All of the dated borings were Series A, with the exception of HB-11, which was Series B. In most cases the end dates listed above do not represent the outermost ring that the tree had put on, since all of the sampled logs had been stripped of their bark and most of them gave evidence of having the outer few rings weathered or worn away. Ten out of a possible twelve trees have the distinctive 1783 "faint latewood".[4]

After these samples were dated each was measured in hundreds of a millimeter and the results plotted. These plots were compared with published measured groups from the Noatak, Squirrel, Koyuk, and Shaktoolik Rivers, as well as with groups of trees from eight different Yukon River stations extending from Fort Yukon to Marshall[5] and with Giddings' unpublished group from McGrath on the Upper Kuskokwim River. The samples that compared favorably with a particular group are shown in the Figure. In panel A, HB-11 is compared with a mean of five trees from Stevens Village. The former is not extremely sensitive during its first forty years of growth and the Stevens Village series ends in 1909, which limits the number

[1]J. L. Giddings, Jr., *Univ. of Ariz. Bull.* 12: *Univ of Alaska Publ.* 4, 1941, pp. 40-48, pp.79-83, Table 2.
[2]*Ibid.*, pp. 62-63. Also, *Tree-Ring Bull.* 9:26-32, 1943.
[3]Giddings, 1941, Figs. 13-19.
[4]*Ibid.*, p. 72. W. Oswalt, *Tree-Ring Bull.* vol. 16, 1950, p. 27.
[5]Giddings, 1941, pp. 92-105. Oswalt, *Tree-Ring Bull.* 16:26-30, 1950.



of comparable rings. Nevertheless, there is good agreement between the hundred comparable rings. It is probable that this tree grew somewhere in the Stevens Village area rather than right at the sampling station; this could account for the slight differences between the ring records. In panel B, HB-7 is compared with a mean of six trees from two different boring stations near Nulato and a mean of seven trees from McGrath. It will be noted that HB-7 is compared with groups from both the Yukon and Kuskokwim Rivers. This comparison is necessary since indications are that the sample is from the 55°-60°F A-dating zone, in which there is remarkable ring uniformity over long distances in a north-south direction.[6] Thus, HB-7 cross-dates best with Nulato and McGrath,[7] which are separated by 150 miles in a general north-south direction. However, it is the writer's opinion that this particular boring is more closely allied in trend with Nulato than McGrath. HB-7 and the Nulato group also illustrate the presence of periods during which ring formation shows little sensitivity, such as around the years 1756, 1815, and 1894.

The percentage of samples whose origin has been determined is small, since there are a number of factors which have restricted the scope of this study. The factors are: one, the need for living tree samples from interior Alaskan stations, mainly the Yukon tributaries and the Kuskokwim River, that contribute driftwood to the Bering Sea region; two, the limited number of samples in the Hooper Bay driftwood series; and three, the presence of many ring records that are easily dated but too complacent for tracing the tree's origin.

Of the fourteen dated driftwood samples, thirteen seem to have been derived from Alaskan rivers where Series A trees grew, and one came from the Series B region; two could be traced to the local area in which they grew. The analysis also showed that eleven of the fourteen end dates fell within the decade from 1939 to 1949.

When the origin of large quantities of driftwood has been established, such as was done for two of the Hooper Bay samples, this knowledge may aid in the study of northern ocean currents by giving an indication of the force, speed, and direction of the various currents.

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[6]Giddings, 1943.
[7]Oswalt, 1950, p. 28.