Reports and Letters

Attempted Dendrochronological Dating of Ice Island T-3

Ice islands floating in the Arctic Ocean have been studied for some years, particularly by scientists attached to the U.S. Air Force. Unlike the thin pack ice of marine origin that largely covers the northernmost seas, and with which they float freely around the New World side of the polar basin, these ice islands have upper layers that are composed of fresh-water ice. This is mainly iced firn (névé) formed *in situ* from snow, although glacier ice is sometimes included. The lower layers are contrastingly salt or brackish, being presumably accreted from below (*1*).

These islands are supposed to have originated as shelf ice on the northernmost coasts of the world, on Ellesmere Island or in some cases possibly Greenland; they evidently broke loose from such places to become free floating (*2*). The known arctic ice islands are up to nearly 20 miles in length, the largest, T-1, having an area of some 300 square miles; the smaller T-3, which has been lived on protractedly and investigated intensively, has proved to be approximately 31 miles in circumference and 165 feet in thickness (*3*).

Drifting as they do far north of any land, and indeed often into the very highest latitudes, these ice islands can be of importance as meteorological and general scientific stations and perhaps for other purposes. They can even afford extensive "landing grounds" for aircraft near the North Pole. In connection with these purposes, it is desirable to know the durability and degree of permanence of the ice islands. One of them appears to have broken away from the shelf ice during the past decade (*2*), but others may possibly have existed for centuries and certainly they may change scarcely at all in shape or thickness from year to year. Some of the component material of T-3 has been indicated by carbon-14 testing to be thousands of years old, whereas other material so tested appears to be relatively modern and may be quite recent (*1, 4*). The older datings may be in part the result of the blowing in of fossil carbon, but on the other hand much of the material appears to be too modern for proper dating by these means. In any case, the age of the component materials bears little or no relationship to the age of the ice island *as such*—that is, the time since it broke away from the shore or land-fast shelf ice and became a free-floating entity—nor, in view of the circumstances involved and the lack of differential, would this "operative" age seem determinable by any such physical means.

The main hope of dating T-3 as the studied example of these potentially important ice islands seems to lie in the plant materials that have been found upon or within its layers of névé (*5*). These materials include numerous pieces of wood of the arctic willow (*Salix arctica* s.l.) that grows more or less flat-pressed against the ground on the northernmost coasts of Ellesmere Island and Greenland. Such scraps of willow often exhibit clear but very variable growth rings and appear to have been washed down from the land when the ice island was attached to it as part of the shelf ice. A few of the pieces on T-3 exceeded 2 centimeters in diameter. They were always dead when collected and evidently had grown on land; clearly the ice on which they were found could therefore be assumed to have been attached to the land as long as any of these growth rings were being laid down. Similarly, the breakaway of the ice island had evidently taken place after the laying down of the last growth ring to be found in these specimens, for other possible sources of the willow material, such as washing on from the sea, had meanwhile been virtually ruled out (*5*).

Toward an attempt to determine the date of the most recent growth ring laid down among the material recovered from T-3, and consequently the earliest possible date of breakaway of the ice island as such, three basic studies were undertaken (*6*).

First, through material collected in northernmost Ellesmere Island in 1953 by G. Hattersley-Smith of the Defence Research Board of Canada, a study was made of the effect of different habitat conditions on the growth rings of willows living in the very Far North. The results proved to be so variable and any correlation so fickle that it became evident that the work would be intricate and that any result would probably be tentative. Thus there appeared to be extreme variation, not only with the immediate water conditions and exposure, but also with snowlie, permafrost melting, and probably also with air temperatures and various microhabitat factors that further complicated the situation by being almost all interdependent!

Second, in an attempt to obtain a satisfactory "base-line" for counting back, a large sample of willows was collected in 1954 by A. P. Crary of the Air Force Cambridge Research Center along a single fairly even slope on the southwestern side of Ward Hunt Island, in the region of northernmost Ellesmere from which T-3 may well have come. Even here, the growth, as indicated by growth-ring widths, tended to be too variable to afford a satisfactory statistical basis for counting back. Laborious weeks of comparison and measuring were occupied chiefly by projecting images of the stained sections of the willow stems onto a screen by means of a bioscope and measuring each ring on several widely spaced radii, these readings being averaged to give a figure for each ring. Yet when all the results from 10 specimens more than 25 years old were averaged, the deviation except in the initial years was too small for satisfactory use. One reason seems to have been the multiplicity of the afore-mentioned operative factors and another that some individuals evidently made little or no growth in particular years. This and the frequent discontinuity of some rings immediately threw attempted correlations off in a manner that may also occur in forested regions (*7*) and seemed to be an insurmountable obstacle to satisfactory counting in some of the material grown under the extremely rigorous conditions of the farthest northlands. Quite often a ring appeared to be represented by a partial "lens," and sometimes one would be broken by radial gaps that in some cases occupied practically the entire circumference. Occasionally only a very few adjacent cells of cambium appeared to have exhibited any activity—sometimes merely to the extent of producing one small vessel each—in any particular period; but whether this period represented a whole summer's growth, or less, could not be determined. Specialists' opinions differed, but with the extremely short maximum growing season thereabouts it is difficult to visualize more than a single ring or distinct partial ring being laid down in any one summer.

Third, museums and herbariums were searched for specimens of willow wood collected by the earliest expeditions to these highest latitudes of land. The only long-lived one that came to light was a gnarled and partly decayed piece of stem in the Museum of the Royal Botanic Gardens, Kew, from which I was kindly permitted by the keeper, F. N. Howes, to cut a scrap for sectioning. This was "from Highest Greenland" and appeared to exhibit some 130 growth rings. Having been collected by the British "Alert and Discovery" expedition of 1875–76, it thus dated back to well before the beginning of the 19th century. However, the rings were scarcely such as might be used for correlation with other specimens, for they were often small and irregular or even uncertain. Similarly unsatisfactory were the only two Ward Hunt Island specimens that showed any comparably large number of rings.

Whereas it seems clear from these considerations that, at least without much more basic knowledge than has yet been gained, the satisfactory dating of T-3 by dendrochronological means is scarcely to be accomplished, the following circumstances would appear to warrant some degree of confidence in a *tentative* dating that has been obtained.

It has long been recognized that for dating purposes with trees it is not so much the normal fluctuations in growth-ring width as the low extremes that are valuable. However, with the generally adverse conditions in the very Far North, low extremes may be represented by one or more summers of little or no growth; here it is rather the favorable summers that are unusual, and therefore a thick ring or series of rings is likely to be especially significant. Using these thick and usually complete rings as "markers," and ignoring occasional very thin and sectorially narrow lenses that might, or might not, represent a summer's growth, it was observed that some of the willows from Ward Hunt Island exhibited, for ecological or genetical reasons, what appeared to be similar reactions to climatic changes. Thus the thick markers were at least bordered by rings of comparable width in the different specimens or by rings showing a comparable amplitude of increase or decrease. This "principle of reaction similarity," as it was loosely termed, seemed to allow comparison between sections, particularly on the basis of the width of growth rings as found on the longest radius of a transverse section.

Ignoring first of all specimens that did not show more than 35 clear growth rings and, second, all that showed any substantial proportion of unclear rings, we were left with six stem specimens from Ward Hunt Island and five from T-3. Of the former, one alone exhibited more than 50 clear rings. This one showed good correlation with one of the T-3 stems, as is indicated in Fig. 1. Thus, except in the initial years of growth—which experience has shown should be ignored—the maxima either coincided or were paired with wide rings; the minima observed also tended to coincide. In making comparisons we should remember that it is these extremes that are most significant and that the Ward Hunt Island specimen in general exhibited better growth—possibly because of its southwest-facing habitat—than the T-3 specimen. The measurements involved were kindly checked by A. P. Stiernotte, while Haig P. Papazian reported that the coefficient of correlation r for these two sets of figures is

$$r = 0.75$$

which for 36 degrees of freedom is significant at less than the 0.001 level, and therefore would be expected to occur by chance far less frequently than once in 1000 times. This is a much higher degree of significance than is usually accepted for biological data, although it should be recalled that it does not take into account the fact that choice was exercised on the five T-3 specimens. However, the other four specimens may well have grown in earlier times (*1, 4*) and for that reason alone have had virtually no chance of correlation.

As is indicated in Fig. 1, these observations strongly suggest that this piece of willow was still growing on land during the summer of 1935, and, accordingly, that the ice island broke away subsequently. Because it was observed free from land early in 1947, it would seem that T-3 became an island at some time between these two dates.

This attempted dating must be emphasized as being only tentative and, moreover, based on a shorter span of time than is usually required (*8*). However, it is interesting to note that the middle 1930's are said to have been the period of maximum marine warming in these regions and that the only living macroscopic plant found on T-3 was a wide tussock of the moss *Hygrohypnum*

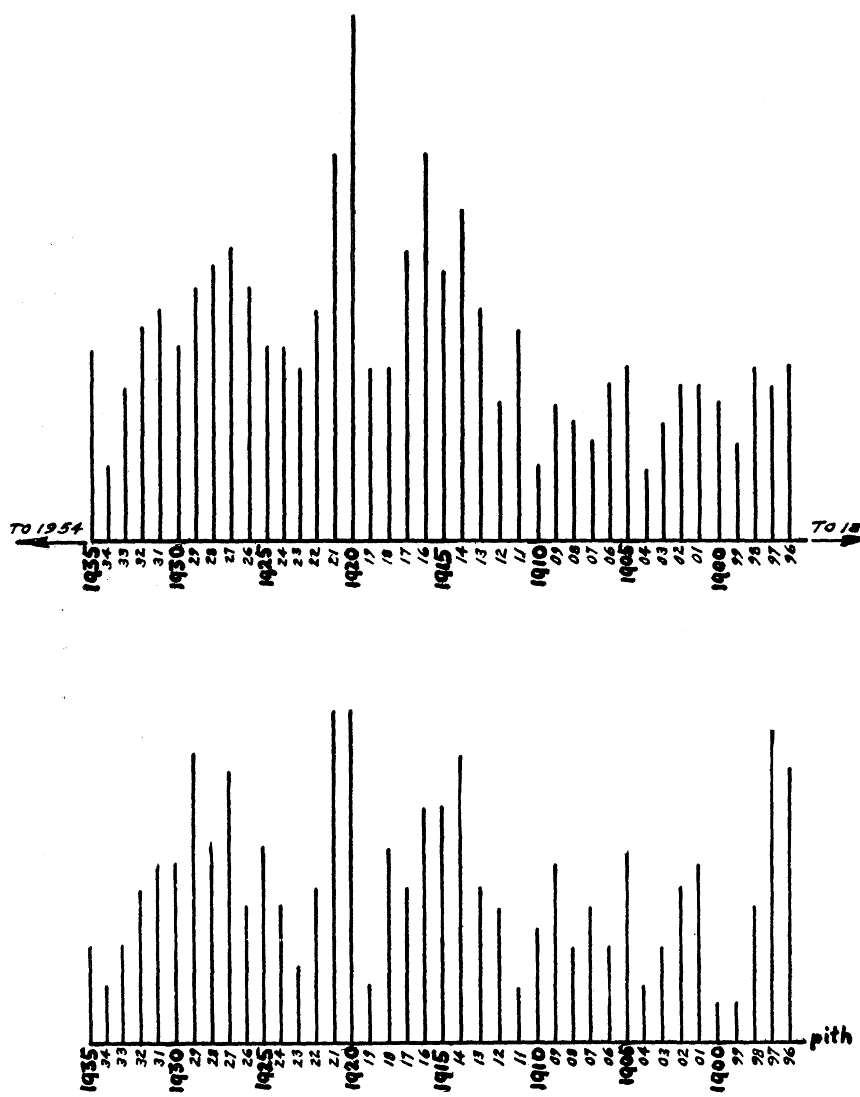

Fig. 1. Top, Ward Hunt Island willow stem; bottom, T-3 willow stem. The vertical lines represent growth-ring widths, obtained as explained in the text.

polare, which is presumed to have grown on the land (*9*). If it had been washed or blown onto T-3 in 1935, it would have lived 19 years to the time when a piece of it was revived in the laboratory (early in 1954; the next year the remainder could not be revived). This is precisely the longest period of which a record could be found of a moss tussock remaining viable in a herbarium (*10*).

NICHOLAS POLUNIN*
Osborn Botanical Laboratory, Yale University, New Haven, Connecticut

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* Present address: Harvard University Herbarium, Cambridge, Mass.

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Electrophoretic Separation of Hemoglobins from the Chicken

Investigations of the dissociation of oxyhemoglobin in birds (*1, 2*) have led to the suggestion that there are two hemoglobins, one embryonic and one adult. Such differences exist in various mammalian species; these have been summarized by Lecks and Wolman (*3*). Recently, electrophoretic methods have been successfully used in separating mammalian hemoglobins (*4*). It appeared that the nature of avian hemoglobins could profitably be examined by a similar technique (*5*).

Hemoglobin was obtained from embryos and adults of White-Olympian-New Hampshire cross chickens. Blood samples were drawn from the vitelline artery, the heart, or from the radial veins, depending on the age of the chicken. Embryonic bloods from several individuals in a single age group were pooled to form a single sample for analysis. Heparin was employed as the anticoagulant. The cells were separated from the plasma by centrifugation and washed three times with 0.85-percent sodium chloride. The hemoglobin solution for analysis was prepared by adding 2 vol of distilled water to 1 vol of packed erythrocytes. The supernatant fluid, after centrifuging, was stored at $-10°C$, then thawed at room temperature for use. Electrophoretic patterns were obtained by applying 5 μl of this hemoglobin solution to the filter paper strips (S. and S. No. 204-313, 20 mm wide) in a thin line. A controlled voltage (300 v) was applied to the strips for 6 hours; the current increased from 6 to 12 ma. The strips were moistened with Veronal buffer (*p*H 8.8, ionic strength 0.05) prior to application of the sample. Boundary diagrams were prepared by direct readings of paper strips in a spectrophotometer (*6*). The results are plotted in Fig. 1.

The samples tested were from embryos (13, 15, 18, and 20 days), hatched chicks (up to 6 hours and 1, 2, 4, 6, 8, 11, and 18 days), and 6-month-old and 2-year-old chickens.

Two hemoglobins were observed in each age group tested. No marked differences were apparent among specimens. The faster moving component, designated as α-hemoglobin, appeared to be in lower concentration. The slower moving component was β-hemoglobin. Migration was toward the anode; the rate of migration was uniform in all samples (Fig. 1). Percentage composition of the hemoglobins, as determined by planimetry of boundary diagrams, appeared to vary with age. There was an approximate 30-percent reduction of the α component in the 2-year-old chicken as compared with the 18-day embryo—that is, 30 percent α and 70 percent β in the embryo, and 20 percent α and 80 percent β in the adult. Determinations on a limited number of samples indicated that the major portion of the change occurred within a few days after hatching.

As early as the 13th day of incubation, two hemoglobins are present. If one were essentially an embryonic hemoglobin and the other an adult hemoglobin (*1*), the replacement of the former by the latter would be expected. It appears that no such major replacement occurs. The average life-span of an avian erythrocyte has been reported to be approximately 32 days (*7*); yet the hemoglobin of both 6-month and 2-year chickens exhibits α and β components in relatively the same proportions as is found in young (18-day) chickens. A logical explanation of hemoglobin types is readily available in mammals; however, in birds, where no placental transfer of oxygen occurs, this explanation does not directly apply.

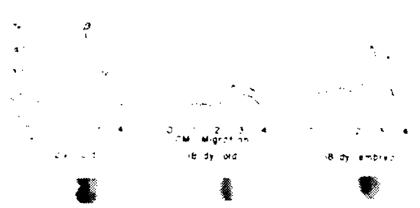

Fig. 1. Electrophoretic analysis of chicken hemoglobin.

VERNER L. JOHNSON
JACK S. DUNLAP
Department of Veterinary Physiology and Pharmacology and *Department of Veterinary Pathology, State College of Washington, Pullman*

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Production of Fungistatic Substances by Plant Tissue after Inoculation

Among the various attempts to learn how plants are able to resist invasion by pathogens, the most successful is the work of Link *et al.* (*1–3*), Angell, Walker, and Link (*4*), and Walker and Link (*5*), who showed that protocatechuic acid and catechol in the outer scales of colored onions were responsible for resistance to smudge and neck rot. Other instances of specific resistance owing to the presence of biochemical entities have been suggested but not proved. Johnson and Schaal (*6*) suggest that chlorogenic acid in the potato peel participates in resistance to scab. Müller and Behr (*7*) point out that tanninlike substances in the potato may be associated with resistance to late blight. The possibility that a pathogen-inhibiting substance might be produced by plant tissue in response to the presence of a pathogen has been conceived by some workers in the field. However, experimental proof has been lacking heretofore.

Helminthosporium carbonum race I, the incitant of a leaf-spot disease of corn, has an exceedingly narrow host range (*8*).