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Near or in the lower forest border, growth factors may be said to fluctuate in degree and in time. Figure 4 is an attempt to show this graphically. Fluctuations in degree would give thick and thin growth layers whereas fluctuations in time would yield multiple growth layers during a year. If this is essentially true, how can a thin growth layer due to variation in degree (annual) be distinguished from one due to variation in time (intra-annual)? Such distinction would appear to be impossible if the intensity of the growth rhythm sharply delimits the individual growth layers.

It happens that crossdating is at its best near and at the lower forest border in the Southwest; it is at its best well within the zone of probable multiplicity, multiplicity impossible to detect by sight alone. An estimate, therefore, of the amount of multiplicity present in the region where much dating has been done may be ventured at this time. This comes out to be a maximum of 15 and an average of about 5 per cent. This takes into account not only the work done in the extreme lower forest border but also allows for genetic differences.

Tree-ring dating, whether or not it is entirely accurate, has given a great impetus to the study of tree growth under different habitat conditions. We are learning something about how and when a tree grows.

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# POLLEN EVIDENCE

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Anyone who suffers from hay fever or pollen allergy will appreciate that there are a number of plants that release, annually, large quantities of buoyant pollen into the atmosphere. While it may not be immediately obvious, the existence of wind-pollinated plants is very much at the basis of researches on pollen concerned with the history and prehistory of vegetation and with relative dating. As a matter of fact, conspicuous elements in North temperate vegetation (e.g. many kinds of trees) are wind-pollinated and have in various ways been related to prevailing types of climate and soil. In a broad sense, some of these elements have been considered to be indicators of successional phenomena relative to generalized types of climate and soil. Such plants contribute to a seasonal precipitation or rain of pollen over the years. If some receptive reservoir could receive, preserve and retain this vegetable evidence, we would have recorded the history of the prominent characteristics of the vegetation of the region. As has been already suggested by Dr. Wright, such documentation of past to present-day vegetation actually does take place. Airborne pollen eventually descends to earth in greatest quantity close to its source—the pollen-producing plants. The most desirably-receptive surfaces are lakes and wet bogs. Here the pollen grains are retained over the years and often to a remarkable degree preserved in stratified sediments, particularly if anaerobic or poorly oxygenated and acidic conditions prevail. In the case of lakes, the rain of pollen eventually descends to the bottom of the lake where it becomes a component of the gradually developing stratified ooze or sediment. It is either in such lake sediments or in peat and similar materials that pollen grains are remarkably well-preserved and often in surprising quantity. One should note that critical researches of the last decade indicate that lakes, rather than bogs, are to be preferred as likely sources for obtaining the most complete sampling of the total pollen record or stratigraphy (see Faegri and Iversen, 1950; Deevey, 1951; Potzger, 1953a; and Andersen, 1954). Since pollen analysis contributes to dating procedure by recording changes, with time, in the composition of the flora it will follow that incomplete vertical sections of the stratified sediments to be analyzed will yield truncated and insufficient records of the vegetational history (*cf.* Wilson and Potzger, 1943).

It now becomes important to establish the fact that pollen grains of many different kinds of plants have sufficiently differing shapes so that they can be identified as to kind under the microscope. Thus if a microscope slide were prepared from a mixture of pollen taken from elm, oak, and maple, one could easily separately identify and count the pollen grains of the three kinds of trees (*cf.* Erdtman, 1943 and 1952; Faegri and Iversen, 1950; Iversen, 1954; Godwin, 1934; Sears, 1930; Wodehouse, 1935; Cranwell, 1953; *et al.*). It follows then that lake sediments, peat deposits, etc. can be analyzed both qualitatively and quantitatively for much of their pollen content, the pollen in successive layers being considered an important recorder of relative, historical and prehistorical time particularly as it is related to the more or less average character of the vegetation of the region sampled.

The careful analysis of the pollen content of the component layers of lake or bog sediments thus yields data on vegetational history which can be considered in terms of relative time. This is particularly true when pollen analysis is correlated with observations, which also represent the course of phenomena in relation to time, in the fields of geology, climatology, and archeology.

The field of pollen analysis as it involves the study of stratified deposits and its correlation with geological chronology is largely of northern European and British origin. Helpful accounts of many of the earlier European investigations will be found in Godwin (1934 and 1940), Erdtman (1943), Faegri and Iversen (1950), Hansen (1947), *et al.* For many years, Erdtman (1954) has published, annually, a very useful world-wide list of literature on palynology (pollen and spore science). The first formal study on pollen analysis was presented in 1916 by Lennart von Post of the University of Stockholm (Faegri and Iversen, 1950). About 30 years later he presented one of the most provocative essays that we have on the subject (von Post, 1946).

Many of these investigations apply to various postglacial deposits. There have been many postulations concerning the successive periods of late-glacial and postglacial time (see *e.g.* Godwin, 1934; Hansen, 1947; Andersen, 1954, *et al.*). Von Post postulated a division of postglacial time into, successively:

(a) period of increasing warmth
(b) period of maximum warmth
(c) period of decreasing warmth.

Thus, the pollen analysis of a *complete* section in a particular region, *e.g.* central Sweden, would provide evidence for a tundra (grass-sedge-Dryas) community or period at its deepest (earliest) levels (late-glacial) followed, successively, by a birch-pine complex (a), a mixed oak community (b), and finally a spruce period (c). The last three communities correspond respectively to von Post's three divisions of postglacial time.

Von Post (1946) also introduced the interesting "Revertence" hypothesis. "Revertence" refers to the fact that the same (or similar) vegetational elements that characterized the oldest phases, but receded during the middle stages, recur as characteristic types during stages in direction of the present time. The sensitivity of plants as indicators of the past is very much involved in such hypothesis (*cf.* Conway, 1948 and 1954). Godwin (1940), Erdtman (1943), *et al.* have contributed studies which give further illustration of a revertence pattern during postglacial time.

Deevey (1951) has made a highly important contribution in his *complete* sectioning of pollen-bearing lake sediments in Maine. This study includes the first North American documentation of late-glacial time (the closing phases of the Ice period). Deevey's analysis indicates that the late-glacial horizon represented a tundra climate characterized by a non-arboreal vegetation dominated by grasses and sedges and in various ways bears a striking resemblance to European sections.

The geochronological method of de Geer (based upon detailed analysis of complete sections of varved clays from carefully selected locations in postglacial lakes) (1951) and archaeological studies (such as those in the Federsee region of south Germany) have been correlated with pollen data to provide relative dating. Now, with the recent introduction of radiocarbon dating we have the unique advantage of essentially absolute dating within the limits of method as will receive attention by another contributor to this Symposium.

An important example of the correlative character of researches in this field is the recent, significant dating, using $C^{14}$ methods, of the Allerod late-glacial period, a period of relative time, supported by pollen analyses of sediments obtained in Allerod, Denmark (see Iversen, 1953 and 1954; Anderson, Levi and Tauber, 1953; and Krog, 1954). Pollen analyses have indicated that the Allerod period supported various temperate species of trees (Betula and Populus) whereas the two periods immediately, and abruptly, preceding and succeeding it are characterized by species suggestive of tundra conditions. Pollen of the same or similar types having this distinctive stratigraphic association has been reported from other widely separted localities (*cf.* Iversen, 1953; Deevey, 1951). Since data on pollen have suggested the essential contemporaneousness of the collections from different localities it is of greatest interest that the radiocarbon method has provided the confirmation for the earlier conclusions on the relative dating of Allerod period.

In all too briefly summarizing some of the contributions of pollen analysis (palynology) to dating the past, the writer has felt that a selection of relevant publications (*cf.* "Literature Cited") from the very large literature would be of possible use to the interested reader. Perhaps it will be evident that some of the problems for the future include far more extensive critical analyses of North American sediments (*cf.* Potzger, 1953a and 1953b). There is, for example, the possibility of the presence in some strata of the vertical section being sampled of secondarily deposited or rebedded sediments that will obscure the true trends of vegetational history. Andersen (1954) in his detailed studies of Michigan sediments gives impressive demonstration of the difficulties that can be expected from rebedded pollen in levels of expected late-glacial character. Also desirable are improvements in technical procedures for extracting the maximum number of pollen and spore types from the samples. There is need, too, for atmospheric studies carried on concurrently with sedimental analysis in the same sampling area (*cf.* Hansen, 1949). Thereby a greater insight into relationships between pollen data and the composition of the vegetational community can be obtained. The atmospheric pollen records gathered continuously for the past two decades in Minneapolis would alone suggest for this region a vegetation whose most abundant trees included oak, elm, and Populus with ragweeds (Ambrosia) and grasses as the most prominent non-arboreal elements. Such observations in addition give information concerning the possible seasonal variation in the amount of pollen produced by individual species.

These are some of the many technical factors which must be kept under careful control in any critical analyses of the pollen and spore content of sediments in research projects in which data that will be of aid in dating the past are sought.

## LITERATURE CITED

ANDERSEN, S. T. 1954. A late-glacial pollen diagram from southern Michigan, U.S.A. Denmarks Geol. Unders. (Geol. Survey Denmark) II. No. 80:140-155.

ANDERSON, E. C., H. LEVI, AND H. TAUBER. 1953. Copenhagen natural radiocarbon measurements, I. Science 118:6-9.

CONWAY, V. M. 1948. Von Post's work on climatic rhythms. New Phyt. 47:220-237.

CONWAY, V. M. 1954. Stratigraphy and pollen analysis of southern Pennine blanket peats. Jour. Ecol. 42:117-147.

CRANWELL, L. M. 1953. New Zealand pollen studies. The Monocotyledons. Bull. Auckland Inst. & Museum. No. 3. Harvard Univ. Press.

DEEVEY, E. S., JR. 1951. Late-glacial and postglacial pollen diagrams from Maine. Amer. Jour. Sci. 249:177-207.

DE GEER, E. H. 1951. Conclusions from $C^{14}$ and De Geer's chronology. Geol. Foren. Forhandl. 73:519-570.

ERDTMAN, G. 1943. An introduction to pollen analysis. Chronica Botanica Co. Waltham, Mass.

ERDTMAN, G. 1952. Pollen morphology and plant taxonomy. Almqvist & Wiksell. Stockholm, Sweden.

ERDTMAN, G. 1954. Literature on Palynology. XVII. Geol. Foren. Stockh. Forh. 76:17-45.
FAEGRI, K AND J. IVERSEN. 1950. Textbook of modern pollen analysis. E. Munksgaard. Copenhagen, Denmark.
GODWIN, H. 1934. Pollen analysis. An outline of the problems and potentialities of the method. New Phyt. 33:278-305; 325-358.
GODWIN, H. 1940. Pollen analysis and the forest history of England and Wales. New Phyt. 39:370-400.
HANSEN, H. P. 1947. Postglacial forest succession, climate, and chronology in the Pacific Northwest. Trans. Amer. Philosoph. Soc. 37:1-130.
HANSEN, H. P. 1949. Pollen content of moss polsters in relation to forest composition. Amer. Midland Naturalist 42:473-479.
IVERSEN, J. 1953. Radiocarbon dating of the Allerod period. Science 118:9-11.
IVERSEN, J. 1954. The late-glacial flora of Denmark and its relation to climate and soil. Denmarks Geol. Unders. (Geol. Survey Denmark, II. No. 80: 87-119.
KROG, H. 1954. Pollen analytical investigations of a $C^{14}$-dated Allerod section from Ruds Vedby. Denmarks Geol. Unders. II. No. 80:120-139.
POTZGER, J. E. 1953a. Nineteen bogs from southern Quebec. Canad. Jour. Bot. 31:383-401.
POTZGER, J. E. 1953b. History of forests in the Quetico-Superior country from fossil pollen studies. Jour. Forestry 51:560-565.
SEARS, P. B. 1930. Common fossil pollen of the Erie Basin. Bot. Gaz. 89:95-106.
VON POST, L. 1946. The prospect for pollen analysis in the study of the earth's climatic history. New Phyt. 45:193-217.
WILSON, I. T. AND J. E. POTZGER. 1943. Pollen records from lakes in Anoka County, Minnesota: a study on methods of sampling. Ecol. 24:382-392.
WODEHOUSE, R. P. 1935. Pollen grains. McGraw-Hill Co. New York.

# COSMIC RADIATION AND RADIO-CARBON AGE DETERMINATION

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All living things are radioactive because they undergo constant chemical exchange with the atmosphere which contains a minute proportion of a radioactive carbon isotope. After death, this exchange ceases and the radioactive carbon in the body decreases at a regular rate. Thus, measurement of the concentration of this radioactivity in a specimen tells how long it has been since the specimen was living—the older the specimen, the less will be the radioactivity. This is the basis of the so-called "radio-carbon age determination."

The technique of radio-carbon dating was developed by Willard F. Libby and others at Chicago's Institute for Nuclear Studies shortly after the end of the last war. During the war, it was found that by bombarding nitrogen with neutrons, it was possible to cause a transmutation of the nitrogen into carbon. Though the yield was small, it was found that the carbon produced differed from ordinary carbon by having an atomic weight of 14 instead of 12. Moreover, this artificially produced carbon was radioactive, and would emit an electron from its nucleus to turn itself back into nitrogen. A given amount of this carbon-14 decays at the rate of one-half every 5000 years.