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Jane Goodale, Editor
Edith Valentine, Ass't. Editor

See p2

DANIEL SUTHERLAND DAVIDSON
(1900-1952)

DANIEL SUTHERLAND DAVIDSON, a past President and active member of the Philadelphia Anthropological Society for many years, died suddenly on December 26, 1952. Professor of Anthropology at the University of Washington, Seattle, he had prepared a paper entitled "Population Density and Culture Dynamics in Aboriginal Australia" for presentation at the annual meetings of the American Anthropological Association on December 29, 1952. On his way to Philadelphia he stopped to visit his mother who lives in Winter Park, Florida. He died in her home.

Davidson was born in Cohoes, New York in 1900. He was graduated from the University of Pennsylvania in 1923, studied anthropology here and took his Master's degree in 1924 and his Doctorate in 1928. "Sud" was one of my earliest students and, for many years, a close colleague. After 202 Bennett Hall was transformed from a Seminar room into an office, we shared it together until I left for Northwestern University. Except for the year that he taught at the University of Buffalo (1932-33), he was a member of our anthropological faculty from 1926 until 1945 and from 1942 on, he was Curator of the Oceanian Section of the University Museum. In this latter capacity he prepared a Guide to the collections. In 1947-48 he taught at the University of Oregon. Receiving an invitation to join the faculty of the University of Washington, he moved to Seattle where he was made Professor in 1949. In the absence of Dr. Erna Gunther, during the past year, he served as Chairman of the Department.

Under the influence of the late Professor Speck, Davidson did considerable ethnological field work among the Algonkian Indians of the Eastern Woodlands in his early years and published a number of papers. He also did some archeological work in this area. Even later, his interest in the New World did not entirely lapse, for his analytic study of the typology and distribution of snowshoes while framed in world perspective, dealt mainly, of course, with American material. But while still a graduate student he developed a profound and abiding interest in aboriginal Australian culture, a fresh and novel field of inquiry at the time, for an American anthropologist. Davidson's doctoral dissertation, a highly original piece of work was concerned with the systematic application of the "age and area" theory to the data then available on Australian social organization, as an approach to the reconstruction of the temporal relations of this order of phenomena. Subsequently, in a long series of papers, published in the *American Anthropologist*, Journal of American Folklore, the *Journal of the Polynesian Society*, Journal of the American Oriental Society, Proceedings of the American Philosophical Society, etc., he extended his research systematically to numerous aspects of Australian material culture and graphic art viewed in terms of the same hypothesis. Under the auspices of the American Philosophical Society he visited Australia in 1930-31 and again spent almost two years there, beginning in 1938, as a Fellow of the Social Science Research Council. This last trip included an archaeological reconnaissance in western Australia, but he did not have very good luck. In 1938 Davidson published "A Preliminary Register of Australian Tribes and Hordes" and "An Ethnic Map of Australia." Certainly no other anthropologist had ever before combed the published sources so meticulously for every scrap of relevant information on the location of native groups as well as their manner of life. Today I received a letter from a fellow anthropologist who writes: "Nobody but a few friends and specialists know how much he published on Australia and how valuable it is." Besides this, Davidson was unique in that he had mastered the technique of string-figures. His second published paper (1929) described those of the Virginia Indians. His demonstrations were as beautifully executed as those of a prestidigitator, and there is nothing in the literature on any other region of the world quite comparable to his Monograph on Australian string figures that appeared in 1941. His capacity for handling the details of material culture with great precision and his memory for them was remarkable.

Davidson's activities likewise included the service he rendered the American Folklore Society for three years as Secretary-Treasurer (1941-44). His business acumen led to a complete reorganization of the bookkeeping system of the Society and, in other ways, he helped this society maintain its scholarly aims during a very crucial period. He later served it as Vice-President. It was Davidson also who promoted the memorable celebration of the twenty-fifth anniversary of the Philadelphia Anthropological Society and who edited the volume of papers that appeared in 1937.

Many more than a handful of the present members of this Society were among Davidson's students while he taught here; to others of us he remains fresh in our minds as a highly congenial and respected colleague. Despite the fact that Sud was often far from robust in health, both as a teacher and colleague he was always the most amiable and sociable of men. Some of us here have missed him and now he will be missed from among the ranks of American anthropologists, too.

A. Irving Hallowell.

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C-14 LAB AT THE UNIVERSITY MUSEUM

THE EXISTENCE of a radiocarbon age determination laboratory in the Museum of the University of Pennsylvania is not well known for a good reason. No archaeological objects have been dated. The laboratory was initiated by Dr. Froelich G. Rainey and with the cooperation of Professor Gaylord P. Harnwell and Dr. William E. Stephens of the Physics Department it has been developed. It has been in operation for more than a year, but numerous hazards have delayed the dating of samples.

The C-14 method of dating depends upon the fact that there is a very small fraction of C-14 (a radioactive isotope of ordinary carbon) in the atmosphere. The isotope is formed by the bombardment of nitrogen with neutrons from cosmic radiation. It was first predicted and then detected by Dr. W. F. Libby of the Institute for Nuclear Studies, Chicago in 1946. This C-14 burns as it descends through the atmosphere to become carbon dioxide. The rates of manufacture and disintegration are known to have been in equilibrium for more than 20,000 years, and as a result this C-14 dioxide is distributed uniformly throughout the world. Everything which lives by breathing in, or exchanging with, the atmosphere such as plants, animals, and marine subjects contain this small fraction of C-14. However, when dead or no longer in equilibrium with the atmosphere, their C-14 content begins to disintegrate. Their age can then be told by the amount that their radiocarbon has diminished. Fortunately, C-14 has a suitable half-life (the time it takes to decrease to half its intensity) – namely, 5568 years – for dating, at least, the last half of the Wurm glacial period and post-glacial time. With present techniques six half-lives can be detected so that the method is applicable to carbon-containing objects that are not older than 30,000 years within an accuracy of approximately 5%.

In the laboratory carbon is extracted from the object to be dated and purified. It is then assembled in a Geiger counter, and its activity is counted. A few special techniques are employed to accomplish this. A week's time will have passed in performing these operations, which are relatively simple but lengthy.

Two major obstacles have delayed progress in this laboratory. The first was that the counting rate for modern carbon, which is used as the basis for age calculations, was lower than expected and not very consistent. Wood from freshly cut young trees persists in giving a count which is slightly lower than seasoned modern wood from larger trees. The explanation is not yet apparent, but it is hoped that it will soon be clarified.

The second obstacle was contamination. Our location in Philadelphia has been fortunate in that the city hasn't been in the direct path of many of the atomic bomb clouds, which travel easterly from Nevada or wherever they are exploded. This type of contamination interrupts operations but it can usually be removed by acid treatment of the sample. More difficulty has been experienced with C-14 contamination from local sources. C-14 isotopes are used abundantly in nearby buildings and although the amount exhausted from their chimneys is too small to be detected by ordinary means, it is probably sufficient to contaminate the carbon samples.

These hazards are due mainly to the fact that carbon is a very good absorber and that a very weak radioactivity, much weaker than the normal atmospheric activity, is being measured. Every precaution must, therefore, be taken to minimize exposure of the carbon to the air. Special steps have been necessitated such as drying the carbon, and even charcoal samples before processing, in a vacuum, and grinding the carbon, which must have a uniform particle size, in water rather than in the dry form. In the near future all operations in which carbon is exposed will be performed in a dust-proof room.

In spite of these difficulties, good correlations with samples of known age have, at last, been obtained, and it is hoped that the levels of Hotu Cave, Iran will soon be investigated. In the process of excavating this cave in 1951, Dr. Carleton S. Coon collected samples of charcoal from the firepits of the different levels. These should prove to be excellent for dating and form a complete chronological sequence from top to bottom. When Hotu cave is completed, the levels of Belt Cave, Iran will be dated. These will be followed by samples from Cape Denbigh, Alaska and other arctic comparison samples which have been collected by Dr. J. Louis Giddings. In view of the unforseen hindrances that are encountered when measuring this weak radioactivity, it is expected that the proposed program will take some time to complete.

Elizabeth K. Ralph

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DEPARTMENT OF ANTHROPOLOGY

DR. LOREN C. EISELEY is on leave of absence from teaching duties during the 1952-53 school year. Aided by a generous grant from the Wenner-Gren Foundation for Anthropological Research, he is putting together a book which discusses various aspects of evolution and cosmology in relation to man. It is suspected that some of the articles currently appearing in *Harper's* magazine will form chapters in his book.

The big event of the year for DR. WARD H. GOODENOUGH was the arrival of a son, Oliver Ramsdell, the Goodenough's third child, the week before Christmas. Prior to this, Dr. Goodenough had found little time for relaxation be-

tween classes during 1952. As soon as the spring semester ended, he drove, with his family, to Tucson, Arizona where he took part in a joint study with social science colleagues. These included Alexander Leighton, Edward Spicer, Solon Kimball, John Adair, and Tom Sasaki. Their task was the construction of a tentative outline for a manual on the human relations problems involved in cross-cultural development programs. Since his return from the southwest, Dr. Goodenough has continued to write his part of the proposed book. In this research he is under contract with Dr. Alexander Leighton, Cornell University, and the Russell Sage Foundation.

DR. LOUIS GIDDINGS, JR., has plans for the 1953 season which will take him again to the edges of northern forest in continuation of the search for timberline trees and archaeological sites that he and Alex Ricciardelli pursued in 1952. Dr. Giddings intends to go this summer to Churchill on Hudson Bay and work out in several directions from this convenient base.

In addition to acting as Chairman of the Department during the current academic year, DR. A. IRVING HALLOWELL has been serving as a member of the Behavioral Research Council and as a member of the American Civilization group committee. He has been also chairman, for the past two years, of the Faculty Committee of the college to recommend candidates on whom the University might confer Honorary Degrees. He likewise has been appointed a member of the Committee on Educational Policy of the Educational Council and on a sub-committee of that body which has been studying in detail the organization of graduate and undergraduate teaching and research at the University. Besides these University activities, Dr. Hallowell is still actively engaged in the editing of the Viking Fund Monographs in Anthropology published by the Wenner-Gren Foundation for Anthropological Research, and has been a member of an informal planning group set up by the Ford Foundation to lay the groundwork for the Center for Advanced Study in Behavioral Sciences that will be opened in 1954. At present he is cooperating with two psychologists, two sociologists, and another anthropologist in the preparation of a volume to be published by the Macmillan Company under the Editorship of Dr. John Gillin. The purpose of this volume is to integrate material from various disciplines that is relevant to the development of a unified science of human behavior. He has recently completed a chapter on "The Rorschach Test in Personality and Culture Studies" that will appear in a book on Rorschach applications edited by Dr. Bruno Klopfer. Dr. Hallowell has been appointed Professor of Anthropology in Psychiatry in the Medical School, and participated in a series of lectures in a new program in Family Welfare organized in conjunction with the Marriage Council of Philadelphia. MR. RICHARD EMERICK has filled in nicely for the department, lecturing a time or so when Drs. Goodenough and Giddings were called out of town although his duties as reader do not require this service.

L. G., Jr.

GENERAL ETHNOLOGY

DR. CARLETON S. COON has been dividing his time between his latest book and the direction of the analysis of the faunal remains of Hotu and Belt Caves. The new book will be an elaboration of the "Hall of Man" theme. The study of the animal remains has been divided into two parts: 1) the comparative anatomy of the various species, to aid in identification, and 2) a cultural interpretation.

Jane C. Goodale and Dexter Perkins, Jr. have been doing the first part of the analysis. References for this material have been scanty. The two main sources have been Klatt's work on the origin of the domesticated animals and Rutimeyer's description of the animal remains of the Swiss Lake Dwellers. The latter is the only source that contains measurements of the skeletal material available for comparison. In addition, previously identified bones from other excavations and modern specimens have been used, the latter having been obtained in large part from the Veterinary School of the University.

Some of the work may prove to be valuable in the study of the origin and morphology of the domestic animals, particularly with swine and the sheep and goat. At the moment the ancestry of the domestic pig is open to question. For a long time it was generally assumed that the Wild Boar (Sus scrofa) of Europe and the Near East was the progenitor of the domestic swine but the Asiatic Wild Pig (Sus vittatus) was also thought to be a possibility. The high percentage of young at Hotu would seem to indicate that the pig had been domesticated. The pig skeletal remains have been closely compared to the data of Rutimeyer, and there can be little doubt that they are closely allied to Sus scrofa.

The problem of determining the morphological differences between the sheep and the goat has been a difficult one. Thus far the only observable difference has been in the teeth, and even this identification is difficult in many cases. The bones of the two species have proved to be all but indistinguishable, even at the higher levels. Apparently the ancestors of the modern sheep must have closely approximated the goat in their general structure, because all of the skeletal material bears a close resemblance to the goat.

Some of the faunal material has required the use of specialists for identification. All of the bird bones have been sent to Dr. Alexander Wetmore of the Smithsonian, Mr. Fred Ulmer has been working on the small mammals, Dr. Horace Richards of the Academy of Natural Sciences is doing the work on the shellfish, and Dr. Henry Fowler, the fish identification.

For her Master's Thesis, T. A. Carter has been doing the cultural interpretation. This includes a study of the fluctuating populations of the animals, and a comparison of the types and frequencies with those found at Belt, Tamtama, and Bisitun caves. She has also been studying the types of bones used for artifacts and the methods of food preparation, based on the tool marks on the bones, the way in which they were shattered, and the ones that were most frequently saved.

Mr. Roy Fisher, from Temple University, has been doing reconstructions of the pottery from Hotu Cave.

A pamphlet describing the "Hall of Man" has been written by Miss Goodale, with an appendix by Mr. Perkins. The illustrations were done by Mr. Raleigh Spinks.

D. P. Jr.

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THE PHILADELPHIA CENTER FOR RESEARCH IN CHILD GROWTH

The Growth Center is a joint research project. It is sponsored by the Graduate School of Medicine and the Evans Institute of Dentistry, both of the University of Pennsylvania; by the Children's Hospital of Philadelphia; by the Pennsylvania Mass Study in Human Nutrition; and by the Dental Study Section of the United States Public Health Service. We are studying a number of groups of children:

1) *School Series:* 600 school children, through the cooperation of the Philadelphia Board of Public Education. These are our "normal control" series, of healthy children, ages 6:0 – 16:0 years. We see them annually; now in our fifth year.

2) *Orthodontic Series:* 500 patients, mostly children, from the Orthodontic Clinic of the Evans Institute. We see these patients semi-annually, or oftener as the clinician may wish. This series is now in its sixth year.

3) *Cleft Palate Series:* 125 children with cleft lip and/or cleft palate, from the Cleft Palate Clinic of Children's Hospital. We see these children semi-annually; now in its second year.

4) *Pilot–Study Series:* 75 school children, ages 6:0 – 8:0. These children are seen quarterly; now in its second year (eighth visit).

5) *"Behavioral" Series:* 100 school children, ages 6:0 – 9:0. We shall see these children annually at the Growth Center. In the school classrooms pertinent social and learning data will be gathered by the Principal, teacher, and school councillor. Biological and behavorial data will be analyzed for possible correlations. This series is just beginning.

6) *Clinical Series:* some 75 referals, mainly from Children's Hospital, who are serious health and/or growth or developmental problems. This series is seen on specific request by the clinician.

The children and the patients in the several Series are studied from a number of viewpoints, as follows:

a) *Anthropometric:* All Series are included here. Height, weight, and detailed measurements of head, face, trunk, and limbs are taken.

b) *Roentgenographic:* All Series. Precision X-rays of head and face are taken in a special Broadbent – Bolton Roentgenographic Cephalometer. From our School Series we are developing norms or standards of facio-dental development. These are used in evaluating the Orthodontic cases. X-rays of hand, elbow, knee, foot are taken for two purposes: 1) to assess skeletal maturation; 2) to evaluate bone density as a measure of mineralization.

c) *Dental:* dental age (eruptive age) is assessed for each child. State of occlusion is determined. Measurements of palate (in situ) are taken on the School Series. Plaster casts of the teeth are taken on the School and Pilot-Study Series.

d) *Biochemical:* Pilot Study only. Microbiology of the blood, correlated with the child's nutritional history. Examination of ocular and oral tissues.

e) *Pediatric:* School and Pilot-Study Series. A complete physical examination by the Staff Pediatrician.

The Staff of the Growth Center is as follows:

W. M. Krogman, Ph.D., Director.
Eleanora C. Gordon, M.D., Pediatrician.
Alvaro C. Henriques, D.D.S., M. Sc. D., Cephalometrist; Orthodontist and Dentist.
Neil C. Tappen, Ph.D., Anthropometrist and Geneticist.
Daris R. Swindler, M.A., Anthropometrist.
Patricia Saunders, Secretary
Marie T. Gorman, Records Secretary.
Diana Sulpizio, X-ray technician.
Luls Clinkscale, dental technician.

W. M. K.

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Miss Palamatary has recently obtained a grant from the American Philosophical Society which will enable her to go to Brazil to study the Tapajo collections in that country. In 1939 she published in Sweden a report on the Tapajo collections which appeared in the Ethnographical Museum at Goteborg, Sweden together with the Tapajo collections at the University Museum and the Museum of the American Indian, Heye Foundation. This new study will include those formerly published together with those in museums and private collections in Brazil. Miss Palamatary plans to leave about the first of August to be gone for a period of about three months.

The Tapajo area is a vast one with the principal site at Santarem at the mouth of the Rio Tapajoz about 600 miles up the Amazon. The age of Tapajo culture is unknown due to the fact that the sites have been so disturbed. However it appears to be later than Marajo which, so far as is known, is pre-Columbian and it probably lasted until the 18th century.

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BY–LAWS

III. a. Students may be classified as *Active Members* upon payment of full dues.
b. A member retains student membership only as long as he is registered for course work on thesis supervision.

IV. a. The council shall function as a nominating committee.

VI. a. Standing committees may be appointed by the President as he deems necessary; these may take the form of:
1) Program
2) Publications
3) Auditing
4) Bulletin
5) Social, etc.

VIII. a. The Secretary from time to time upon suggestion from the membership will be authorized to send letters of invitation to prospective members.

X. a. Members will be dropped from the roll after one year's negligence in dues. The member must be notified prior to this action.

XII. a. By-laws may be added or amended by a majority vote at a meeting of the Council.

Submitted by the Committee on By-Laws:
Dr. Tappen, Chairman
Dr. Butler
Dr. Hallowell
Dr. Mason
Miss Eyman
Mrs. Carter.

The By-laws were voted upon and approved at the Council Meeting held Wednesday, April 22nd, 1953.

PUBLICATIONS COMMITTEE

At the council meeting held on Wednesday, April 22, the Council unanimously approved the recommendation of the Publications Committee, that the balance in the PAS Publication Fund be used toward the publication by the University Press of an anniversary volume in honor of Dr. A. Irving Hallowell consisting of a selection of his papers.

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NEXT MEETING

On May 15, Dr. Daryll Forde of the University of London will talk to the Society on "Cultural Patterns in West Africa."

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PUNXSUTAWNEY, PA.
SPIRIT
D. 7,000

AUG 21 1969

SCIENCE TOPICS

Hurling through space at 360,000 miles an hour, the earth is heading toward the northern constelation of Cances Venatici Hunting Dogs, reports a Stanford University radio astronomer. But the nearest star in that constellation is 100,000 years away and traveling on its own course, the astronomer points out. The earth's movement, of course, means that the whole solar system and our galaxy are moving in the same direction and at the same speed.

Physical exercise is good for the heart, but too much exertion for those not accustomed to it may lead to "oxygen debt," a heart attack and death. Oxygen debt is what an individual owes his body when it is not able to take in all the oxygen it needs. Out of shape, a person can incur the debt in the simple act of climbing stairs, and a denial of oxygen to the blood can lead to heart damage and death, reports a West Coast medical center. The center is conducting

skills.

Radiocarbon dating, which has had profound effect on archaeology and geology since its introduction 20 years ago, has developed a credibility gap, it seems. Discrepancies have been discovered between Carbon-14 analysis and other dating techniques. So a study is under way by University of Pennsylvania researchers to try to find out if Carbon-14 is fallible and why.

JASPER, GA.
PROGRESS
W. 2,396

AUG 21 1969

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LOCKHART, TEXAS
POST REGISTER
W. 2,765

AUG 21 1969

Science Topics

ACID WASTES from color pigment production will soon be pumped into a porous, sponge-like sandstone reservoir far below the earth's surface through a mile deep well near Holland, Mich. It is similar to another deep disposal well at the Chemetron Corp. facility and will provide additional capacity if that one becomes inoperable or overloaded.

PILOT-TO-PILOT is the new approach in aircraft accident prevention being tried by the Federal Aviation Administration. It has assigned 31 specialists in central and southwestern U.S. who are going hangar-to-hangar getting to know general aviation pilots and talking up safety and better flying skills.

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BOONVILLE, IND.
ENQUIRER
W. 2,932

AUG 23 1969

Earth Hits 360,000 MPH In Celestial Travels

Hurtling Through space at 360,000 miles an hour, the earth is heading toward the northern constellation of Canes Venatici (Hunting Dogs), reports a Stanford University radio astronomer. But the nearest star in that constellation is 100,000 years away and traveling on its own course, the astronomer points out. The earth's movement, of course, means that the whole solar system and our galaxy are moving in the same direction and at the same speed.

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NIANTIC, CONN.
NEWS
W. 8,166

AUG 27 1969

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...en Debt

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...ut of shape, a person can ...r the debt in the simple ... of climbing stairs, and a ...ial of oxygen to the blood ... lead to heart damage and ...th, reports a West Coast ...dical center.

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Aircraft Prevention

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Discrepancies have been discovered between Carbon 14 analysis and other dating techniques. So a study is under way by University of Pennsylvania researchers to try to find out if Carbon 14 is fallible and why.

LILBOURN, MO.
SEMO NEWS
W. 1,200

AUG 21 1969

Earth hits 360,000 MPH in its travels

HURTLING through space at 360,000 miles an hour, the earth is heading toward the northern constellation of Canes Venatici (Hunting Dogs), reports a Stanford University radio astronomer. But the nearest star in that constellation is 100,000 years away and traveling on its own course, the astronomer points out. The earth's movement, of course, means that the whole solar system and our galaxy are moving in the same direction and at the same speed.

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YORK, PA.
GAZETTE AND
DAILY
D. 35,000

SEP 9 1969

Inaccuracy Found In Carbon Dating

(By Science Service)

Washington—It has been 20 years since the dating of archeological finds by measuring the amount of radioactive carbon present entered the scientific scene. In that time an assortment of scientists have used it to determine the age of the Dead Sea scrolls, the duration of the Ice age, the movement of ancient peoples, the dates of sediments and even the authenticity of works of art.

It was used to date Stonehenge, and it dated wrong.

It is still a valuable tool, but not an infallible one. Since the mid-50s, investigators have discovered that some of the dates obtained by the method have been short, sometimes by as much as 750 years for a 6,000-year-old artifact.

Now enough background information has accumulated and dating techniques have improved to the point that scientists are confident they can reduce the inaccuracies. But they still cannot get near the pinpoint accuracy they once hoped for.

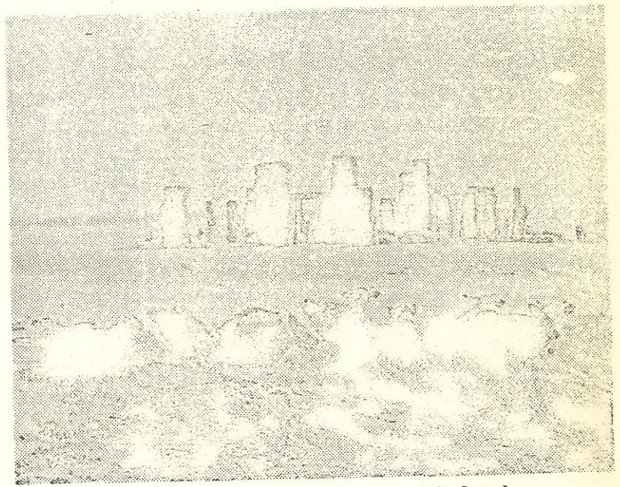
"The best accuracy we can foresee at present — all errors corrected — would be within five per cent," says Dr. George Bien of the Scripps Institution of Oceanography, La Jolla, Cal. The method is good for dates back to about 40,000 years. And five per cent of that is 2,000 years.

Discrepancies Found

The first discrepancies were observed in the mid-50s, when dates fixed by radioactive carbon tests for Greek and Roman pottery conflicted with the pottery's style. Other disputes arose over dates of early Egyptian artifacts, whose age had been established with the aid of lists of kings deciphered from hieroglyphics. Still other discrepancies turned up when the known ring-based dates of trees were compared with the dates obtained by radiocarbon dating.

The latest discrepancy shows that the age of the ancient and mysterious stone structures at Stonehenge as determined by the method is between 500 and 700 years off; Stonehenge is even older than the 3,670 years derived from dating charcoal found near the structure. Tree rings again provided the proof.

Scientists at several places are working on the problem and the National Science Foundation has thrown $56,000 into the pot to assist the University of Pennsylvania—a major center of archaeology—in straightening out the method.



Stonehenge One Monument Misdated

RADIOACTIVE CARBON dating uses the decay rate of radioactive carbon 14 atoms as a nuclear clock to determine the age of organic material.

All living things incorporate tiny amounts of radiocarbon into their tissues along with the predominant carbon 12 atoms. While alive, a plant or animal replenishes both, so that the same ratio of common and radioactive atoms is maintained. When the organism dies, no new carbon 14 is taken in. From that point on radioactive decay continually reduces the number of radiocarbon atoms.

By measuring how much radiocarbon is left, scientists can compute how long it took to reach that point, which tells them when the organism did.

THE CALCULATION however, is based on the assumption that the amount of radioactive carbon in the atmosphere always has been constant. This assumption is not held to be true any longer.

One thing believed to throw it off is the cyclic change in the earth's magnetic field. Since the fluctuations of carbon 14 may be cyclic, the variations in the magnetic field are suspect.

Cosmic rays were also suspected of being a source, but there has been no apparent change in cosmic ray intensity for the last five million years. However, changes in the earth's magnetic field could influence the volume and intensity of cosmic rays coming into the atmosphere. A strong field would keep more out while a weak one would let more in.

A minor factor is the burning of fossil fuels which puts more carbon 12 into the air, thus altering the ratios during the past 100 years. Another factor is the climatological changes that have occurred. An ice age, for example, would change the carbon content of the atmosphere by altering ocean temperature.

THE NATURE of the radiocarbon dating shifts is mostly upward, which makes dates more recent than they actually are. A time profile of the discrepancies obtained so far shows deviations in radiocarbon levels from 1500 to 1700 AD, followed by a leveling off until 500 BC when there is another period of descrepancy, followed by an apparent trend toward leveling off until 5150 B.C.

At that point the skein of information runs out, and scientists are just not sure what happened before. There are also gaps in the profile from 4100 to 3600 and 4850 to 4400 B.C.

One of the purposes of the research at the University of Pennsylvania is to determine if the fluctuations are as cyclic as they seem to be. Also the investigators would like to know the size and duration of the fluctuations.

In their experiments, the researchers, led by Elizabeth K. Ralph, will be making measurements of known-age samples of bristlecone pines. Longer lived than the Sequoia tree samples, the pine samples will be dated by the carbon 14 method and the resulting ages compared.

The Cincinnati Post
AND TIMES STAR
D. 243,618

OCT 2 1969

SCIENTIFIC ENTHUSIASM WANES

Radiocarbon Dating Inaccurate

By Science Service

WASHINGTON: It has been 20 years since radioactive-carbon burst upon the scientific scene. In that time it has been used by scientists to determine the age of such things as the Dead Sea Scrolls, the duration of the Ice Age, the movement of ancient peoples, the dates of sediments and even the authenticity of works of art.

It was used to date Stonehenge, the ancient Druid landmarks in England, and it dated wrong.

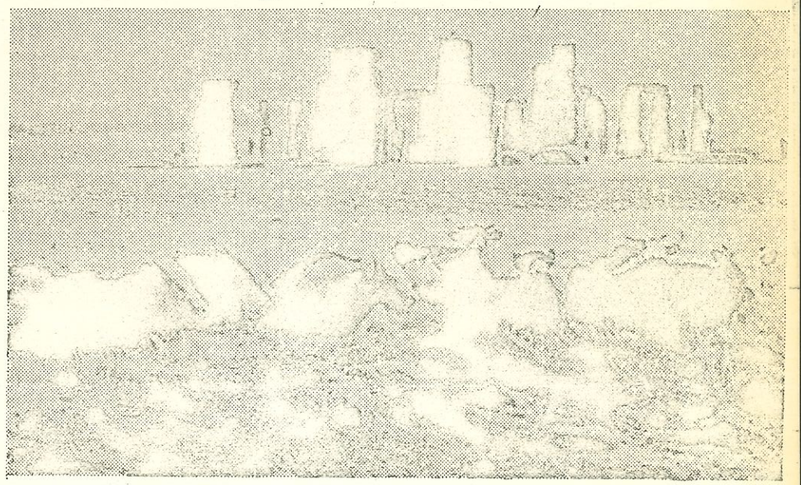
It still is a valuable tool, but not an infallible one. Since the mid-50s, investigators have observed that some of the dates obtained by the method have been short by as much as 750 years for a 6000-year-old artifact.

NOW ENOUGH background information has accumulated and dating techniques have improved to the point that scientists are confident they can reduce the inaccuracies. But they still cannot get near the pinpoint accuracy they once hoped for.

"The best accuracy we can foresee at present—all errors corrected—would be within 5 per cent," says Dr. George Bien of the Scripps Institution of Oceanography, La Jolla, Cal. The method is good for dates back to about 40,000 years, and 5 per cent of that is 2000 years.

THE FIRST discrepancies were observed when dates fixed by radioactive carbon for Greek and Roman pottery conflicted with the pottery's style.

Other disputes arose over dates of early Egyptian artifacts, whose age had been established with



STONEHENGE

Now the age of the mysterious stone structures at Stonehenge, as determined by the method, is between 500 and 700 years off, Stonehenge is even older than the 3670 years derived from dating charcoal found near the structure. Tree rings again provided the proof.

Scientists at several places are working on the problem and the National Science Foundation has thrown $56,000 into the pot to assist the University of Pennsylvania—a major center of archaeology—in straightening out the method.

ST. MARY'S, OHIO
LEADER
D. 5,500

SEP 16 1969

SCIENCE TOPICS

EARTH HITS 360,000 MPH IN CELESTIAL TRAVELS

Hurtling through space at 360,000 miles an hour, the earth is heading toward the northern constellation of Canes Venatici (Hunting Dogs), reports a Stanford University Radio astronomer. But the nearest star in that constellation is 100,000 years away and traveling on its own course, the astronomer points out. The earth's movement, of course, means that the whole solar system and our galaxy are moving in the same direction and at the same speed.

PHYSICAL EXERCISE is good for the heart, but too much exertion for those not accustomed to it may lead to "oxygen debt," a heart attack and death. Oxygen debt is what an individual owes his body when it is not able to take in all the oxygen it needs. Out of shape, a person can incur the debt in the simple act of climbing stairs, and a denial of oxygen to the blood can lead to heart damage and death, reports a West Coast medical center. The center is conducting a program of carefully measured and observed physical training for a group of men who either have had heart attacks or have been identified as potential victims. The object is to strengthen weak or damaged tissue in heart muscle and to reduce the danger of a first or recurring coronary attack.

ACID WASTES from color pigment production will soon be pumped into a porous, sponge-like sandstone reservoir far beneath the earth's surface through a mile-deep well near Holland, Mich. It is similar to another deep disposal well at the Chemetron Corporation facility and will provide additional capacity if that one becomes inoperable or overloaded.

PILOT-TO-PILOT is the new approach to aircraft accident prevention being tried by the Federal Aviation Administration. It has assigned 31 specialists in central and southwestern United States who are going hangar-to-hangar getting to know general aviation pilots and talking up safety and better flying skills.

RADIOCARBON DATING, which has had profound effect on archaeology and geology since its introduction 20 years ago, has developed a credibility gap, it seems. Discrepancies have been discovered between Carbon-14 analysis and other dating techniques. So a study is under way by University of Pennsylvania researchers to try to find out if Carbon-14 is fallible and why.

HOW CAN I?

Q. How can I remove catsup stains from fabrics?

A. Since age makes these stains hard to deal with, act promptly. Flush as much of the stain out as possible in a fairly concentrated solution of neutral detergent and water. Lubricate the remaining portions of the stains with glycerin, working it in with the blunt edge of a knife or the back of a spoon. Then flush again with the water-detergent solution.

Q. How can I keep blankets soft and fluffy?

A. By adding a teaspoonful of glycerin to each pint of rinsing water used when laundering them.

THE BRIDGEPORT POST
BRIDGEPORT, CONN.
D. 82,722 SUN. 85,633

SEP 17 1969

Radioactivity Rate Not Constant—

Error of 5 Per Cent Found In Artifact Dating Method

BY SCIENCE SERVICE

WASHINGTON — If you told a seamstress that the number of inches from the floor to a hem wouldn't really tell her the length of a skirt, her reaction would be like an archaeologist's, on learning that radiocarbon dating doesn't really tell him the age of an archaeological find: if he can't depend on that, what can he depend on?

It has been 20 years since dating by measuring the amount of radioactive carbon present burst upon the scientific scene. In that time an assortment of scientists have used it to determine the age of the Dead Sea Scrolls, the duration of the Ice Age, the movement of ancient peoples, the dates of sediments and even the authenticity of works of art.

It was used to date Stonehenge, and it dated wrong.

It is still a valuable tool, but not an infallible one. Since the mid-50s, investigators have observed that some of the dates obtained by the method have been short, sometimes by as much as 750 years for a 6,000-year-old artifact.

Accuracy to 5 Per Cent

Now enough background information has accumulated and dating techniques have improved to the point that scientists are confident they can reduce the inaccuracies. But they still cannot get get near the pinpoint accuracy they once hoped for.

"The best accuracy we can foresee at present — all errors corrected — would be within five per cent," says Dr. George Bien of the Scripps Institution of Oceanography, La Jolla, Calif. The method is good for dates back to about 40,000 years. And five per cent of that which tells them when the organism died.

However, the calculation is based on the assumption that the amount of radioactive carbon in the atmosphere has always been constant. This assumption is not held to be true any longer.

Cyclic Change

One thing believed to throw it off is the cyclic change in the earth's magnetic field. Since the fluctuations of carbon 14 may be cyclic, the variations in the magnetic field are suspect.

Cosmic rays were also suspected of being a source, but there has been no apparent change in cosmic ray intensity for the last five million years. However, changes in the earth's magnetic field could influence the volume and intensity of cosmic rays coming into the atmosphere. A strong field would keep more out while a weak one would let more in.

A Minor factor is the burning of fossil fuels which puts more carbon 12 into the air, thus altering the ratios during the past 100 years. Another factor is the climatological changes that have occurred. An ice age, for example, would change the carbon content of the atmosphere by altering ocean temperature.

Upward Shifts

The nature of the radiocarbon dating shifts is mostly upward, which makes dates more recent than they would actually be. A time profile of the discrepancies obtained so far shows deviations in radiocarbon levels from 1500 to 1700 A.D., followed by a leveling off until 500 B.C. when there is another period of discrepancy, followed by

is 2,000 years.

The first discrepancies were observed in the mid-50's, when dates fixed by radioactive carbon dating for Greek and Roman pottery conflicted with the pottery's style. Other disputes arose over dates of early Egyptian artifacts, whose age had been established with the aid of lists of kings deciphered from hieroglyphics. Still other discrepancies turned up when the known ring-based dates of trees were compared with the dates obtained by radiocarbon dating.

Tree Rings Reveal Error

The latest discrepancy shows that the age of the ancient and mysterious stone structures at Stonehenge as determined by the method is between 500 and 700 years off; Stonehenge is even older than the 3,670 years derived from dating charcoal found near the structure. Tree rings again provided the proof.

Scientists at several places are working on the problem and the National Science Foundation has just thrown $56,000 into the pot to assist the University of Pennsylvania — a major center of archaeology — in straightening out the method.

Radioactive carbon dating uses the decay rate of radioactive carbon 14 atoms as a nuclear clock to determine the age of organic material. All living things incorporate tiny amounts of radiocarbon into their tissues along with the predominant carbon 12 atoms. While alive, a plant or animal replenishes both, so that the same ratio of common and radioactive atoms is maintained. When the organism dies, no new carbon 14 is taken in. From that point on radioactive decay continually reduces the number of radiocarbon atoms. By measuring how much radiocarbon is left, scientists can compute how long it took to reach that point, an apparent trend toward leveling off until 5150 B.C.

At that point the skein of information runs out, and scientists are just not sure what happened before. There are also gaps in the profile from 4100 to 3600 and 4850 to 4400 B.C.

One of the purposes of the research at the University of Pennsylvania is to determine if indeed the fluctuations are as cyclic as they seem to be. Also the investigators would like to know the size and duration of the fluctuations.

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The Ann Arbor News
ANN ARBOR, MICH.
D. 38,589

OCT 5 1969

This Dating Game Not Foolproof

By Edward Gross
(Science Service)

WASHINGTON — If you told a seamstress that the number of inches from the floor to a hem wouldn't really tell her the length of a skirt, her reaction would be like an archaeologist's, on learning that radiocarbon dating doesn't really tell him the age of an archaeological find: if he can't depend on that, what can he depend on?

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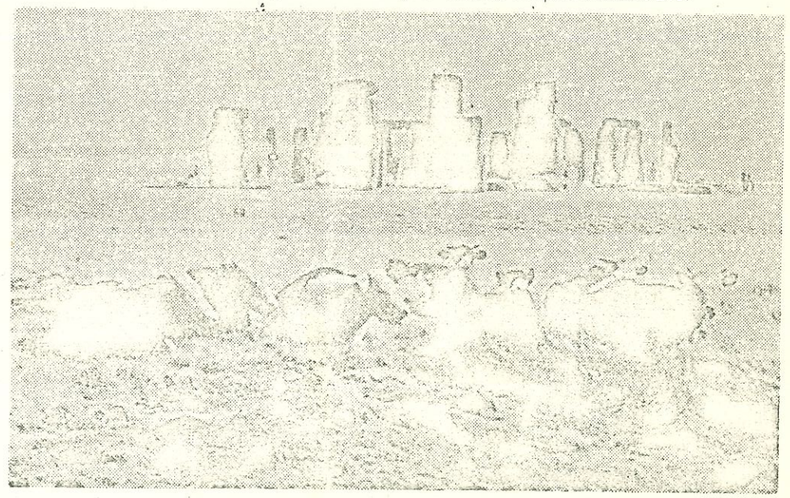
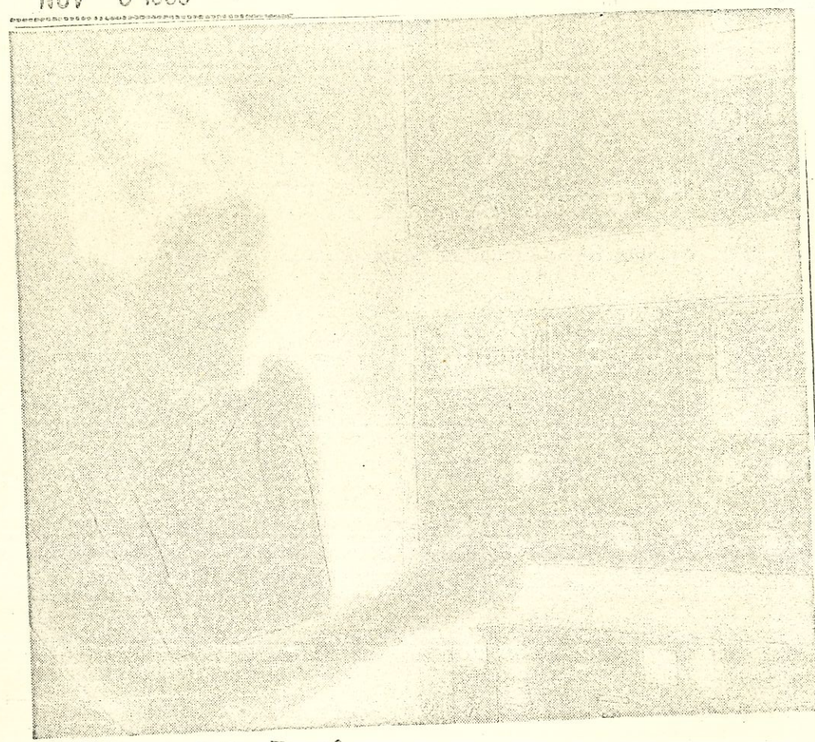


Carbon Dating Was Mistaken About Stonehenge's Age

Improvements in pottery dating methods for archeologists will be sought by Dr. Froelich Rainey, Elizabeth K. Ralph, and Mark C. Han of University of Pennsylvania under a $61,000 grant from the National Science Foundation. Radioisotopes in clay excite other atoms' electrons to triplet states. These descend to ground when the pot is fired and the process begins anew. By heating potsherds and measuring thermoluminescent intensity, a pot's age can be gaged. Pottery, used by man for the past 9000 years, is of interest to archeologists, but is not always amenable to radiocarbon dating.



Carbon-14 Dating . . .

Archeologist Elizabeth Ralph shows some of the equipment used in Carbon-14 dating of materials from sites. She will describe process in talk here.

Archeology in Atomic Age Topic for RC Program

Changes the atomic age has made in being able to assign dates to materials from thousands of years ago will be subject of Prof. Elizabeth Ralph at a talk here on Nov. 16.

Prof. Ralph, associate director of the Applied Science Center for Archeology at the University of Pennsylvania's Museum, will be the speaker. The program, at 8 p.m. in Rockford College's Peterson Science Auditorium, is the second planned by the Rockford Society, Archeological Institute of America.

Carbon-14 dating, the process used to prove that Stonehenge, in England, 500 years older than used to be believed, will be the program topic.

"Carbon-14 Dates for Egyptian, Mayan, and Italian Sites," will be Prof. Ralph's subject.

She has done archeological prospecting with electronic instruments at a number of sites in Mexico, Italy, Greece, Canada, Ireland, and the U.S., and has written articles on radiocarbon date lists. Techniques, problems, and precision of this type of dating will be discussed.

Dr. Gordon Wesner, RC biology department chairman, plans to prepare a display for the program to illustrate some of the techniques of this dating process.

Prof. R. L. Den Adel, classics department chairman, heads the local AIA group and will preside at the program.

Trouble with Carbon 14

Carbon 14 dating, an enormous boon to scientific investigations of the past, has developed a "credibility gap." Discrepancies have appeared between the ages assigned to objects by Carbon 14 analysis and those established by other techniques. Carbon 14 dating of objects from the early Egyptian dynasties, for example, where age can be established from king lists, seems to be off as much as 300 to 500 years. All the errors seem to be in the direction of making the object too young. Now a group from the *University of Pennsylvania* has received a grant to tackle the problem. They'll use samples of bristlecone pine of known age to try to figure out the magnitude and duration of the periods of fluctuation.

N.Y. Times FEB. 27, 1970 page 39

Experts to Study Ruins Linked to Ark

By WALTER SULLIVAN
Special to The New York Times

WASHINGTON, Feb. 26—After years of scientific scoffing at reports that remains of a massive wooden structure, lie collapsed beneath a glacier on Mount Ararat, a prestigious research organization has, at least in part, been won over.

The Arctic Institute of North America, probably the foremost polar research organization on this continent, has decided to help in efforts to remove the ice covering what have been reported as 50 tons of hewn beams.

Canadian and American scientists associated with the institute have been chiefly impressed by the excavation last summer of what appears to be heavily weathered planking close to the original find, almost 14,000 feet above sea level.

According to the Book of Genesis, Noah's Ark landed on "the mountains of Ararat" at the end of the Biblical Flood. The modern Ararat is a towering peak in eastern Turkey overlooking Iran and the Soviet Union.

The find was reported in press dispatches from Turkey last November, and a few weeks ago a piece of the wood, was displayed at a news conference in this city by a Frenchman, Fernand Navarra.

Original Discovery

It was Mr. Navarra who reported the original discovery in 1955 and led a party to the site last summer. He is convinced that the timbers are remnants of Noah's Ark.

However, two laboratories have analyzed the radioactive carbon content of the recently retrieved wood, and both have reported that the wood is from a tree that grew about 600 A.D. The Biblical flood would, by most accounts, have taken place several thousand years earlier.

What has evoked intense scientific interest, therefore, is the evidence that some sort of structure—apparently a large one—existed 1,300 years ago near the summit of one of the loftiest and most inhospitable mountains of the Biblical world.

The site is in the region of permanent glaciation, about 3,000 feet below the 17,000-foot summit. Those who found the wood are being secretive about the exact location because of rumors that funds are being raised for a rival attempt to retrieve the wood.

Members of last summer's expedition reported today, in an interview, that the United States Forest Service had identified the wood as a species of white oak. Such trees are not known to grow within 300 miles of the mountain.

Sponsor of Exhibition

The expedition last summer was sponsored by the SEARCH Foundation. SEARCH stands for Scientific Exploration and Research. It is headed by Ralph E. Crawford, a Seventh Day Adventist, whose son, Harry, took part in the operation.

SEARCH is largely supported by the Seventh Day Adventists, who place stronger emphasis on literal interpretation of the Old Testament than most other Christian denominations.

This sponsorship has raised some delicate problems for participating scientists. They could head off the ridicule of their colleagues by emphasizing the redioactive carbon dates, which would rule out the Ark hypothesis.

Yet to discourage all hope that the Ark has been found would dry up much financial support.

The dating method used by those two institutions could not be determined today, but it was reportedly not the radioactive carbon technique and some are skeptical of its reliability.

The two carbon ages were determined by the University of Pennsylvania and Geochron, a commercial laboratory in Cambridge, Mass.

SEARCH representatives question the results on the grounds that the wood was contaminated by melt water from the glacier and by sulphurous gases from within the mountain.

Fragment of 5-foot beam, with L-shaped cross section, discovered on Mt. Ararat in 1955. Wood, apparently shaped by human hands, was found by a Frenchman, Fernand Navarra.

The New York Times Feb. 27, 1970

Photographs © SEARCH Foundation, Inc.

Site of discovery. Photo was made last summer, when what appear to be wooden planks were unearthed nearby.

Young Volcanic Peak

Ararat is a volcanic peak that is young by geologic standards, and sulphurous fumes seep from rocks near the stagnant glacier tongue where the finds have been made.

Mr. Navarra, who heads a French demolition and excavation concern, said he found the timbers when he descended into a cavern under the glacier in 1955.

The Arctic Institute has asked Dr. Melvin G. Marcus, head of the geography department at the University of Michigan and an authority on glacial responses to climate, to be chief scientist on next summer's expedition.

A number of scholars argue that the name Ararat was not applied to this mountain in Biblical times and that the "Mountains of Ararat" on which the Ark is supposed to have landed were elsewhere. However during the Christian era there have been repeated reports that remains of the Ark were on the mountain.

Expedition participants included Mr. Navarra and his son, Fernand Jr.; Ralph Lenton of the Arctic Institute, Elfred M. Lee, photographer for the SEARCH Foundation, and Hugo A.C. Newburg.

Both Mr. Lenton and Mr. Newburg are veterans of polar work.

Special to The New York Times

LARCHMONT, N. Y., Feb. 26—Miss Wendy Sue Wiegers, granddaughter of the late Bernarr Macfadden, the publisher, plans to be married here April 25 to Cornelius Wayne Geier, son of Mr. and Mrs. John Henry Geier of Westbury, L. I.

Mr. and Mrs. Joseph P. Wiegers have announced their daughter's engagement. Mr. Wiegers is president of the Macfadden Foundation, sponsor of the Castle Heights Military Academy in Lebanon, Tenn., and the Sanford (Fla.) Naval Academy.

Miss Wiegers, who left the nursing staff of the Massachusetts General Hospital in Boston last week, is a graduate of the Academy of the Holy Child in Rye. She attended Russell Sage College and has bachelor and nursing degrees from Columbia University.

The future bridegroom attended Lafayette College and received a bachelor's degree from Hofstra College. He is on the sales staff of the Joel Chemical Company. which his father owns, in Westbury, L. I. Mr. Geier also owns the Acme Chemical Company. Both supply water treatment and chemicals to industry and municipalities.

Altman-Pach

Miss Wendy Sue Wiegers

Arthur Miller, Judith Anderson Planning Bridal

Special to The New York Times

AVON, Conn., Feb. 26—Second Lieut. Judith Carol Anderson, an Air Force flight nurse, and First Lieut. Arthur Reid Miller, a fighter pilot, will be married April 11.

Mr. and Mrs. Jack G. Anderson have announced their daughter's engagement to the son of Arthur Miller and Mrs. Dott Miller, both of Boise, Idaho. Mr. Anderson is president of Kaman Aerospace Corporation in Bloomfield and a vice president and director of Kaman Corporation, a diversified corporation.

The prospective bridegroom's father is a distributor in Boise for Union Oil Company.

Lieutenant Anderson, a 1968 graduate of St. Luke's Hospital School of Nursing in New York, is stationed at Elmendorf Air Base, Alaska, where she is assigned to hospital flights for wounded servicemen returning from Southeast Asia.

Lieut. Judith Anderson

The bridegroom-to-be, a 1968 honor graduate of the Air Force Academy, completed his flight training last year at Williams Air Force Base, Ariz.; took combat training at Elgin Air Force Base, Fla., and expects to be stationed in Thailand.

Joanne Gaffney, Robert Bennett To Be Married

Mr. and Mrs. Arthur Thomas Gaffney of Douglaston, Queens, have announced the engagement of their daughter, Miss Joanne Gaffney, to Robert Sanford Bennett, son of Dr. and Mrs. Robert Edward Bennett of Worcester, Mass.

The future bride is a nurse at New York Hospital and her fiancé is a senior at the Cornell University Medical College. Miss Gaffney was graduated from the Marymount School in New York, attended Marymount College in Tarrytown and received a degree from the Cornell University-New York Hospital School of nursing.

Mr. Bennett, a lieutenant (jg.) in the Naval Reserve, was graduated from the Choate School and Dartmouth College. His father is a physician. Mr. Gaffney is a vice president and director of the W. J. Barney Corporation, a construction company here.

An April wedding is planned.

Bradley Fischman to Marry Cynthia Joy Gardstein in June

Miss Cynthia Gardstein

Dr. and Mrs. Henry F. Gardstein of New York and Lido Beach, L. I., have announced the engagement of their daughter, Miss Cynthia Joy Gardstein, to Bradley Miles Fischman, son of Mrs. Irving Goldblatt of Brooklyn and the late Louis H. O. Fishman.

The wedding is planned for June.

Miss Gardstein, an alumna of Packer Collegiate Institute in Brooklyn and the Château Mont Choisi in Lausanne, Switzerland, expects to be graduated in May from Skidmore College. Her father, a physician, is president of the medical board at Caledonian Hospital in Brooklyn.

The future bridegroom expects to be graduated in June from the New York University College of Dentistry. He is an alumnus of the Wheatley School in Old Westbury, L. I., and Syracuse University. His late father, a lawyer, was vice president and general counsel of the Third Avenue Elevated Railroad.

Nuptials in May For Mary Akin

Miss Mary Akin, a personnel associate with the McCann-Erickson Advertising Agency, and Carl Phillip Horton, an executive with the Oldsmobile division of General Motors here, plan to be married in May.

The future bride is the daughter of Mr. and Mrs. Thomas B. Akin Jr., of Montego Bay, Jamaica, formerly of Englewood, N. J. Her father is an architect with the Architects Collaborative, Inc., in Cambridge, Mass. Her fiancé is the son of Mrs. Richard M. Ohanesian of Newington, Conn., where his stepfather teaches in the public schools.

Miss Akin, a graduate of Dana Hall, Finch and Columbia, made her debut at the Junior League Cotillion in Englewood and at the Debutante Assembly and New Year's Ball here in the 1960-61 season.

Mr. Horton was graduated from Central Connecticut State College.

Polly P. Bullock Planning Bridal

Special to The New York Times

NORTH GRAFTON, Mass., Feb. 26—Mr. and Mrs. Augustus George Bullock of North Grafton and James-town, R. I., have announced the engagement of their daughter, Miss Polly Primrose Bullock to Durban Alexander McGraw Jr., son of Mrs. Joseph Paterno of Osterville, Mass., and Mr. McGraw of Osterville. The wedding is planned for June in James-town.

Miss Bullock's father is a vice president of the State Mutual Life Assurance Company in Worcester, Mass. Mr. McGraw's father is the retired owner of the Liberty Mining Company in Pittsburgh.

Miss Bullock attended the House in the Pines School in Norton and the New York School of Interior Design in New York.

Mr. McGraw was graduated with a B.A. degree in history from the University of Pennsylvania, where he was a member of the Sigma Elmo Club. He attended the Choate School and was graduated from the Colorado Academy in Denver.

Preview on Sunday At Magic Theater

A preview of the Magic Theater, an exhibition

High Court Rul... to Apply to Bo...

By MARTIN TOL...

Lindsay administrati... cials said yesterday th... Supreme Court's extensi... the one-man, one-vote prin... to all local governing boa... was a mandate for a total r... evaluation of the structure ... city government.

Richard R. Aurelio, a Deput... Mayor and chief of staff ... the Lindsay administratio... said, "The Court decisio... clearly makes it imperative fo... us to review the city's entir... legislative structure."

The focus of the review wi... be the Board of Estima... which gives each of the fi... boroughs equal representatio... despite that vary from 2.6 mi... lion in Brooklyn to 250,000 o... Staten Island.

Several proposals had bee... advanced recently to reduc... the power of the board, r... garded as politically entrenche... because of its control of th... budget and, therefore, its powe... to reward neighborhoods an... groups with capital projects. I... also controls the granting o... such franchises as those fo... cable television.

Sadowsky Gains Backing

Several aides of Mayor Lin... say said privately yesterda... that they agreed with the to... of a statement by Councilma... Edward L. Sadowsky, a Quee... Democrat-Liberal and chairma... of the Codes Committee, wh... said, "The Board of Estima... has been abolished by the S... preme Court."

Mr. Sadowsky introduced le... islation last week to depri... the Board of Estimate of i... budget powers, a proposal, o... posed by the Lindsay admini... tration. He said yesterday, "T... program is no longer a questi... of political desirability; it... now a constitutional necessity.

Some City Hall observers al... said that they felt that t... High Court's decision, Wedne... day seemed to affect the Boa... of Education, which is made ... of one member from ea... borough. A further target a... peared to be the 10 City Co... cilmen at Large, elected on t... basis of two from each borou...

The State Supreme Co... last year rejected the cont... tion that the United Sta... Supreme Court ruling of ... man, one vote should be ... plied to the Board of Estim...

No Legislative Role

The state court held that ... Federal ruling applied only ... legislative bodies and fou... that the board "is not auth... ized nor does it have a... serious legislative role in t... enactment of the city's loc... laws."

The High Court's decisi... this week said that the prin... ple of one man, one vote ... plied to the election of al p... sons who performed gove... ment functions, and not mer... to legislative bodies.

The future of Board of E... mate, which is made up of ... five borough presidents (t... votes each) and the May... Controller and Council Pr... dent (four votes each)...

Quaternary Research, vol. 2, no. 1
pp. 117-118 [1971?]

BOOK REVIEWS

Paleopedology—Origin, Nature, and Dating of Paleosols, edited by D. H. Yaalon, International Society of Soil Science and Israel Universities Press, Jerusalem, 1971, 350 pp., $10.50.

This book consists of 29 papers selected from those that were presented at a symposium in Amsterdam in August 1970. Scientists from many countries contributed to the volume and most papers are in English. Discussions that took place between participants are included after each paper. A wide variety of topics is presented and these should be of interest to Quaternary stratigraphers, sedimentary petrologists, pedologists, and archeologists. The papers are grouped into four sections, and only a few are mentioned here.

Section 1 deals with overall concepts and definitions in the field of paleopedology. I found the paper by Yaalon especially interesting because he attempted to show how rapidly certain soil features are produced and how rapidly the features subsequently might change if environmental conditions change. Only those features that adjust slowly or not at all to environmental change are judged best for interpretations of paleopedogenesis.

Section 2 contains a group of papers discussing the problems of radiocarbon dating of soil features. In my opinion, this is the strongest section of the book. Dating of A-horizon organic matter of a surface soil provides only a minimum age for the soil and the date obtained depends on the kind of soil and on the depth of the dated sample. Knowledge of these variations is essential in interpreting the true age of buried soils if radiocarbon dates come from soil organic matter. One paper covers problems in interpreting radiocarbon dates on carbonate horizons; these dates are a minimum for the sediment parent material, and the difference between the sediment age and the carbonate radiocarbon age appears to increase in going from arid to humid climates.

Section 3 contains a variety of papers. Among them are a summary by an international working group on the criteria for recognizing and classifying paleosols, one on the inception of soil salinity in the Mesopotamian Plain by study of mud bricks used in construction of ancient structures, and two on soil development sequences. One development sequence is on Costa Rica podzol-like soils, and the other deals with clay-mineral and great-soil-group variation with age in the northeastern U.S.A. In this latter paper the soils are shown to vary from sol–brun acide → gray–brown podzolic → red–yellow podzolic with increasing age of parent material, and the suggestion is that this variation might be due more to the effect of time than to paleoclimate. This example points out the difficulty of separating the time factor from the climatic factor in explaining features of old soils, and these problems are discussed in several papers throughout the book.

Section 4 is separated into two parts. One part includes papers on the uses of soils in Quaternary research with examples from Europe, Israel, and New Zealand. Most stress is on the problems of environmental reconstruction for the time of pedogenesis, and the dating and stratigraphic position of various soils. The second part of this section, along with the paper by Teruggi and Andreis in section 3, give examples of recognizing and correlating buried soils in sedimentary rock sections of pre-Quaternary age.

I see the main value of this book as reference material for Quaternary researchers and as supplemental reading in some upper division and graduate pedology courses, especially those with a strong geologic and field approach. In this day of high-priced books, the price is quite reasonable.

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Dating Techniques for the Archeologist, H. N. Michael and E. K. Ralph, Eds. The M.I.T. Press, 1971. Price $12.50.

During the past two decades, dating techniques have added much information to archeological investigations. The development of these techniques has been rapid, and it has been a frustrating task for the archeologist to obtain up-to-date information on the various methods. The pitfalls of the "magic box" approach, with its ideal numbers that could be used everywhere, were soon evident to the professional archeologist. Only a better understanding of the methods involved could result in a proper assessment of the limitations and inaccuracies. "Dating Techniques for the Archeologist" should be of tremendous help for such an assessment as it treats most basic and practical aspects of the relevant dating methods in detail.

The book contains seven chapters, each of which is written by an author who has been extensively involved in the field discussed. This assures professional expertise for all chapters, and

results in an overall treatment that often will be useful for the nonarcheologist as well. Because each author is enthusiastic about his own field, the reader will have to assess the limitations of the various methods himself in order to come to a conclusion with regard to their relative importance.

The chapter on ^{14}C dating, written by Elizabeth K. Ralph, gives, among others, a detailed presentation covering general principles, technical laboratory aspects, and practical aspects such as collecting, packaging, labeling, and describing samples. This chapter should answer the majority of the questions involving the ^{14}C method. A topic for concern for archeologists, isotope fractionation, is not discussed in detail, however. Since the text attributes anomalous ages in a few instances to isotope fractionation (pp. 15 and 30), a more extended discussion would have been desirable.

Other chapters involve dendrochronological aspects by H. N. Michael, archeomagnetic dating by V. Bucha, Thermoluminescent dating of pottery by J. Winter, Fission-track dating by H. Faul and G. A. Wagner, Obsidian-hydration dating by J. W. Michels and C. A. Bedrich, and Potassium-Argon dating by H. Faul. The treatment of the various methods is somewhat uneven. Archaeomagnetic dating and obsidian-hydration dating, combined fill half of the book's 227 pages, whereas Potassium-Argon dating is covered in 7 pages. It may be difficult for the user to decide whether he gets too much of the first, or too litttle of the last.

As is often the case, important new additional material is already available even before final printing of this volume. One such example is the fission-track dating of zircons in archeological materials such as pottery, tiles, and baked earth. This method seems at least as promising as the dating of ceramics through thermoluminescence.

Of course, it is easy to find minor inconsistencies for a volume of this size, for instance, the laboratory standard is 100 years on p. 18, but 110–130 years on the next page. As a whole, however, the present handbook on dating techniques is an excellent guide for the archeologist, and makes one look forward to further volumes to be published under the auspices of the Applied Science Center for Archeology at the University Museum in Philadelphia.

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BOOK REVIEWS

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It is interesting to compare this book with one by Gisela M. A. Richter, *Perspective in Greek and Roman Art* (London 1970). Dr. Richter, as always, gives a clear concise survey of her broad subject—foreshortening, linear perspective, representations of objects in the distance, from the orientalizing and early archaic periods to the 4th century A.D. Her conclusion on linear perspective as set forth on pages 50-54 is in contrast to Little's, who assumes that the Romans had a one-point perspective.

Little's investigations can also be used for modern presentations of ancient drama. When at Harvard from 1936 to 1939, he staged Euripides' *Alcestis*, Aristophanes' *Clouds* and *Birds*, and Plautus' *Mostellaria* with stage settings in imitation of Pompeian wall painting. Photographs of these productions, some of which the author kindly sent me, have been exhibited in Widener Library at Harvard since March 1972.

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MARGARETE BIEBER
NEW YORK

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E. Ralph's article on radiocarbon dating is excellent: she discusses most informatively techniques, problems, kinds and amounts of organic samples suitable for dating, and dating precision. Archaeomagnetic dating, written by V. Bucha, is equally good, and the reader will finish it with a sense of feeling and understanding of what the method can do. J. Winter's discussion of thermoluminescent dating of pottery seems to me a thorough and up-to-date review of principles and results of their application. Obsidian hydration dating by J. Michels and C. Bebrich treats the development of the method, laboratory techniques employed, and advice on sample collection and care. It is possible that the authors are more hopeful of the potentiality of this method for securing chronometric age than is warranted, because there are so many known or suspected factors (soil chemistry, conditions of burial, composition of the glass, temperature, humidity) which are difficult to control.

The treatments of dendrochronology, fission track dating, and potassium-argon dating are much briefer, but no less useful. Perhaps these subjects will be given the fuller treatment they deserve in future handbooks.

There are now available a number of books and monographs published in the last two years which cover much of the same ground. D. Brothwell and E. Higg's *Science in Archaeology* (1970), R. Berger's *Scientific Methods in Medieval Archaeology* (1970), R. H. Brill's *Science and Archaeology* (1971), and the Royal Society of London's symposium *Impact of the Natural Sciences in Archaeology* (1970), are equally wide-ranging, and there is considerable duplication of information, as well as of authors, in these volumes. Scientific archaeology appears to have developed as a specialized field which has become so complex that scientists rather than archaeologists are its practitioners. Perhaps we have now, and for a few years to come, enough volumes of this sort which are either collections of symposium papers or articles gathered together by a persuasive editor. Is it possible that the interest in how to apply science to archaeology is not being matched with equal concern by archaeologists (or at least those archaeologists who have not turned scientists) about what the scientific results mean in terms of the cultures and peoples of the past? The precision of science may have beguiled or diverted many archaeologists from the humanistic aim of prehistory. (I am not referring here to attempts to apply the scientific method to archaeology such as that made by Watson, LeBlanc and Redman in *Explanation in Prehistory*, 1971.) Perhaps it is time to organize an international symposium of working archaeologists to discuss and assess the degree to which archaeology actually does and properly should depend on science

and how far archaeology should go in the direction of trying to become scientific.

This suggestion is not made with any intent to depreciate the important help that scientific examination and analysis of archaeological materials can provide. Archaeologists have always depended on the assistance of experts in geology, botany, zoology, chemistry, physics and other disciplines in their efforts to understand man in relation to the physical world—and they have been grateful for this assistance. But I am still bothered by the question of whether archaeologists, to some degree, have not become over-concerned with what natural science experts can tell them, to the extent that such answers have at times become the end or aim of archaeological investigation. Laboratory scientists can inform archaeologists about exact or relative ages of some objects, or about the geologic source of obsidian or flint artifacts, and these are pieces of information that can be of great significance. What concerns me is whether archaeologists in the last 30 years have realized the extent to which the finite amount of research funds for archaeology have been awarded to the penumbral areas of research, which could in the end take over the primary responsibility of human prehistory that archaeologists should insist is their domain.

Despite these observations I found the Michael-Ralph volume to be one of high competence and reliably informative. I recommend that it be in the library of all practicing archaeologists.

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OLMEC, An Early Art Style of Pre-Columbian Mexico, by *Charles R. Wicke*. Pp. xx + 188, frontis., figs. 38, tables 9, map, bibliog., index. University of Arizona Press, Tucson, 1971. $12.00.

In what is evidently intended as a free-wheeling, imaginative, many-sided treatment of Olmec art, Wicke begins with a brief history of the fieldwork and thinking relating to the Olmec; he then goes on to discuss Redfield's folk-urban continuum, the evolution of settlement patterns as outlined by the Beardsley seminar in 1955, the characterization of art styles by Sorokin as Ideational and Sensate, the views of Marx on the primacy of economic factors in culture change, D. Kaplan's analysis of chiefdoms, Durkheim's explanation of ancestor worship, and the thoughts of Freud and J. L. Fischer on the relationship of art to personality, society and culture. These themes are treated at a pace that is best described as a gallop. The path is a rocky one, detours and dead ends are many, and views of the passing landscape are generally blurred. Replete with false parallels and oppositions, irrelevancies and non sequiturs, the discussion touches upon many large and interesting problems, but comes to grips with none of them. Factually, some of the material on the Olmec used by Wicke is, by now, out of date. The writing contains many clichés and the illustrations are uneven in quality.

One problem which Wicke does pause to examine at leisure is that of the seriation of the Olmec colossal heads. For the purpose he uses four attributes, three of them originally proposed by Kubler, and constructs a Guttman scale. His attempt is unsatisfactory for three reasons: 1) the attributes are too few; 2) they are insufficiently objective; and 3) Guttman scaling is not the most appropriate tool for the problem. The first two points need no elaboration, and the reader is referred to a paper by C. William Clewlow and others (*Colossal Heads of the Olmec Culture*, Contributions of the University of California Archaeological Research Facility, no. 4, 1967) for a more thorough and successful analysis of the same data.

With reference to the third point, Wicke seems unaware that similar but more flexible techniques have been available to archaeologists for some time, to deal precisely with this kind of problem. By way of example I have attempted below to apply one of these, a simple presence-and-absence technique, in the search for a linear order in the data both by inspection and through an ordered matrix. The attributes are those recorded by Clewlow and others, with some slight changes. I initially omitted from consideration those features that are confined to either La Venta or San Lorenzo, in the event that they might reflect not trends common to the heartland as a whole, but local intra-site practices or "schools." These features were later reintegrated into the seriation chart, as shown in the accompanying figure. I also tried out separate intra-site seriations for San Lorenzo and La Venta (not figured here), using both inspection and ordered matrices, with results highly congruent with those of the overall ordering.

The pattern that emerges is interesting, and differs in several ways from the one perceived by Wicke. Three major groups are indicated, which are labeled arbitrarily F, M, and S, in that order. They are segments of the series SL3-SL4-SL5-LV2-SL2-SL1-LV1, a series unambiguously supplied both by inspection and by measures of agreement between all specimens. Within it, only the positions of SL1 and SL2 are interchangeable, depending on whether the inter-site or intra-site ordering is preferred. The positions of LV4, LV3 and SL6, though less definite, are clearly within groups S, M, and F, respectively. The Tres Zapotes heads (NS, TZ) are hardest to place as they share few features present at both other sites; for that reason they were excluded from the initial ordering. Their best placement seems to be on the outer fringe of, or beyond, group S, and these results accord with the views of Kubler and Wicke. Moreover, I would agree with Wicke in supposing that LV1, LV4, and the Tres Zapotes heads represent the more recent end of the series, though this, of course, does not follow from the ordering itself. Finally, the present seriation is in total agreement with Clewlow and his associates as to the sub-grouping of the heads on an intra-site basis.

Two unexpected consequences of the new ordering

stereotype was the external façade of an architectural complex, "with a central area of spatial recession." The best example for this is the Room of the Masks from the basement of the House of Augustus on the Palatine Hill (frontisp., pl. III: 3, pl. IX: 1).

In Part II (pp. 13-20), the author discusses the relationship between architecture and perspective in Roman wall painting. He first shows how perspective wall-painting made its way into Roman houses. Mau, in his book *Pompeji in Leben und Kunst* (1900), considered all four Pompeian styles of wall painting to have developed in different places in the "Hellenized Orient." Now only the first style is definitely considered Greek in origin. It consists of a stucco imitation of a wall built in different colored marbles. It had already been adopted by the Hellenized Oscans in Pompeii before the Roman colonization. The oldest parts of the House of the Faun (pl. IV: 1) have a decoration of this style. The second style consisted of imitating real wall construction, not in stucco but in actual wall painting. When the Romans conquered the Hellenistic kingdoms, they brought their art treasures to Rome as part of the booty. Young men went to Athens and Rhodes to study; there they realized that their houses were very modest in comparison to Hellenistic palaces. They therefore adopted for their homes a perspective style of wall painting, which created the illusion of an architectural structure of solid stone and thereby enlarged the room.

This second style came to Pompeii after the Roman conquest and with the establishment of Pompeii as a colony. From then on, the development of wall painting was purely Roman and an important part of creative Roman art. The style of wall painting changed in accordance with Roman architectural patterns. The Romans, with their frequent use of the vault and arch, replaced the straight post and lintel system of the Greeks with curved forms in architecture as well as in wall painting, and thus expanded the illusion of space in regard to height. In regard to width and length, illusion of enlarged space was attained by painting a row of columns on socles or plinths; this left a kind of corridor between the columns and the wall. A good example of the second style is the House of the Griffins on the Palatine Hill in Rome (pl. V: 3-4).

A further development occurred when the wall itself was provided with painted doors and outdoor vistas to enlarge the illusive space more and more. The author describes the different experiments and developments of the painters step by step. The purely architectural background became a more spacious, pictorial one (pl. VII: 1, bedroom from the Villa of Boscoreale in the Metropolitan Museum; pl. VII: 2, wall in the oecus of the House of the Labyrinth, Pompeii).

In Part III, the last and largest part (pp. 23-43), Little considers Vitruvius' book on architecture as a comprehensive, practical, and up-to-date handbook based on the Roman author's wide experience and study. *De architectura* has special sections on the distinctive aspects of the Roman theater, and on planning and decorating the Roman private house. Vitruvius was aware of the contributions made by the Hellenistic science of optics in achieving satisfactory results in architecture and painting. As a decorator and architect, he was especially interested (as Little is) in the "use of perspective for spatial effects in painting both in the private house and in the theater" (p. 23). Little cites Vitruvius on decoration for the Roman house and compares these to actual wall paintings. He finds in Vitruvius as well as in existing wall paintings a sequence first of architectural perspective in the closed areas of the house, then of perspective painting to match more open areas, and finally the use of figures in their settings. Also he quotes Vitruvius on the use of perspective painting in the theater.

He investigates the use of perspective stereotypes to suggest added space in a room, as found in the houses of Rome and Pompeii. The outdoor vistas used for this purpose are traced, in accordance with Vitruvius, to stock forms of ancient scene painting. Little distinguishes between schemes in which the central panel has 1) an elaborate door leading into the central court, 2) a low barrier beyond which is a public square, or 3) curtains, altars, and offerings leading to a closed sacred area with a circular shrine in a peristyle court (see his examples on pl. III: 1; pl. VII: 1; pl. VIII: 4-6). He believes that stereotyped sides with columns and doors were enclosed in a frame of two terminal lanes in perspective recession, as shown in the Room of the Masks in the House of Augustus on the Palatine (pl. IX: 1) indicating a closed corridor running backstage (for the author's reconstruction of the stage inside this frame, see pl. IX: 2-3; for a perspective outline, see the frontispiece).

Little believes that the three different paintings for tragic, comic, and satyric scenes were even painted for the early Roman wooden stage—on flats attached to triangular machines which could be rotated (Greek *periaktoi*, Latin *scaenae versiles*). The scene in midstage was changed by *scaenae ductiles*, flats moved into position behind a frame of columns. From these painted backgrounds developed the stone *scaenae frons* with actual, not painted, recessions. This *scaenae frons* may have taken the plinth-like support for the lowest row of columns from the south Italian stage and from the Hellenistic *thyroma* stage.

In the third and fourth styles of Pompeian wall paintings, some elements of stage settings are found. A new element is the use of curtains, almost certainly suggested by the *aulaeum* and the *siparia* used on the stage. Recognition scenes were put into theatrical settings, such as the recognition of Achilles among the daughters of Lycomedes from the House of the Dioscuri and the meeting of Iphigenia with her brother Orestes (not Pylades, as Little states on p. 40) from the fourth style house of Pinarius Cerialis (pl. IV: 3).

In his Conclusion (pp. 40-43), the author rightly emphasizes the Roman character in Roman and Pompeian wall painting. The second Pompeian style was the first authentic Roman contribution—the creators were not Hellenistic Greeks, but Roman architects and engineers. The text is followed by a short section of

notes (pp. 44-47) and a good Select Bibliography with three subheadings—Ancient Perspective, Roman Wall Painting, Painting and the Roman Stage (pp. 48-50).

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E. Ralph's article on radiocarbon dating is excellent: she discusses most informatively techniques, problems, kinds and amounts of organic samples suitable for dating, and dating precision. Archaeomagnetic dating, written by V. Bucha, is equally good, and the reader will finish it with a sense of feeling and understanding of what the method can do. J. Winter's discussion of thermoluminescent dating of pottery seems to me a thorough and up-to-date review of principles and results of their application. Obsidian hydration dating by J. Michels and C. Bebrich treats the development of the method, laboratory techniques employed, and advice on sample collection and care. It is possible that the authors are more hopeful of the potentiality of this method for securing chronometric age than is warranted, because there are so many known or suspected factors (soil chemistry, conditions of burial, composition of the glass, temperature, humidity) which are difficult to control.

The treatments of dendrochronology, fission track dating, and potassium-argon dating are much briefer, but no less useful. Perhaps these subjects will be given the fuller treatment they deserve in future handbooks.

There are now available a number of books and monographs published in the last two years which cover much of the same ground. D. Brothwell and E. Higg's *Science in Archaeology* (1970), R. Berger's *Scientific Methods in Medieval Archaeology* (1970), R. H. Brill's *Science and Archaeology* (1971), and the Royal Society of London's symposium *Impact of the Natural Sciences in Archaeology* (1970), are equally wide-ranging, and there is considerable duplication of information, as well as of authors, in these volumes. Scientific archaeology appears to have developed as a specialized field which has become so complex that scientists rather than archaeologists are its practitioners. Perhaps we have now, and for a few years to come, enough volumes of this sort which are either collections of symposium papers or articles gathered together by a persuasive editor. Is it possible that the interest in how to apply science to archaeology is not being matched with equal concern by archaeologists (or at least those archaeologists who have not turned scientists) about what the scientific results mean in terms of the cultures and peoples of the past? The precision of science may have beguiled or diverted many archaeologists from the humanistic aim of prehistory. (I am not referring here to attempts to apply the scientific method to archaeology such as that made by Watson, LeBlanc and Redman in *Explanation in Prehistory*, 1971.) Perhaps it is time to organize an international symposium of working archaeologists to discuss and assess the degree to which archaeology actually does and properly should depend on science

and how far archaeology should go in the direction of trying to become scientific.

This suggestion is not made with any intent to depreciate the important help that scientific examination and analysis of archaeological materials can provide. Archaeologists have always depended on the assistance of experts in geology, botany, zoology, chemistry, physics and other disciplines in their efforts to understand man in relation to the physical world—and they have been grateful for this assistance. But I am still bothered by the question of whether archaeologists, to some degree, have not become over-concerned with what natural science experts can tell them, to the extent that such answers have at times become the end or aim of archaeological investigation. Laboratory scientists can inform archaeologists about exact or relative ages of some objects, or about the geologic source of obsidian or flint artifacts, and these are pieces of information that can be of great significance. What concerns me is whether archaeologists in the last 30 years have realized the extent to which the finite amount of research funds for archaeology have been awarded to the penumbral areas of research, which could in the end take over the primary responsibility of human prehistory that archaeologists should insist is their domain.

Despite these observations I found the Michael-Ralph volume to be one of high competence and reliably informative. I recommend that it be in the library of all practicing archaeologists.

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OLMEC, An Early Art Style of Pre-Columbian Mexico, by *Charles R. Wicke*. Pp. xx + 188, frontis., figs. 38, tables 9, map, bibliog., index. University of Arizona Press, Tucson, 1971. $12.00.

In what is evidently intended as a free-wheeling, imaginative, many-sided treatment of Olmec art, Wicke begins with a brief history of the fieldwork and thinking relating to the Olmec; he then goes on to discuss Redfield's folk-urban continuum, the evolution of settlement patterns as outlined by the Beardsley seminar in 1955, the characterization of art styles by Sorokin as Ideational and Sensate, the views of Marx on the primacy of economic factors in culture change, D. Kaplan's analysis of chiefdoms, Durkheim's explanation of ancestor worship, and the thoughts of Freud and J. L. Fischer on the relationship of art to personality, society and culture. These themes are treated at a pace that is best described as a gallop. The path is a rocky one, detours and dead ends are many, and views of the passing landscape are generally blurred. Replete with false parallels and oppositions, irrelevancies and non sequiturs, the discussion touches upon many large and interesting problems, but comes to grips with none of them. Factually, some of the material on the Olmec used by Wicke is, by now, out of date. The writing contains many clichés and the illustrations are uneven in quality.

One problem which Wicke does pause to examine at leisure is that of the seriation of the Olmec colossal heads. For the purpose he uses four attributes, three of them originally proposed by Kubler, and constructs a Guttman scale. His attempt is unsatisfactory for three reasons: 1) the attributes are too few; 2) they are insufficiently objective; and 3) Guttman scaling is not the most appropriate tool for the problem. The first two points need no elaboration, and the reader is referred to a paper by C. William Clewlow and others (*Colossal Heads of the Olmec Culture*, Contributions of the University of California Archaeological Research Facility, no. 4, 1967) for a more thorough and successful analysis of the same data.

With reference to the third point, Wicke seems unaware that similar but more flexible techniques have been available to archaeologists for some time, to deal precisely with this kind of problem. By way of example I have attempted below to apply one of these, a simple presence-and-absence technique, in the search for a linear order in the data both by inspection and through an ordered matrix. The attributes are those recorded by Clewlow and others, with some slight changes. I initially omitted from consideration those features that are confined to either La Venta or San Lorenzo, in the event that they might reflect not trends common to the heartland as a whole, but local intra-site practices or "schools." These features were later reintegrated into the seriation chart, as shown in the accompanying figure. I also tried out separate intra-site seriations for San Lorenzo and La Venta (not figured here), using both inspection and ordered matrices, with results highly congruent with those of the overall ordering.

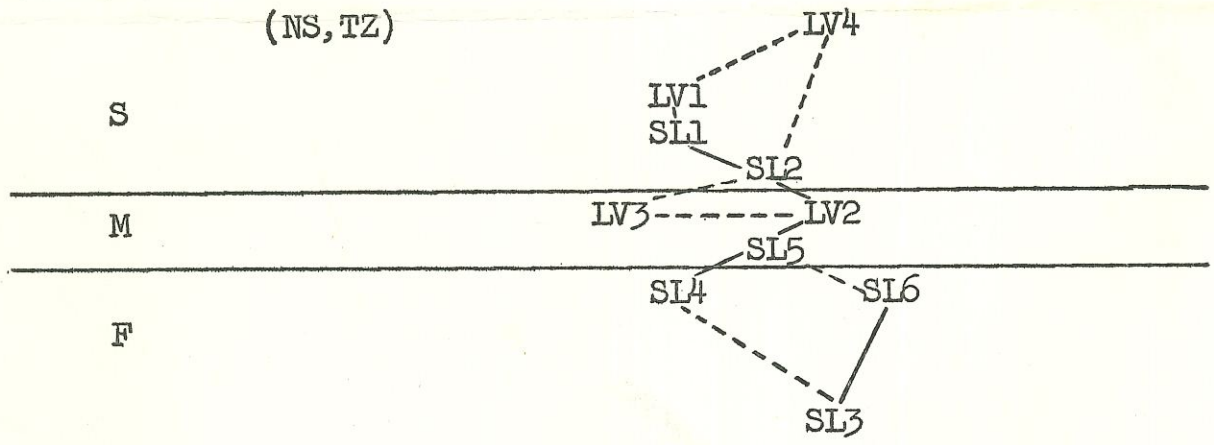
The pattern that emerges is interesting, and differs in several ways from the one perceived by Wicke. Three major groups are indicated, which are labeled arbitrarily F, M, and S, in that order. They are segments of the series SL3-SL4-SL5-LV2-SL2-SL1-LV1, a series unambiguously supplied both by inspection and by measures of agreement between all specimens. Within it, only the positions of SL1 and SL2 are interchangeable, depending on whether the inter-site or intra-site ordering is preferred. The positions of LV4, LV3 and SL6, though less definite, are clearly within groups S, M, and F, respectively. The Tres Zapotes heads (NS, TZ) are hardest to place as they share few features present at both other sites; for that reason they were excluded from the initial ordering. Their best placement seems to be on the outer fringe of, or beyond, group S, and these results accord with the views of Kubler and Wicke. Moreover, I would agree with Wicke in supposing that LV1, LV4, and the Tres Zapotes heads represent the more recent end of the series, though this, of course, does not follow from the ordering itself. Finally, the present seriation is in total agreement with Clewlow and his associates as to the sub-grouping of the heads on an intra-site basis.

Two unexpected consequences of the new ordering

La Ven., LV = La Venta
S. Lor., SL = San Lorenzo

		1-Four-part braid	2-Ear covered	3-Incised iris	4-Double nasion	5-Mouth open, no teeth	6-Defacement: pits	7-Cintepec stone	8-Full chin strap	9-Crosshatching	10-Ear Cylinders	11-Width/height .822 or less	12-Length/height .681 or more	13-Disk and tassel	14-Subrhombic nasion	15-Abbreviated strap	16-Claw on head	17-Mouth open, teeth	18-Defacement: grooves	19-Ear disks	20-Knots on back	21-Weight over 18 tons	22-U ornament	23-Lip ridges	24-Raised iris	25-Mouth closed
La Ven.4													+				+									
La Ven.1	s											+	+				+									
S. Lor.1						s	+	+			s	+			+	+			+		s	+	+	s	+	
S. Lor.2							+	+		s		+			+	+		+	+	+	s	+				
La Ven.3					+	/	+	+		/	/					+		+	+	+						
La Ven.2	M			+		/	+	+		/	/	+		+	+	+		+	+							
S. Lor.5				+		s	+	+		s		+	+	+	+	+	+									
S. Lor.4			s	s	+		s	+	+	s			+		+	+										
S. Lor.6	F		s		+	+	s	+	+	s	s	s	+	+													
S. Lor.3			s	s	+	+	s	+	+																	

Attribute distributions in linear ordering of San Lorenzo and La Venta heads. Key: + = presence, attribute known from SL and LV; s, l = presence, attribute known from SL or LV alone; / = absence, perhaps expectable, because attribute is confined to the other of the two sites. (s, l, and / not used as basis for placement in ordering.) "F", "M" and "S" are arbitrary designations for the 3 groups that emerge to avoid the letters and roman numerals preempted by other schemes.



Link diagram based on ordered matrix (not shown). Solid lines are reciprocal links; broken lines are nearest one-way links. Spacing is roughly proportional to likeness of specimens.

ADENOVIRUSES

Ad2 and SV40

from our Cell Biology Correspondent

WHAT renders a cell non-permissive and unable to support the replication of any particular virus is one of the more interesting questions which virologists face and no doubt the molecular basis of non-permissiveness will prove to be manifold, with different mechanisms operating against different viruses in different cells.

One of the few pertinent cell-virus combinations that has been investigated in some detail is the infection of African green monkey kidney (AGMK) cells by human adenovirus type 2 (Ad2). This virus cannot replicate efficiently in AGMK cells even though the virion penetrates the cells, is uncoated and its DNA is transcribed and replicated. When, however, Ad2 and simian virus 40 coinfect AGMK cells the yield of progeny Ad2 is increased by about 1,000-fold. Precisely how SV40 acts as a helper for the replication of Ad2 in these cells and renders them permissive remains unknown, but recent experiments carried out by Lucas and Ginsberg (*J. Virology*, **10**, 1109 ; 1972) seem to eliminate all but two possibilities ; namely either SV40 protects some Ad2 mRNAs from partial degradation by endonucleases or SV40 specifies some function which allows late Ad2 messengers to be translated.

Lucas and Ginsberg have used DNA-RNA hybridization techniques to compare the extent of transcription of the Ad2 genome in AGMK cells, in AGMK cells coinfected with SV40 and in permissive human KB cells in which the adenovirus replicates without the aid of SV40. They also used immunological precipitation techniques to compare the amounts of adenovirus structural proteins made in these various infections. The hybridization experiments, which were carefully conducted to eliminate artefacts, reveal that both early and late species of Ad2 messengers are synthesized in KB cells and AGMK cells in the absence of SV40. Furthermore, the non-conservative maturation of these messengers and their transport to the cytoplasm are comparable in both sorts of cells. In AGMK cells, however, in the absence of SV40 the synthesis of adenovirus structural proteins is some 90-fold less than the synthesis achieved in the presence of SV40 helper. Apparently therefore AGMK cells support transcription of Ad2 DNA, but the viral RNA is not translated.

Lucas and Ginsberg do not yet know whether or not the late Ad2 messengers are partially degraded and not available for translation. If it proves that these RNAs are degraded, and they are addressing themselves to this question, SV40 must somehow protect the molecules from the endonuclease(s). If, on the other hand, the late Ad2 messengers in AGMK cells are as stable as they are in KB cells Lucas and Ginsberg will look for a function specified by SV40 that directly promotes the translation of Ad2 messengers. The result, whatever it is, will be interesting.

In the same issue of the journal (*ibid.*, 1126) Bhadani, Raskas and Green report a method for partially purifying milligram amounts of Ad2 messenger RNA from KB cells some 18 hours after infection. They have simply exploited the fact that at high ionic strengths the polyadenylic acid tails of the messengers cause them to bind to cellulose nitrate filters. As they point out, these mRNAs should prove useful for analysing the synthesis of adenovirus proteins in cell-free systems and, of course, if Lucas and Ginsberg find that the SV40 helper function is directly involved in facilitating translation, such cell-free systems may provide a means of identifying precisely the helper function.

DATING TECHNIQUES

Using Carbon—14

from a Correspondent

THE intention of the eighth international conference on radiocarbon dating, which was organized by the Royal Society of New Zealand at Lower Hutt on October 18–25, was to bring together scientists engaged in operating dating laboratories and in evaluating results. The programme was designed to deal with technical aspects of dating and the significance of isotopic ratios measured in the estimation of radiocarbon dates and with the environmental factors that might affect the interpretation of the results in terms of absolute years. It was not intended to provide a forum for the discussion of actual projects using carbon-14 dates primarily as indicators of time supporting other geochemical or archaeological evidence. The chief emphasis was on the problems of the variation of concentration and residence times of carbon-14 in ocean water ; the role of radiocarbon in freshwater and in soil development ; the effects and amounts of various contaminants on dates ; and on considerations of suitable standards for carbon-14 activity.

It was appropriate that the meeting was held at Lower Hutt—nine miles from Wellington—because this is the site of the New Zealand Department of Scientific and Industrial Research whose director, Dr A. Rafter, with the collaboration of Dr G. J. Fergusson, established the first carbon-14 dating laboratory, with a range surpassing 55,000 years, in the Southern Hemisphere.

Of general interest were the contributions on secular variations of atmospheric radiocarbon. There are three distinct areas. Dr W. Fergusson (University of Arizona) reported that the bristlecone pine chronology had been extended by another 1,000 years to nearly 8,200 BP and that he would shortly have wood of this age available for radiocarbon analysis. Dr E. Ralph (University of Pennsylvania) and Professor P. Damon (University of Arizona) described separate methods for dealing with the nearly 400 determinations in the literature of the radiocarbon ages of dendrochronologically

Inducing Polyoma Virus Production

IN *Nature New Biology* next Wednesday (February 7) Fogel describes further experiments with the line of rat embryo muscle cells transformed by the large plaque strain of polyoma virus which he and Sachs established in 1967. This line of transformed cells is of interest because at a frequency of about 1 in 10^4 the cells are spontaneously induced to release polyoma virus. Furthermore, various physical and chemical agents which cause DNA breakage increase the frequency of induction of virus synthesis.

In his latest experiments Fogel allowed the cells to incorporate varying amounts of 5-bromodeoxyuridine and then exposed them to various doses of visible light, a procedure which results in single strand breaks in the cell DNA. He reports that after such treatment the number of cells containing polyoma virus capsid antigen can be increased by some 600-fold and the number of cells producing virus can be increased by about 100-fold. The number of infectious virus particles produced per cell, however, decreases.

One obvious explanation of these data is that the extensive DNA breakage induced by the treatment is lethal to the cells which do not survive long enough to produce much virus. This idea is supported by the observation that exposure of the cells to cysteamine at the time of irradiation increases cell survival up to 70-fold, decreases some 2–3-fold the number of cells containing capsid antigen but increases the number of virus particles produced per cell. All these data indicate that the replication of polyoma virus in these cells is induced by single strand breakage of the cellular DNA.

dated wood, in order to provide a calibration of the radiocarbon time scale that could be used for converting conventional radiocarbon dates to calendaric dates.

It was disappointing that the conversion graphs and tables produced by the two methods did not agree sufficiently well for the conference to advise their adoption for calibration purposes. This adoption must be deferred until at least the next international conference on dating, for new data will make little difference to the curves for some time. The causes of carbon-14 variations in terms of geomagnetic and heliomagnetic cycles as well as climatic changes at the end of the last glaciation were sought as explanations by Professor A. Fairhall (University of Washington), Dr E. Ralph (University of Pennsylvania) and Dr M. Baxter (University of Glasgow). Dr Baxter warned that fluctuations induced by Sun spots could introduce uncertainties of up to 120 years in the dating of short lived materials such as grain, straw, seeds, single tree rings, twigs or egg shells.

Professor G. Östlund (University of Miami) introduced the GEOSECS oceanic programme, the purpose of which is the detailed measurement of the chemical constituents of water along sections from the Arctic to Antarctic in the Pacific and Atlantic oceans from surface to bottom. These measurements will provide a set of physical and chemical data that can be used for quantitative studies of ocean mixing and ocean productivity. They will also provide a base line for levels of pollutants and of fission and waste products being added to the sea. One of the most important sections of the programme is the measurement of carbon-14, because its half life is comparable with the time scale of mixing processes occurring in the deep ocean. Special carbon-14 laboratories are being established at Miami and Seattle (Professor M. Stuiver) to deal with the anticipated 1,200 samples each of 200 litres of water.

The nuclear bombs exploded since 1955 have doubled the radioactive carbon dioxide in the troposphere, and large doses have been injected into the lower atmosphere through the tropopause gap. All terrestrial tissues have reacted naturally to this and compounds involved in the usual processes of photosynthesis and feeding have had a fraction of all their carbon positions labelled. Mr H. S. Jansen (Institute of Nuclear Sciences, Lower Hutt) pointed out that there was now an opportunity for measuring residence times (that is, the mean time before a carbon atom residing in a tissue is replaced by atmospheric carbon) in such a way that could be expected to reflect biochemical processes in the animal or plant tissue without conducting experiments which might alter the process. He regretted the fact that the opportunity was being lost by the workers in the life sciences because the activity was at present falling by 1.5 per cent each year. He assumed that this lack of use of "bomb carbon" is probably attributable to inadequate communications between disciplines. In an attempt to redress this, Mr Jansen has compiled families of curves for various latitudes and different years of origin or birth of the tissue. He has plotted $\triangle^{14}C$, relative radiocarbon enrichment of the tissue against calendar years so that, at a glance, a researcher can read off the rate of replacement from the curves. Other experiments can be planned with their aid.

Synthesis of Myeloma Light Chain DNA

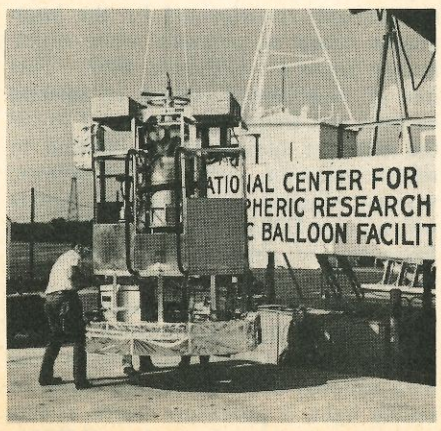
THE biological role of tumour virus reverse transcriptase is apparently the synthesis of a DNA provirus during the establishment of infection, but be that as it may this enzyme in the hands of biochemists is an invaluable tool for the synthesis of DNA chains which can be labelled to a high specific activity and which are complementary to specific cellular RNA molecules. Single stranded DNA molecules complementary to at least part of globin messenger RNA molecules have recently been synthesized and partially purified, and in next Wednesday's *Nature New Biology* (February 7) Aviv, Packman, Swan, Ross and Leder report the synthesis of a DNA complementary to about 40 per cent of a mouse myeloma light chain messenger RNA.

Aviv *et al.* purified reverse transcriptase from avian myeloblastosis virus and partially purified light chain messenger RNA, which in a cell free system stimulates immunoglobulin light chain synthesis, from mouse MOPC 41 tumour cells. Using oligo (dT) as a specific primer of reverse transcription, the oligo (dT) presumably hydrogen bonds to the poly (A) residues at the 3′ terminus of the mRNA molecules, they synthesized a 5S DNA which contains about 325 nucleotides. Hybridization experiments with this DNA and polysomal RNAs from MOPC 41 cells and another line of myeloma cells, MOPC 315, indicate that the product of reverse transcription is heterogeneous.

In addition to a major species of DNA complementary to the light chain mRNA DNAs complementary to RNAs common to both MOPC 41 and MOPC 315 cells are made. As Aviv *et al.* point out, however, it should be possible to purify the major DNA species and use it to discover the number of myeloma light chain genes in these mouse MOPC 41 cells.

Two New Infrared Sources Discovered

STUDIES of astronomical sources in the infrared continue to be carried out by the group at University College, London. Telescopes carried on balloon flights from Texas last September scanned known objects, and also resulted in the discovery of two new sources, not previously detected in the infrared. These objects, RCW 117 and DR 15, are both HII regions, and were previously known by their radio emission.



The UCL balloon-borne infrared telescope being rigged at NCAR, Texas, shortly before launch.

Details of the observations are reported by Emerson, Jennings and Moorwood in next Monday's *Nature Physical Science* (February 5). RCW 117 appears as a compact infrared source, smaller than the 4 arc min beamwidth of the detector. It seems that it is a compact HII region, whereas the other object discussed in this work, DR 15, is not particularly compact. The new observations at infrared frequencies have made it possible to test the theory that much radiation is produced by the degradation of ultraviolet photons by dust grains. The data suggest that the amount of ultraviolet energy required could be supplied by an underlying young O star within the HII region, but that the radiation would then have to be coupled very efficiently to the dust.

was introduced so that the deviations could be plotted against radiocarbon age (which is non-linear) and hence a correction factor was obtained as well as the standard deviation for 250-year intervals. This deviation is a function of the geomagnetic field intensity since sunspot variations have a larger effect on radiocarbon production rate during periods of low magnetic field intensity compared with periods of high geomagnetic field intensity.

Throughout the discussion of the work on the Bristlecone Pine calibration of the radiocarbon time-scale Dr H. E. Suess has stated that his is the only true calibration and has refused to allow his results to be published on a single chart together with those from other laboratories.* He maintained the stand in New Zealand that nature is not necessarily as simple as we would wish and an attempt to draw a smooth curve amongst the measured points is probably the wrong approach. He believes that the 'kinks' and 'wriggles' are real and do represent rapid changes of atmospheric C14 activity. These idiosyncrasies of the original data are necessarily obscured by the extensive procedures of averaging used by both Michael and Ralph and Damon *et al.* in obtaining their new correction curves. The curves have the computational advantage, however, that each radiocarbon measurement yields but one calendar age.

In order to investigate the 'non-agreement' of the two correction factors the columns in Table 1 show the following: The first two columns give the radiocarbon age in terms of ad/bc and bp using the 5730 half-life for radiocarbon (in order to convert dates bp provided by the dating laboratory it is necessary to multiply by the factor 1·03). The third and fourth columns give the corrected age in calendar years as given directly by the Arizona correction and as derived from about the mid points of the Pennsylvania correction factor for the same BP age. The next column gives the difference, in years, between the two corrections; positive (+) if the Arizona correction yields the older age and negative (—) if the Pennsylvania correction gives the older age. The final column gives the mean of the two corrected ages.

The numbers in column 5 are plotted in FIG. 1 and one can immediately see from this the effects of either correction on any individual radiocarbon date. It will be observed that the difference in most cases is comfortingly small and probably within the limits of the standard deviation provided with the radiocarbon date. Only during the radiocarbon time period 3900 to 5500 bp does the difference exceed 100 years, the average difference for the whole of the time covered being only 34 years.

Since these two correction factors are so close, even though based on different methods of averaging it was thought convenient to accept their mean values as the best corrections available at the present state of the art. Accordingly, these are presented for the 50-year intervals in column 6 and are plotted in FIG. 2. It should be emphasized that the two papers given at the Conference contain full details of the derivation of the correction factors and tables containing a larger number of conversion points.

The conversion factors are based on about 600 individual measurements and it will be many years before a sufficiently greater number of measurements will be made to alter the shape of the deviation curve significantly. Hence there is little likelihood that correction factors that are very different from these given will be derived. There is every probability, however, that the curve will be extended and areas having a low density of measurements so far, will be made more definitive.

Finally, in Table 2, a systematic comparison is made between the ages obtained by the use of the new correction and those calculated by means of the equation found by Wendland and Donley in their exercise of fitting a curve to the tree ring measurements available at that time.† Their equation for the calendar age is:

$$112 + (0{\cdot}690 \times R) + (1{\cdot}520 \times 10^{-4} \times R^2) - (1{\cdot}38 \times 10^{-8} \times R^3)$$

where R is the radiocarbon age (5730 half life).

Over most of the time scale the equation predicts marginally older calendar ages than the new correction. The difference only reaches a magnitude of 70 to 100 years in the earlier two millennia, and is probably due to the larger number of data points now available yielding a more accurate result.

In practice, when converting radiocarbon ages to calendar ages, the statistical uncertainties must not be ignored. The uncertainty quoted with the radiocarbon date is squared and added to the square of the uncertainty given in Damon *et al* for the appropriate time range. The root of this sum is the uncertainty of the corrected date. As an example take a radiocarbon date of 5894 ± 110 bp

(*a*) correct to 5730 half life giving 6070

(*b*) correct by the calibration chart giving 6747

(*c*) the uncertainty is $\sqrt{110^2 + 77^2}$ (77 is from Damon *et al.*)

$$= \sqrt{12100 + 18029}$$
$$= 134$$

So the calendar age for this sample is 6747 ± 134 BP or 4797 ± 134 BC.

If this correction is carried out in a publication it is essential that the original date and laboratory number are quoted.

Table 1. Investigation of the non-agreement of the two correction factors

Columns 1 & 2: Radiocarbon age (5730 half-life), ad/bc (1) and bp (2)

Column 5: Difference between corrected ages

Columns 3 & 4: Corrected age according to Arizona (3) and Pennsylvania (4)

Column 6: Average of corrected ages BP

1	2	3	4	5	6	1	2	3	4	5	6
1837	113	179	167	+12	173	387	1563	1498	1475	+23	1487
1787	163	221	227	+12	224	338	1612	1548	1545	+3	1547
1737	213	263	324	−61	294	288	1662	1601	1597	+4	1599
1687	263	305	347	−42	326	238	1712	1653	1640	+13	1647
1637	313	347	397	−50	372	188	1762	1707	1702	+5	1705
1587	363	390	433	−43	412	137	1813	1761	1752	+9	1757
1537	413	432	438	−6	435	88	1862	1815	1792	+23	1804
1487	463	475	467	+8	471	38	1912	1869	1835	+34	1852
1437	513	517	542	−25	530	bc					
1387	563	560	580	−20	570	12	1962	1925	1886	+39	1906
1337	613	603	627	−24	615	62	2012	1980	1953	+27	1967
1287	663	647	659	−12	653	113	2063	2037	2015	+22	2026
1237	713	691	682	+9	687	162	2112	2093	2092	+1	2093
1187	763	735	721	+14	728	212	2162	2150	2109	+41	2130
1137	813	779	762	+17	771	262	2212	2207	2206	+1	2207
1087	863	824	813	+11	819	312	2262	2265	2248	+17	2257
1037	913	869	868	+1	869	363	2313	2324	2346	−22	2335
987	963	915	917	−2	916	412	2362	2382	2454	−72	2418
938	1012	960	962	−2	961	462	2412	2441	2507	−66	2474
887	1063	1007	1002	+5	1005	512	2462	2501	2504	−3	2503
838	1112	1053	1062	−9	1058	562	2512	2560	2552	+8	2556
788	1162	1101	1128	−27	1115	613	2563	2622	2622	0	2622
738	1212	1148	1151	−3	1150	662	2612	2681	2707	−26	2694
688	1262	1197	1188	+9	1193	712	2662	2742	2779	−37	2761
637	1313	1247	1254	−7	1251	762	2712	2803	2843	−40	2823
588	1362	1295	1307	−12	1301	812	2762	2864	2885	−21	2875
538	1412	1345	1345	0	1345	862	2812	2926	2896	+30	2911
488	1462	1395	1375	+20	1385	912	2862	2988	2937	+51	2962
438	1512	1446	1420	+26	1433	962	2912	3050	3029	+21	3040

* Olsson I. U. Explanation of plate IV (1970) Radiocarbon variations and absolute chronology, *XII Nobel Symposium*, 625–6.

† W. M. Wendland and D. L. Donley 1971. Radiocarbon-calendar age relationship, *Earth and planetary science letters*, vol. 11, 135–9.

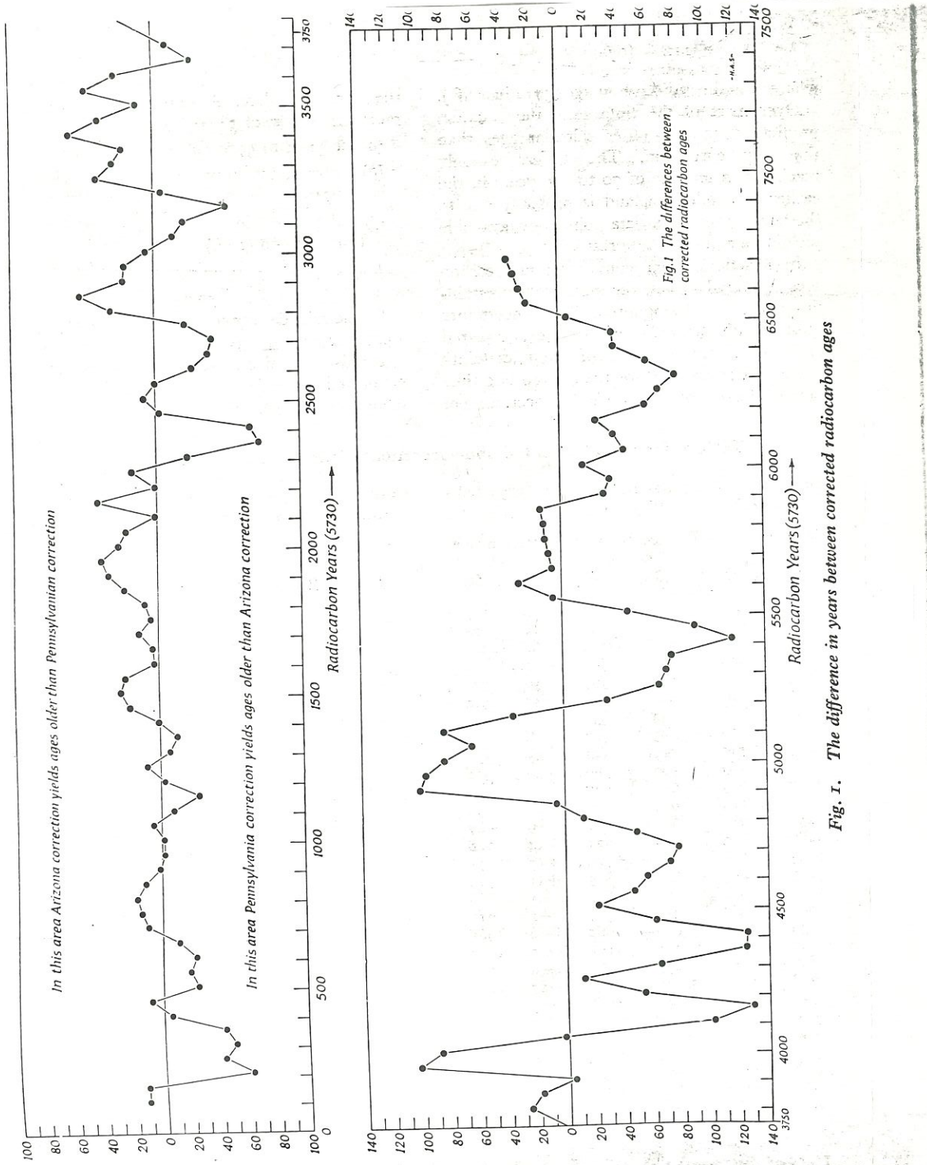


Fig. 1. The difference in years between corrected radiocarbon ages

1	2	3	4	5	6
1012	2962	3112	3092	+20	3102
1062	3012	3175	3170	+5	3173
1113	3063	3238	3252	−14	3245
1162	3112	3300	3321	−21	3310
1212	3162	3358	3408	−51	3382
1262	3212	3420	3426	−6	3423
1312	3262	3483	3444	+39	3464
1363	3313	3547	3519	+28	3533
1412	3362	3610	3589	+21	3600
1462	3412	3673	3615	+58	3644
1512	3462	3736	3698	+38	3717
1562	3512	3793	3782	+11	3788
1612	3563	3858	3811	+47	3835
1662	3612	3920	3894	+26	3907
1712	3662	3984	4011	−27	3998
1762	3712	4047	4057	−10	4052
1863	3813	4168	4141	+27	4155
1912	3862	4230	4211	+19	4221
1962	3912	4293	4297	−4	4295
2012	3962	4356	4253	+103	4305
2062	4012	4419	4331	+88	4375
2113	4063	4482	4480	+2	4481
2162	4112	4544	4645	−101	4595
2212	4162	4606	4735	−129	4671
2262	4212	4668	4721	−53	4695
2312	4262	4730	4742	−12	4735
2363	4313	4792	4857	−65	4825
2412	4362	4853	4977	−124	4915
2462	4412	4914	5039	−125	4977
2512	4462	4974	5041	−67	5008
2562	4512	5035	5057	−22	5046
2613	4563	5096	5143	−47	5120
2662	4612	5155	5211	−56	5183
2712	4662	5214	5286	−72	5250
2762	4712	5273	5351	−78	5312
2812	4762	5332	5381	−49	5357
2863	4813	5391	5404	−13	5398
2912	4862	5448	5388	+6	5418
2962	4912	5506	5406	+100	5456
3012	4962	5563	5467	+96	5515
3062	5012	5620	5537	+83	5579
3113	5063	5677	5613	+64	5645
3162	5112	5732	5649	+83	5691
3212	5162	5787	5649	+35	5770
3262	5212	5842	5872	−30	5857
3312	5262	5897	5963	−66	5930
3363	5313	5952	6023	−71	5988
3412	5362	6005	6080	−75	6043
3462	5412	6059	6176	−117	6118
3512	5462	6111	6202	−91	6157
3562	5512	6164	6209	−45	6187
3612	5562	6217	6211	+6	6214
3662	5612	6268	6238	+30	6253
3712	5662	6319	6312	+7	6316
3762	5712	6370	6311	+9	6366
3812	5762	6421	6410	+11	6416
3863	5813	6472	6460	+12	6466

1	2	3	4	5	6
3912	5862	6521	6507	+14	6514
3962	5912	6570	6600	−30	6585
4012	5962	6619	6653	−34	6636
4062	6012	6668	6684	−16	6676
4113	6063	6718	6762	−44	6740
4162	6112	6765	6802	−37	6784
4212	6162	6813	6838	−25	6825
4262	6212	6861	6920	−59	6891
4312	6262	6908	6976	−68	6942
4363	6313	6957	7037	−80	6997
4412	6362	7003	7063	−60	7033
4462	6412	7050	7088	−38	7069
4512	6462	7097	7134	−37	7116
4562	6512	7144	7150	−6	7147
4613	6563	7191	7170	+22	7181
4662	6612	7238	7211	+27	7225
4712	6662	7285	7254	+31	7270
4762	6712	7332	7297	+35	7315

Table 2. Comparison of the new corrections with the Wendland and Donley regression equation

Years bp	This work	Wendland—Donley regression equation
113	173	192
263	326	304
513	530	054
763	728	721
1012	961	952
1262	1193	1197
1512	1433	1455
1762	1705	1724
2012	1967	2003
2262	2257	2291
2512	2556	2584
2762	2875	2887
3012	3173	3192
3262	3464	3501
3512	3788	3812
3712	4052	4062
4012	4375	4436
4262	4735	4745
4512	5046	5052
4762	5357	5354
5012	5579	5651
5262	5930	5941
5512	6187	6222
5762	6416	6494
6012	6676	6756
6262	6942	7005
6512	7147	7240
6712	7315	7418

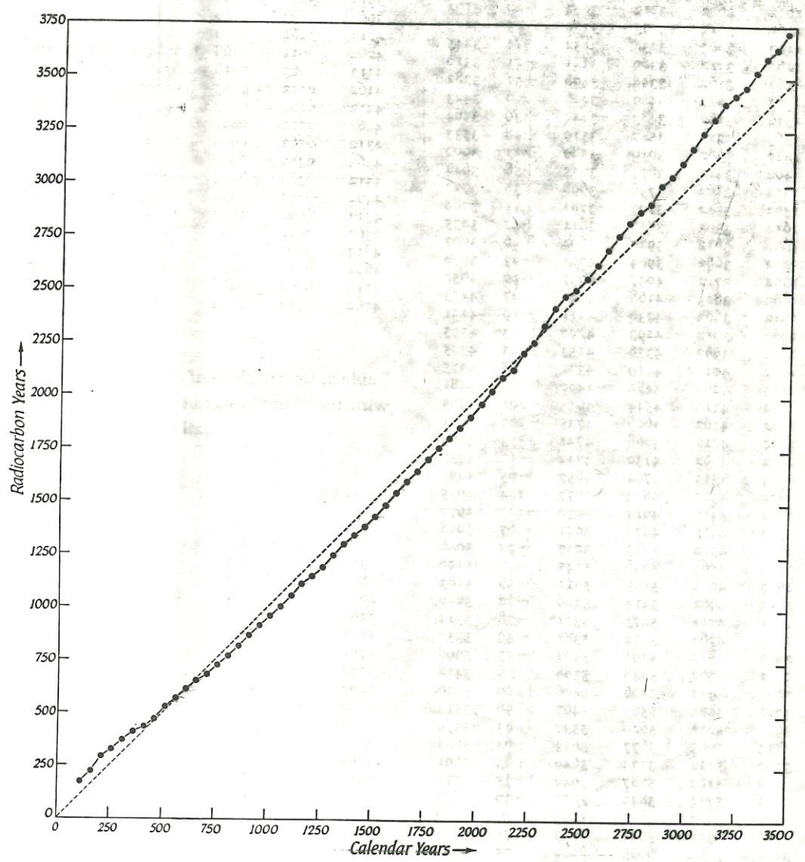
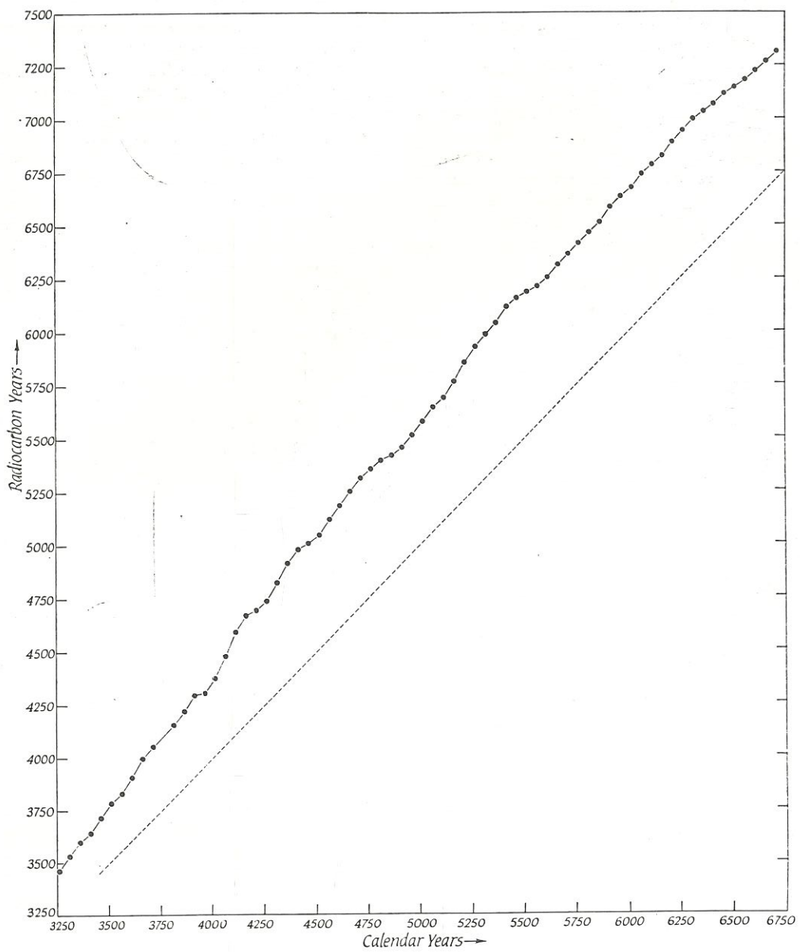


Fig. 2. Calibration chart : radiocarbon age versus *calendar age. For reasons of space this chart is printed in two parts, part 1 on this page, and part 2 opposite*



Recalibrating the radiocarbon clock

The greatest thing since sliced bread, as far as archaeologists were concerned, was the development of the radiocarbon (C^{14}) dating technique. For the past 25 years they have employed it extensively in dating objects up to 40,000 years old. But in recent years researchers have double checked some radiocarbon dates against objects of a known age and found that not all C^{14} dates are as accurate as they were thought to be. Some dates were found to be off by as much as 750 years. Now researchers at the University of Pennsylvania Museum have solved part of the problem.

Radiocarbon dating is based on the assumption that organic matter, while it is alive, absorbs atmospheric C^{14} at a steady rate. When the organic material dies it stops absorbing C^{14} and the radioactive carbon begins to decay. The rate of decay or half-life of C^{14} is known (5,730 years) and from the amount of C^{14} left in an organic sample its date of death can be determined. The error

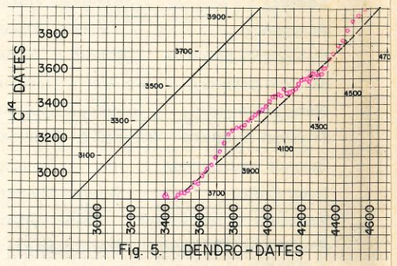


Fig. 5. DENDRO-DATES

in the method comes about because, contrary to what was believed, the amount of C^{14} in the atmosphere has fluctuated during past times. So for most periods, archaeologists must apply corrections to radiocarbon dates to get true ages.

One way of arriving at the proper corrections is by cross-dating radiocarbon dates with known dates. Some of the most accurately dated organic samples to do this with are trees whose annual rings can be counted. The science is known as dendrochronology, and E. K. Ralph, H. N. Michael and M. C. Han have used it with bristlecone pines, the oldest known living trees. Samples of these trees, found mostly in the

C-14 Date	Range or Mid-Point for Corrected Date	C-14 Date	Range or Mid-Point for Corrected Date
2960 BC	3610 BC	3260 BC	3820-3850 BC
2970 BC	3620 BC	3270 BC	3850-3880 BC
2980 BC	3620 BC	3280 BC	3880 BC
2990 BC	3630 BC	3290 BC	3890 BC
3000 BC	3640 BC	3300 BC	3900 BC
3010 BC	3650 BC	3310 BC	3900-3920 BC

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Graph, table give corrected dates.

mountains of California, have been shown to be about 8,000 years old.

By comparing 631 radiocarbon dates obtained from samples of bristlecone pine with the wood's true age, they have established correction factors for 85 percent of the radiocarbon dates falling between 1849 A.D. and 5383 B.C. Going back in time prior to 700 B.C., the corrected dates become increasingly older than the C^{14} dates—by as much as 600 years. Since 700 B.C. the trend of the correction is mixed—sometimes older, sometimes younger. The corrections are in close agreement with similar work done at the University of Arizona and the University of California at La Jolla.

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which is distinctive enough,[3] there is an unusual feature which distinguishes this cup from most other Attic cups, namely, the presence of a hollow foot, which, in the writer's opinion, must once have contained pellets which rattled when the cup was tilted. The cup has unfortunately been broken and repaired at some time and the pellets consequently lost, but this does mean that it is now possible to see into the hollow foot (pl. 40, fig. 2).

A close parallel is the rattling cup in University College Dublin, which was recently published by the writer (pl. 40, fig. 3).[4] This cup is identical in nearly every respect with the Oxford example, down to the slightly unusual groove around the upper edge of the foot. It differs only in its dimensions (ht. 7.7 cm., diam. 13.8), the fact that it has black glaze where the Oxford cup has coral-red, and in the presence of pellets in the hollow foot, which an X-ray examination revealed to be three in number (pl. 40, fig. 4). One has no hesitation in attributing the Oxford cup to the Potter of Dublin V3020, and in calling it an "ex-rattling" cup.

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BRISTLECONE PINE CALIBRATIONS OF RADIOCARBON DATES: SOME EXAMPLES FROM THE NEAR EAST

One of the major assumptions of radiocarbon (C-14) dating at its inception was that the radiocarbon content of the atmospheric carbon dioxide has remained constant during the effective time range of the technique, i.e. during the last ca. 70,000 years. Beginning in the late 1950's this assumption was challenged, first by DeVries,[1] later by Stuiver, Suess, and others.[2] Many archaeologists had by this time expressed mild suspicion of certain C-14 dates. For example, it had been noted that there were some major discrepancies between historically dated events in ancient Egypt and the C-14 dates for these same events—often a difference of several hundred years.[3] Generally, however, it was assumed that the problem was due to "contamination" in the samples rather than to a defect in the dating technique itself.

Recently, several correction methods have been devised by which the C-14 date for an event, historic or prehistoric, may be directly cross-checked. These were made possible through the development of a 7100 year tree-ring chronology for the bristlecone pine (*Pinus aristata*, Engelm.) of the White Mountains of east central California,[4] a chronology which has now been extended to 7484 years.[5] This has permitted scientists to measure, quantitatively, the variations of the radiocarbon content in atmospheric carbon dioxide even, if necessary, on a year-to-year basis. First, a bundle of ten annual tree-rings is subjected to C-14 analysis, and then the resultant C-14 date is compared with the known absolute age based on the tree-ring chronology. It was found that in most cases there were discrepancies. In fact, for C-14 dates greater than 4000 years ago, the error may be 500 years or more, with the C-14 date being far too late.

Several correction methods have been suggested which would allow us to convert the results from C-14 dates into new, more accurate, absolute ages (calendar years). One of these is a calibration curve developed by Hans E. Suess (ill. 1).[6] We may briefly illustrate how to use this curve. An archaeologist has received a C-14 date of 1000 B.C. (2950 B.P.). He finds the point at which his C-14 date crosses the calibration curve starting from the top line labeled Conventional C-14 Dates in C-14 Years. Next he draws a diagonal line parallel to the bristlecone pine lines, and the new date is read off the bottom line of the chart. Our new absolute age for a C-14 date of 1000 B.C. is ca. 1340 B.C.[7] The discrepancy here is about 340 years.

Careful attention should be paid to the fact that the Suess curve is a curve and is not linear. Because of the short-term fluctuations ("wiggles"), it is possible for a single C-14 age to refer to more than one calendar date. For example, a C-14 date of 1 B.C. crosses the calibration curve several times (ill. 1).

[3] For full discussions of the technique of coral-red, which seems to have been not uncommon in the later 6th and earlier 5th centuries B.C., see M. Farnsworth and H. Wisely, "Fifth Century Intentional Red Glaze," *AJA* 62 (1958) 165-173, pls. 36-37, and G. M. A. Richter, "Red-and-Black Glaze," *Nederlands Kunsth. Jb.* 5 (1954) 127-136. Cf. R. M. Cook, *Greek Painted Pottery* (2nd ed., London 1972) 247.

[4] C. W. Ferguson in Olsson, ed. (supra n. 3) 237-259.

cup in Dublin," *JHS* 90 (1970) 199-201, pls. 4-5. Cf. *JHS* 91 (1971) 118, bottom. Rattling cups have also been discussed by B. Shefton, *JHS ArchRep 1969-70*, 61-62, and by A. Seeberg, *JHS* 92 (1972) 183-184, pl. 25. The rattling fourth century kantharos mentioned by Seeberg, Schwerin 746, has now been published by G. von Lücken, *CVA* Schwerin, pl. 59, 2, but the fact that it rattles has been overlooked.

[1] H. Devries, *KoninkljNederlAkademicWetenschappen* Proc Series B61 (1958) 94-102.

[2] M. Stuiver, H. E. Suess, *Radiocarbon* 8 (1966) 534-540.

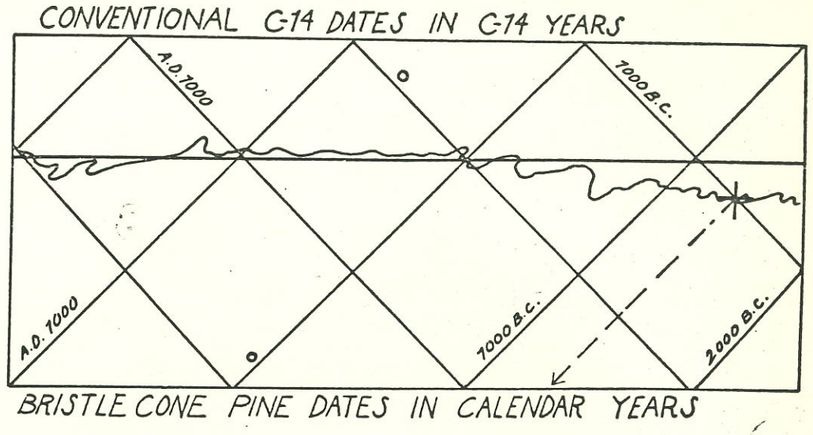
[3] This particular problem in regard to Egypt has been discussed in detail by H. E. Suess, *ZPhysik* 202 (1967) 1-7; and T. Säve-Söderbergh and I. U. Olsson in *Radiocarbon Variations and Absolute Chronology*, ed. I. U. Olsson (New York 1970) 35-53.

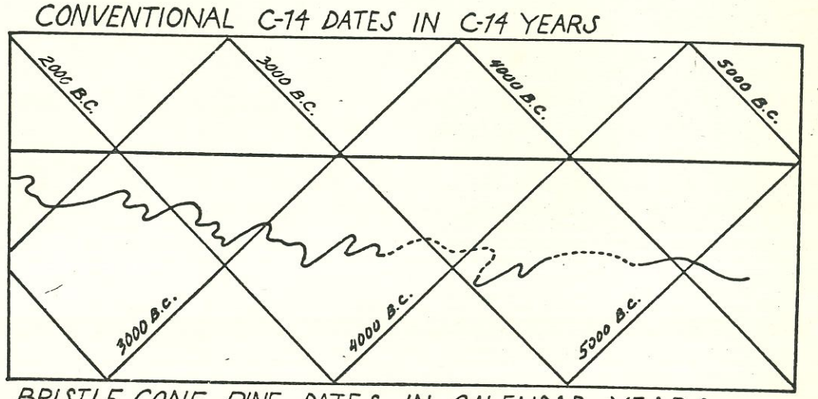
[4] C. W. Ferguson, *Science* 159 (1968) 839-846.

[5] C. W. Ferguson in Olsson, ed. (supra n. 3) 237-259.

[6] This curve has appeared in several of Suess' articles, most recently in Olsson, ed. (supra n. 3) 303-09. Ill. 1 is redrawn and modified from H. E. Suess in *Proceedings of the Monaco Symposium on Radiocarbon Dating and Methods of Low Level Counting*, March 2-10 (1967) 145-151. Ill. 1 should be seen as an example of the curve. There is still some criticism over the exact placement of the solid line connecting the points (C-14 dates) which results in the actual correction curve. Though there is general agreement that it is a curve with oscillations or "wiggles," the exact placement of the line is not completely agreed upon. For the recalibration of dates, Suess' latest curve should be used.

[7] Accurate here to ca. ± 25 years.





A second method of adjustment has been proposed by H. N. Michael and E. K. Ralph.[8] It is termed the MASCA (Museum Applied Science Center for Archaeology) correction factors. Michael and Ralph have divided the last 7150 years into 500-year tree-ring intervals and have constructed a table (Table 1) giving the average deviation of the C-14 dates from the dendrochronological ages within each interval. Thus, for each 500-year tree-ring interval there is only one correction factor, a number of years which must be added to or subtracted from the C-14 date:

For instance, an archaeological sample from which a radiocarbon date of 2200 B.C. has been obtained falls into the range of 2499-2100 B.C. (column 1, Table 1). To this radiocarbon date the correction factor of 450 years is added to obtain the date of 2650 B.C.[9] A C-14 date of 1000 B.C. would be corrected by adding 100 years for a new calendar date of 1100 B.C. As noted the Suess curve gives a new age of ca. 1340 B.C. for a C-14 date of 1000 B.C.

There are obviously a number of problems. First, the Suess curve uses the 5568-year half-life and the MASCA table the 5730-year half-life. Second, the Michael and Ralph table is a linear-average adjustment within each interval. The Suess curve is not linear and indicates that the fluctuations are not constant within each of the Michael and Ralph intervals. The MASCA table discounts these internal fluctuations by averaging them.[10] Finally, there may also be significant time gaps across the boundaries of the MASCA 500-year intervals.

[8] H. N. Michael, E. K. Ralph, in Olsson, ed. (supra n. 3) 109-119.

[9] *Ibid.* 112.

[10] The nonlinearality of the long-term and short-term fluctuations has been discussed in detail by a number of authors. See, for example, R. Berger in *Scientific Methods in Medieval Archaeology*, ed. R. Berger (Berkeley, 1970) 95-97 and fig. 2. It is obvious from both the Suess and Berger curves that in cases where a high accuracy of date recalibration is required these short-term variations should not be discounted.

TABLE 1

MASCA: suggested method of adjustment of radiocarbon dates to calendar dates. Radiocarbon dates calculated with the 5730 year half-life.

Time period represented by radiocarbon dates	Average deviation of C-14 dates (+ = younger, − = older)	Calendar period represented by precisely dated tree-ring samples
A.D. 1525-2000	+ 50	A.D. 1500-1950
A.D. 975-1524	0	A.D. 1000-1499
A.D. 450-974	− 50	A.D. 500- 999
A.D. 1-449	− 50	A.D. 1- 499
449- 1 B.C.	+ 50	499- 1 B.C.
924- 450 B.C.	+ 50	999- 500 B.C.
1324- 925 B.C.	+100	1499-1000 B.C.
1699-1325 B.C.	+250	1999-1500 B.C.
2099-1700 B.C.	+350	2499-2000 B.C.
2499-2100 B.C.	+450	2999-2500 B.C.
2949-2500 B.C.	+550	3499-3000 B.C.
3999-2950 B.C.	+600	4395-4135 B.C. (260 years)
4499-4000 B.C.	+750	5110-4810 B.C. (300 years)

For example, a C-14 date of 2495 B.C. will be corrected by adding 450 years, while a C-14 determination of 2505 B.C. will have 550 years added to it.

Now I should like to discuss two cases of how the recalibration of C-14 dates can lead to the solution of some formerly perplexing chronological problems from the Near East. First, we may look at a series of six C-14 dates from the site of Karataş-Semayük in Lycia.[11] The dates were all obtained from the same building in the burnt level at the site. They were calculated by the University of Pennsylvania Laboratory using the 5568-year half-life and then were recalculated for Mellink using the 5730-year half-life.[12] Both sets of dates are given in Table 2.

Mellink recognizes two major problems. First, on the basis of the absolute ages of the C-14 dates (5730-year half-life), it appeared that the building was contemporaneous with the Akkadian Period in Mesopotamia (= Early Bronze IIIa in Anatolia) which is dated by historical (and not radiocarbon) evidence to have begun early in the 24th century B.C. However, the pottery and other objects in the building and burnt level were clearly Early Bronze II (late Troy I, Poliochni red subperiod, Kusura B, Tarsus Early Bronze II) in age.[13] Thus the historical, archaeological, and stratigraphic evidence indicated an absolute age and chronological placement somewhat earlier than was allowed by the C-14 dates.

[11] M. Mellink, *AJA* (1965) 241-251.

[12] R. Stuckenrath, Jr., W. R. Coe, E. K. Ralph, *Radiocarbon* 8 (1966) 348-385.

[13] M. Mellink (supra n. 11) 250.

TABLE 2

Radiocarbon Dates and Corrections for Karataş-Semayük

Lab. No.	5568-Year Half-life	5730-Year Half-life	Suess Curve	MASCA Table
P 917	2271 ± 61 B.C.	2398 ± 63 B.C.	2940 B.C.	2848 B.C.
P 918	2180 ± 61 B.C.	2304 ± 63 B.C.	2925 B.C.	2754 B.C.
P 919	2176 ± 60 B.C.	2300 ± 62 B.C.	2925 B.C.	2750 B.C.
P 920	2324 ± 64 B.C.	2452 ± 64 B.C.	2970, 3040, 3200 B.C.	2902 B.C.
P 921	2188 ± 62 B.C.	2312 ± 64 B.C.	2950 B.C.	2762 B.C.
P 923	2278 ± 62 B.C.	2405 ± 64 B.C.	2950 B.C.	2855 B.C.
Ave.	2236 ± 25 B.C.	2362 ± 26 B.C.	ca. 2945 B.C. using 2970 for P 920 as the most likely of the three new dates	2812 B.C.
Range	2176-2324 B.C.	2300-2452 B.C.	ca. 2925-2970 B.C. using 2970 for P 920	2750-2902 B.C.

Second, the C-14 determinations gave a rather surprising range of dates for the occupation of the building. Using either set of half-life dates, the time span is approximately 150 years. In her comments on the dates, Mellink felt that a temporal magnitude of 150 years was highly unlikely.[14]

In an attempt to solve these problems, I converted the 5568-year half-life dates by using the Suess calibration curve. The corrected calendar ages are given in Table 2. Five of the C-14 dates correspond to only one new calendar age. One (P 920) has three new absolute ages. One of these, at ca. 2970 B.C., agrees with the new determinations from the other five C-14 dates. The new calendar dates indicate that the building in the burnt level was clearly pre-Akkadian, dating to the early 3rd millennium B.C. Furthermore, the temporal range of the corrected absolute ages is now ca. 2970-2925 B.C., a duration of closer to 45 years than to 150 years. The new age calibration suggest that Mellink's reservations about the absolute ages and range of the original C-14 dates were well founded.

We may also recalibrate the dates using the MASCA table. Since the C-14 dates determined by 5730-year half-life all fall within the interval of 2100-2499 B.C. in Table 1, the correction factor is + 450 years. These new age calibrations also support Mellink's belief that the occupation of the building was early in the 3rd millennium. The MASCA dates range from 2902 to 2750 B.C., but are on the average of 100 to 150 years later than those obtained from the Suess curve. Furthermore, by adding a constant of 450 years to each of the original C-14 dates, the time span for the occupation of the building remains unchanged at 150 years. Thus the MASCA table, unlike the Suess curve, does not allow us to test Mellink's second reservation about the original dates.

Our second case deals with Early Dynastic I in Mesopotamia. Estimation of the absolute age and duration of E.D. I, based on historical evidence, have varied. For example, Frankfort[15] used a date of ca. 3100 to 2900 B.C. Porada[16] is slightly more conservative, dating E.D. I from ca. 2900 to 2750 B.C. A set of C-14 dates from Nippur,[17] levels IXA and IXB, support neither Frankfort nor Porada. Instead, we find a range from 2322 to 2142 B.C. (ave. 2227 B.C., 5568-year half-life) (Table 3). These C-14 dates fall into the chronological range of the Akkadian and Post-Akkadian Periods and cannot possibly be correct.

For level IXB, the Suess curve calibrations give new absolute ages of ca. 2925 and 2940 B.C. Two of the IXA dates are now ca. 2930 and 2910 B.C. The final IXA date, however, crosses the calibration curve at three points: ca. 2970, 3040, and 3200 B.C. Each date is slightly out of line with the other new determinations; but since the standard deviation of sample P 819 is ± 65 years, the new date of 2970 B.C. may be seen as essentially correct. The new calendar dates do demonstrate that E.D. I is certainly earlier than the original C-14 dates had suggested.

Also, we may point out that level VIII at Nippur had an original C-14 date (P 807) of 2140 B.C., and level VIIB had two C-14 dates (P 804 and P 805) of 2145 and 2056 B.C. respectively. Both levels are E.D. II. These three dates recalibrate to ca. 2910, 2910 and 2780 B.C. respectively. Thus, according to the Suess curve, the transition from E.D. I to E.D. II took place around, or just prior to, 2900 B.C., and based on these dates it appears that the Frankfort chronology with its earlier placement of E.D. is given some measure of support.

In contrast, the MASCA dates (Table 3) give an average of 2744 B.C. for level IX. This is slightly earlier than Porada's shorter chronological estimate for the end of E.D. I. Three of the five MASCA dates fall later than 2750, one at 2654 B.C. Whereas the Suess curve recalibrations suggest a duration of ca. 60 years for the samples from IXA and IXB at Nippur, the range for the MASCA dates is nearly 200 years. Sample P 807 from E.D. II converts on the MASCA table to ca. 2654 B.C., suggesting a transition from E.D. I to E.D. II in the early mid-27th century B.C. This date is nearly 100 years later than Porada's more conservative estimate. It appears than the linear-average adjustment of the MASCA table results in dates that are slightly too late for the time range of the first half of the 3rd millennium B.C.

In conclusion, the bristlecone pine calibration corrections promise to be a major asset to archaeologists in helping to explain many anomalous C-14 dates. However, such corrections may also necessitate major rethinking of some chronological schemes. Also, we must add a word of caution. Two correction methods were discussed. They are not always in agreement as to new dates, as we have seen. Work is still continuing in attempting, for example, to reverify the "wiggles" in the Suess curve. Nor should any of the strictures concerning the proper collection of samples for C-14 dating and their treatment in the field be forgotten. No correction factor will ever make sense out of a sample not in association with the cultural material for which the date is intended.

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[14] M. Mellink, in Stuckenrath et al. (supra n. 12) 353.
[15] H. Frankfort, *The Birth of Civilization in the Near East* (Bloomington 1951).
[16] E. Porada, in *Chronologies in Old World Archaeology*, ed. R. W. Ehrich (Chicago 1965) 133-200.
[17] R. Stuckenrath, Jr., E. K. Ralph, Radiocarbon 7 (1965) 187-199. Three of the original C-14 dates have not been included because of questions about their reliability. For example, P 799, Level IXA, had a C-14 date of 6522 ± 102 B.C. The E.D. II dates mentioned in the text also come from this dating list.

TABLE 3
Radiocarbon Dates and Corrections for Level IX, Early Dynastic I, at Nippur

Lab. No.	Level	C-14 Date 5568 Year Half-life	Suess Curve	MASCA Table 5730 Year Half-life
P 798	IXB	2195 ± 59 B.C.	2925 B.C.	2711 B.C.
P 803	IXB	2271 ± 53 B.C.	2940 B.C.	2788 B.C.
P 800	IXA	2207 ± 62 B.C.	2930 B.C.	2723 B.C.
P 819	IXA	2322 ± 65 B.C.	2970, 3040, 3200 B.C.	2841 B.C.
P 820	IXA	2140 ± 62 B.C.	2910 B.C.	2654 B.C.
Ave.		2227 B.C.	ca. 2935 B.C. using 2970 for P 819	2744 B.C.
Range		2140-2322 B.C.	2910-2970 B.C. using 2970 for P 819	2654-2841 B.C.

ANTIQUITY, XLIX, 1975

return to MASCA

British prehistory and the radiocarbon revolution

R. J. C. ATKINSON

In this article Professor Richard Atkinson reviews (Ed.) C. Renfrew, 'British prehistory: a new outline' (London, Duckworth, 1974. 352 pp., 3 tables, 42 figs. £6·95 (cloth) £2·50 (paper). As he says, any book on British prehistory as a whole is an event that needs especial attention. This book needs more than usual attention as it is the first synthesis of our pre-Roman past since C14 dates in sufficient number are available to give a fresh assessment of problems which in the past were dated without accuracy.

The appearance of a book dealing with British prehistory as a whole is an event rare enough to require special notice. The last such survey, Piggott's *British prehistory* (a work acknowledged, curiously enough, by no more than a footnote in its present successor of the same title) appeared in 1949, and gave a short but balanced picture of the state of knowledge at the very end of the pre-radiocarbon era. Since then the vast increase in the volume of raw material and the many complexities and uncertainties of radiocarbon dating itself have alike deterred any single prehistorian from attempting the same task again.

The solution adopted by Professor Renfrew, the editor of *British prehistory: a new outline*, was to invite an acknowledged expert to review in eight to ten thousand words the material of his or her special period, and to order it in the light of the corrected radiocarbon chronology. As their contributions show, this brief has been interpreted in a somewhat elastic way, the shortest chapter (by Professor Cunliffe on the Iron Age) running to little more than seven thousand words and the longest (by Colin Burgess on the Bronze Age) to well over double that length, with nearly four hundred footnotes. Cunliffe has only twenty-one. For the reader the result is inevitably very uneven.

Some other variations, however, could have been avoided. Why, for instance, does the first chronological table for the Iron Age run upwards from the bottom, like those in all the other chapters, but the second in the opposite direction? Why in two of the lists of radiocarbon dates (otherwise a most useful feature) are the sites arranged in descending order of age, and in the other three alphabetically; and why is the list for the Bronze Age unpaginated? Why is it only in Cunliffe's chapter that bc dates are uniformly followed by their BC equivalents in parentheses, and elsewhere one has in almost every case to turn up the *corrected* date (which is what matters) in a separate list at the end? Individually these are minor deficiencies; but cumulatively they detract seriously from the usefulness of a book which will be widely read by students for many years to come. Editorial reluctance to interfere with the decisions of contributors need hardly be carried to these lengths.

It is unfortunate too, though perhaps unavoidable, that the corrections are taken from the Suess curve, which was drawn by eye even if *'mit kosmisch Schwung'* (Suess *ipse loquitur*). The MASCA correction tables, published in August 1973 (Ralph, Michael and Han, 1973), are not only much easier to use, but are also to be preferred because they are based on a larger quantity of raw data and an averaging process which preserves the second-order oscillations, but at a reduced amplitude. Even at the cost of some small delay in publication (the preface is dated January 1974) it might have been better to adopt the MASCA corrections throughout.

The book opens with an acute and fascinating

analysis by Renfrew of the changing attitudes and models of the past which have informed British prehistory during the last hundred years. As he says, until the advent of radiocarbon dating to fulfil 'the need to make the material yield a chronology as well as an explanation of change. . . the analysis of diffusion seemed the most profitable approach'; and it is this, of course, which accounts for the universal adoption of the 'invasion' model which explained change as the result of actual immigrations, or of less well-defined 'influences', from across the Channel and the North Sea.

I would myself go further than Renfrew, in regarding this model as something more than the 'most profitable approach'; for with hindsight one can see that the implied choice never existed. So long as the only reliable basis for an absolute chronology lay in the eastern Mediterranean and beyond, the diffusionist hypothesis (of which the British 'invasion' model is a special case) offered the *only* route of escape from nescience, given that so much of the material, especially in the Bronze Age, came from short-lived contexts which provided no local relative chronologies based on deep stratification.

It should not be supposed, however, that radiocarbon dating itself did much damage to the diffusionist picture of European and British prehistory painted by Gordon Childe and elaborated by his pupils and followers. On the contrary, the *uncorrected* dates, taken at their face value, went a long way to confirm the rightness of that picture, even if the neolithic part of the canvas had to be stretched. It is the bristlecone pine corrections alone which have made the diffusionist model obsolete, and have converted it from a working tool to a by-gone in the museum of archaeological concepts.

Renfrew might also, perhaps, have given more emphasis to another important component of British archaeological thinking, which is the paramount place accorded until recently to studies of pottery. For reasons which are to me as fascinating as they are obscure, the oracle consulted by almost all British prehistorians for more than half the present century has been Abercromby, not Montelius or Reinecke. For many of our continental colleagues our obsession with ceramics—'long misused as a chronological and cultural indicator', as Burgess so rightly says (p. 167)—has been in archaeological terms *le vice anglais*, charitably regarded as a wayward and unprofitable aberration. In much, though not quite all, of this book there are encouraging signs of a cure.

The final section of Renfrew's introduction is essentially a prescription for the continued and growing health of a patient formerly suffering from the progressive disease of 'invasionism', happily arrested by radical radiocarbon therapy. Whether the prescription is sound can be judged only after the patient's present state of health has been assessed.

The first of the five 'period' contributions, that of Paul Mellars on the Palaeolithic and Mesolithic, is balanced and informative, though it underlines that reliable interpretation rests on an all-too-slender foundation of sites adequately excavated by modern techniques, in the lower palaeolithic field. There are but three of these, and it is significant that one of them is financed by the University of Chicago and not from native sources. Here, of course, the problems of absolute chronology are unsolved, for the period lies outside the boundaries both of radiocarbon and of potassium-argon dating. For the upper palaeolithic there is now at least a skeleton framework of radiocarbon dates, within which it has been possible to re-think the origins of the British 'Proto-Solutrean' industries; while in the mesolithic radiocarbon dates provide a detailed chronology and show, *inter alia*, that in places microlithic techniques of tool-making persisted for well over half-a-millennium after the introduction of the neolithic economy. This important point is unfortunately thoroughly obscured by careless proof-reading. The relevant passage on p. 89 makes sense only if 'neolithic' is read for 'mesolithic' in line 14, and 'earlier' for 'later' in line 20. This evidence does not, of course, rehabilitate Piggott's original concept of the Secondary Neolithic, which was workable only within the framework of a much shorter chronology; but it does suggest that more attention to the flint industries of the Neolithic, and less to pottery, may well confirm and enlarge the evidence for a long

symbiosis of mesolithic and neolithic life-styles, which it is now fashionable, though facile, to reject.

Dr Isobel Smith's long devotion to the study of neolithic pottery is well reflected in her contribution here. She isolates a series of six ceramic styles, ending with beakers, and uses the 150 radiocarbon dates now available to show that some of these (notably the Grimston/Lyles Hill and Sandhills wares) endured for over a millennium-and-a-half, and all of them for at least a third of that time. This is a valuable demonstration of the great conservatism of British neolithic societies which the new chronology implies; but if we are to heed Renfrew's plea for a more intensive study of the processes of culture-change it is clear that we need some reliable means of differentiating the pottery (to say nothing of the flint, stone, bone and antler artifacts, which have hitherto been relatively neglected) in a much more detailed way. Here, perhaps, the best hope lies in the analytical work of Dr Peacock, which deserves the flattery of imitation on the widest scale; though it is sobering to note that his gabbroic wares, originating near the Lizard in Cornwall, can be shown by radiocarbon dates to have been produced over a period as long as eight centuries.

Dr Smith's review of the neolithic material is so succinct (she is the only contributor to conform to the editor's original limits of 8–10,000 words) that she omits all discussion of the problems of chambered tombs, and refers merely to other studies recently published. The student will regret this omission, though equally he will welcome Dr Audrey Henshall's admirable summary of her own monumental work on the megalithic tombs of Scotland. What emerges most clearly from this is how many of these sites are almost certainly of multi-period construction; but the very few radiocarbon dates so far available serve merely to raise questions, not to give answers. Nothing could demonstrate better that up to now radiocarbon dating has effectively destroyed the old order, but is not yet able to provide anything in its place.

The Bronze Age chapter by Colin Burgess is a monograph in miniature which deserves more detailed comment than there is space for here. A warning must be given, however, about the dates 'in calendar years BC', attached to his main chronological table which, probably more than anything else in this book, will be studiously committed to the memory of successive generations of students. The main text shows, though the caption to the table itself conceals, that these are a selected mixture of dates arrived at by applying the Suess corrections, mainly for the third and first millennia BC, and the 'historical curve' of McKerrell (1972, fig. 4) for the second millennium. In the present state of uncertainty this is perhaps justifiable; but the principle of *caveat emptor* does not apply in academic transactions.

In this period the main impact of the new chronology is on the duration of the Early Bronze Age, and particularly of its Wessex manifestations. Burgess makes a strong case against the 'minimum view' of Coles and Taylor (1971), and argues, with McKerrell, that at least some of the Mycenean contacts formerly posited can still be accommodated without straining the time-scale. Here again only many more radiocarbon dates (including those obtained from the re-excavation of a number of key sites, of which Bush Barrow may stand as an example) will help us to advance towards a solution.

For the bronze industries the scheme here proposed, divided into ten phases and six regions, will doubtless engender controversy about details; but as a working framework it is a worthy successor to Professor Hawkes's scheme of 1960, to which it owes much, duly acknowledged. In this field of study, however, we are all still effectively in the pre-radiocarbon era, since it is only the selected types occurring as grave-goods, almost all of them in the Early Bronze Age, which can normally be dated, even indirectly, by this means. We should, perhaps, exploit more the potentialities of the bronze-founder's cores which still remain, occasionally, in sockets and other hollow castings, and normally contain a high proportion of comminuted charcoal or other organic carbon, of presumably contemporary date.

After this long and wide-ranging review of

the Bronze Age, Cunliffe's brief treatment of the complex problems of the Iron Age is inevitably a disappointment. Its brevity is to be explained, of course, by the recent publication of his own *Iron Age communities in Britain*; but it would have disarmed criticism better to have said this boldly at the beginning of the text, rather than relegating it to the obscurity of a footnote.

For the detailed chronology of the 'full' or Hawkesian Iron Age (*Hocheisenzeit*) it has long been admitted that the inherent statistical uncertainties of radiocarbon dating offer little help. What the new chronology has done, however, and that quite unmistakably, is to show that features formerly regarded as wholly diagnostic of the Iron Age, such as 'hillforts' with simple box-ramparts of timber construction, manifest themselves at the very start of the conventional Late Bronze Age, if not indeed earlier. Here, therefore, the new chronology has not merely destroyed the diffusionist model of Hawkes and Childe (though let it be remembered with honour that as early as the Prehistoric Society's conference in Edinburgh in 1954 Hawkes was already foreshadowing the things since to come); it has also quite undermined the latter end of the Three Age system, still adopted ostensibly in the arrangement of this book. Here too, perhaps, the editor might have displayed more forcibly the courage of his undoubted convictions.

The conclusion to be drawn from these varied and uneven contributions is that the radiocarbon therapy, however timely, has left the patient in a state of confusion and disturbance, to be ameliorated only by massive and continuing doses of the same treatment. In other words, the new radiocarbon time-scale has shown up the falsity of much of the former picture or model of British prehistory; but the phase of iconoclasm has not yet given way to the phase of new construction. *We need more dates*, indeed many more. Some of these will accrue simply from the increased frequency of excavation; but we ought not to neglect the resources which lie dormant and unregarded in our existing museum collections, or in sites long since partially, but only partially, excavated. The bones of the 'tall and stout man' for whom Bush Barrow was built still lie where Cunnington and Colt Hoare left them; there are still, in museums up and down the country, Bronze Age urns which contain, undisturbed, their ash-laden cremations; and, now that the collagen fraction of bone and antler has been shown to yield reliable dates, there is a great reservoir of well-contexted specimens which is still almost untapped. To utilize all this requires the planning of scarce resources, most of which come, directly or indirectly, from State funds. It is worth asking whether it is more profitable, in terms of the ultimate return in knowledge (which is what archaeology is about) to devote so much to the answering of questions, through rescue excavation, which have not yet been properly formulated, rather than to divert at least a part of those resources towards the construction of a chronological framework within which alone the right questions *can* be asked.

I return at the end to Dr Renfrew's prescription for the convalescent patient, which is essentially a regime which requires the abandonment of our former preoccupations with the typology and taxonomy of sites and artifacts, and a greater concentration on the processes of culture-change, within the systems-space defined by the 'dimensions' of subsistence, technology, social organization, cognitive basis (including religion), trade and communication, and population.

For the student, who will be the principal user of this book, the attractions of this prescription will far outweigh the basic fallacy which it contains, which is that of supposing that the 'dimensions' proposed have any common status in reality. The very nature of archaeological evidence imposes limits on the inferences which may validly be made from it under various headings—a point made long ago by Christopher Hawkes (1954) and Margaret Smith (1955) in two papers of fundamental importance, which deserve to be read and re-read by every prehistorian and indeed to be reprinted (perhaps in *Antiquity*) for the benefit of future generations. Inferences about technology, on the one hand, can be safely

made, because there is no reason to suppose that the 'laws' of physics and chemistry have changed. The inferences are made here within the framework of an invariant system. This is manifestly not true, however, of inferences about social organization or religion, where there is no one-to-one correspondence between intention and action (or between cause and effect), and therefore no possibility of unambiguous inference in the reverse direction. The essential frame of reference here is a system of inference which gives due weight (and does not elide or ignore or equate, as the proponents of 'systems analysis' are all too prone to do) to the strength of inference that the individual data will bear, but no more.

To this doctor, therefore, let us in all humility and gratitude give thanks for his past and present diagnosis; but for his prescription I will take it upon myself to say 'Physician, heal thyself!'.

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THE SAN DIEGO UNION · Sunday, July 4, 1976

Dead Trees Help Date Antiquities

By CLIFF SMITH
Science Writer, The San Diego Union

Old, buried logs dug up out of California's White Mountains are advancing the ability to accurately date antiquities and determine ancient climates, according to two scientists.

Dr. C. W. Ferguson of Tucson and Dr. Henry N. Michael of Philadelphia predict that tree rings in the long dead bristlecone pine logs they are finding soon will extend science's most reliable yardstick of time back from its present limit of about 7,500 years to beyond 10,000 years.

ADDRESS MEETING

Ferguson is professor of dendrochronology (the study of dating from tree rings) at the University of Arizona. Michael is an anthropologist, geographer and dendrochronologist at the University of Pennsylvania.

They were among the speakers who addressed the 9th International Radiocarbon Conference at Scripps Institution of Oceanography last week. Approximately 120 scientists from 21 countries attended the meeting, last held in 1970 at Upsalla, Sweden.

The conference coordinators were Dr. Hans Suess of UCSD and Dr. Rainer Berger of UCLA.

All those who attended the meeting are concerned with the carbon-14 dating method developed shortly after World War II by Dr. Willard Libby of UCLA, who was present at the conference.

The carbon-14 method is based on the fact that cosmic rays react with nitrogen in the upper atmosphere to form radioactive carbon-14, which then is absorbed by all living things. When an organism dies, the radiocarbon begins to decay at a steady rate. By measuring the remaining amount of radiocarbon in the organic remains of an old object, its age may be determined.

NOT PERFECT

The method, however, is not perfect. Some scientists say that rather than indicating a long period of decay, a low radiocarbon reading may simply mean some organisms started out with fewer radiocarbons.

Radiocarbon absorption differences, they say, can be explained by changes in planet temperatures and by geomagnetic and solar magnetic field changes which may have varied radiocarbon production in the atmosphere.

CROSS CHECK

With tree rings, nature has left a device for cross-checking the dating techniques invented by man. Using the wood of long-lived trees — redwoods, pinyons, limber pines and, especially, the bristlecone — Ferguson and Michael are gradually constructing a "master chronology" which is useful in "calibrating" C-14 dates.

A natural diary of climate also is locked in the wood. Wide rings indicate years of heavy rain; narrow rings, dry years.

Ferguson said the oldest living trees on earth, bristlecones, are about 4,600 years old. By searching out trees that died long ago, however, the tree calendar can be extended.

Dr. Michael, for instance, has dug up a bristlecone pine log and calculated that the tree died 5,000 years ago. Another log of rosewood was dated by the radiocarbon technique to be 13,000 years old.

RADAR SYSTEM

Michael described how he and his colleagues are using a radar system, which can see objects up to 45 feet beneath the ground surface, to search out more old logs.

The radar system was designed and built for the City of San Francisco for the purpose of visualizing under-

The New York Times/John Noble Wilford

Dr. Henry N. Michael of the University of Pennsylvania Museum examining the base of a bristlecone pine, a tree that may live 5,000 years, in California's White Mountains.

Scientist Trac

By JOHN NOBLE WILFORD
Special to The New York Times

BISHOP, Calif.—"You realize, of course, how much of a needle-in-a-haystack job this is," Henry N. Michael remarked, shifting into a lower gear and steering the Toyota Land Cruiser across the dusty alluvial plain toward Silver Canyon.

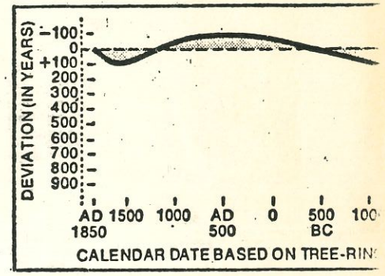
Dr. Michael, a 62-year-old anthropologist, ge-

Scientists at Work

This is another in a series of articles describing the creative process of scientific research.

ographer and dendrochronologist, was looking in the high desert here at the foot of California's White Mountains for old buried logs of the bristlecone pine. The older, the better—preferably 8,000 to 9,500 years old.

"I know there's wood somewhere in here," said Dr. Michael, though his weeks of searching, by radar probe, digging and educated guess, had



Christmas Passes

By DENA KLEIMAN

At Bloomingdale's they pushed their way into crowded elevators. At Macy's they waited in line. At Saks Fifth Avenue they rushed to use their credit on newly marked-down bargains.

Yesterday was the day after Christmas and despite nonstop rain, the stores were jammed with people returning presents.

Some blamed the size, others the color, but most everyone reaching into a soggy shopping bag to pull out what had been their Christmas bounty came up with an excuse.

"One of the arms started comng off," Myra Villereal was saying to the returns clerk at Macy's toy department. She handed him a $15 doll she had bought for her niece. "This doll's supposed to walk, drink and eat. All this one does is eat."

Some Stress Discretion

While Saks had set up special tables for returns and Macy's had roped off certain areas, there were some stores that seemed to go all out for handling exchanges with

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L.I. Pupils Aid Neediest for the 6th Year

of Defense for Public Affairs.

The 35-year-old Mr. Carlson, a native of Tacoma, Wash., had been assistant press secretary for domestic affairs. He has been on the White House staff since April 1972 and will now be No. 2 man under the press secretary, Ron Nessen.

Mr. Nessen said that he and Mr. Carlson would be considered "interchangeable" in running the press office and would have the same authority and the same access to the President and to senior staff meetings.

On another matter, Mr. Nessen said that President Ford "will not campaign" into Florida and New Hampshire to campaign before the primary elections in those states, where he is being pressed closely by Ronald Reagan, the former Governor of California. Mr. Nessen said that the President would go into those states "once, maybe twice".

Lunches With Patrol

He also said that the President was thinking about skiing in New Hampshire on a political trip there, but had made no plans to do so.

Mr. Ford went skiing again here today, this time accompanied by members of the United States Alpine Skiing Team. He lunched on elkburgers with members of the Vail Ski Patrol at the patrol shack on top of the mountain.

Just after the Alpine skiers gave him two racing patches, Mr. Ford took a mild tumble. As he was turning from a steep trail into a flatter run, he pitched forward. He was on the ground for only a few seconds, however. He rose and continued skiing.

The wife and mother of John Patrick Tully, a convicted Mafia "hit man," parked their car near the President's house this morning in an effort to see Mr. Ford and make an appeal for clemency for Mr. Tully, who is serving eight years in prison.

The two women were told to move their car, because they were in a no-parking area, and they did so. They did not see the President, however, Mr. Nessen said that they would see Richard B. Cheney, the White House chief of staff. Mr. Cheney is exepected to tell the two women—Hilda Tully, the wife, and Dorothy Tully, the mother—to see a pardon attorney.

Mr. Nessen reported that the President made several telephone calls yesterday to extend Christmas greetings. One call was to former President Richard M. Nixon and Mrs. Nixon.

Fund Bill Signed

VAIL, Colo., Dec. 26 (AP)—President Ford signed a $9.3 billion appropriation today to finance until Sept. 30, 1976, major Federal public works projects and energy research activities

Laboratory of Tree Ring Research, the University of California at San Diego and the University of Pennsylvania physics department and its Museum's Applied Science Center of Archeology. Dr. Michael is a research associate at the Pennsylvania center and a professor of geography at Temple University.

The purpose of the project is to compile a master chronology of tree-ring dates stretching as far back as possible.

A Constant Search

Year after year, separately and sometimes together, Dr. Michael and Dr. C. Wesley Ferguson of the University of Arizona have combed the slopes of the White Mountains looking for ever-older bristlecone pines, living or dead, standing or fallen.

On each expedition the scientists took pencil-thin core samples from living pines and sawed off cross sections of fallen trees, many of which had remained in solid condition several milleniums after their deaths. The samples were sent to the University of Arizona for microscopic analysis of the rings.

"It's more than just counting rings," Dr. Michael explained. "It's a long, tedious, imaginative process of looking for signatures."

In trees such as the bristlecone pine, a distinct growth ring is produced each year. Thin-walled cells grow during the spring and early summer, and these contrast with the smaller, thick-walled cells of the late growing season.

Dendrochronologists look for the usually clear line between the late wood of one season and the next spring's growth—and then count the lines inward from the outermost, or bark, ring to the center, assigning an absolute calendar date to each succeeding ring.

Signatures of Tree

Because year-to-year variations in climate are never the same, a tree in any given century will produce several distinctive patterns of narrow and thick rings. These are the tree's signatures, and they enable scientists to extend their master chronology beyond the lifetime of any living bristlecone pine.

They do this by cross-dating wood from both living and dead trees. A piece of dead wood will exhibit signature patterns that partially overlap ring patterns in living trees whose age is known. If part of the dead tree is older than any part of the living tree, then the chronology can be extended farther back in time.

Michael explained the "mental process" underlying his search strategy.

"According to geological evidence," he said, "about every 400 or 500 years there is an exceptionally strong thunderstorm here that washes the big boulders and fallen trees down these

work of finding buried logs, counting tree rings and dating milleniums.

"Eventually dendrochronology will be carried to 10,000 and 11,000 years," Dr. Michael concluded. "I think it can be done right here in the White Mountains."

Group Seeks to Improve Benefits In Thrift Food Stamp Program

WASHINGTON, Dec. 26 (UPI)—The Food Research and Action Center of New York, a public-interest group that has already forced the Government to liberalize parts of the food stamp program, is preparing to take the Agriculture Department back to court to win new benefits for the poor.

The target this time, center officials said in an interview, will be the new thrifty food plan the Agriculture Department will begin using Jan. 1 as the basis for food stamp allotments.

The thrifty plan was developed by department specialists on the basis of 1974 recommendations by the National Academy of Sciences for major nutrients in the diet, and on the basis of a decade-old survey of the kinds of foods used in American homes. But Ronald Pollack, director of the center, charged in the interview that the plan did not comply with the basic food stamp law.

'Nutritionally Adequate'

Under the law, Earl L. Butz, the Agriculture Secretary, is required to set stamp allotments at levels that will provide "a nutritionally adequate diet."

"It does not meet that test," Mr. Pollack asserted. Mr. Pollack's group took the Agriculture Department to court earlier with a similar complaint against its rules for setting allotments for families of varying sizes. The result was a court order that forced the agency to restructure allotments to provide extra stamps to "some groups—particularly large families—that had allegedly been shortchanged by past procedures.

Administration officials contended that by adopting the more generous treatment for larger families and the thrifty plan, with its specific nutrient allowances and recommended lists of foods and menus, they had complied with the law's demands.

But Mr. Pollack said the action center planned to go back to court early next year with a new suit against use of the thrifty plan, which critics regard as little better than the food stamp base it replaced. The older base for setting allotments was an economy diet plan that Agriculture Department officials calculated simply by taking 80 percent of the cost of an older, standard low-cost diet.

No Change in Amount

On the basis of November food costs, the thrifty plan allows $166.10 monthly to feed a family of two adults and two children. Beginning Jan. 1, food stamp allotments will rise from $162 to $166 a month for a family of four—no different from the amount that would have been allowed under the oil economy plan.

Mr. Pollack declined to go into details about the legal tactics his group would use in seeking a court order to force use of a higher base for stamp allotments. But some of the group's complaints against the plan are on record. They include charges that it fails to provide enough iron and some other nutrients for some sex and age groups, and that it was specifically designed to keep Government spending low rather than to provide full nutrition.

The center also charged that the plan unrealistically assumed that poor people who buy cheap foods can keep food waste at lower levels than wealthier families. And it charged that the plan assumed incorrectly that poor people had sufficient money and storage facilities to take advantage of savings that could be realized by buying in bulk.

MONEY BRINGS FISH TO DETROIT RIVER

DETROIT (AP)—It took an investment of some $750 million and 10 years of labor to bring the Chinook salmon and steelhead trout back to

communities. Private sources joined the state and city authorities with additional funds to improve further the environmental quality of the river.

In 1973 the Michigan Department of Natural Resources began to plant game fish in the river. In that year, 304,500