

New York State Archeological Association

THE BULLETIN

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N.Y.S.A.A. ANNUAL MEETING, APRIL 12, IN ALBANY

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Some Sources of Uncertainty in Radio-Carbon Dating

John Witthoft

Pennsylvania Historical Commission

The use of archeological carbon for dating by measurement of its radioactive isotope content has provided archeology with a powerful tool and with many opportunities for premature conclusion. In this paper I present a few conservative ideas, none of them in any way original with me, about the roles of such dates in archeological thinking and about causes for misleading dates. Since radiocarbon dates appear either as year dates or as counting rates, we tend to think of them as having a precision alien to archeology, and as being imposed from more exact sciences. This is unrealistic, and I therefore try to explain something of the structures of archeological thinking and the roles of radio carbon measurements as data in these structures.

Classic systems of formal logic seem to be of little utility in the sciences, traditional as they were to metaphysics. Such criteria as those of John Stuart Mill's Principles seem to lead only to conclusions that are inherent in one's original premise. Some critics believe that these older systems of logic present only structures which have their root in grammar rather than in the external world. Oriental systems of formal logic are even more obviously derived from grammars.

Archeological reasoning, like that which prevails elsewhere in the sciences, proceeds mainly by imaginative construction and criticism of models, which are large networks of statements and relationships, in several dimensions. These models, in verbal and visual media, fit more or less well to situations in the external world. Many of them are poor hypothesis, quickly junked. Others have some adequacy, and are subjected to continuous revision, correction, extension, and improvement. They often come to scarcely resemble their original forms, and they seem to have more potential for duplicating the situations and operations of external reality than do any simpler schema for organizing ideas. All parts of such models can be constantly checked for validity, and changes and additions and alternate structures checked for validity, by several criteria. These criteria include degree of internal consistency, consistency with new data, the law of parsimony, revelation of new relationships, and the observation of results in test situations. Ultimately, degree and order of consistency indicates validity and determines direction of growth and revision of the model. Not only do new data and observations test and correct such models, but models also serve as screens to test the reliability or relevance of observations. As compared with some other disciplines, archeology and

anthropology are at a primitive level of development, most models are as yet poorly elaborated, not filled with detail, and their fit to the external world does not satisfy us. Nevertheless, radiocarbon age determinations are data to be manipulated within these models; the intellectual processes involved will serve as a two-edged sword, doing violence to both models and radiocarbon observations.

The radiocarbon dates available cannot be merely fitted together into a chronological framework for any region. Many series of dates for related phenomena show poor internal consistency. Grievous errors of several kinds must affect the validity of many dates. These uncertainties, apart from those which may be involved in the original collection and interpretation of the samples, seem to be of two types: statistical errors and field errors.

Statistical errors are a condition of the counting procedure, and are significantly large because the radioactivity of the samples is very slight. The emitted particles which are counted represent a very tiny sample of the radioactive emission of the carbon during its total period of decay, and they also represent a very tiny total amount of energy. Each emission is a discrete event, a single nuclear change. These emissions are random events and they do not occur periodically, regularly, or at a constant rate. Only over a long period of time can one assume that a sampling by counting may approach an average rate. If counting times were sufficiently long or if the level of activity of the sample were high enough, chances of a measurement representing a good average would be better. With convenient counting times and the low rate of activity of samples, some determinations will represent a period of irregular activity and will not give a valid age determination. The correction figures published with radiocarbon dates are statistical devices which indicate the degree of uncertainty presented by each measurement due to randomness.

The corrections, the plus and minus figures, are calculated for each sample from considerations of sample size, rate of activity of the sample, equipment fluctuations, counting time, background radiation, and other conditions. Such a correction represents an interval of one standard deviation to each side of a mean value or a natural curve (probability curve). The correction figure, representing this statistical and geometrical interval, says that the odds are two to one that the correct date lies somewhere within the range of the correction. This is pure probability, and there is no way of saying which thirty samples out of ninety may not lie within this range. By extending the correction figure to two standard deviations, the chances can be increased to nineteen out of twenty. Likewise the size of the deviation can be compressed by extending counting time, lowering background radiation, using larger samples, improving equipment so as to miss fewer emissions in counting, and perhaps by enriching samples. However, the odds of being correct can be altered or the range within which the correct date may lie can be compressed, but the probability features cannot be eliminated. We can affect the odds but

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we cannot make a sure thing out of the gamble. Groups of dates on different parts of the same sample, remeasurements of a sample, and consistency within groups of related samples are the only types of defense against statistical error. In every sense, however, the dates themselves represent a point, the mean value, on a probability curve and must be interpreted by probability law considerations. An "exact" science is one able to calculate its degree and chances of inexactness.

Field errors are the ones which generally involve a date too recent to fit the archeology. Many causes for them lie in the chemistry and physics of carbon and its compounds. One could scarcely pick a more difficult chemistry than that of carbon for such studies, and much in the C14 results has pointedly shown how much remains to be understood of carbon chemistry. Problems of contamination and problems in plant and animal physiology are involved.

Charcoal as a mass of carbon should be almost chemically inert in a normal environment, but its physics can be distressing. In fine-structure, charcoal is a sponge with surfaces of really tremendous area, each charred fragment of a wood vessel-wall being chambered with innumerable tiny spaces and passageways. The roles of activated charcoal as a purifying material indicate the large forces for adsorption of other materials that these surfaces exert. Normally, large parts of these surfaces are covered with a thin layer of molecules of air gases, water, and other materials held to the carbon surfaces by molecular forces. Some of these molecules are driven off by heating, some can be pumped off by evacuation, but it is unlikely that all of them can be driven off by any normal procedure. Deeply buried charcoal that has not been percolated by drainage, charcoal from arid environments, and charcoal from biologically sterile environments, should not have much recent organic material adsorbed to it. Char from shallow depths in humid climates may have had a very elaborate history of adsorption and molecular exchange on surfaces. I don't believe it is yet possible to evaluate this type of contamination or to do any adequate chemical preparation of samples to overcome it.

Woods and plant debris, both fresh and decayed, are complex structures of a number of different carbon compounds which have varying solubilities in solutions of different relative acidity. The lignins of wood, humic acids from plant debris and other soil constituents are quite soluble and are readily transported from some chemical environments, redeposited in others. De Vries in the Netherlands has worked with controlled peat samples from stratigraphic columns which gave false and inverted dates due to such transported materials, and which yielded apparently valid dates after leaching with alkaline solutions to remove soluble constituents. I have not seen any information on the concentration of such humus fractions in charcoal or in cellulose, but we suspect that these may sometimes represent serious contamination situations.

Most of our char and other organic material from local archeological sites are very much root-riddled. Not only are there living or recently-dead rootlets which can be more or less successfully dissected out, but there is some decayed remnant of many previous generations of rootlets. This stuff can only be cleaned out chemically and it may not be possible to remove all of it from charcoal. Char in our soils has long been part

of a complex soil ecology, and it can scarcely fail to reflect the history of its environment.

These suggestions indicate difficult problems of contamination that may lie back of some of our inconsistent date series. With current improvements in apparatus and technique, more attention is being given to chemical preparation: of samples, and we can hope for more adequate protection against contaminated samples, and trivial errors have added up to significant ones.

One classic problem which has not yet been solved is the dating of the buried fossil soils of our prairies and Great Plains. Even when deeply buried, these soils are riddled by modern grass roots, and contamination from multiple causes is so severe that  $C^{14}$  determinations have not been satisfactory. It should be possible, with elaborate chemical treatment, to remove all soluble and transportable organic material and obtain valid dates from the most inert organic residue of the soil. This may require removal of practically everything except a tiny cellulose fraction from the soil sample. In less severe form, the same problems of contamination probably apply to many of our ordinary archeological samples. Adequate knowledge of the chemistry and of chemical decontamination methods should go far in eliminating the uncertainties in many of our present determinations.

The  $C^{14}$  studies have produced many surprises, especially in biology. We have often taken for granted that organisms which metabolize calcium carbonate utilize mineral carbonate in the calcite and aragonite which they secrete. In many realms this is very untrue. Marine shellfish secrete shell in which all of the carbon of the calcium carbonate comes from atmospheric sources, practically none of it from mineral carbonate. Sea shells generally give valid dates. Fresh-water shells often give false or anomalous dates, and the physiological background for this is not yet understood. Calcareous algae, including those of hot springs, secrete tufa in which most of the carbon originated in the atmosphere, less than ten percent of it in mineral carbonate. Antler and bone contains mainly atmospheric carbon in its calcite and carbonaceous fractions, but both generally give invalid dates, for reasons not yet clear. The calcium carbonate precipitated out of temporary hard water should derive half of its carbonate from the atmosphere, half from limestone, according to classic models of limestone weathering. In samples studied at Heidelberg, more than ninety percent, and perhaps all, of the carbon in these carbonates had a recent atmospheric origin. This indicates that these carbonates do not come into solution by the mere reaction of carbonic acid with limestone in weathering. These carbonates must have passed through the metabolism of organisms, and must be the product of soil micro-floras which are agents in calcite weathering.

These few examples not only cast a great deal of light on the complexity of our environment, but they all have some implication for archeological dating.

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## NEWS AND NOTES

The awards committee has distributed recommendation forms for Association members

to nominate Fellows and recipients of the Achievement Award. The criteria were published in the November, 1957, BULLETIN (No. 11). All communications on this subject are to be sent to Dr. Marian E. White, Rochester Museum of Arts & Sciences, 657 East Ave., Rochester 7.

A few copies of Researches & Transactions, Vol. V, No. 4, "Notes on Rock Crevice Burials in Jefferson County", by John B. Nichols, listed as out of print on the list distributed recently, are now available. Available to members only at 50c. postpaid from Morgan chapter secretary, c/o Rochester Museum.

Members are reminded that copies of the latest printing of A. M. Stewart's "Map of Seneca Villages and Jesuit and French Contacts, 1615-1708", are still available. The map is 23" x 26" (borders 20 1/2" x 25 3/4"), was executed by a professional artist, and is printed on fine paper suitable for framing. For your postpaid copy, with guide which describes the sites and early visitors, shipped in a substantial mailing tube, send \$1 to A. M. Stewart, 30 Audubon St., Rochester.

Wm. A. Ritchie spoke before Morgan chapter, January 10th at the Rochester Museum. His topic, "Post-Molds in the Sands of Time", described the 1957 field work on settlement patterns. An outline on the subjects covered:

Getman site (Mohawk) -- double walled stockade of 320' diameter. There were 2-5' between the stockade rows and 2-6" between the posts of a row. One longhouse, 90' long and 22" wide was uncovered as well as portions of 4 others. There were an estimated 6-8 houses in the village. The Getman site appears to belong between the Chance and Cayudutta sites in the Mohawk sequence.

Bates site (Greene, N. Y.) -- This Owasco site was surrounded by a stockade which was 96' by 50'. This was a double row stockade with a single gate and baffle. Many postmolds all in arcs but insufficient pattern to determine the house type. The temporal position within the Owasco sequence is not clear. The pottery from Bates shows none of the characteristic Castle Creek traits of late Owasco such as the beaded lip, collar, and incised decoration. However, in motifs of pottery decoration the trends would suggest a position later than Castle Creek.

Massachusetts -- The Cohannet chapter of the Massachusetts Archeological Society has been working for some time on an Archaic site at Assawompsett Lake. Here remains of Archaic houses had previously been found. In August Ritchie went to work with the chapter to check further on the houses. There they have found 5 lodge floors. 30' or more in diameter and formed by paired postmolds. Associated with these are gouges, plummets, ulus, bannerstones, and Laurentian-type projectile points. Some cremations have been found.

Major suggestion -- That sites which have been nearly dug out as far as artifacts are concerned, still may yield important information on settlement patterns. The exploration of house types and numbers and arrangements is a project especially suited to chapter or group activity because of the need for considerable labor force.

Letter to the Editor --

Your remarks in the November Bulletin regarding the membership status of the N.Y.S.A.A. compared to that of other state archeological societies in the ESAF require further comment. Your assumption that the N.Y.S.A.A. should have a larger membership is obviously not shared by the majority of the members. An examination of our membership rolls from 1953 through the end of 1957 shows an increase from 247 to 283 members or about 15%. Only one chapter, Morgan chapter, has had an increase greater than this, 23%, while much of the remaining increase in the Association results from the addition of one new chapter (Mid-Hudson) and members-at-large. One must conclude that on the whole there is not a general interest in increasing membership.

That our low gain through these years is not the result of lack of interest in archeology is shown by an increase in the membership of the Pennsylvania Society for Archeology from 1953 through 1956 of about 80%. That our low gain is not the result of a "natural reluctance" on the part of Yorkers to support similar organizations is indicated by a glance at the membership of the New York Historical Association which reported in 1957, 8576 members of which about 70% are Juniors. These are the reasons for concluding that there has been a general lack of interest among members of the N.Y.S.A.A. in getting others to join the Association.

Perhaps this so-called lack of interest may stem from explicit policy on the part of some chapters or members, apathy or uncertainty on the part of others. The Association needs to find out from members and chapters their reasons for not "selling" memberships in the N.Y.S.A.A.

Should the Association desire to increase its membership and the individual members desire to help through their chapters, there is one obvious starting place, institutional members. This is not a new suggestion but a comparison with two neighboring societies indicates that it is still a fruitful one. We find that the Massachusetts Archeological Society reports 49 institutional members (1957), the Pennsylvania Society, 82, (1955), and the N.Y.S.A.A., 6 (1957). Institutional memberships have another advantage. The circulation of our publications through libraries helps to acquaint many new people with our activities and creates a new area for potential memberships.

Marian E. White

The above is the only response to the item on relative membership published in the November 1957 BULLETIN (No. 11). Possibly this is a manifestation of the apathy referred to by Dr. White.

--Editor

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Current Trends in American Prehistory<sup>1</sup>

Alfred K. Guthe

Morgan Chapter

Periodically, it behooves us to consider and review the status of our fields of interest. Such a review may provide insights which otherwise would have remained obscured. It also permits us to reanalyze our approach to problems and to reorient our thinking with regard to specific situations. Guided by these thoughts, I have recently gathered together various observations and notes pertaining to archeology in North America.

It is quite evident that there is an increased public interest in archeological and historical subjects. The close relationship between these two fields is obvious. Archeology is simply the investigation of extinct cultures for which written records do not exist. Perhaps, this should be qualified so as to include historic archeology, i.e. the excavation of sites from which artifacts of European origin are obtained. This may be true of sites which are not documented as well as those described in historic journals. The kinship between these two fields will permit us to consider trends in both of them as indicative of the same general interest.

Evidence of the increase in public interest in these related fields is indicated by the formation of museums and historical societies across the nation, the increase in popularly written articles and books on archeological subjects, the increasing number of requests for information and talks from local groups such as the Boy Scouts, various church and other organizations. Grants to aid archeological and historical research are now being received from new sources.

The growth in numbers of museums and historical societies demonstrates that people are realizing that there is a local history, that there is a regional heritage, and that it is a precious one. K. Ross Toole in discussing this growth writes "This coincided with a great unease and insecurity which resulted from war, and the sudden knowledge of vulnerability. It was, indeed, one world ... and not a very stable one. Thus the natural process of maturation, plus the sudden need for some kind of rudder, turned people's minds and interests backward. This happened, of course, all over the country" ("The Impact of the Museum in the Hinterlands", Clearing House for Western Museums Newsletter 201, November, 1956, p. 994).

Probably recognition of this interest has prompted publishers to seek manuscripts with at least a semi popular appeal. At any rate, several articles and books of varying quality have been published during the last few years. Among these are Geoffrey Bibby's The Testimony of the Spade (1956); C. W. Ceram's Gods, Graves, and Scholars (1951); Carleton S. Coon's The Story of Man (1954); all published by Alfred A. Knopf, Inc. Houghton Mifflin Company has published Herbert Wendt's In Search of Adam (1956). The Vantage Press published William S. Fowler's Ten Thousand Years in America (1957). Articles on archeological subjects have appeared in the New York Conservationist and The Fisherman, a sportsman's magazine. Newspapers have presented feature articles on

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1. Revision of a paper given before Morgan Chapter, March 8, 1957

local archeology. The New York Sunday Mirror (Dec . 23, 1956) printed a one page account of the longhouse floor plan uncovered at the Factory Hollow site. The Newark Sunday News Magazine (Nov. 11, 1956) presented several pages on the work of the Archeological Society of New Jersey.

Another indication of an increased interest in archeology can be seen when noting the sources of research and conference subsidies. In addition to the National Science Foundation and the Wenner-Gren Foundation for Anthropological Research, Inc., firms granting financial aid to archeology are: the Rand McNally & Co., Carnegie Corporation of N. Y., Humble Oil Company, Socony Mobil Oil Co., Melville Shoe Corporation, and the El Paso Natural Gas. Co.

Acts and proposed acts in Congress and the New York State Legislature are still another barometer of public interest and awareness. The Federal Aid Highway Act of 1956 passed in May, 1956 provides for millions of dollars to be expended on highway construction. Section 120 of this act states: "Funds authorized by this title to be appropriated, to the extent approved as necessary by the highway department of any State, may be used for archeological and paleontological salvage in that State in compliance with the Act entitled 'An Act for the preservation of American antiquities', approved June 8, 1906 (34 Stat. 225) and State laws where applicable". In order to implement this section, a bill is currently (Feb. 1958) before the New York State Legislature (#1340) which will enable such funds to be utilized by the New York State Museum for the State Education Department. It can be seen that our lawmakers are conscious of the need to preserve the evidence of earlier life and culture in our area. We must consider ways to aid in this preservation.

The recent activity of our governmental offices is not the first evidence of such an interest on their part. Since 1906, the Federal government has had an antiquities act which applies to federally owned and administered lands. It has supported anthropological work for years. As early as 1848, the Smithsonian Institution published a report on Indian sites in the Mississippi valley. The River Basin Surveys is another example of this interest. This interagency program grew out of a realization by archeologists that the development and expansion of a nation-wide program for flood control, irrigation, hydro-electric, and navigation projects by the Federal Government would eventually destroy many archeological sites in areas about which little was known. The program was organized in the fall of 1945 and field work began in July, 1946. It involves the Bureau of American Ethnology, the National Park Service, the Bureau of Reclamation and the Corps of Engineers. Under this program work has been conducted in at least 25 states, thousands of sites have been located; the excavation of many of them has been recommended and undertaken on several.

Of course, archeological work is sponsored by many other institutions and many individuals finance their own research. This activity increases the need for the dissemination and integration of information. It is only through the exchange of information that one can arrive at a logical and verifiable interpretation of past events and cultures. Most of us are familiar with the reports issued by the federal and state government agencies, and know of American Antiquity which is published quarterly by the Society

for American Archaeology. The existence of state archeological societies is also common knowledge. In the east, 17 states and 2 of the Canadian provinces have joined into the Eastern States Archeological Federation. The federation conducts an annual meeting in the fall of the year. It issues a bulletin, and has prepared a bibliography on archeology. It is attempting to provide information to its members through exhibits, a research program, a speakers list, etc. All of this is being done on a very limited budget. In addition to this, many of the member societies publish bulletins, news letters, and occasional monographs on materials in their respective areas. The New York State Archeological Association, organized in 1916, has published 32 issues of its *Researches and Transactions*, and 12 issues of *THE BULLETIN*.

Still, the need for an increase in the exchange of information seems to be necessary. During the 21st annual meeting of the Society for American Archaeology (May 3-5, 1956), three possibilities for increasing communication were considered: 1) establishing a news letter, 2) expanding the Notes and News section of *American Antiquity* and 3) the affiliation of state and local societies with the S.A.A. During the summer of 1955, four seminars were held. They dealt with theoretical implications of archeological data. 1) Stability and Instability in Prehistoric Cultures, 2) Evolutionary and Functional Implications of Community Patterning, 3) The American Southwest: A Problem in Cultural Isolation, and 4) Prehistoric Culture Contact. In April, 1956 another seminar or "Early Lithic and Archaic Cultures in North America" was held. The titles of these clearly indicate that a need for synthesizing current data exists.

If we turn to the area of our greatest concern, New York and Northeastern archeology, we find that the same need for increased communication exists. The theme of the Ninth Conference on Iroquois Research held October 14-16, 1955, was "Exploring Ways of Achieving Cooperation in Anthropological Studies in the Northeast". Among the subjects considered were state and local relationships in archeology, professional and amateur responsibilities, and roles of institutions as training centers. The problem of how to foster good communications between national, state, and local levels without control flowing from the top and to provide the amateur, part-time scholar with a sense of full participation was recognized. Suggestions to improve communications included conferences, diffusion of information, and the formulation of specific archeological projects were made.

Some of these suggestions can be acted upon by the New York State Archeological Association as an organization and its members as individuals. If we consider only those on which action can be taken as individuals we have the problems in New York Archeology to consider. Where are the sites, what do they yield? A system for recording these has been developed and approved by the Association. Its use can also be of help in cataloging the material recovered from the sites. The nature and content of habitation areas of the Hopewellian, Point Peninsula, and early Iroquois cultures are inadequately known. The Owasco-Iroquois transition is not clear. What are the similarities and differences between the several

Iroquois cultures? MacNeish has provided a beginning on this. Why are there so many projectile point forms in the Laurentian complex? Do they suggest a temporal difference or the mixture of several traditions? Are these forms always associated with each other? How were various artifacts used? What can a bore awl perforate? How long does it take to drill a hole in a piece of slate when using a chert drill? How hot a fire is needed to burn bones in a pit? These are only some of the questions whose answers will provide us with greater insights.

With the continuing reduction in the number of sites, it is certain that our work must be directed toward seeking information on archeological problems, not simply amassing a sizeable collection of interesting remains of this area's early occupants. Conducting our excavations with attention to details of soil deposition and color, the occurrence of plant and animal remains and the association of these with artifacts can provide valuable information for interpreting the past. After all, in the long view, we as archeologists do seek to reveal the story of the past as it is recorded in the soil, don't we?

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BOOK REVIEW. Frank J. Soday: An Archaeological Field Manual; including Excavation an Archaeological Site. Misc . Paper No. 2, Tenn. Arch. Soc., June, 1957. Available from the University of Tennessee, 6 Biology Bldg., Knoxville, Tenn. at 50c.

Mr. Soday presents a step-by-step account of the procedure and technique of conducting field work, processing of the findings, and record-keeping. The paper is in two parts. The first comprises 18 pages plus five appendices, and covers site surveys, collection of artifacts, photography, recording and processing, and preservation of the material. The second, which occupies 20 pages plus three appendices, covers points relating to the purpose of excavation, mapping, tools required, exploratory excavation, recording of data, and excavation of burials.

The author emphasizes the importance of notes. Examples: The site itself is an artifact. Digging destroys this artifact. Notes are important as they will be the only source available of the layout of the site. Every object and feature, once extracted, can never be seen in its original context; therefore complete records (notes, sketches, photographs) are essential for future reference. An archeological find is only as good as the notes recorded at the time of the excavation. That which is not recorded is lost.

This work is the result of 20 years' practical experience in the field as an amateur, during which time, the author estimates, he has conducted 1000 field trips, discovered nearly 700 sites, and recovered approximately 100,000 artifacts. This led to the development of a systematic procedure for conducting field work, the results of which are embodied in this valuable manual. It has also been published by the Alabama society, and several other state societies are considering publishing it.

One searches in vain to find important details which may have been omitted, but everything--and we repeat: step-by-step --seems to be there. This is just the manual for

which so many of us have yearned, the kind of guidance required to provide the understanding of what should be done, why, and how. With this kind of information one cannot help but do a commendable job, and enjoy it immensely.

Mr. Soday's manual is a model of the systematic method. It should be read by every digger, non-professional or professional. We recommend it highly.

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Meet Our Four Step-Children

Ballots for Association officers covering 1958-59 are at hand as we go to press. We are disappointed to note that the nominating committee chose to select a slate composed exclusively of Morgan and Van Epps-Hartley chapter members.

Isn't it about time that we were offered a slate of something other than the same old stereotyped composition? How about some nominees from Auringer-Seelye, Long Island, Mid-Hudson, Susquehanna chapters? It cannot possibly be that the other two have a corner on the competent, qualified personnel.

It would seem that some, if not all, of the members of the committee were remiss in their duty. For each chapter is represented on the committee. One wonders where they were when nominations were in order. Is this another example of apathy?

The Association's step-children should see to it that this regrettable state of affairs does not continue.

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Authors of papers to be presented at the annual meeting are requested to submit a copy, for publication, no later than the time at which they are read.

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