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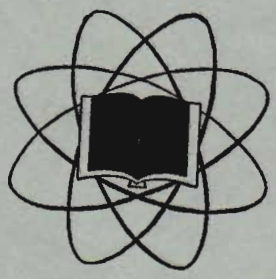

The fear of the Lord is the beginning of wisdom. Psalm 111:10

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*Radiocarbon Dating**

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Rarely has a scientific tool attracted the interest that has been shown toward the radiocarbon method of dating since its discovery some ten years ago. In their journals, the archeologist and geologist are continually presented with time evidence. Where once there were vague time estimates based on such qualitative evidence as sedimentation rates, today a radiocarbon date may appear, expressed to the nearest hundred years. Even the theological journals have recorded the voice of radiocarbon dating as it was called to witness in the case of the Dead Sea Scrolls. In popular magazines and newspapers, too, the atomic clock—as it is often called—is a topic of discussion. It is the purpose of this paper to examine this new aid to chronology. The outline to be followed is as follows: (a) theory, (b) checks on the theory, (c) sample processing and counting, (d) problems, and (e) pertinent dates.

Theory

In the magazine *American Scientist* Dr. Willard Libby, now an AEC commissioner and originator of radiocarbon dating, makes this statement,[1] "Radiocarbon dating had its origin in the curiosity about the possible effects that cosmic rays might have on the earth and particularly, of course, on the earth's atmosphere. We were interested in testing whether any of the various effects which might be predicted could actually be found and used." One might wonder how the jump from cosmic rays to dating could possibly be made, yet it is the nature of basic scientific study that seemingly down-to-earth applications are its offspring. In Libby's mind there were two facts meshing together. First, Korff had discovered free neutrons in the upper atmosphere, a secondary radiation originating from cosmic ray bombardment of the air molecules; secondly, laboratory work with neutrons had shown that they can transmute nitrogen atoms into the carbon isotope of weight 14, called radiocarbon, an isotope unknown in nature at the time Libby began. Combining these two facts with the obvious knowledge that nitrogen is the atmosphere's most abundant component, Libby concluded that the atmosphere should contain natural radiocarbon.

Next he turned to speculation and assumption. He pictured a newly created carbon-14 atom as readily joining an oxygen molecule to form carbon dioxide. Then this $C^{14}O_2$ would be uniformly mixed into the atmosphere and become a small part of the total CO_2. Finally, because there is a cyclic interchange between CO_2 and both living materials and oceanic dissolved carbonates, some radiocarbon would enter the biosphere and the oceans. The circular part of Figure 1 pictorially summarizes the proposed origin and history of a C^{14} atom.

Having postulated the existence of radiocarbon in the dynamic carbon reservoir (i.e., atmosphere, biosphere, and hydrosphere), Libby was next faced with predicting the expected concentration of radiocarbon relative to normal carbon-12 and then devising a method for detecting C^{14} and measuring its concentration. The radioactive nature of C^{14} enters all of these problems.

First, if C^{14} were not radioactive—that is, would not decay to the nitrogen from which it originated—it would have been impossible for Libby to make any prediction about the amount of C^{14} now in the dynamic reservoir. The reason for this is that the terrestrial amount of C^{14} would be forever increasing. How long production has gone on no one can say with any certainty. However, laboratory work with artificially made carbon-14 had established it as radioactive with a half-life of about 5500 years. That is, a hypothetical isolated pound of radiocarbon today would be ½ pound in 5500 years, ¼ pound in 11,000 years, ⅛ pound in 16,500 years, etc. Libby realized that if cosmic rays of uniform intensity had bombarded the earth for perhaps the last 100,000 years or so, the present amount of radiocarbon being produced would be balanced by the amount of radiocarbon decaying to the original nitrogen.

As an analogy, consider a funnel into which water is being poured at a constant rate. At first, less water comes out than goes in; but when the level in the funnel builds up to a certain point, it ceases rising and outflow balances inflow. For any particular inflow, there is a corresponding level to achieve a matching outflow. In fact, one could mathematically predict the equilibrium level from a knowledge of the rate of outflow. Similarly, the laws of radioactivity permit mathematical determination of the quantity of a radioactive isotope if one knows its rate of disintegration. At the time of his speculation, no equipment was in existence for Libby to measure the radiocarbon disintegration rate directly, but he did have a "handle" on

*Paper presented at the 12th Annual Convention of the American Scientific Affiliation at Gordon College, August, 1957.

the production rate. And the two rates, he had postulated, were the same. That "handle" was the published data on the intensity of the neutrons which father radiocarbon.

The intensity of cosmic-ray-produced neutrons varies in a known manner with both latitude and elevation.[2] By integrating the neutron flux over the entire earth surface and from the ground up, one can determine how many neutrons per second are available for atomic transmutations. Since laboratory work has shown that neutrons overwhelmingly favor the reaction to produce radiocarbon, there is essentially a one-to-one equivalence between neutron intensity and atoms of radiocarbon produced per unit time. So calculated, Libby's radiocarbon production rate—and disintegration rate as well—is 2.6 C^{14} atoms per second for each square centimeter of earth surface. The total amount of radiocarbon necessary for such a disintegration rate is 66 metric tons.

Now to determine the concentration of C^{14} relative to the total dynamic carbon reservoir requires estimating the size of the reservoir as well. Unfortunately no convenient "handle" is available such as was the case for the amount of radiocarbon. The three parts of the dynamic reservoir—atmosphere, hydrosphere, and biosphere—must be considered separately. The atmosphere presents little problem since its mass and carbon content are well measured. In the hydrosphere, inorganic carbon, present as dissolved carbonate and bicarbonate, is calculable by methods outlined in Sverdrup's classic text on *The Oceans*[3]; the temperature, pH, and so-called alkalinity of the ocean fix the inorganic carbon content within a small range. Dissolved organics are obtained by analysis of many samples. In the case of the biosphere, estimation is more difficult. Libby estimated the amount of biosphere carbon from published annual rates of photosynthesis together with a rough figure of the average carbon atom's residence time in the biosphere. Fortunately, the biosphere is a small fraction of the total dynamic carbon reservoir even in the most liberal estimates, and so any errors in it have little influence on the total estimate. In Table I are listed the reservoir estimates of several men.[2, 4, 5] The controlling size of the hydrosphere contribution and the consistency among estimates are immediately obvious. Libby considers his total to be accurate within ± 15 percent.

In review, then, before Libby had found any natural radiocarbon, he had postulated that 66 metric tons of it were contained within the 42 trillion metric tons of carbon comprising the dynamic reservoir. If distributed evenly, each radiocarbon atom would have about 600 billion stable carbon atoms to itself. Should any portion of the dynamic reservoir—such as a piece of wood or a clam shell—be cut off from the dynamic reservoir, as by death, its source of radiocarbon replenishment would also be cut off. Then the radiocarbon concentration would begin to drop through C^{14} disintegration. Table II shows the decay pattern of a hypothetical sample containing 512 million radiocarbon atoms at the time of its departure from the dynamic carbon reservoir. In mathematical language, this table is equivalent to $\frac{N}{N_o} = e^{-\frac{.693T}{T_{½}}}$ where N_0 = initial number of C^{14} atoms, N = number of C^{14} atoms at time T, and $T_{½}$ = the C^{14} half-life of 5568 years. This is the solution of the basic radioactive decay equation, $\frac{dN}{dT} = -\lambda N$ where λ is the decay constant.

It becomes obvious, therefore, how radiocarbon dating is possible. One must first establish the carbon-14 concentration in the dynamic reservoir and then measure the radiocarbon concentration of an object removed from that reservoir. The ratio of the two concentrations is a direct measure of the object's age, provided the reservoir has been uniform in C^{14} concentration through time. A ratio of ½, for example, means an age of one half-life or 5568 years.

All this is clear-cut it would seem. But all Libby had then was a potential method of dating. Natural radiocarbon existed only as a necessary conclusion from other facts, and its uniform distribution throughout the dynamic carbon reservoir was merely a postulate. If Libby could detect C^{14} in the reservoir and could find it disintegrating at about 19 atoms per minute per gram of total carbon, then a new method of dating seemed assured. In short, Libby did detect C^{14}, first in sewage methane that had been enriched in radiocarbon by thermal diffusion, finally in unenriched methane. And the disintegration rate per gram of total carbon was found to be around 15 per minute, amazingly close to the predicted value of 19.

Checks on the Theory

There are a number of empirical checks which can be made on the theory of radiocarbon dating. Five are listed as follows:

1. Check the uniformity of the dynamic reservoir by measuring the disintegration rates of samples gathered throughout the world.
2. Check radiocarbon dates against known historic and tree-ring dates.
3. Check a stratigraphic sequence of dates for consistency—as for example the levels of human occupation in a cave or carbonate shell samples from various places along an ocean sediment core.
4. Check the dates of contemporaneous samples of different chemical nature—as wood and shells.
5. Check the radiocarbon date of a sample against the date obtained by another physical-chemical procedure, such as the ionium method for ocean sediments.

Check No. 1 From various parts of the world

Libby[2] obtained numerous wood samples. Samples were taken from sea level up to the tree line. Except for one sample, all specific activities were between 14.5 and 15.9 disintegrations per minute per gram. This uniformity is in sharp contrast to the wide range over which C^{14} production rates vary as a consequence of differing geomagnetic latitude and elevation within the atmosphere. Apparently, the atmosphere is turbulent enough to distribute the radiocarbon evenly.

Check No. 2 Tables III and IV list several historical and tree-ring dates along side the corresponding radiocarbon dates.[6] Errors attached to the C^{14} dates are due only to the statistical or random nature of radioactive disintegrations. It is well to emphasize that the dates tabulated are the rule rather than the exception. Unfortunately, historical and tree-ring dates are limited to the last 5000 years or less.

Check No. 3 In Table V are radiocarbon date sequences from an Iranian cave[7] and from the bottom deposits of Searles Lake, California.[2] Both show the expected progressive age increase with depth.

Check No. 4 Table VI presents dates from three sites each providing several samples that, from field evidence, appeared contemporaneous.[2, 6, 8] Note the different material types dated: peat, marl, charcoal, organic mud, and several different species of wood.

Check No. 5 An independent method for checking C^{14} dates far beyond historic time is the ionium method.[9] Limited to certain ocean sediments and independent of cosmic rays, this method is based on the selective adsorption of radioactive ionium (thorium—230) on fine sediments as they settle. The subsequent radioactive decay pattern provides a key to the sediment age. Animal shell fragments included in the sediments provide the carbon for radiocarbon dating. Figure 2 is a plot of ionium ages versus C^{14} ages for several samples.[10] If the two dating methods agree all points fall on a 45° line. The use of blocks rather than points is to show the range of error possible in the measurements. This check is significant in that it seems to confirm the assumption that the cosmic ray flux, and thus the rate of radiocarbon production, has been essentially constant for at least 25,000 years.

Another check, not on theory but on technique, is to date a given sample at several laboratories. A number of such checks have been carried out and no significant differences found.

Sample Processing and Counting

To detect the presence of C^{14} atoms each with about 1 trillion surrounding carbon-12 neighbors is obviously a difficult task. Nevertheless, that is the very easiest job required of equipment in a radiocarbon dating laboratory; for one to a trillion is the ratio for the dynamic carbon reservoir. Samples 35,000 years old, for example, have only 1% of this concentration.

No device that measures isotopic concentrations through their mass—such as the mass spectrometer—is sensitive enough for natural radiocarbon. Only the fact that the atoms of carbon-14 are continually disintegrating permits concentration measurement. In disintegrating, a radiocarbon atom ejects an electron from its nucleus and becomes a nitrogen atom. This electron is detected—that is, counted—by one of three devices: (a) a Geiger counter utilizing elemental sooty carbon, (b) a scintillation counter with carbon in a liquid compound, and (c) a proportional counter in which carbon is present in gaseous form.

Libby's pioneering work[2] was done with a Geiger counter, a cylinder with a wire at its axis. All samples are first converted to CO_2, the organics by combustion, the carbonates by acidification. The CO_2 is then reduced to elemental carbon by magnesium metal. After grinding to powdered-sugar fineness, the carbon is spread on the inside of the Geiger counter cylinder. Electrons produced by radiocarbon disintegrations then pass over to the positively charged center wire and trigger a counting device. Today few radiocarbon laboratories employ Libby's black carbon technique, primarily because finely ground carbon is an excellent adsorber of minute airborne radioactive contaminants. These trigger the Geiger counter as readily as radiocarbon.

The second device, a scintillation counter, detects radiocarbon disintegrations through the minute light flashes produced by ejected electrons flying from C^{14} nuclei. Carbon from the sample to be dated is converted into any one of a number of liquid organic compounds. So as to avoid spurious counts resulting from electronic static, two inter-connected photomultiplier tubes are focused on the sample. Only when both tubes indicate a scintillation is it added to the sample counting register. Were it not for the problems of chemical synthesis, scintillation counting might be standard in radiocarbon laboratories.

The third counting device is the proportional counter utilizing carbon in a gaseous compound. In its construction and operation, the proportional counter much resembles the Geiger counter. Electrons from disintegrating radiocarbon atoms are attracted to a positively charged center wire and thus trigger a counting register. Today, almost all the world's radiocarbon dating laboratories use gas counting, but the particular gaseous compound varies. Some use acetylene, some methane, but most prefer carbon dioxide. At Lamont Geological Observatory, CO_2 is used.[11] It has several advantages: (1) it is produced directly from the combustion of organic samples or the acidification of carbonate samples; hence, no complex chemical syntheses are required, (2) no explosion hazards exist, and (3) the storage of dated samples in the form of solid calcium carbonate is readily carried out. About the only disadvantage of CO_2 is that it must be ultra-pure in order to count at high efficiency.

Figure 3 is a summary of the counting and pro-

cessing methods just discussed.

On the surface, it would seem that all one need do is to place a sample in a counter for a minute or two, read the counter to get the count rate, ratio this count rate with the rate of a recently living sample, and calculate the age from a simple formula. For two reasons, this idealistic scheme is not possible. In the first place, the time pattern of C^{14} disintegration is random. One minute 40 counts may be recorded, the next minute perhaps only 20. In the second place, though one may build a tomb about his counter, he still cannot eliminate a certain number of spurious counts called "background."

To solve the first problem, it is necessary only to extend the time of counting. An analogous situation arises when one wishes to prove that a coin should land heads 50% of the time and tails the other 50%. Certainly ten flips will not always show a 50-50 distribution, but the more flips made, the closer to 50-50 will be the overall result. Even so, if a finite number of flips is made, there is a certain statistical error that is present. It is such a statistical error that is indicated by adding ± 100 (or some such number) to radiocarbon dates. At Lamont, every sample is counted at least twice, 16 hours each time. In special cases where one wishes to pinpoint a date, longer times are used. For example, Libby counted one sample almost three months in seeking sufficient accuracy to correlate the Babylonian and Christian calendars.[2]

The second problem is one of background. When CO_2 produced from anthracite coal gives a count rate of 15 counts per minute, it is obvious that spurious counts are involved. Coal has been outside the dynamic carbon reservoir so long that no detectable amount of radiocarbon could possibly remain. Then what is the source of the background counts? There are several sources: mesons, gamma radiation, alpha and beta particles.

Of most importance are mesons, highly penetrating particles of cosmic ray origin. Since no practical amount of shielding can cope with mesons, a so-called anti-coincidence ring of about a dozen Geiger counters is placed all around the sample counter. Any meson that passes through the sample counter must necessarily pass through one of the Geiger counters an instant before. By electronic interconnections, it is possible to reject all pulses that occur simultaneously in the sample counter and in any one of the Geiger counters.

Alpha, beta, and gamma radiations originate from minute uranium and other radioactive contaminants that are everywhere present. Iron is comparatively free of such impurities and so the Lamont counters are housed in an eight-inch thick iron tomb. To reduce the background still further, an inch-thick mercury shield envelops the counter, lying inside the anti-coincidence ring of Geiger counters.

With this shielding and electronic circuitry, the background of the Lamont counters is reduced from about 1000 to approximately 15 spurious counts per minute. If this background were to remain constant at all times, there would be no problem. A simple subtraction of 15 from each total count rate would yield the true sample count rate. Unfortunately the background varies somewhat from day to day, apparently correlating with atmospheric pressure change. It is this variation in background together with the statistical uncertainty in its measurement that limits the present dating equipment to about 45,000 years. In other words, when the total count rate of a sample is so low that it approximates the background variation, it is impossible to give the sample a date other than "greater than 45,000 years."

At Lamont modern and background samples are counted at least once a week and the electronics are checked daily. Every sample counted is checked for purity. With two counters in operation and everything working properly, about four or five dates can be turned out weekly. Obviously radiocarbon dating is anything but a mass production operation.

Problems

How reliable is a given radiocarbon date? It is as reliable as the certainty of two assumptions:

1. The radiocarbon concentration of a particular sample when it was alive is the same as that of today's dynamic carbon reservoir.
2. During the years since sample withdrawal from the dynamic reservoir there has been no alteration of its isotopic carbon composition outside of radiocarbon disintegration.

Assumption 1 requires:

A. that the mass of terrestrial C^{14} be constant with time.
   —True if the cosmic ray flux has not varied.

B. that the mass of the dynamic carbon reservoir be constant with time.
   —True if there has been complete isolation from the dormant carbon reservoir.

C. that the distribution of C^{14} in the dynamic reservoir be uniform at all times.
   —True if the mixing rates among all parts of the dynamic reservoir are rapid compared to the 8000 year average life time of a C^{14} atom.
   —True if photosynthetic and solution processes have no natural discrimination against any particular carbon isotope; that is, cause isotopic fractionation.

From the outline above, assumption 1 depends for its validity upon these physically measurable quantities: cosmic ray intensity, interaction between the dynamic and dormant carbon reservoirs, mixing rates among the parts of the dynamic reservoir, and isotopic fractionation.

As to variations in cosmic ray intensity over the

range of radiocarbon dating, one can offer as data only the checks between ionium and radiocarbon dates mentioned before. The statement of several scientists that there is no known reason for significant cosmic ray variations is of questionable value in discussing the problem.

That there is interaction between the dynamic and dormant reservoirs of the earth is obvious. Figure 1 diagramatically shows several ways that carbon-bearing material moves between reservoirs. Carbon with no radioactive content (i.e., dead carbon) enters the dynamic reservoir through the combustion of coal and petroleum, through rock weathering, and through spewed volcanic gases. Carbon leaves the dynamic reservoir as carbonate sediments, organic accumulations such as peat, carbonate weathering products, and of course the samples that are dated. As far as radiocarbon dating is concerned, the question is whether the magnitude of the exchange has been sufficiently great and unbalanced as to have altered the dynamic reservoir appreciably during the last 50,000 years. From the meagre data available the answer seems to be no.

Of all the transfers, the combustion of fossil fuels is apparently the most significant. According to Revelle and Suess,[12] "This is probably two orders of magnitude greater than the usual rate of carbon dioxide production from volcanoes, which on the average must be equal to the rate at which silicates are weathered to carbonates." It is estimated[13] that almost 4×10^{17} grams of combustion CO_2 have been added to the dynamic reservoir since the modern industrial revolution began. Relative to the total dynamic reservoir, this added carbon is but a fraction of a percent. Relative to the atmosphere, however, it is about 15%. Almost all of this radiocarbon-free CO_2 has been introduced since 1900. If it all remained in the atmosphere, trees growing today ought to have a 15% lower C^{14} concentration than trees of the nineteenth century. Evidence of a lower atmospheric C^{14} concentration today has indeed been found by Suess[14] and others, but nowhere near 15%. Exchange with the vast ocean reservoir has lowered the figure considerably—to about 3% in U. S. industrial areas[14] and to about 2% over the earth as a whole.[15] Fortunately, this dilution of the dynamic reservoir's carbon-14 content is no problem in radiocarbon dating; it has all taken place so recently. With the advent of nuclear bomb testing man-made radiocarbon has been produced in quantities large enough to more than offset the effect of dilution with combustion carbon dioxide.

In a way, combustion CO_2 has been an asset, for it has brought to light information on the rates of mixing between the various dynamic reservoir components.[5,12,16] The information so far brought out emphasizes the validity of assuming a grossly uniform radiocarbon distribution throughout the dynamic reservoir; nevertheless, experience reveals some variations. Table VII lists the percent variations from wood taken as the standard of comparison. From this table, it is evident that, in general, the reservoir components pertinent to radiocarbon dating fall within a small range of C^{14} concentrations. The only exceptions are from unusual environments: hard water lakes[17] and caliche soils, both of which provide dead limestone carbon for the organisms they support. Richest of all in radiocarbon is air, partly because C^{14} originates there but mainly because plants slightly discriminate against utilizing C^{14} in their life processes.

How then can one utilize the empirical evidence of reservoir variations in radiocarbon dating? At Lamont, wood samples are dated by comparing with the radiocarbon concentration of oak grown in 1890 before the modern industrial revolution. Corrected for radiocarbon lost in the past 67 years, this C^{14} concentration is assumed to be the same as that of the wood sample when it was alive. A similar technique is used for other types of samples.

In cases where there is opportunity to check historic dates, another scheme is used. Similar material living today is obtained from the area from which the sample came. For example, a recent sample[18] was some bread remains from Pompeii, charred by the volcanic ash fall that buried the city in 79 A.D. The estimate of the radiocarbon in this bread when it was still wheat came from wheat growing today near Pompeii. The measured age came within 50 years of the true age.

The second of the two assumptions involved in the reliability of a particular radiocarbon date says simply: the sample is isotopically identical to its living state except for radiocarbon lost by disintegration. Assumption 2 requires:

A. that there be no addition of carbon-bearing substances having a different C^{14} concentration from that of the sample. Potential contaminants include:
   - —Substances borne by ground water (i.e., carbonates, humic acid)
   - —Intruded rootlets
   - —Material added through careless field or laboratory handling.

B. that there be no decay or exchange processes whereby one carbon isotope is preferentially enriched or depleted.

Contamination is by far the most frequently heard objection to certain radiocarbon dates. Hunt[19] likens the environment of many geologic samples to a laboratory sink and a solution of vinegar. Granting that "sealed test tubes" such as tombs and dry caves should give good radiocarbon dates, he feels that buried samples have little chance of withstanding contamination by fine rootlets or ground water organic solutions.

At Lamont there is constant alert for the contam-

ination of which Hunt and others speak. Unless Lamont personnel collect a sample, it must be *assumed* that field collection has introduced no contamination. In the laboratory extreme care is taken throughout the sample's journey from glass jar to counting chamber. If surfaces are decayed, outer wood portions are removed; rootlets are picked out carefully; organic materials are acid-leached to remove carbonates, then base-extracted for removal of humic acid.[20] Shells are surface cleaned thoroughly, first mechanically and then by acid.

To evaluate the significance of contamination, the Lamont laboratory is carrying out a dating program[20] on geologic samples in the 40,000-year range where even slight contamination is a big problem. By chemically isolating celulose from woods and peats and then comparing the cellulose dates to those of the bulk samples, it should be possible to get a statistical picture of contamination in buried organic materials. The first four samples, two woods and two peats, have indicated no contamination.

Figure 4 shows the age error resulting from various percentages of both contemporary and dead carbon contamination.[6] The closer the ages of a sample and its contaminant, the smaller will be the error in the radiocarbon age.

Besides macroscopic contamination, there is the potential problem of atom by atom exchange with the surroundings. That is, carbon-12 atoms in the air or moisture surrounding a sample may interchange with carbon-14 atoms in the sample; or the reverse may happen. For organic samples, this is almost a chemical impossibility. On the other hand, carbonate samples, being ionic, are theoretically capable of undergoing exchange. The evidence available for well preserved shells and calcareous tufa indicates that such exchange is usually insignificant.

Finally, Antevs[2] suggested that when a piece of buried wood undergoes decay isotopic fractionation might occur—that is, a larger amount of one carbon isotope might be lost in the decay products, thereby depleting that particular isotope in the sample and thus changing the radiocarbon age. Libby[2] examined several contemporary decayed wood samples and was unable to detect such fractionation.

Now to return to the original question: "how reliable is a radiocarbon date?" Because a method's reliability does not hinge on one or even several dates, it is better to reframe the question to read, "how reliable is the radiocarbon method of dating?" Radiocarbon dating is without a doubt theoretically sound and, in the author's opinion, empirically established. Only a small percentage of the several thousand dates so far have been called into question. True, there is still work to be done in the matters of contamination, cosmic ray history, and dynamic reservoir changes. Statistically speaking, however, radiocarbon dating has proved itself.

Without question, there are some radiocarbon dates that are in error. In the opinion of archeologist Frederick Johnson, author of the final chapter in Libby's book on *Radiocarbon Dating*.[2] "barring mistakes by collectors and laboratory workers, the very large majority of the errors are traceable to the process of selection and collection of samples. Such range all the way from faulty observation of conditions in the ground to controversy over the significance of a given stratum."

This points up the fact that this paper is not concerned with the matter of associating a past event with the radiocarbon age of a given sample. The archeological, geological, and anthropological interpretations placed on a sample are completely independent of the very high probability that the sample was alive X years ago. Therefore, one must be cautious in questioning a radiocarbon date until he has first reviewed the evidence refuting the date. When this involves questioning certain presuppositions in a given field and perhaps revising them, human reluctance to change may sometimes make an objective approach quite difficult. Archeologist Johnson observes,[2] "In instances where various types of evidence lead to real conclusions concerning chronology, the radiocarbon dates are in general agreement. Where the major difficulty actually appears is in situations where geologists or archeologists do not agree among themselves."

Dates

In the Appendix are listed a number of published date lists. With dating laboratories springing up all over the world, it will not be long before the total number of dates is measured in tens of thousands; today dates are numbered in the thousands. Starting in May of 1959, most of the world's radiocarbon dates will be published together in a special supplement to be put out annually by Yale University's *American Journal of Science*.

Since this paper is concerned with the age of man, only samples specifically associated with evidences of man's contemporaneous presence are presented. There has been an attempt to pick out the oldest dates of various localities, but this does not guarantee that certain old dates have not been overlooked. The author's field is not archeology, so that in most cases there is no mention of why a sample is thought to date human existence. Generally speaking, the association is through charcoal or burned bone remains in a cave hearth or human relics in a refuse pile. In order to avoid needless detail, ages are rounded off to the nearest hundred years and sometimes to the nearest thousand years. Tables VIII and IX give the specific material dated, the sample number including a letter prefix to identify the laboratory, and the exact published date with its statistical error. More detailed information is to be found in the appropriate date lists; and if these are still inadequate, anyone suffic-

iently interested can write the archeologists personally.

In the United States until recently, radiocarbon evidence had established man's presence back some 11,000 years. At Fishbone Cave in Nevada, juniper roots and stalks at the base of much human debris had given this date.[21] In Texas, Folsom man was fixed around 10,000 years ago[2] and Midland man about 7,000 years ago.[22] Sandals from an Oregon cave gave an age of 9,000 years.[2] Nearby Washington gave about the same date.[2] From Utah and Missouri[22] came dates around 9,800 years, from Nebraska 8,900 years,[2] from Alabama 8,000 years,[23] and from Tennessee 7,200 years.[22]

The north central and northeast sections of the United States have shown later dates. For example, the Boyleston Street fishweir in Boston gave one of the earliest New England dates, about 5,000 years.[2] This fishweir was unearthed during the digging of a foundation for an office building; it consisted of some 16,000 hand hewn stakes. In New York, charcoal at the base of a refuse pile has dated 5,400 years.[2]

Within the last couple years, several laboratories have reported dates that seem to triple the antiquity of the oldest American. One such date is from Santa Rosa Island off the northern California coast. A charred bone of a dwarf mammoth was found there with numerous large uncharred pieces of bone from the same animal. The date: 30,000 years.[23] From Sandia Cave in New Mexico came a date "greater than 30,000 years" for several mammoth tusk fragments.[24] It is still uncertain, however, whether these fragments establish contemporaneous human occupation. Perhaps the greatest surprise came within the last year from Texas. Two charcoal specimens both gave ages greater than 37,000 years.[25] Many archeologists question whether this really represents a culture age.

Now a look at several worldwide samples. A date of great interest is that of 8,600 years for burned bone from the tip of South America.[2] From France come cave dates of 24,000[22] and 16,000 years,[2] the latter from Lascaux Cave, famed for the wall paintings of ancient animals. England's maximum date[2] is around 9,500 years, probably because ice covered the land in previous millenia. Ages beyond 30,000 years come from Iraq,[2,26] Cyrenaica,[27] and Afghanistan.[28] South Africa's Florisbad skull was found beneath a peat layer that dated 28,000 years.[21] In general, then, it appears that older ages are more common in Afro-Eurasia than in the Western Hemisphere.

Within the next few years many new dates will be coming out. Perhaps a more detailed picture of man's earthly migrations will then be possible. In the meantime, on the basis of radiocarbon dates alone, it seems reasonable to measure man's tenure on earth in terms of tens of thousands of years.

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TABLE I

Dynamic Carbon Reservoir Estimates

All numbers are in units of grams of total carbon per square centimeter of earth surface.

	Libby[2]	*Rubey*[4]	*Craig*[5]
1. Atmosphere	.12	.125	.126
2. Hydrosphere - carbonate	7.25	6.95	6.94
- organic	.59		.533
3. Biosphere - terrestrial		.78	.06
- marine	.33		.002
- humus (Craig)			.215
	8.29	7.86	7.88

TABLE II

Radioactive Decay Pattern In A Hypothetical Sample

Start with a living sample containing 6 micrograms of carbon.

*Time**	*C^{14} Atoms Remaining*	*%C^{14} Remaining*
today	512 million	100.00%
in 5,550 years	256 million	50.00%
in 11,100 years	128 million	25.00%
in 16,650 years	64 million	12.50%
in 22,200 years	32 million	6.25%
in 27,750 years	16 million	3.12%
in 33,300 years	8 million	1.56%
in 38,850 years	4 million	.78%
in 44,400 years	2 million	.39%
in 49,950 years	1 million	.20%

* Actual C^{14} half-life is 5568 years ±40 years rather than 5550 years.

TABLE III

Comparison of Radiocarbon and Historic Ages

Sample Description	*Lab**	*Historic Age*	*Radiocarbon Age*
Mammalian remains from midden at Inca Temple	L	444±25	450±150
Wood from Roman ship	R	1990±3	2030±200
Wood from Egyptian mummy coffin	C	2280	2190±450
Charcoal from Etruscan Tomb	R	2600±100	2730±240
House beam, Tayinat, Syria	C	2625±50	2531±150
Wood from funeral ship in tomb of Egypt's King Sesostris	C	3750	3621±180
Wood from Egyptian tomb of Sneferu	C	4575±75	4817±240
Wood from Egyptian tomb of Zoser	C	4650±75	3979±350
Wood from Egyptian tomb of Hemaka	C	4900±200	4883±200

*L=Lamont (Kulp), R=Rome (Ballario) C=Chicago

TABLE IV

Comparison of Radiocarbon and Tree-Ring Ages

Sample	*Lab*	*Tree-Ring Age*	*Radiocarbon Age*
Sequoia	Lamont	880±15	930±100
Douglas Fir	Chicago	1372±50	1100±150
Sequoia	Lamont	1377±4	1430±150
Redwood	Chicago	2928±52	3005±165

TABLE V

Samples of Known Stratigraphic Sequence

1. *Hotu Cave, Iran*—charcoal from trench A (Univ. of Penna.[7])

Distance from Surface	*Radiocarbon Age*
Subsurface (trench C)	1220±230
190—200	2200±280
400—415 cm.	2775±315
590—660 cm.	4730±320

2. *Hotu Cave, Iran*—charcoal from trench D (Univ. of Penna[7])

Distance from Surface	*Radiocarbon Age*
765 cm.	8070±500
950 cm.	9190±590
1015 cm.	9220±570
1115 cm.	11,860±840

3. *Searles Dry Lake, California*—organic extract from mud. (Univ. of Chicago[2])

Distance from Surface	*Radiocarbon Age*
73.7 feet	10,494±560
76.7 feet	15,089±1000
80.2 feet	18,000±730
83.3 feet	23,923±1800

TABLE VI

Dates on Different Contemporary Samples from The Same Place.

1. *Two Creeks Forest Bed Overrun by an Advancing Glacier* (Chicago[2])

Spruce Wood	10,880± 740 years
Tree Root	11,437± 770 years
Peat (around root)	11,097± 600 years
Spruce Wood	12,168±1500 years
Peat	11,442± 640 years

2. *Swiss Neolithic Lake Dwelling* (Copenhagen[8])

Spruce	4500±150
Ash	5080±280
Bark	4780±140
Charcoal	4720±130

3. *Allerod Glacial Period in Europe* (boundary between zones II and III) — (Copenhagen[8])

Lake marl	10,930±300
Wood	10,890±240
Non-calcareous lake mud	10,770±300

TABLE VII

Carbon-14 Content of Contemporary Samples

Numbers express % difference from wood and plants taken as standard

Carbon-Bearing Material	*% Difference From Wood*
Wood and plants (normal)	0±2%
Plants (highly calcareous soils)	—10±10%
Air	1±2%
Ocean water	—3±2%
Shell (marine)	—2±2%
Shell (hard water lakes)	—10±10%
Bone (inorganic)	2±2%
Bone (organic)	1±2%

TABLE VIII

Sample Dates of Man in the United States

Location	*Material Dated*	*Sample No.**	*Age*	*Remarks*
Massachusettts	wood in silt	C—418	3851±390	above fish wier
Massachusetts	peat	C—417	5717±500	below fish wier
New York	charcoal	C—367	5383±250	
Wyoming	charcoal	C—795	6920±500	
South Dakota	charcoal	C—604	7073±300	
Texas	carbon from animal bone	M—411	7100±1000	Midland Man
Tennessee	antler	M—357	7150±500	
Alabama	charcoal	L—344	7950±200	Russell Cave
Nevada	guano	C—281	8660±300	
Washington	charcoal	C—827	8700±400	
Nebraska	charcoal	C—824	8862±230	
Oregon	grass rope sandals	C—428	9053±350	300 prs. in a cave
Missouri	charcoal and bone	M—130	9700±500	cave
Utah	charcoal	C—611	9789±630	Danger Cave
Texas	burned bison bone	C—558	9883±350	Folsom Man
Nevada	juniper roots and stalks	L—245	11,200±250	Fishbone Cave
California	charred bone	L—290R	29,700±3000	Santa Rosa Island
New Mexico	mammoth tusk	M—	>30,000	Sandia Cave
Texas	charcoal	H—235	>37,000	

*Laboratory key as follows: C=Chicago, M=Michigan, L=Lamont, H=Humble

TABLE IX

Sample Dates of Man Throughout the World

Location	*Material Dated*	*Sample No.**	*Age*	*Remarks*
Palestine	charcoal	W—245	5280±150	Negev
Pakistan	charcoal	L—180A	5300±500	
Egypt	wheat, barley grain	C—550	6391±180	
Chile	burned bone	C—485	8639±450	Straits of Magellan
England	wood	C—353	9488±350	
France	charcoal	C—406	15,516±900	Lascaux Cave
France	charcoal traces	W—151	24,000±900	
Iraq	charcoal ash	C—818	>25,000	Hazer Merd Cave
South Africa	peat	L—271	28,450±2200	Florisbad skull below
Iraq	earthy charcoal	W—180	>34,000	cave
Cyrenaica	charcoal traces	W—85	34,000±2800	long history in cave refuse
Afghanistan	?	W—226	34,000±3000	Kara Kamar rock shelter

*Laboratory key as follows: W=Washington, L=Lamont, C=Chicago

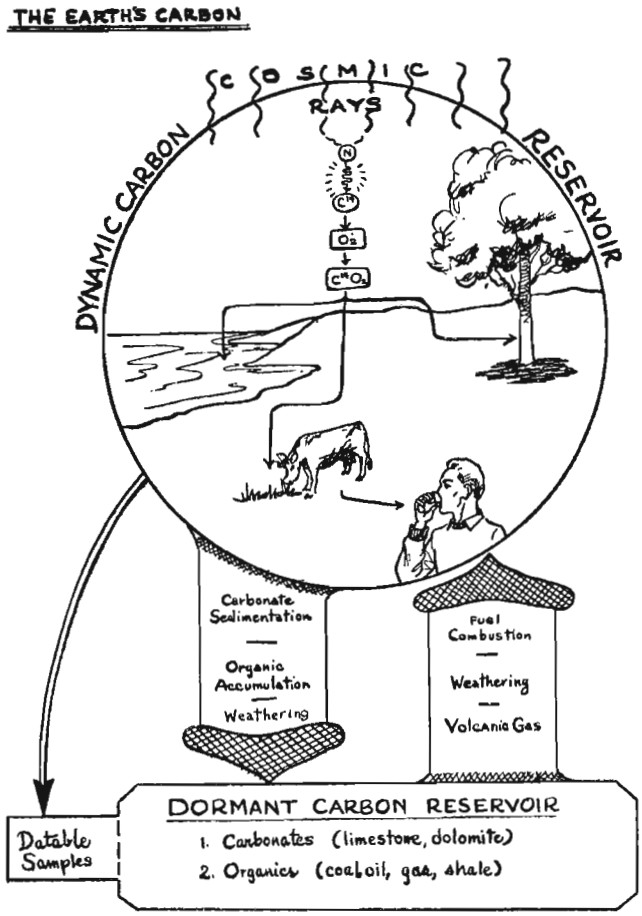

Figure 1: The carbon in the earth's crust can be divided into two parts: a part continuously undergoing turnover (called the dynamic reservoir) and a part which remains isolated in place for millenia to millions of years (called the dormant reservoir). Carbonaceous materials which have moved from the dynamic to the dormant reservoir within the last 50,000 years are potentially datable by the radiocarbon method.

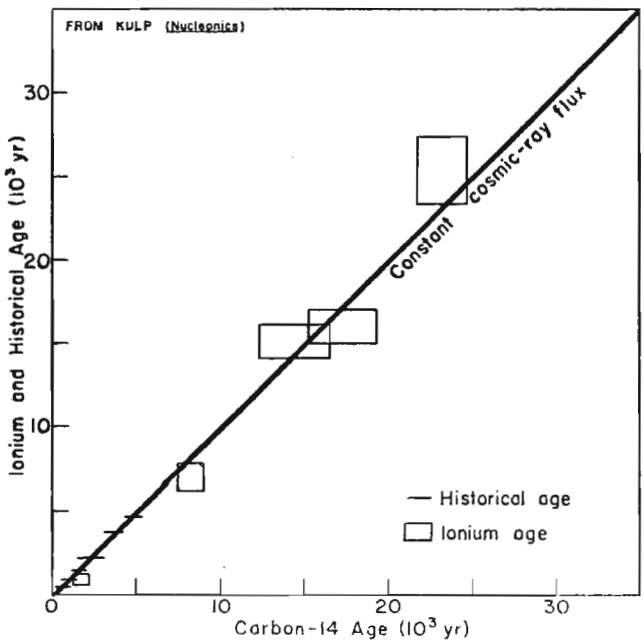

Figure 2: A plot of radiocarbon age versus historical and ionium ages. The latter apply only to oceanic sediment core samples containing both carbonate and clay fractions. Since points fall on a 45° line, a cosmic-ray flux essentially content over the last 25,000 years is indicated.

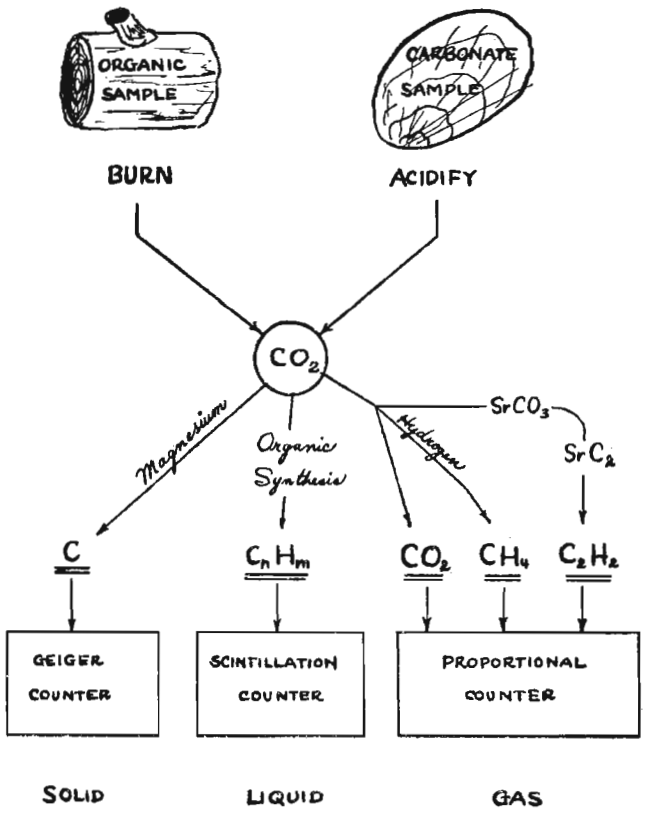

Figure 3: Almost all samples datable via radiocarbon fall into two categories: so-called organics (wood, peat, charcoal) that are burned to CO_2 and carbonates (shells, bone, tufa) which are acidified so as to release CO_2. Further chemical steps are sometimes carried out to permit radiocarbon measurement by a number of techniques.

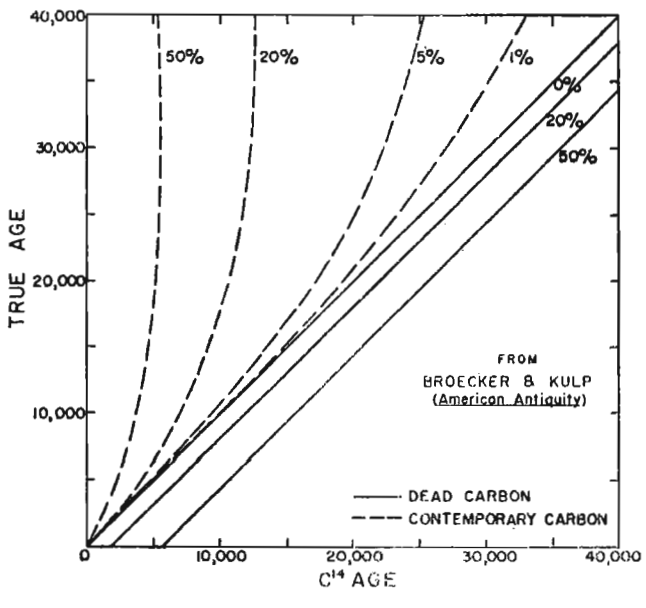

Figure 4: Radiocarbon ages are not true ages if significant extraneous carbon has been introduced into samples. This figure shows the relation between true ages and radiocarbon ages for differing amounts of both modern and C^{14}-free contaminants.

*It's Time To KO Our Calendar Chaos**

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How long is a year? This question appeared in Ripley's Believe-It-Or-Not column some years ago. The answer listed nine types of years, as follows:

Common year—365¼ days.
Calendar Year—365 days.
Leap Year—366 days.
Lunar Year—354 days.
Gregorian Year—365 days, 5 hrs., 49 min., 12 sec.
Solar Year—365 days, 5 hrs., 48 min., 46 sec.
Sidereal Year—365 days, 6 hrs., 9 min., 8 sec.
Anomalistic Year—365 days, 6 hrs., 13 min., 53 sec.
Tropical Year—365 days, 5 hrs., 48 min., 46 sec.

This list indicates that planning a calendar is no easy matter. In addition to determining which type of year is to be followed, the motion of the earth on its axis, the relative motion of the earth and the moon, and the relative motion of the earth and the sun, three incommensurate motions, must be taken into consideration, and have made the reckoning of time a difficult problem through the ages. Actually, the relative motion of the moon and the earth no longer affect our calendar directly. Imagine, if you can, the conflict calendar makers must have faced when the lunar month was abandoned! H. G. Wells wrote in his Outlines of History: "The earliest recorded reckoning is by moons." Eventually the moon became engraved in the minds of people and took on religious significance. Twelve lunations, 354 days, constituted the lunar year. Attempts to reconcile the lunar calendar with the seasons led to various soli-lunar calendars of which the Jewish calendar is the most notable.

The fact that most nations had their own calendar makes it difficult for the archeologist to correlate the events in different parts of the world. Add to this the fact that few, if any, of the nations recorded a year date or started their years on the same date, and the problem becomes more difficult. Even in Egypt, with its more modern calendar, the years were listed as the year of the reign of a ruler: e.g., the fifth year of the reign of the president, Eisenhower.

Probably the first solar calendar was invented by the Egyptians as early as 4236 B.C. Julius Caesar, who had seen this well organized calendar in operation while in Egypt, determined to revise the Old Roman lunar calendar if he ever had the opportunity. This calendar, as was common with all lunar calendars, was in the hands of the priests. Eventually, corrupt and fraudulent pontiffs began to "misuse (the calendar) for political and economic purposes. They were able to manipulate the months to their advantage in the collection of rents, taxes, and interest . . . (and) by the time of Julius Caesar it was entirely at variance with the seasons . . . The public (was) so disgruntled with it, that it afforded . . . (him) a unique opportunity to make drastic changes and necessary reforms" when he came to power. (1:67) From history we gather that an old 10 month lunar calendar, taken from wild tribes of northern Europe, was adopted by King Romulus, with the years dating from the founding of Rome. (753 B.C.) It was soon extended to 12 lunar months by the addition of January and February, the year beginning in March. Later the months were reshuffled, giving us the present arrangement. This was the calendar Julius Caesar ordered an Egyptian astronomer to revise. The result of this revision was a solar calendar named the Julian Calendar. Even in those days the politicians knew on which side their bread was buttered. They renamed the seventh month, (Quintilis), July. Later, Sextilis was named August in order to butter up another emperor, since under him a number of minor revisions were made.

The Julian Calendar went into effect in 46 B.C. It was to begin at the time of the winter solstice, but since a new moon came 7 days later, it was begun at the time of the new moon, after a year of confusion consisting of 445 days. Picture what would happen today if the Democrats (or Republicans) would attempt something like this, and in an election year yet! History may some day unearth records to show that this is why Julius Caesar was assassinated the following year.

The Julian Calendar, a perpetual calendar, divided each month into three sections, Kalends, Ides, and Nones, each of different length. (You will recall the warning to "Beware the Ides of March" in *Julius Caesar,* which began on March 15.) In Leap Years, observed every fourth year, February 24 was repeated to add the extra day. Under this calendar the year had 365¼ days, which is 11 min., 14 sec. longer than the solar year. A little arithmetic will show that this amounts to one day in approximately 128 years.

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In this form the calendar was used by the Romans until 321 years after the birth of Christ. At this time Constantine was the Roman Emperor, who had a soft spot in his heart for the Christians. History tells us that he was raised in Britain and was the chief priest of the pagan Roman hierarchy, but that at his death he became a Christian. In 321 A.D. Constantine introduced the seven-day week into the calendar. The names of the days of the week are the Nordic names of the then known seven heavenly bodies. The order was established by the Assyrians who used it as their basis of astrology. The astrological belief was that each hour of the day was governed by a different heavenly body in the order of their distance from the Earth: Saturn, Jupiter (Thor), Mars (Tiw), Sun, Venus (Frigg), Mercury (Woden), and Moon. The "planet" which governed the first hour of the day was called its "regent." Taking the hours in order, each of the seven becomes a regent in the order of the days of the week. Thus the perpetual characteristic, one of the chief merits of the Julian Calendar, was lost, and the wandering week became the chief difficulty of the calendar, a serious defect that has continued to this day.

By 325 A.D., the year of the Council of Nicea, the vernal equinox had migrated back from March 25 to March 21. The rule for determining the date of Easter was stated at this time to avoid further confusion: "Easter is always the first Sunday after the Full Moon which happens upon or next after the twenty-first day of March; and if the Full Moon happens upon a Sunday, Easter is the Sunday after." (Lutheran Hymnal, p. 158) From this all of the moveable festivals are determined. Thus the pagan Julian Calendar gradually became "Christianized." Many of the special feast days were set on the days of pagan festivals, probably to "wean" the Christians away from them.

In A.D. 532, Dionysius Exiguus, a monk and Abbot of Rome, established the present manner of counting our years. The method of dating from the founding of Rome was changed to dating from the birth of Christ. Modern scholars contend that he made a four year error and that Christ actually was born in 4 B.C. Would that this were the only error our Catholic brethren had made! Dionysius also set March 25 as the date of Christ's conception and fixed this date as the beginning of the Christian year.

This was the last major change in the calendar in over 10 centuries. By that time it was obvious that March 21 was no longer the first day of spring. This was recognized by scholars for several centuries before any action was taken. The Council of Trent in 1545 authorized the Pope to rectify the situation. After an additional 37 years of deliberations and discussions, Pope Gregory XIII issued a decree which made three changes in the Julian Calendar, as advised by astronomers and mathematicians of that day: (1) The vernal equinox was returned to March 21, where it had been at the time of the Nicean Council. (2) The present leap year rule then put into effect to prevent a recurrence of the situation, provides that every year that is divisible by four except those century years which are not divisible by 400 is a leap year. So, for example, the year 1900 was a leap year under the Julian Calendar because it is divisible by 4, but not under the Gregorian Calendar, since it is not divisible by 400. This calendar is 26 seconds longer than the solar year, which would amount to a day in 3323 years. (3) New Year's Day was returned to January 1.

The new Gregorian Calendar was put into effect in 1582, when Thursday, October 4, 1582, was followed by Friday, October 15, 1582. Our colonies, controlled by England, did not adopt the Gregorian Calendar at this time. In 1534, at King Henry VIII's behest, the English Parliament had passed the Act of Supremacy, thus severing all connection with Rome and the English church. So, naturally, England and her colonies did not follow the papal decree. It was not until 1752 that the change was made, when Wednesday, September 2, 1752 (Julian Calendar) was followed by Thursday, September 14, 1752. The change, we are told, caused riots and bloodshed in England by people who demanded back the 11 days of their lives they thought had been taken from them. Russia did not adopt the Gregorian Calendar until 1918, and the Greek Orthodox Church has still not made the change.

Here, then, in brief, we have the history of our present calendar, a battle-scarred relic, originated by the Old Romans. In it are reflected the superstitions and myths of the ages. It bears effects given it by politicians, astrologers, astronomers, and mathematicians. It is encrusted with the whimsies of kings and dictators; it has been paganized, Christianized, modernized, and renamed through the centuries. It now keeps time with sun in a respectable manner, but that is about all.

It has months that are not months, with names of four that are misnomers (September through December) and eight that have no meaning for present or future mankind. Its week day names are a reversion to pagan superstitions whose origin has been lost in antiquity. Its halves are not halves and its quarters not quarters, and each may begin on any day of the week. It has 14 different kinds of years and 28 different types of months, most of which are caused by that "extra day", and each year begins at a time of the year that has no logical basis. The number of work days and Saturdays varies in each month from year to year, and yet our whole economy is based on business forecasts, which in turn are based on month to month or quarter to quarter comparisons. In short, "the Gregorian Calendar is unbalanced in structure,

unstable in form and irregular in arrangement." (9:LV) It is an old model-T with new tires, converted to battery, and with new ising glass curtains, but a model-T still.

Then why don't we discard it as we do our old cars, out moded school books, and balloon dresses? A personal reference illustrates the attitude of so many people in this matter. Some years ago, after my mother had raised her eight boys and two girls to manhood and womanhood, we thought it was about time she got herself a refrigerator. She said she didn't need one. She was better off than most of her neighbors, since she had her cave under the house, and that was luxury enough. And besides, the exercise was good for her. But when her oldest insisted he would buy her one if she didn't do it herself, she let him know that he could buy her one if he wanted to, but she assured him she would not use it. And use it she didn't . . . for a long time. It was a gradual process, but today her refrigerator is one of her prize possessions, as jam-packed as yours. Calendarwise we need an older brother who will buy us a new one, since, apparently, we prefer the cave we grew up with, not realizing its limitations.

Miss Elisabeth Achelis, in "Of Time And The Calendar", chapter IX, gives an excellent resume of the history of proposed revisions. It finally became an important item on the League of Nations agenda, and when it appeared to be ready for adoption, World War II broke out and the League of Nations folded. Many years of study by various experts in the field sifted 187 proposed plans. The last two calendars to stay in the running were the 13-month plan and The World Calendar, both containing the perpetual feature. The World Calendar was finally settled upon because of the few differences it has with the present calendar. One disadvantage of the 13-month calendar in this enlightened age is the fact that every month would have a Friday the 13th.

The World Calendar

January April July October							February May August November							March June September December						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
1	2	3	4	5	6	7					1	2	3	4						1	2
8	9	10	11	12	13	14	5	6	7	8	9	10	11	3	4	5	6	7	8	9
15	16	17	18	19	20	21	12	13	14	15	16	17	18	10	11	12	13	14	15	16
22	23	24	25	26	27	28	19	20	21	22	23	24	25	17	18	19	20	21	22	23
29	30	31					26	27	28	29	30			24	25	26	27	28	29	30 W*

*Worldsday, December W (365th day), a world holiday, follows December 30th every year.

Leapyear Day, June W, another world holiday, follows June 30th in leap years.

The following points are listed as strengths of the World Calendar:

1. One unvarying calendar year.
2. There are 3 regular kinds of months in every quarter.
3. The first month has 31 days, the remaining two have 30 days each—a rhythmic pattern of 31, 30, 30 days.
4. Quarters always begin on a Sunday and end on a Saturday.
5. The quarters are equal in length.
6. Each quarter contains three months, 13 weeks or 91 days.
7. Month-dates always fall on the same weekdays.
8. Days and dates always agree from year to year.
9. Holidays are fixed.
10. Each year begins on Sunday, January 1, and the working year on Monday, January 2.
11. Each year is comparable.
12. The World Calendar is balanced in structure, perpetual in form and harmonious in arrangement. (9:V)

It is also interesting to note that each month has 26 weekdays. The calendars of 2000 years ago were national in scope and religious in character. Since this is actually the only type of calendar people are familiar with, it is difficult to imagine any other kind. However, in today's shrinking world a common calendar molded to fit today's needs is imperative. It should be clear that such a calendar must be a civil and secular calendar, free from religious bias of any kind. It must be universal and scientific in character, making it possible to be used by all nations, peoples and races. It must not deal with religious belief, dogma, theology, tradition, myth, or orthodoxy. The World Calendar is such a calendar.

Once it is adopted, the various religions can take up the questions of revising their respective religious observances within the scope of this orderly, balanced, and harmonious civil system. It will also be necessary for each nation to set its own national holidays and civic observances.

It is hoped that after the change is made that the Christian churches will establish a fixed Easter. While it should be done for its own sake, it will be a great aid to business and to any schedule-making groups, such as schools and colleges.

Many articles and pamphlets have been written to show the benefits, monetary and otherwise, which would accrue once a perpetual calendar is adopted. Some of these are listed in the bibliography. It would take too long to discuss them adequately here. A reliable authority estimates that a saving of four to five billion dollars annually would be effected by the adoption of the World Calendar. Much of this waste is due to absenteeism caused by roving holidays. However it is not possible to measure many of the inconveniences in dollars and cents. We may consider these as the human values of a stabilized calendar, even including such "little" things as being able to know on what day of the week various days of the month will fall. For many of us in schools and colleges the additional work we need to do because of our present calendar simply means extra hours in our busy schedules. The ever-changing school calendar is the big offender. Last year's plans and schedule cannot be followed because no week, month, or year is the same under the irregular calendar. Pity the poor organist

and pastor when Christmas falls on a midweek day. For them and their families there is no Christmas "vacation."

It should make an interesting study to determine the man-hours wasted per year in any particular business or profession because of our inefficient calendar. At Concordia, where I teach, it starts with the picking of an opening and closing day in such a way that the right number of teaching days is included. Vacations, sports events, and choir tours must be scheduled carefully each year; the many other extracurricular activities of our campus high school and college, and the dozens of administrative, academic, and social groups must have proper (and nonconflicting!) dates and facilities. Additional headaches come when the many emergency meetings pop up. Small wonder that church and civic groups accuse us of being self-centered and uncooperative!

Dates do make a difference. With a regular calendar like the World Calendar much of the work and most of the conflicts could be eliminated. Since last year's plans and schedules could now be used every year, we could concentrate on eliminating the trouble spots. And now that there are more nonconflicting events, attendance will increase, and all of us will have more time to attend them. But wouldn't the World Calendar be monotonous? Of course it will. Monotonous like having lunch at 12 every day and eight hours of sleep every night. That we could stand, too.

It is hoped that when the United States puts the calendar into operation it will set all or most of our national holidays on Fridays or Mondays, making three-day weekends possible as something that can be planned for each year. Actually, it would not be necessary to wait for the World Calendar to do this. We could observe a Presidents' Day on the third Monday in February, Memorial Day on the last Monday in May, Independence Day on the first Friday in July, Labor Day on the first Monday in September, and Veterans' Day on the second Friday in November, giving us five national holidays, well spread out through the year. After the Roosevelt fiasco there seems to be a reluctance to meddle with Thanksgiving, but it surely could be celebrated on Friday as well as on Thursday. This is the holiday that causes the most headaches for school administrators.

Miss Achelis (13:5) states that the "obstacles to calendar reform are two fold—first traditionally religious sectarianism, and second, apathy and indifference." In considering the second point we should recall the words of Samuel Johnson: "Nothing will be attempted if all possible objections must first be overcome." It does appear, however, that an informed group is invariably in favor of the adoption of the World Calendar. A score of nations has gone on record as being in favor of its adoption. The December, 1954 issue of the Journal of Calendar Reform lists over 250 groups of various kinds that have endorsed the World Calendar. A dozen religious organizations are listed, including the General Convention of the Protestant Episcopal Church (U.S.A.), the College of Bishops of the Methodist Episcopal Church South (U. S. A.), the Reformed Church of America, The American Lutheran Church, the Council of Bishops of the Methodist Church (U.S.A.), and my own church, The Lutheran Church - Missouri Synod.

Probably the most controversial feature of the World Calendar is the use of the Worldsday at the end of each year and at the end of June in Leap Years. For the bulk of Christendom there is no problem. Col. 2:16, 17, for example, where we read: "Let no man therefore judge you in meat, or in drink, or in respect of an holy day, or of the new moon, or of the sabbath days: Which are a shadow of things to come; but the body is of Christ", makes it clear to them that the Old Testament rules listed here have been set aside. Many of Jesus' condemnations of the Scribes and Pharisees centered around the misinterpretations of the Old Testament, including their interpretations and man made rules in regard to the Sabbath. On one such occasion (Mark 2, 27) He concludes that "The Sabbath was made for man and not man for the Sabbath." To quote Miss Achelis again, "Worldsday is not new. Actually it is a revival of the 50th day in the ancient calendar used by the early Israelites, described in Leviticus 23: 15, 16 of the Old Testament. In that calendar, known as the Pentecontad, a series of 49 days of seven weeks and seven sabbaths was enriched and fortified by adding a 50th day, dedicated to the Lord and observed as a 'high holiday.' Other series of 49 days plus the 50th day followed. It is most interesting to note that the ancient Jews were the first people to honor not only an extra day in their calendar but to give it religious connotation.

It is not known with any accuracy when the Jewish leaders adopted the newer concept of an uninterrupted succession of weeks. With the adoption of this new feature the holy 50th day had to be abandoned because the 49th day on one Pentecontad and the 7th day of the next, both being sabbaths, the 50th day would bring an 'eighth day' into the week. It was actually a day *outside* the week, coming *between* two separate weeks, which erroneously was interpreted as bringing about an 8-day week. Worldsday in the World Calendar also comes *between* two separate weeks and often has been wrongly interpreted as making an '8-day week.' . . . There are people today who relate the 150-day duration of the flood in Genesis to three Pentecontad periods and the origin of the fifty-year anniversary to the same source."

The best time to put the World Calendar into op-

eration is when both the old and new calendars coincide at the start of the year. The next time this happens is in 1961, and then again in 1967. At present, 1967 is the target year World Calendar enthusiasts are aiming at. As individuals we have two responsibilities in this matter: (1) to become informed, and (2) to express our views to our representatives in Washington.

We are gradually breaking down the barriers of nationalism, and are entering an era in which all people, regardless of race or religion are cooperating in the search for peace. In such a world, civilization urgently needs a good uniform calendar for all nations. We must have vision in this endeavor, for "where there is no vision the people perish." It is high time for all of us to lend a hand so that we may soon K. O. our calendar chaos.

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   (This publication was discontinued with the January, 1956 issue. This office was then closed. Miss Elisabeth Achelis is still active and can be reached at P. O. Box 224, Lenox Hill Station, New York, 21, but the main work is being done by the International World Calendar Association, P. O. Box 20, Besserer Street, Ottawa, Canada.)

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*Leprosy In Ancient Hebraic Times**

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Historical:

Pusey[1] states that the first fully described symptoms of today's leprosy was made by Aretaeus (100 AD)[2] as

> "thick dense condition like an elephant, with decreased sensitivity to impressions," as Barbadoe's legs.

At this time, elephantiasis in Greece, Juzam in Arabia,[3] were true leprosy, while the Greek lepros (round scaly superficial lesions and crusting as described by Aegueta[4]) and baras in Arabia,[5] leuce or melos of the Alexandrian Greeks[6] was probably chronic psoriasis vulgaris of today. Some hold that the vitiligo of Celsis (25 B.C.) is true leprosy,[7] others judge it was psoriasis[8] or scabies with psoriasis.[9]

Johansen[10] states that the conditions including leprosy are recorded in the Egyptian Ebers papyrus (1350-2020 BC) but Rosen[11] reports on studies on mummies of the 20th dynasty (1100 BC) revealing the presence of a vesicular and bullous eruption with the form and distribution of small pox.[12] Dharmendra,[13] in reviewing the Ebers papyrus supposed that uchedu was leprosy found among the Negro slaves from the Sudan while Ebbel[14] interpreted uchedu as a pyoderma. Johansen[10] also reports that conditions including leprosy were recorded in the Indian Vedas (about 1500 BC). Dharmendra[13] commenting on the Vedas, interprets their general word, Kushtha, as skin diseases in general, but in one of their subdivisions, Arun-Kushtha is described as today's anesthetic and lepromatous types of leprosy, and in the chapter on the nervous system, Vat-Rakta, or Vat shonita, the hyperesthetic type with its loss of sweat in the affected parts and curvature of the fingers. Therefore, the descriptions in the Vedas do describe today's leprosy.

Similarly, the Hebraic equivalent of the Indian Kushtha, Zara-ath, means any skin disease; it connotes something rough, scaly, and its primitive meaning being to sting, to smite, and general cutaneous distress.[25] Others claim it means white, glistening or dull white[2]; and on the basis of the Septuagint and Vulgate translations, it is interpreted as today's chronic psoriasis vulgaris.[2]

A review of Leviticus of the Old Testament shows that the priests were in charge of infectious diseases, as well as of the moral and religious welfare of the nation. The differential diagnosis between infectious and non-infectious cutaneous diseases is quite modern.

Since the first modern scientific classification of skin lesions was made by Plenck in 1776,[15] one must translate into today's language, the descriptions found in the ancient writings.

In the Old Testament, ** leprosy is diagnosed as:

1. " . . . . a swelling, eruption, or a spot, ... on the skin of the body" Lev. 13:2 and appearing spontaneously;
2. " . . . . if there is a white swelling in the skin, which has turned the hair white, and there is quick raw flesh in the swelling," Lev. 13:10.
3. " and when there is in the skin of one's body a boil that has healed, and in the place of the boil there comes a white swelling or a reddish-white spot . . . . Lev. 13:18-19.
4. "Or, when the body has a burn (hot burning in the King James version, 1611) on its skin, and the raw flesh of the burn becomes a spot, reddish-white or white, ... " Lev. 13:24.
5. " . . . . a disease on the head or the beard, ... and if it appears deeper than the skin, and the hair in it is yellow and thin, then the priest shall pronounce him unclean, it is an itch, a leprosy of the head or the beard." Lev. 13:29-30.

It is not leprosy if:

1. the rash fades under two weeks of observation in isolation, Lev. 13:6.
2. the rash does not spread, Lev. 13:6.
3. it is not deeper than the skin, Lev. 13:3.
4. if the hair merely falls out, Lev. 13:40.
5. if a boil or burn heals and does not spread, and leaves a scar: Lev. 13:23, and Lev. 13:28.
6. if there is a white skin disease all over the body from head to foot. Lev. 13:38.

In Table 1, biblical definitions are translated into modern scientific descriptions and terms.

Comparison of today's leprosy with Ancient Hebraic Leprosy:

The earliest skin lesion of today's leprosy is often a macule, flat, level with the skin, varying in number from one to many, of various sizes and shapes, varying in color from loss or depigmentation, to an excess or hyperpigmentation, often with a reddened sometimes

*Paper presented at the 13th Annual Convention of the American Scientific Affiliation at Iowa State College, August, 1958.
**From the Revised Standard Version of 1952.

Table 1: A comparison of Biblical and modern scientific definitions.

Biblical Title	*Modern Title*	*Description*	*Example*
Spot—Lev. 13:2	Macule	A lesion level with the skin	Freckle
Swelling— Lev. 13:2	Papule	A small round solid lesion above the level of the skin up to ¼" in diameter	Adolescent solid pimple
Swelling— Lev. 13:2	Nodule	A larger papule, over ¼" diameter	Small lump on the skin
White swelling— Lev. 13:10	Vesicle	A small round lesion above the skin level, up to ¼" diameter containing clear fluid	Cold sore or Chicken pox
White swelling— Lev. 13:10	Bulla	A larger vesicle, over ¼" diameter	A blister in a burn
White swelling— Lev. 13:10	Pustule	A vesicle filled with a thick yellow-white fluid	Adolescent pus pimple
Quick raw flesh— Lev. 13:10	a decapitated bulla	A raw moist base with slight scale at edge	A ruptured blister
Quick raw flesh Lev. 13:10	Ulcer	A destructive excavation of the skin	Skin cancer
Burn or hot burning, Lev. 13:24	Puritis, hyperesthesia	Itching, increased sensitivity of skin	Itching like in mosquito bite

raised border and a paler center, and accompanied by a decrease in sensation due to local involvement of the nerves in the lesion.[16] Today, we also think of the ordinary brown pigmented nevus, a superficial cancer of the skin that today is ruled out by a microscopic examination of the lesion, and circumscribed scleroderma, or morphea, a collagen or connective tissue disease, which, during the Middle Ages, was considered as the first sign of leprosy[8].

Early in the maculo-anesthetic type of today's leprosy, we find macules, vesicles and bullae.[17] Today, when we see these lesions, we clinically eliminate from our thinking, herpes zoster (shingles), herpes simplex (the common cold sore), chicken pox, the pemphigus group, dermatitis herpetiformis, and bullous erythema multiforme.

The macular stage of leprosy later develops an infiltration that may raise the center or the edge, while others may be raised with fine papules within it.[16]

Today, we eliminate papular syphilis from our thinking in these cases. The bullae may rupture to give the raw flesh appearance, and rarely today, may be followed by gangrene producing the lazarine form of leprosy.[17] When the body tissue has a strong bacterial defense, the macular stage proceeds to the benign tuberculoid or nodular stage of leprosy. When there are several nodules on the face, the text-book picture of a lion-like appearance results.

Since sensory nerve changes are present in leprosy, some patients notice a sense of burning or itching.[17] In association with external injury, i.e. trauma will result in the typical trophic ulcer of the foot, or thermal injury will produce the common severe self-induced burn on anesthetic areas of the skin. Itching dermatoses such as scabies, lichen planus, prurigo, and parasitic infestations, are eliminated from our thinking in these cases. When inflamed sores or boils are present, we usually consider the pyodermas,[14] the deep mycotic or fungus infections, i.e. actinomycosis, small pox, scabies,[2] anthrax,[9] the venereal diseases including syphilis, and tuberculosis of the skin. When a fine scale appears on papules covering the entire body, we usually think of secondary syphilis; if a thick white mica-like scale results, it is usually chronic psoriasis vulgaris.

In Biblical leprosy, there are two distinct types of scalp lesions:

1. The hair in the diseased spot is white (Lev. 13:3). One is not able properly to evaluate this white hair phase, for Ormsby[17] reports only 1% of cases with alopecia leprosa, and Faget records 78.6% of such cases in a Japanese Leprosarium in 1943.

2. The hair is thin and yellow (Lev. 13:29). These cases were probably chronic psoriasis vulgaris, or the fungus diseases of the scalp, favus, and tinea capitis.[19]

Summary:

This evaluation indicates that the earliest manifestations of clinical leprosy, the macule, the burning, or itching, the anesthetic areas with self-induced burns producing lesions, the appearance of nodules, vesicles, and bullae, with ulceration or decapitation of the bullae producing a quick raw flesh, are accurately described and considered in the differential diagnosis, to determine if the patient is clean (non-contagious) or unclean (contagious). Friendenwald[20] concludes that

most of the cases labelled leprosy were true leprosy as we know it today. It is my opinion, that leprosy as well as the diseases mentioned in the differential diagnosis, e.g., chronic psoriasis vulgaris, syphilis, pemphigus and dermatitis herpetiformis, small pox, fungus infections as well as the pyodermas were included under the general label of leprosy.

The period of 14 days of isolation by the priest allowed the disease to progress under observation, to permit a more accurate diagnosis. At the end of this period, the patient was labelled clean (not contagious) and allowed to rejoin his tribe, or classified unclean (contagious) and expelled from the confines of the tribal community.

It has been stated that leprosy of the Old Testament is not the same as today's leprosy, for the advanced stages of the nodular leonatious facies, the nerve paralyses, the claw hands, etc., are not recorded as being present.[14] These were the patients already labelled contagious and were excluded from the activities of the tribe.

For the following reasons, I judge that some of the cases labelled leprosy were syphilis:

1. Syphilis is probably the oldest skin disease of man.[21] Ducrost found in the excavation at Solutre, a female skeleton among a heap of bones from the Stone Age, and the tibiae showed characteristic syphilitic exostoses.

This opinion was concurred in by Broca, Parrot, and Virchow. Zambuco in 1900 exhibited photos of bones from Egyptian graves at Abydos dating before 1700 BC of skulls with exostoses, and long bones showing evidences of syphilis.

2. We find in Lev. 22:4: "None of the line of Aaron who is a leper, or suffers a discharge . . . . "

A discharge (running issue, in the King James Version), was probably gonorrhea. Today, gonorrhea and syphilis are often found in the same patient.

3. Leprosy was considered contagious by conversation and coitus with a leprous woman.[8] Today, syphilis is almost always acquired by the latter method.

4. We read in Deut. 28:27: "The Lord will smite you with the boils of Egypt . . . . "

This was acquired from worship of Baal Pe'or, in the temples of debauchery and syphilis.[21]

Some of the cases of Biblical leprosy were probably

Table No. 2: Current Clinical Data of Diseases considered as Biblical Leprosy

Disease	*Degree of Contagion*	*Causative Agent*	*Therapeutic Agents*	*Duration of therapy*	*Cure or control*
Leprosy	† †	Lepra bacillus of Hansen	Sulfones	9-12 months	Cure
Syphilis	† † † †	Treponema pallidum—bacteria	Penicillin	1-2 weeks	Cure
Small Pox	† † † †	Virus	No active—preventive vaccination	3 weeks	Cure
Scabies	† † † †	Acarus scabei-a parasite	Sulfur, benzyl benzoate	2-3 days	Cure
Favus	† † †	Achorion Schoenleini-fungus	X-ray therapy and epieation	6-12 months	Cure
Tinea of Scalp	† † † †	Microsporon audoini or lanosum fungus	X-ray therapy and salicyl-anilides	3-6 months	Cure
Deep or systemic fungus infections	† † †	*e.g.* Actinomysosis due to actinomyces bovis or Nocardia	Potassium Iodides, PABA	4-12 months	Cure
Boils and furuncles	† †	Staphlococcus and streptococcus -bacteria-	Antibiotics, *e.g.* penicillin	1-2 weeks	Cure
Pemphigus	unknown	unknown	ACTH and oral steriods	4-8 weeks	Control only
Dermatitis Herpetiformis	unknown	unknown	Inorg. As, and sulfapyridine steroids	1-25 yrs.	Control only
Cancer of skin	unknown	Virus?	no medical cure—surgical excision	0	95% cure in skin

chronic psoriasis vulgaris because:

1. In some cases of early psoriasis before lesions appear on the body, one finds a moderate amount of scaling in the scalp.

2. Lepra vulgaris of ancient times is today's chronic psoriasis vulgaris.[14]

3. The case of Naaman's leprosy (2 Kings 5:1) was probably psoriasis.[14] [22] It is possible that some cases of Biblical Leprosy were small-pox. Ruffer[23] in studies of mummies found a case of small pox (1200-1090 BC) indicating that perhaps there were others. This could have spread to the Jewish nation due to the highly contagious and epidemic nature of the disease. Ebbell[14] doubts this.

There is a marked divergence of opinion as to the leprosy of Job (Job 2:7-8). Lie thinks it was scabies crustosa,[2] Gordon feels that it was pemphigus foliaceus.[23] Pruess judged that it was generalized eczema,[4] Ebbel[4] and Friendenwald [20] thought it was hemorrhagic small pox, and Brim[24] thinks it was pellegra.

Careful scrutiny of the column of the degree of contagion of Table 2, reveals that the common belief that the isolation techniques applied to Biblical leprosy were too rigid, is incorrect. When a scientific paper is given concerning portions of the Holy Bible, the speaker usually concludes at this point. He is so intent in his minute study of the tree, that he misses the entire forest.

Today's dermatologist, using the latest medical therapeutic agents as tabulated in Table 2, cures or controls the diseases tabulated as possible Biblical leprosy in from 2 days to 12 months, but our Lord, Jesus Christ cured 10 lepers immediately (Luke 18:14). He performed a super-human act, a miracle, even by today's standards and therapeusis. But people don't want miracles to happen; they wish there were no miracles so that they could get around them. They only want to believe the miracle of the natural law, so that they can order the earth for his own well being, and object to any interference with this latter way.

Today, individuals with extra-ordinary abilities are considered in one field are accredited with extra-ordinary talents in others: i.e., President Eisenhower, a military man of 35 years experience, is today a politician as the President of the U.S.A., the mathematician, Prof. Albert Einstein, a leader in the Pacifist movement, etc. In the same vein, when our Lord Jesus Christ performed the miraculous cure of 10 lepers immediately, it attested to a divine revelation, visible to the senses, and serving as objective proof to one and all, that He was a divinely commissioned religious teacher drawing attention to new truths.

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BIOLOGY

I. W. Knobloch, Ph.D.

It was my belief that the recent series here listing points about biology would stir up a hornet's nest because of the controversial nature of the material. However, to date, I have received only one reply. This was from Dr. William Tinkle and with his permission, the letter is quoted in full below.

Instead of criticising your views as expressed in the September Journal I agree whole-heartedly. I regret the typographical errors here and there but think they are not your fault.

Your paragraph, "Is Science Evil" illustrates the present unfavorable position of biology in public esteem. This situation is not realized by many people, for we are said to be living in a scientific age. It is not biology, however, which occupies the headlines but physics and chemistry applied to warfare. Even the chemists and physicists are not accorded wholesome appreciation but are regarded as wizards, doing the dirty work which our national existence requires.

There is a little appreciation, we must admit, for medical research. But where, at the present, is there honor for men like Louis Agassiz and Asa Gray who introduced to us the living world and taught us to love it? We still have such men and women, devoted, big souled, underpaid, some of them devout Christians. If we could get the ear of the public to explain our kind of science, no one would ask if it is evil.

Another condition which gives me concern is the subservience of science to national governments in the last few decades. Science, unlike magic, is supposed to be reported objectively and fully, so that any one who understands the data can check the correctness of the conclusion and apply the principle so obtained. The international status thus attained has helped preserve the peace of the world, increasing common purposes and understanding. We even suspect, as in the case of Russian genetics, that political interference leads to erroneous science.

The workers themselves are very glad when such restrictions are lifted. At the Second U. N. International Conference on the Peaceful Uses of Atomic Energy, "The American scientist who said 'This is pure joy to be able to talk freely' spoke for most participants." (*Science,* 26 Sept. 1958)

Science can not be evil if it leads to correct theories and laws, but we do not vouch for the soundness of all that passes as science. That is one reason we have an American Scientific Affiliation. And of course we deplore the improper use of the results of research.

Dr. Tinkle mentions Russian Science and it is planned to say something on this matter soon.

Hybrids

It is the present writer's opinion that recombination or hybridization is one of the most important methods evolved by "Nature" for the production of new species. From time to time, we shall bring important articles to your attention, dealing with this subject. Below is a short review of such an article by Dr. Stebbins.

The Inviability, Weakness, and Sterility of Interspecific Hybrids, by G. Ledyard Stebbins. *Advances in Genetics 9,* 147-215 (1958).

Dr. Stebbins is one of the leading biologists of our time and beside doing a great deal of fact-finding, he is able to draw facts together into generalizations. This is an important part of science because from generalizations (or principles) we may frequently make useful predictions.

The title is an exact lead to the contents of the article. The fact that there are thirteen pages of cited references is a good indication of the solid substance of the article. As some readers of this column are aware, the present writer is an advocate of hybridization as *an* important method of speciation and it is a trifle disconcerting to read of the many cases of sterility among hybrids. However, after recounting, in one section, the cases where the sterility of the hybrids increase after the first generation, he subsequently cites examples of the reverse situation.

In his conclusion, Dr. Stebbins is of the opinion that his speculations and generalizations are premature. However, he is quite definite in believing that "the causes underlying the erection of barriers of reproductive isolation and therefore of the origin of species, differ considerably from one group of organisms to another". He also believes that no further causes of the origin of species need be searched for since reproductive isolation is sufficient. With this philosophy, the present writer cannot agree because he feels that we are but on the very threshold of discoveries regarding the nucleic acids and heredity, the production of man-made heredity through the substitution of desirable acids for undesirable ones, and similar intriguing topics.

CHEMISTRY

Walter R. Hearn, Ph.D.

To those of you who think our *Journal* is thinner than it ought to be, what did you think of No. 22 of the 1958 volume of *Chemical Abstracts?* Whew! Reading the literature in your own field is getting to be a tremendous chore, and brings into sharp focus the problem of allocating our time wisely, a problem that always seems to come up when Christian faculty people get together. Maybe we could be of help to

each other by sharing ideas for making the best use of our time. One scheme I often try is combining two different activities into one. For instance, I like to keep up my reading in foreign languages, so I bought some inexpensive New Testaments from the American Bible Society in the languages in which I want to maintain some proficiency, and do part of my Bible reading in one of these. Currently I am reading Romans in Spanish. An added advantage is that doing this slows me down enough to make me rethink the meaning of the passages that have become familiar in English. I once read each chapter at a time in the Gospel of John in English, then in French, then in German, and finally in Russian, in order of my decreasing ability; I knew very little Russian, but by that time I knew the passage so well that I could read understandingly without using a Russian-English dictionary.

Some of my other time-saving gambits backfire occasionally. The other day I went to an oral Ph.D. examination as late as I dared to without offending the poor student being examined, in order to save a few minutes in a busy day, only to discover that I was the first member of the committee to arrive! The other professors were trying the same stunt! So of course the student and I had to wait for them, and I ended up spending more time than I would have ordinarily at an examination.

Seriously, have you done some thinking about this problem in your life? Every Christian has the problem of learning how to be *in* the world but not *of* the world, but the Christian who tries to do any kind of scholarly or creative work must feel the problem more intensely. As a Christian he feels the need to identify with the people around him in order to communicate the Gospel, but as a scholar he must withdraw to some extent in order to get his work done. How do you avoid spreading yourself too thin, at one extreme, and completely cutting yourself off from effective contacts with people at the other extreme? Where do you draw the line? Have you just given up trying to read *Chemical Abstracts?* I would be glad to pass your comments on to other readers of this column in future issues.

An A.S.A. member who thinks I was too harsh in my criticism of "vitalism" in one of my articles on the origin of life has kindly sent me the current issue of the *London Times Quarterly Science Review,* containing an excellent article on "Enzymes and Life" by Malcolm Dixon of Cambridge. Dixon, by the way, who is well known for his excellent publications in biochemistry, including a brand-new reference work on enzymes (reviewed in *J. Am. Chem. Soc. 80,* 6152 (1958).), is also President of the Inter-Varsity Fellowship in Great Britain. After discussing the high degree of cellular organization which has now been revealed (illustrated beautifully in Tahmisian's paper at the 1958 A.S.A. Convention, some of you will recall), Dixon has this to say about the idea of a "vital force":

"Of course, 'force' was the wrong word: 'pattern' or 'organization' would have been more to the point. There is no need of a new force to account for the chemical activities of living matter; the chemical reactions are brought about by known chemical forces. It is the organized pattern of chemical reactions, directed toward one end, that is the unique characteristic of living matter. If belief in a 'vital pattern' is vitalism it is a vitalism which is abundantly justified by both electron microscopy and enzymology."

Touche! I agree with this point of view, of course. But to the theologian who asks rhetorically, "Are we then to think of life as merely a complicated chemical system—of man himself as merely an extremely intricate machine?" I still think it is best to say: "*Yes,* if you want to learn how the reactions are coupled or how the machine works; *No,* if you want to think about the purpose of this chemistry and machinery." As human beings we do want both kinds of answers. As scientists we are interested in finding the best possible mechanistic descriptions. As Christians, we feel we have been given the answer to the teleological questions, an answer which now must apply in our daily attitudes toward all the chemistry and machinery in God's universe, including ourselves, and concerning which we must bear witness to others. The problem of having to ask two different kinds of questions to get two different kinds of answers does produce tension in our lives, I think. The other evening I was attending a lecture on the effect of vitamin deficiencies on the production of congenital abnormalities. A photograph of a terribly abnormal stillborn human child was projected on the screen, and I was immediately conscious of two possible ways in which I could respond: I could regard this thing with compassion and pity, or I could consider it as a scientifically interesting phenomenon. Actually, I'm afraid I sat there wondering if any others in the group were having this same conflict in their minds!

The next week, Dr. Kirtley Mather, the famous Harvard geologist, was on our campus and I had a chance to discuss this matter with him. Dr. Mather has written in *American Scientist* and elsewhere on evolutionary geology and its implications for Christian faith and I expect some of us would not completely agree with his point of view; nevertheless he is now some sort of representative to the United Nations for the YMCA, and it was under their auspices that he visited our campus. After his talk on "Science and Ethical Values" at the YMCA Faculty Forum, I asked him if it might not be possible that a man could be a better scientist by being "less human," and told him about my experience described above. He gave me an

interesting answer. He pointed out that much so-called scientific work could now, in theory at least, be carried out by machines. In fact, the only thing that cannot be done by machines is creative, conceptual thinking. And who knows how that comes about? In other words, he was suggesting that some kind of tension might be an asset to conceptual thinking, and that this kind of thinking is the only really significant contribution a scientist is likely to make. Then I asked, "But suppose my choosing to think scientifically makes it harder for me to feel compassion? As a Christian, maybe I wouldn't want to be that good a scientist, if that were the price I had to pay." He admitted that I had touched on a really difficult personal problem, and had no answer for it. He said he thought a biochemist might feel more of a problem here than a geologist, since a geologist seldom feels compassion for the rocks with which he works!

This kind of conflict between modes of thought may be more extreme or more explicit in the life of a scientist, but I think it is a universal problem. You react always either objectively with your reason or subjectively with your emotions in any situation and you can't really do both at the same time. Or can you? It seems to me you usually have to make a choice, and this involves not only immediate conflict but also an influence on the choices you make in the future. I know I am getting over into the territory of the psychologists and philosophers here, but I would like to stick my neck out and get some criticism of one of my own concepts about the Christian life: It seems to me that the real function of the Holy Spirit in the life of a Christian is to allow us to remain stable in the midst of this kind of conflict. That is, the Christian is enabled to live creatively (and thus to conform to the image of his Creator) because he is able to interchange these two approaches to life's problems freely and continuously. In other words, because he has committed his ultimate will to Christ, he is *not* in a desperate turmoil over which of these two approaches to life is the best one, but is free to use them both, in *any* situation. If I am confronted by tragedy, I can think of God's purpose in it, and also of ways to avoid it in the future, and I am not torn between these two viewpoints; they are both valid for me. If I am confronted by my own sin, I can confess and repent subjectively, and at the same time analyze my sinfulness objectively to see what is really wrong and exactly where my own responsibility lies. By the phrase "at the same time" I suppose I really mean "without making the other mode of thought more difficult," since it is probably necessary to concentrate on one or the other as an operational procedure. To be justified by faith in Christ means I am free from having to make attempts to justify myself: I can be honest about the extent of my sinfulness and yet live joyfully! That is, the Holy Spirit allows me to plumb objectivity and subjectivity both to their ultimate depths and thus to live "abundantly." The conflict is not resolved entirely for the Christian, or at least in my own experience, but its destructive power is broken. The Christian can live as a redeemed and creative human being instead of as "just a machine," or as "a spiritual being," or (even worse) as something which swings violently back and forth from one of these poles to the other. What do you think of this idea?

The article by A. J. Bernatowicz, "Teleology in Science Teaching," *Science 128,* 1402 (December 5, 1958), is of interest as a demonstration of how hard it is to think in *purely* mechanistic terms even if one tries to rid himself of teleology and anthropomorphic thinking operationally. Several of my colleagues agree that it is almost impossible to give a lecture completely devoid of the kind of non-rigorous language Bernatowicz deplores ("H and O combine to form water." Better form, mechanistically: "H and O combine *and* form water"). Of course, some A.S.A. members would argue that teleology need not be excluded from science (Frank Cassell has been debating this point with me in correspondence; how about a rebuttal in the *Journal,* Frank?). Some might even argue that teleology *should* not be excluded from science (See review of John DeVries' new textbook elsewhere in this issue).

One of our members, a chemist by the way, has been doing some serious study of this problem recently. George K. Schweitzer, an Associate Professor of Chemistry at the University of Tennessee in Knoxville, is on leave of absence in New York City this year under the auspices of the National Science Foundation doing work on "the interrelationships of religious thought in various cultures and the practice of science in these cultures." He is taking course work at Columbia, Union Theological Seminary, and N.Y. U., and may end up with an M.A. in the philosophy of religion with a minor in the philosophy of science. In his research he is attempting to see if the lack of the Christian doctrine of creation can be the reason, or part of it, why science failed in every culture up until its flowering in the 16th and 17th centuries of Western civilization. George writes:

"I agree with you regarding operational procedure in science. Of course, as we both realize, there are some non-mechanistic presuppositions behind the whole scientfic endeavor, but once they become part of the scientific *Weltbild,* then it must be mechanistic from then on! This historical problem that I am working on is one of the strongest evidences of this. For it turns out that it was not until science restricted itself to efficient causes (excluding its ability to work with final causes) that it really flowered. This, of course, was what prevented Greek science from developing. I have thoroughly shown that the pre-Socratics, Socra-

tes, Plato, Aristotle, Plotinos, and almost all the Greek philosophers believed that you could enter into 'the mind of the divine' and discover the patterns in nature by operating with final causes, that is, teleologically. It was only when science gave up the search for final causes, and concentrated on efficient causes, that we had the Scientific Revolution."

Incidentally, George's address until the end of the summer session is Apt. 4H, 434 W. 120th St., New York 27, N. Y. It's too bad he won't be able to make it to the A.S.A. Convention in June—he would be "loaded" for our joint meeting with the E.T.S. on "A Christian Philosophy of Science." I hope the rest of you can be there!

Finally, I might call your attention to an article which not only points out some of the non-mechanistic presuppositions of science, but then goes on to state that religion is superior to science because "there are elements of perfection in religion that do not have counterparts in science." The *Saturday Review* article (January 3, 1959) is entitled "A Scientist Ponders Faith," and was written by Warren Weaver, vice-president for the natural and medical sciences of the Rockefeller Foundation. Although some A.S.A. members might object to some of the statements in his brief paragraph dealing with the idea of progress in religious thinking, I think you will all appreciate his development of these arguments for the superiority of religion over science: "First, scientific thinking always expands out to face an ever larger area of unsolved questions whereas religion closes in, more and more securely, on an inner core of truth; second, as the external successes of science grow, it becomes more and more clear that there are unavoidable and inescapable inner imperfections in the underlying structure of science; and third, there is a quality of permanence to religious thought which is not to be found in science."

PHILOSOPHY

Robert D. Knudsen, Ph.D.

For this issue I have requested Professor John W. Sanderson to take the column. Professor Sanderson is on leave of absence from the Covenant Theological Seminary, where he taught apologetics, in order to complete work for the doctorate in philosophy. At present Mr. Sanderson is also serving as special lecturer in practical theology at the Westminster Theological Seminary, Philadelphia.

The Contribution of Plotinus to Scientific Thought

The scientist, already wary of the philosopher and jealous of his sovereignty as a scientist in his own domain, will no doubt cast a doubtful glance at the title of this article, reach for the nearby pen, and send off a letter of protest to the editor: "Why clutter up a magazine devoted to science with an article on that miso-somatic of antiquity, Plotinus?" The protest is in part well-founded. "Plotinus, the philosopher our contemporary, seemed ashamed of being in the body. So deeply rooted was this feeling that he could never be induced to tell of his ancestry, his parentage, or his birthplace." So Porphyry began his frustratingly meagre account of Plotinus' life. Would such a man have any interest in, or ever say anything pertinent to, scientific pursuits?

On the other hand, Plotinus' interest in the science of his day, if we measure it by the number of extant treatises on scientific subjects, was considerable. Of the 54 articles of varying length which comprise the "canon" of Plotinus, eighteen were grouped together by Porphyry to constitute the second and third Enneads because they were "disquisitions on the world and all that belongs to the world" and they discuss "the philosophical implications of some of its features." These tractates deal with astronomy, physics, optics, fate and providence, time and eternity, and the origin of man. If we include ancient psychology among the sciences, we may properly designate the fourth Ennead as scientific since it is Porphyry's grouping of his treatises on the soul. Some of these were written in the middle period of Plotinus' life when, Porphyry says, he displayed the "utmost reach of his powers" and treatises then written attained the highest perfection.

All of this might indicate that for one to reject science, one must become a scientist! But Plotinus, for all his mysticism, was concerned with many details of our present life and his statements about the world *above* are not based on his experiences of it but on a process of reasoning which takes *this* world as the starting-point. A mystical experience is not his substitute for observation and reflection.

Although the details of Plotinus' science have little interest for the scientist of today, some of his insights are remarkable for their similarity to modern theories. Plotinus, in opposition to Aristotle, believed that light needed no medium for its transmission. He asserted this (IV,5) because the assumption of an intervening vehicle necessary to the transmission of light leads to problems: if air, for example, is the vehicle, then the source of light activates the air next to it, and this air in turn excites the portion next, and so on until the eye is illuminated by being stimulated by the air contiguous to it; but this means that the eye perceives not the light or an illumined object, but the air! Moreover, the above explanation is based on the theory that light is transmitted by touching; but if we touch the eye with an object, sight does not result; rather, the eye sees nothing. Light then needs no medium to travel in.

Plotinus rejected the materialism of his day, and developed a theory of matter which makes it almost immaterial (IV,7). The Stoics made gods, the soul—

everything, material. Plotinus argued against them as follows: if both soul and body are material, then each is divisible into the same elements; but these cannot be alive since matter is inert. How then can a combination of them be alive? Moreover if "life" is in a certain arrangement of material things, what principle arranged them?

In his own theory of matter (II,4 and III,6) Plotinus used the term for a mere abstraction, not really material; this "something" underlies all physical objects and is acted upon by forms and agents; no quality or quantity can be predicated of it; it is nowhere; it is even "unembodied." Dean Inge thinks that this concept anticipates some modern theories of matter which reduce it to energy or to indivisible points of which nothing can really be predicated.

If we are to find an abiding contribution to science, we must look for it in Plotinus' place in the history of thought in general, and in the progress of scientific thought in particular. The current tendency of the philosophers who are studying Middle- and Neo-Platonism is to reject the suggestion that Plotinus was greatly influenced by oriental religions. Instead his system is viewed as a logical development within the Greek tradition itself. Writes Paul Henry: "Heir to the great philosophies of the ancient world, those of Plato, Aristotle, and the Stoics, he borrowed from all of them the insights which he needed, but without surrendering at any point the dominant influence of Platonism."

If this is so, then it is not unreasonable to infer that an impersonal universe is the end-product of Greek philosophy. Above and beyond even the world of the changeless, is the One, completely unknowable and self-contained. In fact, the One does not "exist". Plotinus says, "Generative of all, the One is none of all; neither thing nor quantity nor quality nor intellect nor soul; not in motion, not at rest, not in place, not in time: it is the self-defined, unique in form, or, better, formless, existing before Form was, or Movement or Rest, all of which are attachments of Being and make Being the manifold it is" (VI,9). This is the object of Plotinus' worship. Such a One lies at the end of any search which leaves out of it the living God.

But on the positive side of things, Plotinus had a salutary influence on the history of thought at the time of the Renaissance. Writes Henry: "He is a precursor of modern times . . . The Renaissance, in the person of Marsilio Ficino, rediscovered his works and was enthralled by his teaching." In particular, it was the neo-Platonism of Plotinus which inspired Giordano Bruno when the latter forsook the narrow limits of the universe assigned to it by Aristotle, and allowed his imagination to carry him off into the limitless space of which the modern astronomer speaks so much. And if this insight seems insignificant in itself, it should be noted that this thought, as much as any other, led to the rejection of Aristotle's world and prepared for the world as Galileo, Kepler, and Copernicus were to see it.

Westminster Theological Seminary
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PSYCHOLOGY

Philip B. Marquart, M.D.

Many of the non-Freudians of the profession are wont to taunt the psychoanalytic school with being non-scientific, and many a Christian would shout "Amen". Even though this school of thought has been formulated without being validated by experimental procedure in the usual sense, there are some of the concepts formulated by Freud which stand the test of veracity. For instance, we know that some of Freud's defense mechanisms are described, though not named, in some of the Bible characters. We find many of these ego defenses illustrated in the unfortunate behavior of King Saul. Romans 2:1 describes the action of the mechanism of projection better than modern man has ever done. Men of our time have unwittingly given forth truth, because the same facts are found in the inspired Word of God. Incidentally, such validation of facts and principles is far more secure than that of the scientific method could ever be.

One of the so-called defense mechanisms is very desirable to have in the Christian life. It is the "sweet-lemon" or "Pollyanna" mechanism. The Christian may well have "songs in the night" and something to be glad about, even under the worst of circumstances. Job gives us a good illustration of this at Job 1:21: "the Lord gave, and the Lord hath taken away; blessed be the Name of the Lord". Even an attitude of the so-called "sour-grapes" mechanism may be benign in the Christian experience, when the Lord is trying to remove some "idol" from the life of one of His children.

The man who taught his Sunday School class, but owned several liquor stores which were kept open on Sunday, found it necessary, when rebuked, to defend himself by rationalization. He answered, "I know a plenty of church members who are doing worse than I am."

On the very day, when human nature came to be as it is now, (Gen. 3:10) Adam used the first defense mechanisms in history, and thus set off a holocaust of psychologic defect. Adam lied when he said he was afraid because he was naked. He was rather afraid because he was guilty. However, he was already so mixed up that he believed his own lie. This is the way

that rationalization started: an error in fact, for an unconscious purpose, but the error is believed to be true by the perpetrator. Projection is another form of rationalization. In successive verses in the same chapter we find both Adam and Eve projecting the blame for their sin upon one another, upon the serpent, and even upon God himself. These mechanisms are still the same Garden variety of human nature that we see about us today.

Gen. 3:10 is interesting in that it reveals the onset of many items of abnormality which have become inherent in our nature. These are not the first hint of abnormal psychology in Gen. 3, but they are the most significant and sweeping. Not only does this verse show the onset of defense mechanisms, it shows the most extreme form of fear, which is called *panic*, which arises out of disturbed emotional life. The error in the intellectual apprehension of the facts, which is illustrated by the mechanism of rationalization is but one aspect of that diffusion and clouding of man's mind which we call the "Unconscious." Apparently this "cover-up" was permitted to man so that he would not be undone by knowing everything about himself. "Who can know it?" (Jer. 17:9.) In fact this diffusion which was smoked up into the basement of man's mind, covered up so much of man's personality, that modern man has lost sight of the fact that "heart" is the core and nucleus of his personality.

SOCIOLOGY

Russell Heddendorf, M.A.

In our day, natural science has come of age. The practicality and profit of scientific research is obvious. This condition has not always existed, however, since natural science started in sterile laboratories finding its sustenance in theoretical argumentation. A study of the history of science clearly shows the development from stray bits of disconnected beliefs to a unified body of propositions resulting in practical consequences.

If natural sciences have come this far, their social cousins have not. The social sciences still look forward to that day when their fruits will yield concrete food, not for thought, but consumption. The question with which we are immediately concerned is how much of that food may be consumed by Christians. In particular, how practical is sociology for the church and the individual Christian.

In general, the Christian scientist seems to have two main responsibilities; 1) he may use his knowledge as a contribution in defense of the faith; 2) he may find tools which may be used in meeting some concrete need of the church. Until recently, the natural sciences have centered in performing the former function. Lately, however, it seems that they have provided some concrete tools for service, notably in the area of missionary endeavor. Contrarily, the social sciences seem to center their potential contribution in the area of the latter responsibility. It was indicated in a previous column that attempts by sociologists to use the Social Gospel in defense of the faith were not very successful. What, then, would be a problem for which sociology could provide a tool?

It is the rare church which does not go through change. In a typology of churches, this would usually be the change from a sect to a denomination. Such a transition would include an emphasis upon education rather than evangelism, a desire to unite with forces of power and prestige in society, and a general compromise with worldly standards. Some churches would be motivated toward such a change and find it to be an indication of growth. In a fundamental church, however, it would probably indicate an unconscious change in goals; an emphasis on organization rather than Biblical preaching and teaching.

For the sociologist, it raises a problem in organization. What are the mechanisms at work in a group to cause it to unconsciously change its goals. Is it merely the result of growth so that the old goals are no longer seen? It may be that the needs of organization increase faster than the means or personnel to meet them. Perhaps there are not enough mechanisms providing for reinforcement of the original goals. It might be simply a matter of leadership. Then again, if the answer was found by means of research in secular groups, would the results also be valid for religious groups? Are there organizational factors which are not common to both secular and religious groups requiring individual treatment of both? If so, there would have to be analysis of concrete fundamental churches. Essentially, what makes one church grow and maintain a live gospel witness while another wanders off into the problems of organizational complexity as it grows?

The question could be answered in a general way. Specific research is needed, however, to provide a detailed answer which may be used as a tool by each pastor in coping with the problem. Sociology is on the verge of beginning to provide such specific answers and it would seem advisable for the Christian church to derive an early benefit.

Book Reviews

Essentials of Physical Science. John DeVries (Geological section by Donald C. Boardman). Eerdmans, Grand Rapids, Michigan, 1958. 375 pp. $6.95.

Matter, Earth, and Sky. George Gamow. Prentice-Hall, Englewood Cliffs, New Jersey, 1958. 593 pp. $6.95.

Reviewed by W. R. Hearn, Assistant Professor of Chemistry, Iowa State College.

Here are two new textbooks for general science courses for the non-science major, with many things in common with other texts—coverage of physics, chemistry, and geology (astronomy also in Gamow's longer book), good illustrations, study questions, and considerable space devoted to up-to-date topics such as nuclear fission (and in Gamow's book, rockets and satellites as well). But these two books also have in common a feature which distinguishes them from most other texts—and curiously enough it is this feature which also sharply distinguishes them from each other. For it is the personal viewpoint of the author, in each case, which makes these books unusual.

You may wonder why a religious publishing house such as Eerdmans would publish a general science textbook. John DeVries, Professor of Chemistry at Calvin College and a member of A.S.A., in his *Essentials of Physical Science* has tried to place the emphasis "on the relation of the basic facts of science to our commitments as Christians." He has done this not only in a 40-page introduction on the philosophy and methodology of science, but also in comments scattered throughout the book pointing out the unity of phenomena as evidence of design in nature. The section on geology, written by Professor Donald Boardman of Wheaton College and also an A.S.A. member, is devoid of teleological commentary. Although little or no reference to biological phenomena is made in the text, evolution is briefly referred to disapprovingly in the introduction. Probably the major use of this text will be in Christian colleges in which a large proportion of the students will have a definite Christian commitment, and for this purpose I think Dr. DeVries has written a useful book. He has avoided the two extremes of either presenting bare science with a dab of Christianity tacked on at one end, or of molding scientific facts into a theological polemic, and has produced a serious-minded, philosophically-oriented textbook.

Believing that "we can appreciate the present only in so far as we understand the past," DeVries has given the student a historical approach throughout; this approach is used effectively to present each topic in a logical framework, but for some reason does not seem to convey as much of the excitement of the scientific adventure as might be hoped for. Perhaps the author's serious purpose in writing has consciously or unconsciously caused him to place his emphasis on the logical at the expense of the romantic in the development of science. The value of this book, apart from its intrinsic worth as a science text, will be in its encouragement of Christian students to face the facts of science fearlessly and to deal with scientific theories intelligently in the context of a Biblically-based Christian philosophy. Men like John DeVries and Donald Boardman bring credit to the American Scientific Affiliation by publishing a work in such close harmony with the objects of the Affiliation.

George Gamow's book, *Matter, Earth and Sky,* gives one a completely different impression. Here you will find no philosophical arguments or even much historical background—instead you will see the buoyant personality of the author woven into every paragraph of the book. If you are a Gamow fan, as I am, you will be delighted. For Gamow, now Professor of Physics at the University of Colorado, thinks that science is terrific fun and it is obvious that he had fun writing this book. The science content is solid, and in fact seems to come at a faster pace than in DeVries' book, making one wonder a bit whether an average undergraduate liberal arts student could keep up; but the style is light and thoroughly enjoyable. There is nothing at all stuffy about this book—photographs of famous 20th century scientists are liable to be snapshots of them riding a motorcycle or strumming a banjo! The illustrations, pictorial and verbal, are often whimsical (some taken from the author's *Mr. Tompkins in Wonderland,* for example), and there are a few outright jokes scattered here and there (The populace of Alexandria paid little attention to Archimedes shouting "Eureka"; undoubtedly they thought he had found a missing cake of soap in his tub). A few serious-minded folk might object to these undignified goings-on in a science textbook, but what better way could there be to capture the imagination and enthusiasm of students? Science *is* fun; why not let our students know that we think so?

The Story of Life. H. E. L. Mellersh. G. P. Putnam's Sons, New York, 1958. 263 pp. $3.95.

Reviewed by W. R. Hearn, Assistant Professor of Chemistry, Iowa State College.

This book is a popular presentation of evolution written by a Britisher who is apparently a novelist rather than a biologist, and addressed, interestingly enough, to Christians. It is written in the hope "that it may help to heal the breach between the scientist and the theologian, or, to put it a little lower, that it may help to persuade the orthodox Christian—or even the Laodicean but professed Christian—that evolution is

not something taboo." The author goes on to say, "Evolution is not worthy of taboo, it is important and it is interesting; and perhaps one day soon parents and guardians and other responsible people will not only find this out for themselves but insist that school teachers should have a little more courage and see that evolution is brought into the study of biology in schools from which as far as I can discover it is at present very largely excluded."

This book is much easier to read than a standard textbook (and also not so well illustrated) but still presents enough information to give an ordinary layman a satisfactory grasp of the major facts which evolutionary theory has been evoked to explain. Some A.S.A. members might disagree strongly with Mellersh's point of view, but he seems to be reasonably accurate and unusually fair in his presentation. He is never dogmatic nor guilty of overstating his case. An idea of his attitude can be gained from this paragraph in the introduction:

"I hope, naturally, that people will care to open this book (the closed book of most of natural history). I hope even that people who still say ruggedly that they do not believe in evolution will open it. Organic evolution is not a provable fact; but as one biologist has said, with commendable restraint, it is a demonstrably likely proposition. Unfortunately not all biologists are restrained, nor for that matter are always their opponents. I have tried to keep a fair balance. If in any of these pages I have been rude to the Fundamentalist and the intuitive mystic, or rude to the more narrow, humourless or superior of the scientists, I apologize in advance: at least I do not mean to be rude."

Recently a student asked me if I had a small tract stating the case *for* evolution; his pastor had announced that he intended to preach a series of sermons on evolution and had requested up-to-date information on both sides of the question. I thought such open-mindedness was refreshing and regretted not having at hand what the student wanted. Now that I have discovered Mellersh's book, I think I would have recommended it to his pastor. It may be a bit long to call it a pro-evolution "tract", but it was written for the same purpose, with good will and with good sense.

LETTERS

To the Editor:

Northern Delaware Chapter of the American Scientific Affiliation.

About two and one-half years ago a group of scientists in the Wilmington, Delaware area organized a local chapter of the ASA. A primary objective was to sustain and promote the national organization as outlined in its constitution. The original membership included some former members of the ASA, and since then new members have been enrolled who have been accepted by the ASA. The local chapter has adopted a set of by-laws as a guide for its activities. A copy is appended to this report which may be of some interest to members in other areas who would like to organize a local chapter.

I believe that participation in the activities of an ASA local chapter has been of real help to me and can be to each one of us. I am convinced, moreover, that an opportunity for service exists here that can be the means of intellectual, spiritual and professional growth for the individual, of very definite benefit to related Christian organizations, and will help us bring a positive witness to associates in our profession.

The following script was prepared for the purpose of summarizing the activities of the Wilmington chapter and to tell why a local chapter of the ASA has found a useful place in the sphere of Christian activities.

There are three ways in which we have been able to take part in the activities of a local ASA chapter. These are in discussion, in fellowship and in service.

Discussion:

An informal seminar for discussion of subjects of mutual interest to the membership is one of the objects of our local chapter. The subjects which have been presented for discussion at our monthly meetings have included a variety of topics including "Methods of age determination and principles of C-14 dating", "Deluge geology and the Genesis account of Creation", "The basic needs of the human personality" and "The inspiration of the Holy Scriptures" to mention a few. One years' meetings were devoted to a discussion, chapter by chapter, of Ramm's book, "The Christian View of Science and the Scriptures". This was a good experience for all of us, and we gained a better appreciation of the problems involved in bringing about a rapprochement between the data and conclusions of the sciences with a conservative Christian philosophy.

From time to time we have attended lectures by outstanding men on subjects of interest to Christians and scientists. Dr. William F. Albright spoke on the Dead Sea Scrolls at the Lincoln University a couple of years ago and a number of our members were there. The all-day symposium on "Science and the Christian Faith" at Eastern Baptist College was co-sponsored by our chapter and featured several excellent talks, including one by our ASA president, Dr. H. Harold Hartzler. This talk has since been published in the Journal. Several of our members participated in a panel discussion, and the 1957 president of our chapter, Dr. Arthur Nersasian, presided at the afternoon sessions. Another ASA member, Dr. Richard Bube of the RCA laboratories of Princeton, N. J. spoke in the evening on "Related Limitations to Human Rea-

soning in the Interpretation of the Physical World and of the Scriptures." I hope his talk can be printed in the Journal as well.

In March our chapter co-sponsored with Youth for Christ of Wilmington the showing of the Moody Bible Institute of Science film, "The Red River of Life". Introduction and some very pertinent comments were given by Dr. John Brobeck of the University of Pennsylvania. Several hundred people were present, and much ASA literature was distributed. In May our chapter presented Dr. Allan A. MacRae of Faith Theological Seminary, who spoke on the Dead Sea Scrolls. The audience of about one hundred people, mostly technically-trained, asked many questions in a lively discussion period.

Fellowship:

There is much I could say praising the good fellowship we enjoy at our ASA meetings. Fellowship with other Christians strengthens one's faith and develops our personalities. One of the aims of our chapter is to promote Christian fellowship and understanding among the membership. Certainly there is no need to feel that one stands alone in his profession as a conservative, Bible-believing, practising Christian when a local chapter of the ASA is open for membership. Opportunities of social contact with fellow scientists, however, has too often been limited to the "mixer" or cocktail hour at a professional society meeting. At our regular monthly meeting we have been enjoying light refreshments served by the host and hostess. This seems to stimulate rather than interfere with the continuance of discussion. As a partial compensation for the ladies we invited them to a Ladies Night supper in their honor. We hope to make this an annual event. An outing for ASA families in the summer is another activity which we have planned.

Service:

How about the opportunities of service? As a local ASA chapter we have as a goal the giving of assistance to related Christian organizations. In a minute I will tell you what some of our fellows have been doing along this line. As individual Christian men of science we have a responsibility to bring to our colleagues a positive witness for Christ and the integrity of the Scriptures on which our faith is founded. The circle of influence around each one of us includes people who otherwise would have little occasion seriously to consider faith in Christ because of their sceptical attitude towards religious beliefs. I believe our testimony as Christians can be strengthened and made more effective by our activities in a local chapter of the ASA. We can invite our friends and associates to our meetings. We can show them by solid achievement in the area in which we work that Christian convictions and able, constructive effort go hand in hand. We can develop a healthy Christian philosophy of science, and keep informed on questions which are relevant to our Christian faith. Our Christian testimony will in this way be reinforced.

Individuals of our group have been assisting various Christian organizations in behalf of the ASA. One of our men spoke at Career Day for students at Eastern Baptist College on "Careers in Chemistry". Two of our men are serving as professional representatives on the local Youth for Christ Council. We have hardly scratched the surface of the opportunities, I am sure. Strong, active local chapters will serve as a vital factor in making the American Scientific Affiliation a live, growing organization of increasing influence.

Neal O. Brace, President
Northern Delaware Chapter
American Scientific Affiliation

W. R. Saadeh, Secretary
Northern Delaware Chapter
The American Scientific Affiliation
221 Edgewood Road
Alapocas, Wilmington, Delaware

Dear Mr. Eggenberger:

In June of this year I addressed letters to Dr. Hartzler and others suggesting that I desired to publish an open letter in the ASA Journal relating to questions I earnestly desire comments on from our constituency. I was assured that this is a function of the ASA Journal which has not been utilized to the full and that in all probability you would be pleased to accept such a letter. Please feel free to criticize or comment upon my thinking. I do not apologize for the "job wanted" atmosphere of my statements, for there is no medium to my knowledge whereby the Christian colleges make such information available and here the ASA can serve a definite need. I think there should be an interchange of information relative to available equipment, summer exchange programs, etc., through the medium of the Journal!

I am entering upon my final year of doctoral preparation as a Science Faculty Fellow of the National Science Foundation. This culminates years of part-time graduate work in Biology and will bring me closer to a realization of a long term goal: to be prepared to handle some of the Bible-Science controversy with a modicum of scholarship. Having a four year seminary preparation in Biblical languages and exegesis and now with biological preparation well along, it pleases me to take up again the challenge of Christian education. Several important questions arise at this point:

1. I believe our Christian college students should be confronted with both the data and the philosophical implications of modern science. They should be made aware of the inadequacies which exist in any framework which attempts to solve the intricate relationships between creation and revelation, and they should be challenged to prepare themselves to contribute to

the further elucidation of this problem area. Is this too broad an outlook?

2. How much academic freedom is actually provided within the Christian college situation?

3. Do the science-trained personnel have a voice in determining academic objectives?

4. What is the attitude of Christian college administrators toward adjusting the teaching load of personnel who desire a limited research project?

5. Granting that a professor obtains his own research support will the college supply space and equipment and otherwise encourage the project?

6. Are salaries and other compensations provided by the Christian college adequate to support a man with a family?

7. Can a Christian professor find a place of fulfillment and wholesome satisfaction in a University teaching position?

H. Omar Olney
R R. No. 2
Newark, Delaware

The American Mission
Dembi Dollo, Ethiopia
December 6, 1958

Dr. H. Harold Hartzler, President
The American Scientific Affiliation
121 Clark Street
Mankato, Minnesota

Dear Dr. Hartzler:

Thank you for your recent (?) letter of September 16th about the activities of the A. S. A. The mail comes by boat, hence takes six weeks to two months, therefore the above parenthesis, and the lateness of this response to your request that all members write you a personal letter.

I and my family are in our second term of missionany work here in the land of Ethiopia. At present we are located at Dembi Dollo, which is almost directly west of the capital city of Addis Ababa at about 8½ degrees north and near the Sudan border. We are serving with the United Presbyterian Mission which has been here working among the Gallas since 1920. My work is training teachers and evangelists for the church. At present their course consists of Bible subjects and teacher-training courses. Some work is in Amharic, the national language and some in English. However, the language of these people is Gallinya, so I cannot yet converse with the local people who have had no schooling. After spending so much time learning Amharic, now I will have to find time to begin on Gallinya.

I want to tell you that I have appreciated my membership in the A.S.A. very much and have profited a great deal from the studies in the Journal. (Before entering the ministry—training at Fuller Theological Seminary—I graduated in mechanical engineering at University of California.) Our chief problem out here is communication of the truth of the gospel in the broadest sense, and in that respect, where it has been necessary to interpret the relationship between the gospel and the gifts of science to a culture under rapid social change, the A.S.A. has been helpful. I regret to say that the burden of work here has been such that I have only been on the receiving end of the activities of the A.S.A.; yet as I turn and face these people, it is largely one of giving out and from this standpoint, I know you will be glad with me that A. S.A. has been of some help to me in doing this better for the Lord.

When we were last home on furlough I did want to attend the convention in Boston. But at the time my wife was presenting me with a new daughter and we were also packing to return as well as getting ready for a short period of refresher courses the Board was offering us. I do regret I could not attend. I did have some good talks with John Sinclair while in southern California, whom I am sure you know.

Wishing you every success as you lead the A.S.A. in service for the Kingdom, I am,

Sincerely yours,
Albert C. Strong.

NEW MEMBERS

Anderson, V. Elving, 1554 N. Pascal St., St. Paul 13, Minnesota, is Professor of Zoology and head of Biology Department, Bethel College, St. Paul, and Assistant Director, Dight Institute for Human Genetics, University of Minnesota. He received an A.A. degree from Bethel Junior College and B.A., M.S. and Ph.D. degrees from the University of Minnesota.

Barkman, Paul F., 708 S. Main, Upland, Ind., is an Assistant Professor of Psychology and Religion. He earned an A.B. from Bethel College (Kansas), S.T.B. from Biblical Seminary in N. Y. and an M.A. from New York University in mental hygiene.

Blomquist, Conrad A., 1713 S. Second Ave., Maywood, Illinois, is Assistant Professor of Zoology at the University of Illinois. He received his B.S., M.S. and Ph.D. degrees from the University of Illinois.

Boebel, F. W., 103 N. Wright St., Naperville, Ill., visiting instructor at Wheaton College, holds a B. A. degree in Chemistry from North Central College and a D.V.M. from Kansas State College.

Bright, Albert S., 4809 Broad Brook Drive, Bethesda 14, Maryland, is a self-employed physician, specializing in obstetrics and gynecology. He

earned both his A.B. and M.D. degrees from George Washington University.

Bushman, Donald G., Mendon Center Rd., Honeoye Falls, N.Y., is a graduate student in Organic Chemistry at the University of Rochester. He earned a B.Ch.E. degree from Rensselaer Polytechnic Institute, Troy, N.Y.

Caley, Wendall J., Jr., 263 Stonewood Ave., Rochester 16, N.Y., is a Development Engineer at Eastman Kodak Co. He received a B.S. degree in Physics from Houghton College.

Carlstrom, Robert A., 2183 Waltoffer Ave., No. Bellmore, N.Y., is Senior Engineer at Sperry Gyroscope Corporation, Marine Division. He received a B.S. in Aero. Engr. from the Aeronautical University, Chicago, Ill., and a B.S. in Applied Physics from Hofstra College, Hempstead, N. Y.

Clark, Douglas A., 808 W. 11th St., Plainview, Texas, is an Assistant Professor of Sociology at Wayland Baptist College. He received a B.S. degree from Wheaton College, a B.D. degree from Eastern Baptist Theological Seminary, and a M.A. degree from the University of Illinois.

Clark, Edward H., 13155 Stagg St., North Hollywood, California, is an Instructor at Los Angeles Valley Junior College, Van Nuys, California, and part time an Associate Professor at San Fernando Valley State College, Northridge, California. He received his B.S. degree from the University of Rochester, and M.S. degree from U.C.L.A. His field of study is Physics.

Coker, E. Howard, 540 N. 9th, Corvallis, Oregon, is a Student at Oregon State College. He received an A.B. degree in Chemistry from the University of California at Davis and is currently working on the Ph.D. degree at Oregon State College at Physical Chemistry.

Constant, Roland M., 4463 Bill-Mar, Grandville, Michigan, is an Instructor in Zoology at Grand Rapids Junior College. He earned an A.B. degree in Biology from Calvin College and the M.A. degree from the University of Michigan in Biology.

Curran, Thomas D., 1200 Alpine Rd., Walnut Creek, Calif., is employed in Research at the Fibreboard Paper Products Corp. He earned a B.Sc. degree in Chemistry from the College of Technology, Belfast, Northern Ireland.

DeVries, David A., Box 147, Station A., Hattiesburg, Miss., is Professor of Geology at Mississippi Southern College, Hattiesburg, Miss. He holds a B.S. from Wheaton College in Geology, and a Ph.D. in Geology from the University of Wisconsin.

Donovan, Ross G., Box 1175, Aurora, Ontario, Canada, is employed as Chief Chemist at the Callis Leather Co., Ltd. He holds a B.A. in Chemistry and a M.A. in Physical Methods in Organic Chemistry from the University of Toronto.

Enslow, George M., 1038 Essex Ave., Sunnyvale, California, is Associate Engineer, Lockheed Missile Systems Division, Solid State Electronics Department, Research and Development Laboratory, Palo Alto, California. He received a B.S. degree from the University of California, Los Angeles, in Applied Physics, and an A.A. degree from Fullerton Junior College in Mechanical Engineering.

Faram, Harvey D., 10208 Calumet Drive, Silver Springs, Maryland, is employed by Emerson Research Laboratories, Washington, D.C., as Principal Electronics Engineer. He received both the B.S.E. and M.S.E. degrees in Electrical Engineering from the University of Michigan.

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Ho, Grace, 1668 Norman House, Helser Hall, Ames, Iowa, is a Graduate Assistant at the Atomic Research Institute, Ames, Iowa. She received the B.S. degree in Physics from Oregon State College.

Ismond, Morrison D., 1220 Garfield Rd., R. No. 1, Box 19B, Lansing, Mich., is Game Biologist for the Michigan Conservation Department. He earned B.S.F. and M.F. from the School of Natural Resources, University of Michigan.

Mack, Harry J., 3650 Jackson St., Corvallis, Oregon, is Assistant Professor of Horticulture at Oregon State College. He earned both the B.S. and M.S. degrees in Horticulture from Texas A & M College and the Ph.D. degree from Oregon State College in Horticulture.

Morris, Joe H., 5479 North Suggs, Memphis, Tenn., is a self-employed dentist and an Assistant Professor of Anatomy at the University of Tennessee. He attended Marion Military Institute, Vanderbilt University, and the University of Tennessee College of Dentistry where he received his D.D.S.

Shope, Wilson R., Box 116A, R.D. 1, Connellsville, Penna., is employed by the West Penn Power Co., as Division Engineer. He has earned a B.S. in E.Ch.E. and a E.E. from Pennsylvania State University.

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Stephens, Harold R., 11650 National Blvd., Los Angeles 64, Calif., is a Control Chemist at Lever Brothers Co. He received a B.A. degree from Westmont College in Chemistry.

Taylor, Floyd B., 3219 E. Thornapple St., Chevy Chase, Maryland, is Chief, Special Studies Unit, General Engineering Program, U. S. Public Health Service. He received a B.S. degree in Sanitary Engineering from Pennsylvania State and a M.P.H. from Columbia University.

Thommen, Ernst K., P. O. Box 4111, Pasadena, Calif., is a student of Theology at Fuller Theological Seminary. He earned a M.S. degree in Chemistry from S.F.I.T., Zurich, Switzerland. He has also attended Syracuse University, N.Y., College of Forestry.

Thompson, Gail F., 61 Vernon Ave., Yonkers, N.Y., received her B.S. degree in Biology from Kings College, June, 1958.

Whiteside, Haven, 16 Quint Ave., Allston 34, Mass., is a Ph.D. candidate in applied Physics at Harvard University where he received his S. M. He also holds an A.B. degree from Middlebury College in Physics.

Wilson, Donald R., 1221 Kenyon Court, Rock Hill 19, Missouri, is an Instructor in Sociology and Anthropology at Covenant College. He received a B.A. degree from Wheaton College, a B.D. degree from Faith Seminary and is presently a candidate for the M. A. degree in Sociology at Washington University.

Woods, John E., Shell Mera, Ecuador, South America, is a Medical Missionary with the World Radio Missionary Fellowship. He received the A. B. degree from Asbury College, and M.D. degree from the School of Medicine, Western Reserve University.