JOURNAL OF THE
AMERICAN
SCIENTIFIC
AFFILIATION

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

VOLUME 17 NUMBER 4 December 1965

The Journal of the American Scientific Affiliation

The subscription price is, one year $5.00; two years $9.00; three years $12.00. Single copies may be purchased at $1.25 each. Second class postage paid at Mankato, Minnesota. Back issues: $1.25 per issue from 1963 to date: $2.00 per volume or 75c per single issue before 1963.

Concerning subscriptions, changes of address, requests for back issues, and other business, address: Executive Secretary, The American Scientific Affiliation, 325 Brett Building, Mankato, Minnesota 56001.

Concerning manuscripts, notes, and letters for publication address the editor.

Concerning book reviews, address the book review editor. The opinions and conclusions published in this *Journal* are those of the authors. The American Scientific Affiliation studies relationships between Christianity and science in the conviction that the frameworks of scientific knowledge and evangelical Christian faith are compatible. Open discussion is encouraged. Non-members as well as members are invited to submit manuscripts, letters, and brief contributions for consideration for publication.

The *Journal of the American Scientific Affiliation* is indexed in the CHRISTIAN PERIODICAL INDEX.

JOURNAL OF THE AMERICAN SCIENTIFIC AFFILIATION

DECEMBER, 1965 PRINTED IN THE UNITED STATES OF AMERICA VOLUME 17, NUMBER 4

ON THE MANNED LUNAR LANDING

RODNEY W. JOHNSON*

I. INTRODUCTION

A survey of a representative section of several groups of individuals categorized perhaps, according to their occupational activities would produce a wide disparity of opinion among scientists, theologians, agriculturists, and industrialists regarding the merits and justification for a manned landing on the Moon. From a philosophical point of view the scientist might consider that the Moon may prove to be the Rosetta stone which unlocks the secrets of the Universe. The industrialist may tend to believe that exploration of the Moon may prove to be the lodestone indicating the direction of subsequent space exploration programs and a manned landing is a first step in that direction. The agriculturist, on the other hand, may express the opinion that man has sufficient problems on Earth without seeking additional ones in space. Most theologians seem to reflect the opinion that exploration of the Moon may be necessary to convince man he has no purpose in space. At the present time no one can say with certainty which one of these philosophical viewpoints may be valid, yet most thinking individuals are convinced that when a society or culture foresakes a mode of life to pursue another, something of value must replace that element which is lost or changed. Manned exploration of the Moon and space represents such a departure and thus must return something of value to the society which supports the program and to whom these derivitives must accrue.

*Dr. Rodney W. Johnson is Manager, Manned Lunar and Planetary Systems, Valley Forge Space Technology Center. Paper prepared for the 19th Annual Convention of the American Scientific Affiliation, August 1964, at John Brown University, Siloam Springs, Arkansas.

II. THE SPACE EXPLORATION PROGRAM DEFINED

Space activities have been categorized by Barre[1] into five groupings as shown in Table I. These activities have been defined by degree of uniqueness to conventional human affairs or by degree of involvement with the existing social and cultural order.

TABLE I
CATEGORIES OF SPACE ACTIVITY

Category	*Scope and Emphasis*	*Example*
I	Activities oriented toward existing problems of man.	Communications, weather, geodetic and navigational satellites.
II	Extending man's knowledge of his surroundings and relateable to known possible needs of man.	Rocket plane, space probes.
III	Activities which utilize knowledge developed from Type I and II programs to extend man's knowledge of the solar system and the universe.	OSO, OAO, Ranger, Surveyor, Mariner, Lunar Orbiter.
IV	Activities directed toward placing man in space for extended periods.	Mercury, Gemini, Manned Orbital Laboratory.
V	Activities oriented toward manned exploration of other bodies such as the Moon and Mars.	Apollo, Lunar Base, Voyager.

Of the value and utility of the programs identified with categories I through III there is little question. Even category IV which represents a hazard to man not readily resolvable from the standpoint of direct benefit, possesses the capability of application to improved air transportation systems. It is the last category, that of manned space exploration which appears to be the most difficult facet of the national space program to defend.

The manned lunar landing project, titled Apollo by NASA, has as its goal the landing of two men on the Moon and returning them safely to Earth during the decade of the 1960's. The Apollo project, however, represents but one step or goal in man's determination to explore space and the solar system. The ultimate objective is development of systems which will permit man to safely explore the entire universe and attain, as the late President Kennedy declared, "a position of pre-eminence" in space. Though this objective is reasonably well understood by both the scientific community and the public; the motives behind this undertaking are more obscure.

III. POPULAR JUSTIFICATION

Many reasons have been advanced to explain why man should explore space and the Moon. Some of the more logical are tabulated in Table II.

TABLE II

POPULAR REASONS FOR EXPLORATION OF SPACE

Theory	*Motive*	*Basis*
Kennedy	National Prestige	This is a new ocean and we must sail in it.
Archimedes	Scientific	Advancement of science is more important than life itself.
Columbus	Economic	Economic return will be known only in retrospect.
Panama	Military	Strategic value.
Barnum	Entertainment	Public will support extensive entertainment expenditures.
Hillary	Adventure	It's there.

The Kennedy Theory—Former president John Kennedy made the observation after John Glenn's successful return to Earth from his three-orbit mission that this nation must sail in the new ocean of space as an obvious part of our manifest destiny. One could argue the validity of this basis, yet history has demonstrated that what man is capable of doing, he will do.

The Archimedes Theory—This theory holds that advancement of pure science is more important than life itself. The name derives from the death of Archimedes during the capture of Syracuse, Sicily at the hand of a Roman soldier, Marcellus. Archimedes, while engaged in drawing mathematical symbols in the sand, was speared in the general massacre which followed the fall of the city.

The Columbus Theory—The true commercial value of Columbus' voyage became evident only in retrospect. Space exploration may very well be similar from a commercial standpoint. In this context, only the direct economic benefits of lunar and planetary exploitations are considered, not the indirect benefits such as the WPA effect.

The Panama Theory—Powerful military and political needs of the leading nations of the world make it imperative for them to hold dominant areas of space which, like the Panama Canal, are important to national survival. This theory has been expressed in a slightly different form by Cole[2] as: "there are strategic areas in space, vital to future scientific, military or space programs which must be occupied by the United States, lest their use be forever denied us through prior occupation by unfriendly powers."

The Barnum Theory—Recollection of the early Mercury flights as well as the recent very successful televised Ranger IX flight and the resulting photographs of the Moon indicate that the American public will support activities from which it receives no direct benefit providing these activities do not erode the then current standard of living or deplete the funds allocated for other socio-cultural programs having more direct application, such as public housing, medical assistance and educational programs. The popular appeal of space since earliest mankind has attracted the imagination of men; providing the achievements continue to be of a spectacular nature with little of the ho-hum or hum-drum to them, they will continue to receive public interest if not support.

The Hillary Theory—This concept considers that man will venture into space if for no other reason than the fact that, like Mt. Everest, it is there. The Hillary theory probably best justifies the attempts of man to reach the poles. In their day, the polar regions were as inaccessible and difficult of conquest as was Mt. Everest and as the Moon is proving to be.

Popular theories for manned space activities suffer from lack of rigor and thus afford only cursory interest. Recognizing this deficiency coupled with an interest in determining motivating factors supporting the space program in general led to additional surveys of more "scientific" nature.

IV. SOCIO-HUMANISTIC JUSTIFICATION

Recently the author sent out 100 questionnaires to key individuals within the General Electric Company asking them to indicate by completing the questionnaire, their opinions regarding the purpose for exploration of the Moon and space. This questionnaire was generated by one of the field offices of a Washington based space agency, and contained several sections, each section listing a set of objectives which might constitute the basis for space exploration. The participants in the questionnaire represented individuals within the Missile and Space Division of General Electric occupying positions of considerable stature in engineering and scientific pursuits and who were considered to possess objectivity in attempting to answer the questionnaire without undue influence from their own biases regarding the space activities of G. E. All of the individuals were mature, experienced scientists or engineers, some occupying managerial positions, but none reflecting only managerial or administrative responsibilities. Fifty-one questionnaires were returned indicating a 51 percent response. The first set of objectives reflected eight elements of the Congressional Legislation of July 29, 1958, which created the National Aeronautics and Space Administration. The re-

spondees were asked to rank these objectives according to their importance from a national point of view, by distributing one hundred points among them.

A group in first rank by 19 percent indicated that the United States must preserve its role as a leader in space sciences and technology and in the application thereof to the conduct of peaceful activities inside and outside the atmosphere. Second rank by 18 percent indicated that the objective was to make available to national defense agencies those discoveries that have military value or significance. Third, fourth, and fifth ranks were devoted to the objectives of expansion of human knowledge of phenomena in the atmosphere and benefits that would be gained from the exploration of space, together with improving the ability of space exploration vehicles. These three activities constituted an average of 14 percent each of the total. The last three objectives were devoted to the developing of improved space vehicles, utilization of space information, and scientific resources, as well as cooperation by the United States with other nations and groups of nations in the peaceful application of space activities to human affairs.

These eight objectives thus tended to group into five categories which are listed as follows:

Political value.
General welfare.
Additional security.
Additional transportation capacity.
Additional scientific knowledge.

The second section of the poll requested the individual to rank these in terms of importance, again by distribution of one hundred points among them. The results of this portion are displayed in Table III.

TABLE III

RELATIVE RANKING OF SPACE OBJECTIVES

Objective	*Rank*	*Percent*
Political value	1	25
Additional scientific knowledge	2	24
Additional security	3	23
General welfare	4	20
Additional transportation capacity	5	8

Similar data were obtained from the referenced field center and indicated that in the viewpoint of the individuals polled at that center additional security was highest priority followed by scientific knowledge. Political value and general welfare ranked next in importance with additional transportation capacity and capability least important. This result is not totally unexpected since individuals in a large diversified industrial complex might be quite convinced that political motives would be more important in the achievement of certain goals and objectives in space exploration; a situation that would obviously be denied by the government agency involved. For this reason, it appears that one must accept the fact that increased scientific knowledge probably represents the highest priority goal followed by improvement of the national security base. Moreover, achievement of security is partially a function of national politics and these political values and security values have bilateral implications on one another.

The broad scope and wide variety of the postulated objectives of manned space exploration explained in the preceding paragraphs tend to mask out a more subtle and more nebulus implication of these proposed space activities. If we explore the postulated popular opinions that are held by the average individual, we must discard the majority of them as trivial. Exploring the more relevant opinions held by the informed individual, we find that many of them are inadequate to express a fundamental reason for the exploration of space. It appears that other reasons might exist which are less readily articulated.

V. THE THEOLOGICAL QUESTION

History and sociology demonstrate that down through the ages of time man has associated his spiritual belief with the heavens, celestial bodies and the Sun. This is quite natural perhaps, since man tends to worship that which he understands least. The age of space has thrust upon mankind the unwelcome proposition that he may be capable of exploration of not only the Solar System, but also the entire Universe! Whole new realms of scientific endeavor are visible which afford new challenges and opportunities for scientific discovery, only to be confronted by the theological viewpoint that man has no purpose in space.

There will be a critical moment in the destiny of man when he first sets foot on the surface of the Moon. This event will rank in importance and significance with the discovery of the New World by Columbus or the Polar regions. A new scientific playground will be opened up to view, the use of which must exceed our expectations. "Each space development or potentiality will inspire people or leave them indifferent, and will be understood or misunderstood, to the extent that it meshes with the prevailing world view of the spectator or participant."[3] There is evidence that man is conservative when it comes to changing his personal world view, in spite of frequent claims about wanting progress. If our activities in space do come to touch directly upon a large part of our culture, they undoubtedly will affect values and attitudes, generally acting to reinforce old attitudes and values rather than stimulating new ones. Thus it is not likely that man's perspective of himself in relation to the cosmic system will be greatly affected. Most people attend carefully only to those experiences which are immediately significant to their own personal life. Yet it is in this area that space activities will probably prove most significant. *Manned exploration of the Moon and the Universe represents an attempt to relate the origin of life and the Universe to man's spiritual beliefs and aspirations.*

Continued on page 117

THE SCIENTIST AND HIS FAITH

JOHN A. McINTYRE*

Three contemporary issues are raised and the Christian's responsibility concerning these issues is discussed. The issues are (1) the Christian's responsibility in political and economic affairs, (2) the Christian's attitude toward the inspiration of scripture, and (3) the Christian's commitment to his secular vocation. It is suggested that some prevalent Christian attitudes concerning these matters should be changed.

As a scientist goes about the business of living a Christian life, he is continually faced with practical problems which call for Christian decisions. During the last few years I have found that three particular questions have arisen again and again which, to my scientific mind at least, we, as evangelical Christians, may not be answering in a Christian manner. Since my audience is composed of Christian scientists like myself, I would like to put my thoughts on these, perhaps controversial, questions to the test here.

THE CHRISTIAN AND SOCIETY

Let me introduce my first question with a true story. Last winter a respected leader of the evangelical community visited Texas for several days. He made headlines twice. The first time was when he said that Richard Nixon was the American Winston Churchill; the second time was when he said that the Communists were going to "take over" the world in 1972. Now, one cannot help but be strongly impressed by such statements, because they represent opinions that are so different than those of the vast majority of Americans. Bypassing the controversial Mr. Nixon, one could say concerning the communist take-over that almost all of the information that one can obtain indicates that the communist world is growing weaker and the free world stronger. Russia and China have become enemies, Western Europe has become a strong third power, American economic health is at an all-time high, and the American communist party is weaker certainly than it was 20 years ago. What is the basis for the statement about the communist take-over? I must confess that I haven't the slightest idea. And, in particular, it seems to be impossible to link the novel views of society of this Christian leader with any Christian principles or practices.

This sense of puzzlement and unreality connected with these strange remarks by the evangelical leader is not limited to this particular event. Rather, the evangelical community as a whole seems to have lost touch with the rest of America on social issues. There would be nothing wrong, of course, with evangelical Christians standing alone for Christian principles if one could understand what particular Christian principles are being defended. However, so far as I can see, Christian principles seem seldom to be at issue when evangelical Christians differ from other Americans.

The Christian principles that would seem to apply to our social life are illustrated, for example, by the parable of the good Samaritan. Here we are shown, that those in need are to be helped whether they be close friends or the outcasts of the community. Then, we have the Old Testament prophets emphasizing the importance of justice being applied equally to the rich

*Dr. John A. McIntyre is in the Department of Physics, Texas A. & M. College Station, Texas. Paper presented at 19th Annual Convention of the American Scientific Affiliation, August 1964, at John Brown University, Siloam Springs, Ark.

and to the poor. And, the New Testament tells us of the responsibility of the community to care for the helpless old people through remarks about the Christian responsibility for widows.

Yet, how are these principles applied by evangelical Christians? When the Marshall Plan for aid to Europe was proposed, the eastern states with their strong Jewish, Catholic, and liberal Christian communities supported the plan. The so-called Bible Belt in the midwest opposed the plan. Yet here was an opportunity to offer a drink of water to the thirsty, to offer a cloak for the naked. On what principles then did the Bible Belt oppose the Marshall Plan?

On medical care for the elderly, which admittedly is inadequate, have evangelical Christians led in a search for solutions to the problem? Do evangelicals not tend to oppose, rather, all solutions suggested for solving the medical care problem? On aid to Appalachia, or to the slums of our great cities in the form of job training, health care, and education, have the representatives of the Bible Belt supported such legislation? Or, in supporting the negro in his right to vote or for giving him opportunity in employment, what has been the position of evangelials? And what part have rural evangelical Christians played in the illegal retaining of legislative seats from their city brethren so that, in desperation, the Supreme Court finally was forced to transfer the seats? And finally, on the race question, has not the evangelical community been a dead last in breaking down the barriers that the New Testament says so clearly are un-Christian? Not only in our schools but even in our own churches where Paul says that there is neither Jew nor Greek, bond nor free, male nor female, we oppose scriptural teaching by separating black from white.

What are the reasons given by evangelicals for the positions that they take on social matters? They do not seem to be specifically Christian reasons. They have to do with states' rights, opposition to communism, and free enterprise. These reasons are all valid reasons in their proper place, but are they reasons which we dare to use in opposition to the Christian imperatives of justice for both rich and poor, compassion for the weak, and assistance for the needy?

We are left then with the question of why the evangelical Christian community has consistently taken positions in social matters that seem to oppose Christian principles. I believe that the social scientists of the ASA have a great responsibility as well as a wonderful professional opportunity to use the knowledge and techniques of their specialty to determine the answer to this question. What are the causes and also the cures for this schizophrenia that has taken hold of evangelical Christians? Why are we relatively successful in applying our faith in Christ to personal relationships but seemingly so unsuccessful in using Christian principles in social matters? These are puzzling questions that cry for a Christian answer. I understand that some of our members already have been active in looking into these matters. Our organization, as well as the Christian colleges, should give these men every encouragement in the pursuit of their investigations.

THE CHRISTIAN AND SCRIPTURE

My second topic is one which has always been of great concern to the American Scientific Affiliation, namely, "How are we to reconcile the facts of science with the record of history that we find in the Bible?" I am thinking in this connection, for example, about the problems that come up in the early chapters of Genesis where we read about the creation of the world in six days, the creation of Eve from Adam's rib, the destruction of the race by the flood, and similar questions. These problems have led to all kinds of wild and fanciful interpretations of both scientific findings and scriptural passages. I would like to try here to apply to these questions some of the insights into the pursuit of truth that we have gained through our profession of being scientists. In particular, I would like to make use of the close relationship between the study of God's creation, the natural world, and the study of God's revelation, the scriptures.

Both Christians and non-Christians alike agree that God's creation, the natural world, is a real and valid fact. Except for some of our philosopher friends, we believe that we can profitably study nature, that it is not capricious, and that it is internally consistent. Now, do we, who believe in the inspiration of scripture, claim any more for scripture, or rather, does scripture claim any more for itself? We read, for example, from Paul: "All scripture is inspired by God and profitable for teaching, for reproof, for correction, and for training in righteousness." Also, Peter writes: "First of all, you must understand this, that no prophecy of scripture is a matter of one's own interpretation, because no prophecy ever came by the impulse of man, but men moved by the Holy Spirit spoke from God." And Jesus used the following expression concerning inspiration: "The scripture cannot be broken." Thus scripture declares itself to be valid, dependable, profitable for study, and to be given by God. Cannot precisely the same things be said about the natural world? My thesis is then, that just as we have learned to study and comprehend the natural world, we could profitably use the same methods to study and comprehend scripture.

We can now use this similarity between the natural world and scripture to distinguish between the *inspiration* of scripture and the *interpretation* of scripture. Our commitment as members of the ASA to the inspiration of scripture is nothing more than the scientists' commitment to the validity of the natural world. On the other hand, our *interpretations* of scripture correspond to the scientists' *theories* about the natural world. Among Christians there is ordinarily no disagreement about the inspiration of scripture any more

than there is disagreement among scientists about the validity of nature. All of our disagreements lie in the area of interpretation. That is why it is not only unkind but also illogical in an argument about the interpretation of, say, the account of the flood, to accuse our opponents of not believing in the inspiration of scripture.

Turning then to the problem of the interpretation of scripture, what insight can our knowledge about scientific theories give to us concerning the validity and limitations of scriptural interpretations. There are several things about scientific theories that would also apply to scriptural interpretations. First, both scientific theories and scriptural interpretations are man-made and hence are limited in scope and subject to future correction. A good example of such a scriptural interpretation is the Ussher date of 4004 B.C. for the creation of the world. Later, scientific evidence has caused this date to be changed. This example also shows the equivalence of scientific theories and scriptural interpretations. A change in a scientific theory can also produce a change in a scriptural interpretation. We can then conclude that since scientific theories are continually changing that scriptural interpretations will also be continually changing. This close connection between scriptural interpretation and scientific theory emphasizes the importance of the joint meetings of our organization and the Evangelical Theological Society.

Another feature about scientific theories that should be considered in connection with scriptural interpretation is the meaning of their content. This feature brings us into the realm of the philosophy of science, and I hope that at our meeting next year we will all be further educated about these matters. As an example of what I have in mind here, I will use the theory of wave mechanics which is basic to all of physics. In this theory, the quantity which appears in the fundamental (Schroedinger) equation is denoted by the Greek letter psi. This quantity, however, cannot be measured in any way; yet there are rules which tell us how to find measurable quantities from a knowledge of psi. Since, however, psi itself can never be measured, the question arises as to just what psi is, or "What does psi mean?" Here the philosopher of science must enter into the picture to evaluate the meaning and content of the psi symbol which the physicist finds so necessary for his work.

Now, I wonder if there might not be similar problems in the interpretation of scripture. May there not be symbols in the Bible which should not be interpreted in a literal way? This question can properly be answered only by the philosopher and the theologian, and I will leave it here. However, the scientist can rightfully be skeptical, I believe, of a theology which is more literal in interpreting the things of the spirit than is a mathematical science in describing such a concrete entity as the physical world.

These comments bring me to my final point. Cannot the scientist recommend to the theologian the use of some of the techniques and attitudes that have proved so fruitful in the study of the natural world? When the scientist investigates nature, no holds are barred. Nature is stretched, pulled, and twisted, in every conceivable manner. New, tentative, theories are proposed and put to the experimental test. An atmosphere of experimentation and excitement prevails. Nevertheless, there is, at the same time, a profound respect for the traditional, fundamental, time-tested parts of the science, an example being in physics the law of the conservation of energy. Why cannot the enterprise of interpreting the scripture be carried out in the same manner? Of course, we must not overemphasize the experimental and skeptical features of science at the expense of the respectful attitude toward the sound edifice that has already been constructed. At this last point, incidentally, I believe the liberal theologians have erred. But, while our conservative theologians have opposed this fundamental error, for which we may be forever grateful, there has been a, perhaps natural, tendency to oppose also the inventive, skeptical aspects of liberalism, and of science, as well. Such opposition to experimentation in interpretation is a dangerous thing for, if our interpretations of scripture are to develop in a healthy way as new scientific evidence accumulates, we must capture theologically the free-thinking as well as the conservative features of a scientific enterprise. Then, our conservative theology will once again take her place as the "Queen of the Sciences."

THE CHRISTIAN AND HIS VOCATION

I would now like to turn to the third question of this talk. This question lies particularly near to my heart, because it is a question that must be faced everyday: "In what light should one consider his daily work?"

Let me begin with an account of an exchange of views that took place in our adult Sunday School class a year ago. One member of the class, studying Chinese in preparation for the mission field in Formosa, made the remark that the most important thing for a Christian to do was to win souls for Christ. Everyone nodded his head in abject agreement, and I found that I could sit still no longer. For if all of those carpenters, car salesmen, teachers, and policemen in that class really believed such a statement, then they were all hypocrites. It would be very difficult for them to show that they were devoting their lives mainly to winning souls for Christ. I, therefore, challenged the statement, and needless to say, we had a most interesting discussion—one which lasted several weeks. In our discussions, a number of fundamental points came to our attention. We found, for example, that evangelical Christians have separated themselves into a clergy and laity in a manner very similar to that of the Catholic church. We call our clergy, "those in full time Christian service." And, incidentally, we expect that those in this class will take the vow of

poverty. We also feel that those in this group are more devoted to Christ—for example, they can win more souls for Christ. Our young people are exhorted to enter "full time Christian service" often with the implication that this is the most Christian thing to do. We seem to have rejected the Protestant emphasis on the dignity of labor; Luther's shoemaker who glorified God in his making of good shoes has been largely forgotten. We have also turned our back on the Old Testament concept of God's people where the Levite who tended to God's temple was not considered to be in any way more religious than the farmer or the administrator.

In adjusting his thinking to this heretical viewpoint, the average Christian not in "full time Christian service" has subconsciously developed a defense for himself by deciding that he really has chosen his job because somehow, through his work, he can "reach people for Christ." Thus, the teacher feels that he can use his professional position to influence his students, the nurse to counsel her patients, while the automobile salesman perhaps just gives up attempting to salve his conscience in this manner. To me, this attitude of the Christian in secular life is even more frightening than the hypocritical one of believing that "full time Christian service" is the best place for a Christian. Here, the Christian is prostituting his profession; he is pretending to be a teacher while really he is an evangelist.

The natural result of these, perhaps subconscious, guilt feelings of Christians in secular life is that Christians are inhibited in pursuing their professions. And the further result of these inhibitions is that there are few, if any, great creative Christians in the arts or in the sciences today. This situation is, of course, quite different from previous times when many devout Christians were found among the leaders of the scientific and artistic communities. As an example of how Christians are led away from scientific careers today, I know from personal experience of a rather large number of promising young Christian scientists who have given up scientific careers to teach in Christian colleges. In fact, I would almost say that most of the Christian scientists that I have known have chosen teaching careers in Christian colleges in preference to research careers. Now, clearly, there is a very great need for good science teachers in our Christian colleges. And, I know that many of the men in the ASA have been called to do this important work. And, there is no doubt that those who choose to teach in Christian colleges usually do so at a considerable financial sacrifice. Nevertheless, I cannot help but feel that we subconsciously have been taught to believe that somehow by associating ourselves with a Christian institution we are being better Christians.

Another example of how our false conception of our professions inhibits our work has to do with the use of our time. There are so many demands from Christian and other sources for our time that we are in a constant state of perplexity about how we should use it. In making the decisions about our time, are we willing to say that our professions must come first? In fact, if these professions are our true calling are we not obligated to put them first? How can a person be creative, be he scientist or artist, unless he immerses himself in his work, unless he goes to bed thinking about it and awakes with it again on his mind? Did not Beethoven agonize day and night in writing his symphonies? Do we not marvel at the devotion of Michelangelo in painting the Sistine Chapel? And, don't we remember that Newton many times calculated through the night with hardly a pause for food? Do we, as Christians, wish to say that such devotion to the highest achievements of the human spirit is not appropriate for the Christians? Perhaps we should say so. Perhaps such devotion inevitably leads away from God to the idolatry of the art or science being pursued. Being a scientist myself, I know the terrible temptation to permit my work to come between me and God. Nevertheless, just because a course of action is spiritually dangerous, are we to forsake it? Would that not be making the cowardly error of withdrawing from the world to the monastery? The Christian has been told to live in the midst of the world, among the wolves of the world and has been promised preservation.

I believe that there is another reason why we can with good conscience devote ourselves wholeheartedly to our professions. The Westminster Confession puts it this way: "The chief end of man is to glorify God and to enjoy him forever." But, how should man glorify God? I believe that the answer is given in Jesus' parable of the three men with the talents, where he shows the responsibility that we have as Christians to use the gifts given to us. What better way is there to glorify God than to use to the full the abilities that we have been given? Of his own gift of preaching the gospel, Paul exclaimed: "For if I preach the Gospel, that gives me no grounds for boasting. For necessity is laid upon me. Woe to me if I do not preach the gospel!" Does this not express clearly the attitude that each Christian should take toward his own calling? The musician sings because he *has* to sing, not so that he can help the choir; the novelist writes because he *must* describe human lives; the scientist works in his laboratory because he is never so happy as when he is probing the secrets of nature. Oh, how we have lost the joy of work, because we feel that somehow, the work itself, is not devoted to Christ and that we must atone for the hours in the laboratory by teaching a Sunday School class!

I believe that as Christian men of science we should think through carefully this question of the calling of a Christian. If we do not feel that a scientific career merits the full devotion of a Christian, we should say so clearly, and a large number in our organization should change their professions. Also, we should be prepared to abandon all pretense of being informed in

Continued on page 112

THE ORIGIN OF THE SOLAR SYSTEM, GALAXY, AND THE UNIVERSE

JACK T. KENT*

The objective of this paper will be to survey the historical background and thinking behind the present opinions as to the origin of our Solar System. A correlation will be made between the various theories presented and the Bible. The most widely accepted theory at the present time, developed by Dr. Gerard P. Kuiper, will be presented in detail. It will be pointed out that by means of this theory, when one explains the origin of our Solar System, one likewise has explained the origin of the Galaxy, and the Universe.

In developing this thesis, some of the major theories of past years will be briefly surveyed. This will cross the lines of the sciences, illustrating clearly that sciences are now more closely related than ever before. This will involve the question of time, the stumbling block over which so many people fall when trying to separate science and the Bible. It will be shown in clear detail that there is no conflict here.

The Heavens declare the Glory of God, and the Firmament Sheweth His Handiwork. Surely the Universe is full of His Glory.

The problem of the Origin of the Solar System is one of the most complex problems in Nature. It has intrigued men and women for ages, and still offers some of the most profound opportunities for advancement of scientific endeavor present today. The understanding of this problem offers the opportunity for the investigator to delve into the field of Mathematics of the most advanced type, and to cover the spectrum of science—Biology, Chemistry, Geology, Physics, and Engineering, not to mention Astronomy and Astrophysics.

I shall endeavor to present to you the fundamentals of the most widely accepted theory, and all such proposals are theories. This is the theory advanced by Dr. Gerard Peter Kuiper. He was doing his basic research on this problem during 1951 to 1952, while I was fortunate in being at the Yerkes Observatory, where this work was being done. And through the intervening years, Dr. Kuiper has kept his concepts up with the times, revising and enlarging the theory on the basis of the later developments. Through the years I have checked with the leading astronomers of our country as to the beliefs held by those of this discipline, and almost without exception, they tell me that Dr. Kuiper's protoplanet theory of origin is the one which comes most nearly explaining those things which are necessary to explain.

In explaining the Origin of the Solar System, the protoplanet hypothesis explains the Origin of the Universe. Whether there originates a solar system, a double star system, a stellar cluster, or a galaxy, is only a matter of degree. This we shall see.

However, we must first understand what it is that we wish to explain. Let us therefore first define our problem. This may best be done by demonstrating the ORDER of the Solar System, and listing its properties.

So therefore, our Theory when complete, must explain:

1. The 9 planets and their properties.
   a. The planets move in almost the same plane.
   b. They move in direct revolution about the Sun.
   c. They move in direct rotation about their individual axes.
   d. They move in nearly circular paths, obeying Kepler's Laws.
   e. They are endowed with similar masses and densities.
   f. Now let us name the planets in order as they progress outward from the Sun, and give only briefly their properties:

* Jack T. Kent is Professor of Math & Astronomy, Texas A&M University, College Station, Texas. Paper prepared for the 19th Annual Convention of the American Scientific Affiliation, August 1964, at John Brown University, Siloam Springs, Arkansas.

1. First comes Mercury, only 0.4 of the way from the Sun to the earth, moving rapidly in an eccentric orbit around the Sun in 88 days, keeping its same face to the sun, as does our moon. It is devoid of atmosphere, and literally the hottest and coldest spot in the Solar System, with the exception of the Sun.

2. Next we have Venus, the controversial planet, a near sister planet to the earth in size. It is 0.7 of the way from the Sun to the Earth, and covered with clouds of carbon dioxide, with an unknown period of rotation and an unknown temperature on its surface, which we cannot see, and revolves around the Sun in 116 days.

3. The Earth comes third in this order.

4. After the earth, we find Mars, most nearly like the Earth in its ability to support life, actually possessing an elementary form of lichen life. It has two moons. Read Jonathan Swift's Gulliver's Travels for an interesting true story concerning these moons. Mars revolves with a period of a little under 2 years.

5. Between Mars and Jupiter we find the 35,000 Asteroids, of which some 1800 are catalogued with orbits.

6. Jupiter, some 5 astronomical units from the sun, revolving in 12 years, is the largest and most massive of the planets, as massive as all the others together, about 0.001 part of the Sun itself. With its 12 moons, it is truly a solar system within the Solar System, as Galileo stated. In fact it almost forms a double star system with the Sun.

7. Saturn, at 10 AU from the Sun, had a period of 29 years, and yet a density of only 0.7. It would float, were there a large enough tub of water in which to throw it.

8. Uranus appears at 19 AU from the Sun, just about the average distance for binary systems. It has five moons, and revolves in 84 years.

9. Neptune, with its 2 moons, appears at 30 AU and revolves once in 165 years.

10. Pluto, at 39 AU, is so far away from the Sun, that the Sun appears only as a dim star in its sky. Plutonians, were they to exist, would need to live to be 248 years old to have their first birthday.

Our theory must explain the

2. 31 natural satellites, varying in motion
   a. from direct to retrograde, and
   b. moving in more or less eccentric orbits.
   c. Incidentally, E. C. Pickering, in 1907 at Yerkes, and R. S. Richardson at Mount Wilson in 1952, discovered two other satellites of Saturn. Observations were not sufficient to establish their orbits, and they were lost.

3. Our theory must explain the Asteroids, ranging in distance of 2.7 to 3.1 times the Earth's mean distance from the Sun. There are a few exceptions. Some of these objects come very near to the Earth.

4. We must explain the Comets and Meteors, and finally

5. We must explain the Sun's Angular Momentum.

   This is only 0.3 of 1% of the system, whereas the Sun's mass is more than 99.9% of the System. The smallness of this ratio requires explanation.

Now let us take only a moment to trace historically the development of thought as illustrated by a few of the more renowned theories.

1. Kant, in 1755, assumed a clotting of gas into a cloud, in slow rotation.

2. Laplace, in 1796, assumed a cloud of gas in slow rotation, contracting, and throwing off gas on the equatorial bulge, which later collected to form the planets. Laplace published his Theory very inconspicuously in an appendix of one of his volumes of Celestial Mechanics. Yet this theory governed Philosophical, Scientific, and Religious thought for 100 years.

3. By 1900 people began to realize that Laplace's Theory left much to be desired. So Chamberlain and Moulton, at Chicago suggested the near approach of two stars. The probability of this occurring was its downfall.

4. Sir James Jeans and Sir Harold Jeffreys, in 1917, assumed a grazing approach of two stars. They should have known better.

5. Lyttleton in 1936 thought of the Sun as a binary system, with a third star coming by and capturing the Sun's companion, leaving debris for the planetary system.

6. In the meantime, Berlage in Holland in 1930 had assumed that electrically charged particles shot out from the Sun to take up orbits according to their mass. His work was inspired by that of Birkeland in 1912.

7. Alfven, in Sweden in 1942 thought of the Sun as passing through a gaseous nebula, charging the particles to form rings.

8. By 1945, C. F. Von Weizsäcker had visualized the collapse of a gaseous cloud to form a flat disk. A system of vortices formed in this disk in geometric progression, with more rapid rotation at the center. Coagulation occurred along the circles where secondary eddies were created by the viscous shear between the successive rings of the vortices.

Each of these theories, among other weaknesses, has essentially two. In the first place, none of them properly explains the distribution of angular momentum in the system.

In the second place, Dr. Lyman Spitzer, Jr., at Princeton University, proved in 1939, that the materials hypothesized by the theories up to that time would dispurse to outer space, not coagulate.

Of course, Dr. Von Weizsäcker was aware of this, and his theory was coming closer to what is thought to be the true explanation than any before. His difficulty was in not being bold enough, and not going sufficiently far.

Before proceeding farther, let us digress briefly merely to mention a few facts which serve to indicate the many facets which must be considered here. In 1930, at the University of Arkansas, I was taking a course in Mathematical Physics from R. A. Houstoun's book. Suddenly the age of the earth jumped overnight from $2x10^9$ to $3x10^9$ years. This was when radio active dating of rocks was first reported. Certainly the age of the earth must be a prime consideration. It is noteworthy to observe that none of the crustal rocks seem to be primeaval but to be secondary. Best estimates now indicate an age of from $5x10^9$ to $7x10^9$ years.

Temperature is also both an interesting problem and of great importance. In 1952, I heard Dr. E. C. Bullard state that he felt the core of the earth to be fluid. His latest paper that I have seen, coming out last year, states more or less the same thing. Perhaps "Mohole" will tell us more. It has been confirmed, however, by various corings in deep wells, that the temperature rises 1°C for each 125 feet down. I saw this confirmed in a deep water well at College Station, Texas a few years ago.

Harrison Brown, and others, furnish us with chemical clues. This leads us into the equally fascinating problem of abundances of elements. Certainly "Cosmic Composition" is uniformly true throughout the universe. However, for the lighter planets, the lighter elements, hydrogen and helium, were allowed to escape, which does not therefore leave an 80-20-1 distribution for H-He-Heavy Stuff on the earth and its sister planets. The major planets come closer to this cosmic distribution, because their masses retained a greater part of this original material. Certainly, however, the earth's atmosphere is secondary, with the earth's original atmosphere having been lost.

Meteors appear to be startlingly close to the age of the earth, and represent some primeavel matter. Harrison Brown shows that they must have been under tremendous pressure at some time, and it is interesting to note that many evidences of trapped gases have been found in meteors.

So the evidence piles up, and it must all be sifted, and coordinated. Order must be made out of the whole. Dr. Gerard Peter Kuiper, now at the Lunar and Planetary Laboratory, Tucson, Arizona, has seemed to come closest to this order than any one else. Now let us proceed in the presentation of his Protoplanet Theory.

Let us trace briefly the story, to return to the details later in this talk. Kuiper assumes the existence of a cloud of gas, whose mass is 100 times the present mass of the solar system. This cloud is in slow rotation, in a direction which we call west to east. He proves mathematically that this rotating cloud will collapse in a direction perpendicular to the plane of rotation. This collapsing process will continue for 10,000 years to 100,000 years, until a time occurs where the Roche Density obtains. This density is that density where the internal attraction of the cloud is equal to the tidal forces of the Sun, simply, where push is equal to pull.

Now why was Kuiper successful in almost identical assumptions where others failed. He started with a larger, more massive cloud, and he allowed the collapse to progress to a greater degree. Actually, 99% of the mass of the cloud was lost during the process of formation. So you see, if the present solar system should be wiped out completely, and spread out uniformly into a slowly rotating cloud, then the solar system could not form again.

And besides, this process makes Solar System formation the rule instead of the exception. It is estimated by Kuiper that there must be 10^9 solar systems in our galaxy similar to our own. Surely somewhere there must be some people living who have more common sense than we do, and can live together more peaceably by the rule of Christ. You no doubt remember when Frank Drake at the National Radio Observatory in West Virginia attempted to communicate with one of these systems. It happens the two nearest stars suitable for such life are 11 light years away, requiring 22 years for the round trip.

We must therefore enquire, "Just what type of star is best suited for a Planetary System?" It is more probable than not that certain classes of stars *will* have planetary systems about them. Astronomers classify stars with capital letters, the class being determined by its temperature. It turns out that when we have classified stars by temperature, we likewise have separated them according to their brightness, their chemical content, their mass, their space velocities, their age, and also to some degree as to their region of location in space. One says the following apothegm: "Why, Oh Be A Fine Girl, Kiss Me, Nay, Romeo, Scram." The first letters of these words form the stellar classification known as the Spectrum Luminosity Diagram, or the Henry Draper Classification, or the Hertzsprung-Russell Diagram.

Now this classification, W through M, carries us from surface temperatures of 100,000°K to 3200°K. It turns out that a star of class G, like our Sun, is of surface temperature 6,000°K. And this seems to be a very happy state for a star to be in if we expect to find a planetary system associated with it. Now this is not to say that a star of higher spectral class, such as F at 8,000°K, or even A at 12.000°K, may not have planetary systems revolving about them. But if they do, the chances are very good indeed that the system was formed before the temperature got that high. This is to say, condensations of size 1 MM in diameter occurred before the temperature rose too high.

If and when Roche Density occurs, the formation of a planetary system is a necessity. It cannot help being formed.

This Roche Density, or Limit, is quite critical. It must be realized within a factor of 3. A miss by a factor of three is all that is needed to cause the formation not to occur.

If, after the evaporation loss, and the radiation loss, and after the rotational flattening his occurred, then the density is less than this Limit by a factor of 3, all materials are lost to outer space, except for the central star, or we may get a system similar to the rings around Saturn. If however, the density is larger than this Roche Density by a factor of 3, then we get a binary system formed. It should be pointed out here that more than half, about 2 out of 3 stars are multiple systems. In fact, it appears that less than 10% of stars formed as singles, even if such a star is now a single star.

Now if our cloud has several hundred or several thousand times the solar nebula, we will get a cluster of stars, open or globular, depending on the amount. The open clusters are called Galactic clusters, since we see them only close at hand because of their smaller brightness. They are a passing phase of the Universe and our Galaxy, because they continue to be broken up and to lose member stars by the field star effects. The globular clusters are supposed to have been formed as original members of our system.

Certainly you can see that if sufficient material is present in some region of space, this same Rotational flattening effect will form a galaxy. The only thing left to do is to ask why the material collected together and rotated in the first place. Suffice it to say that the rule of the universe is motion. We do not live in a static universe. Where there is matter there is energy, and electromagnetic radiation. The mere shadow of a proton on an electron is sufficient to establish a thermal inequality, and hence motion.

So, let us now return to our solar nebula and carry this process farther. The Roche density, though critical, is surprisingly small.

This density, occurring where gravitational attraction balances tidal forces, gives a minimum distance for a planet to have satellites of 2.44 diameters. The distance for Saturn's rings is smaller. The distance of the moon is larger.

For comets, this gives a minimum distance of 90 million miles from the sun. Some creep closer, with more or less disastrous results. For example, Comet 1882 went through the Solar Corona at 1 million miles per hour, and came out on the other side as four comets. They will return to the sun around 2800 AD, spaced 200 years apart. This also serves to confirm that solar accretion cannot alone explain the heat of the sun, in fact is only an inconsequential part.

Now for a few startling figures. For Mercury's distance, this Roche Density is 10^{-5}; for the earth's distance, it is 10^{-6}; for Jupiter's distance, it is 10^{-8}; and for Neptune's distance, it is 10^{-10} Naturally for Pluto's distance, it is negligible. Out past Pluto, all materials were pushed away from the sun.

Now condensation begins as loose snowflakes, ices, and silicate an dmetal grains. The flakes were composed of water, ammonia, methane, and other hydrocarbons, since 99% of matter is hydrogen and helium. And to him that hath shall be given, and to him that hath not shall be taken away, even that which he hath, one of the God Laws of Nature. The bigger flakes sweep up the smaller flakes and so it goes.

In the colder outer regions, objects of the order of 100 meters to 10 kilometers in diameter would form by the above process. These resemble comet heads. In the inner parts, where it was denser and warmer, objects of larger size were allowed to grow. These were largely composed of silicates and metals, with some H_2O snow. These resemble Nereid, and Pluto, and smaller planets.

Out past Neptune, and out past Pluto, this process led to the formation of comets. Jupiter did not allow a large mass to form near it. Some think, and there seems to be evidence to substantiate it, that the asteroids were at one time about 10 to 100 protoplanets, but were caused by Jupiter to break into 35,000 odd pieces.

At maximum size, the protoplanets touched one another, thus sweeping the system relatively clean. Not completely though, for we, in the solar system are still bathed in the solar plasma, and subjected to the solar winds.

As a result, we find that Neptune is different from Mercury, not because of distance from the sun, but because proto-Mercury was smaller than proto-Neptune. Furthermore, no planet could form in a region of too low a density.

As the planets, or satellites grew, all particles spiraled inward. The smaller particles, less affected by friction, spiraled in more rapidly to form the nucleus, while the larger and lighter ones, come in more slowly to form the crust.

If it were not for the solar tides, the protoplanets would rotate three times as fast as they do. So if a body found itself revolving outside the envelope, then it may find itself shed to interstellar space. The contraction itself, perpendicular to the plane of rotation, occurs because of collisions and dissipation of energy. It is the transition from a Sun with weak, infrared emission to a central sun of its present ultra violet type of emission which allowed the planets to form, and then caused their near complete destruction by evaporation and the clearing out of interplanetary space by radiation pressure.

There were four methods of loss of material by the nebula: evaporation, radiation pressure, expulsion by solar corpuscular rays, and a quite hypothetical fourth method of hydromagnetic coupling between a rapidly rotating sun and the ionized cloud.

For efficiency, evaporation requires the root mean square velocity of the particles, usually here of atomic or less in size, to be no less than one-fourth the velocity of escape. The mean free path above the escape layer must be no less than the size of the solar nebula. Radiation pressure had little effect on the ionized HII regions. It was extremely important for low-latitude HI regions in the nebula. It was also extremely important in the mass losses for the protoplanets themselves. It seems therefore that radiation pressure was nearly the sole cause of the almost complete dissipation of these bodies. Furthermore the loss was entirely radial, and ejection for the most part began in low levels within the nebula. And we are talking about radiation pressure from the solar energy itself, and not of any local effects.

Bierman believes the high accelerations of the corpuscular rays was due to the action of the solar electrons on the cometary ions. The solar electrons are kept moving in turn by the solar protons. The rate of escape to space will be close to the maximum allowed by the total kinetic energy. The instreaming hydrogen atoms will be ionized by the solar UV radiation less than 910 A, and by corpuscular rays. Thus the second source of ionization, the corpuscular beam itself, probably dominated the dispersal of the solar nebula, by first ionizing the material and then sweeping it away.

Helium and the other high ionization potential gases were probably removed in the same manner as was hydrogen. Once these gases are ionized by corpuscular radiation, the ions are rejected much as happens in comet tails today.

Even at the present epoch, planetary evaporation and ejection is not entirely absent. However, interplanetary space is so low in density that only in the comets do we find the violent exposure to which formerly the entire solar nebula was subjected.

The planetary surface temperatures are not nearly so important as the planetary exosphere temperatures for the outer atmospheres. The latter determine the planetary mass losses. These temperatures became quite high, of the order of 10^4 to 10^5 degrees Kelvin.

There were two different modes of origin and evolution for satellites and comets, depending upon whether the planetary envelope in which they arose was gravitationally stable or unstable. The large ones formed as proto-satellites. The small ones formed as nebula type bodies where gravitational instability was permitted. Some satellites are 100,000 times as small as they should be to have formed as proto-satellites. For example, the outer satellites of Jupiter are no doubt nebula satellites, later captured. This will also explain retrograde motion which does occur in certain instances.

In the early stages, as evaporation occurred, the protoplanets shed their outer satellites of all sizes. They were either deposited into interplanetary space from which they could be recaptured, either by their own planet again, or by another planet; or they were pressed into forced orbits as are the Trojan Asteroids, which are probably spherical in shape; or they were scattered throughout the solar system by planetary perturbations. For example, some objects now near the Earth may have originated in Proto-Neptune.

It can be shown that in the absence of viscosity, the obliquity of the planetary axis will increase to 90°, and there remain fairly constant, unless acted on by other forces. However, where viscosity is present, obliquities may be shown to be about what they are today. The obliquity will oscillate due to perturbations.

So we may conclude this by returning to our original thesis, and state briefly how Kuiper's Protoplanet theory explains fairly satisfactorily those things which were required to be explained.

In the first place, the common direction of revolution of planets about the sun and their low inclination to the ecliptic are due to the extreme flatness of the solar nebula after collapse.

Second, the nearly circular orbits of the planets are due to the internal viscosity of the nebula. Mercury and Pluto are exceptions to this rule, because of the absence of a constraining force on the edges. All material within Mercury's orbit fell into the central Sun. All material outside Pluto's orbit was lost.

Third, the direct rotation from west to east of the planets is due to the solar tidal friction. The Roche Densities are nearly equal. Since this density is where solar tides and internal attraction nearly match, the protoplanets started with synchronized periods of rotation and revolution. Then the periods of rotation decreased with time. In these units, Neptune is no farther than Mercury from the central mass. However, the rotational periods are a complex problem in physics, chemistry, and dynamics. This is probably the most important source of potential information available today. This is associated with the rotation of all stars by spectral classes, and leads us into the consideration of magnetic stars, which constitute a different story from what this lecture was designed to give.

Fourth, the largest obliquity can be 90°. All of them are actually much less, as indicated above. However, the largeness of the obliquity for Uranus, having its equator nearly at right angles to the ecliptic, is no doubt due to the action of some extraneous body.

And finally Fifth, this theory gives 10,000 times the present angular momentum. So our problem here, instead of requiring the explanation of the absence of angular momentum, requires the explanation of its loss. This is an entirely different problem, and much simpler. Part is lost during the original evaporation period. Part is lost due to continued tidal friction. And it is still being lost.

Continued on page 117

RELATING MODERN SCIENCE AND TECHNOLOGY TO HUMANITARIAN PURPOSES

BY RUDOLPH H. DYCK*

This paper deals with some of the relationships which exist between the vocation of a scientist or engineer and the things of greatest value to him as a whole person. The position is taken that each of us cannot be ultimately satisfied with his vocation until he has discovered a direct positive relationship between it and his faith. The search for this relationship may prove to be a very satisfying activity linking vocation and ultimate concern.

The particular problems of feeding the starving peoples of the world and of unemployment due to automation are explored as to how they might be used to help establish the relationship.

Consider the following problem: What is the basic relevance of an engineer's or a scientist's vocation to his faith? More specifically, how does one find the relevance of one's own specific area of research or development to things which stand high in one's basic value system in life; that is, which are relevant to things of ultimate concern?

I wish to present the following thoughts because I feel that they are valid for many Christians and others as well working in the fields of science and technology, and because I believe that there are some specific problems that emerge which should be talked about and worked on in organizations such as ours.

The very existence of this organization testifies to some area of relevance between science and Christianity. In fact, if one scans over the recent cumulative index of this Journal, one might conclude that the whole scope of science is relevant to Christianity—and this is probably true in a sense. But I have misgivings about this conclusion because if one sets aside studies which aim at ironing out inconsistencies between scientific hypotheses and Biblical interpretation, and also those which merely testify to the glory of God in nature, then things are narrowed down a bit and we see that it is not at all so easy to relate the various sciences to the ultimate concerns of Christianity.

Why is it then that the ASA exists? Why is it that people participate in its functions? Some might do so because they are scientists or engineers and are also Christians and are looking for a specialized fellowship, but only in a general way. Others may have become involved with the ASA because of a particular problem widely discussed within it. Still others may participate because of a curiosity about or a searching for the relationship of science to Christianity. But in all cases, I venture to say, there is an attempt being made to relate one's vocation to one's faith.

This relationship may start out in a pretty nebulous form but sooner or later it would be a good thing if a more firm relationship could be found. For some of us, at least, there was a decision period in our youth when we did some soul-searching and came to the conclusion that God was probably leading us into the field of science for a vocation. Further decisions worked themselves out in the course of time, and here we are.

But how do we more concretely relate our faith to our vocation? There are many different aspects to a day's work, and there are just that many different points at which we could search and probably find a relationship. We have dealings with our employers, of course, which call for the honest response of doing

*Rudolph H. Dyck is on the research staff of Fairchild Semiconductor, Palo Alto, Calif., a division of Fairchild Camera and Instrument Corp. Paper presented at the San Francisco Bay Section meeting, May 1964.

our best job in his interest. We have dealings with our fellow-workers which call for such things as fairness, forming meaningful friendships, respecting them as individuals, et cetera. But I suggest that more important than these avenues—especially for scientists and engineers—is that avenue of relating to the work itself—to the things being discovered, invented, or developed. One reason why scientists and engineers are special is that they have a good bit of freedom in various aspects of their work. Another reason is the inherent importance that their work has now-a-days to our economy, our society, and to the world at large. Thus, whether a particular individual is working in pure research, where he might exercise considerable freedom in choosing his direction of effort, whether he is working with applied problems, where utility of a product is of major concern, workers in the area of science and technology have particular reason to relate their work to their ultimate concerns. For me this means relating it to human welfare.

Of great concern to many people these days are the problem of the population explosion in the underdeveloped countries, and the problem of unemployment as a result of automation in this country. These are areas toward which I feel the scientific and technological community can contribute in a significant way. With regard to the population explosion, I do not have any particular thesis other than that some means must exist whereby the extreme poverty, misery and starvation which exists over much of the globe today could be decreased without at the same time accelerating the explosion and thereby increasing the need. The matter of unemployment due to automation is of concern to me in this context because my field, which is photodevice research and development, and which is carried out in an electronics firm, seems to be contributing in most cases toward computer-type systems which form the general basis for automating machinery.

Thus, one way of giving our work broader meaning is to become involved in some way with how it is to be used. For example, it appears like a worthwhile effort to try to control, in some way, the application of automation, so that unemployment remains at a tolerable level, and at the same time to explore what computers could do to solve the population explosion dilemma outlined above.

The ways in which we can go about tackling problems like these are many. A direct approach would be to quit the job at which we work and to find employment with a social welfare organization or a relief organization. This may have a good short-term effect on the individual as far as his inner well-being is concerned, but it certainly is impractical, since several years of preparation and probably some years of experience too, would be going to waste. I would consider this solution to be a desperate last resort. But, who knows! Perhaps the person who would make this change is really the wiser. Perhaps the days will even come when a computer, monitoring the total manpower distribution in the nation or the world, and assigned to determining the optimum redistribution from time to time for the good of the total society, might answer that cutbacks in certain fields of research are in order because their relationship to needs of society has become too remote and because manpower is needed elsewhere.

Other approaches might involve such worthwhile things as giving of one's income to support other people who are presumably better qualified as social workers, et cetera, or to offer extra-curricular time of our own to these causes. Or, on the other hand, one might find a use for one's extra-curricular time which makes use of special technical knowledge, such as consulting for DATA, International, an organization that offers information research service to Americans overseas.

But as good as these avenues may be, they miss the point that is being made here, namely, that there is a need to relate to our work itself or to what we consider to be the essence of our work.

A practical starting point would be to locate some other individuals with similar concerns for the sake of dialogue. Possibly right where one works one could find a group of like-minded collegues. For example, where I work there are several such men in the nucleus of a weekly noon discussion group which deals with political and foreign affairs and the like. And then there are whole organizations which have objectives along these lines. In fact it is worthwhile to mention a few at this point, to appreciate their scope.

The American Association for the Advancement of Science has as the third of four stated objectives, "to improve the effectiveness of science in the promotion of human welfare." The Federation of American Scientists is an organization concerned with the impact of science on national and international affairs. Quoting from its principle brochure, it was formed "to meet the increasingly apparent responsibility of scientists in promoting the welfare of mankind . . ." It is known for its stands on the issues of disarmament, the test ban, and freedom for foreign travel among scientists. Then there are the World Health Organization, and Food and Agricultural Organization, the World Meteorological Organization, and others. In addition to organizations, we have conferences such as the Pugwash Conferences on Science and World Affairs, and the Plowshare Symposia, and also some very good magazines—in particular, the Bulletin of the Atomic Scientists.

In fact it was in this magazine that the late Academician, Alexander Topchiev, wrote the following words, which run closely parallel to the thoughts being developed here:

> The high title of scientist obliges one to be a humanist, an enemy of war and a fighter for peace, for fruitful coopera-

tion between nations. Scientists cannot but be interested in releasing science from its unnatural connection with militarism. Disarmament would accomplish this release. It would permit turning the entire genius of science to lightening and extending of human life.1

Similarly, the late President Kennedy said in his address two years ago to the National Academy of Sciences, "This seems to me the greatest challenge to science in our times, to use the world's resources, to expand life and hope for the world's inhabitants.2"

Turning again to the specific problem mentioned earlier of the population explosion and the associated poverty, misery, and starvation, we see that there are a good many avenues of approach from the several sciences. Therefore there are opportunities for cooperation with the other sciences as well as opportunities to specialize, as we try to relate to our daily work. The major dilemma in tackling the problem is that the more one supplies impoverished people with food, medical care, and clothes, the worse becomes the need—due to increased longevity and birthrate. But nevertheless it is wrong to ignore the problem simply because of this. President Kennedy showed great faith when he made the following comment in the above address:

Malthus argued a century and a half ago that man by using up all of his available resources, would forever press on to the limit of subsistence, thus condemning humanity to an indefinite future of misery and poverty. We can now begin to hope and, I believe, know that Malthus was expressing not a law of nature, but merely the limitation then of scientific and social wisdom. The truth or falsity of his prediction will depend now, with the tools we have, on our own actions, now and in the years to come.3

And of course, there is much to be discussed within the circle of the church about this problem. For one thing, the church is a leading supporter of relief efforts and therefore has a responsibility to look at the possible undesireable repercussions of certain phases of world relief. For another thing, there are very difficult moral questions about such matters as birth control and the calculated distribution of relief materials in which certain groups of people are deprived of what little relief they may be getting now if and when it is shown that relief is just magnifying the problem.

My personal opinion about world relief is that our nation, because of its high standard of living relative to the world's average, has a responsibility to do far more than it is doing at present. And furthermore, since science and technology have contributed so heavily in bringing our nation to where it is today, we in these fields should accept a large part of the responsibility to see that applications of our work are not constrained within national boundaries.

The other problem concerns the effect of computer electronics on our own society and economy; that is, effects due to automation and the recent rise in the unemployment level. While it is quite obvious that this is primarily an economics problem, and that any pursuits we take along the line to contribute to a solution, should be made in cooperation with the economic sciences, still it seems to me that people working in the development of electronic systems and components for these systems should have some sort of vantage point. Admittedly this is rather vague, but it is based on the principle that vertical specialization should not eliminate responsibility at the earlier levels of development of a product for its final use.

An example of what a few people and groups in the computer sciences are doing in facing this problem, is given in the latest Spring Joint Computer Conference. Three papers there dealt specifically with the relation between computer science and unemployment.4 One paper warned that computers and automation were now beginning to threaten jobs of skilled technicians and even some middle-management positions. For example some jobs that might be called routine-creative in nature such as bridge design and building design are now being handled by computers. In another paper the effects of this job displacement are outlined. Not only does it require drastic reevaluation of our economic structures, but of our social structures as well. Not only must we cope with poverty, but the psychological effects as well, which result when a man's work is taken away from him and done by a machine. Not least of all, we must re-examine our stand on the (quote) "Protestant ethic" of nobility of work and immorality of idleness. In the third paper of this group a suggestion is made that a computer system be designed and built which would give advanced warning of the impending changes in our society that will displace workers. I would suggest, along this line, that an early warning system be considered which could monitor relief programs to indicate where they might backfire by seriously effecting population rise.

All of the things we hear about unemployment these days makes it look like some real changes are imminent. Possibly it will be a trend toward a shorter work week. With a mature attitude toward the resulting free time, it could be a very valuable asset, both to the individual and to the community. Or possibly the trend will be toward more publicly supported projects, giving people work and at the same time accomplishing things for the good of society which might not otherwise get accomplished. While such things have been called, unflatteringly, WPA projects, and while they do verge on socialism, they will still have to be considered seriously.

One interesting possibility has been discussed by Frederick Seitz, president of the National Academy of Sciences.5 He sees in the near future, such a growth in interest in science by the public at large—an interest transcending the purely practical aspects of science—that the fraction of our gross national product invested in research and development will continue to rise and approach the order of a quarter or even fifty percent. The argument for this possibility

is based largely on the projected available labor. If the farm labor force has dropped by five-fold in the last fifty years, why not anticipate similar decreases in the labor forces required for the other vital needs such as shelter, clothing, medicine, and transportation?

Another possibility would be to use this very large available labor force on direct approaches to the problems of world-wide human misery.

In conclusion, it might be said that the search for relevancy between specific scientific endeavors and human welfare is not one that will result in simple answers, but rather the search itself will prove to be a meaningful continuing experience which will also reflect new meaning onto those scientific endeavors.

Finally, I would like to reiterate the appeal made at a recent Bay Area Section meeting by Dr. Beal for increased emphasis within the ASA on a direct involvement in the needs of the peoples of the world.

REFERENCES

1. *Interdependence of Science and Society*, A. V. Topchiev, *Bull. Atomic Scientists 19*, 3 p. 7 (March, 1964).
2. Research, Technology and Public Policy, J. F. Kennedy, *Physics Today 16* 23 (December, 1963).
3. *Ibid.*
4. See article in *Electronic News*, p. 1, April 27, 1964.
5. Science and the Government, F. Seitz, *Physics Today 16* 28 December, 1963.

Continued from page 103

a basic way about scientific subjects. In fact, don't we find even now at our ASA meetings that our members are forced over and over again to quote other authorities? Why do we not have the leaders of the scientific community in our organization? Is it not because we have considered that the devotion required to produce such leadership is not in keeping with our Christian witness? If, on the other hand, a scientific career can be considered worthy of being a Christian calling, then a large number of our members should be devoted scientists, in the sense that they creatively, and out of the strenuous efforts of their productive years, contribute to the scientific edifice being constructed by mankind.

As I said at the beginning of my talk, I have chosen three, perhaps controversial, questions for discussion. For, in contemplation during the past years as a scientist and also a Christian, I have become convinced that evangelical Christians must learn to apply their Christian faith to the political and economic society around them, that they should be more creative in their interpretation of scripture, and that they should re-examine the meaning of a Christian calling. I believe that the professional training of the members of the ASA prepares them in a peculiar way to search for the resolution of these problems.

CHRONOLOGY OF THE ICE AGES

WILLIAM F. TANNER*

The Pleistocene ice age in which we now live has been characterized by fluctuating continental ice sheets. Two of these are still in existence: those on Antarctica and Greenland. Two have vanished temporarily: those on North America and Europe. The existence of a fifth sheet (Asia) is still uncertain. The sizes of these glaciers can be visualized in terms of their effects on the oceans: if the two remaining ice caps were to melt, sea level would rise by about 400 feet; if the two former ones were restored, sea level would drop about 450 feet. At least two, and perhaps as many as five, major glaciations are known from widely-spaced parts of geological time; the most recent one (the Pleistocene) has had four important ice advances and retreats.

A simple geological model can be used to account for the beginning of the current ice age, and a combination geological-meteorological model can be used to explain the fluctuations. These models permit the following predictions: (1) Although only about half of the maximum ice has melted, no additional warming is in sight (that is, we have reached what is essentially the most melting and the highest sea level possible in the present cycle); and (2) The over-all glaciation, although momentarily is an "interglacial phase," has barely gotten started.

Radioactivity dates show that conditions have been shifting, in the general direction of glaciation, throughout much of Cenozoic time. Carbon-14 dates provide a fairly detailed history of the most recent sycle (the Wisconsin) within Pleistocene time. Deglaciation (and sea level rise) began roughly 20,000 years ago, and this change halted about 5,000 years ago. Deglaciation was, however, sporadic, and modern sea level has fluctuated both above and below its present position.

North America and Europe are still "bouncing back" — at measurable rates — as a result of the removal of the load of ice. The ice on North America alone was enough to provide each presently living person on the earth with an individual supply of approximately 25 billion pounds. This quantity of ice provides a good measure of the storage of water necessary, on the continents, during times of lowered sea level.

Pre-Pleistocene

Although there are extremes in both directions, a conservative summary of the glacial history of the earth must contain these two statements:

1. North America has undergone, probably, three major glaciations, at intervals of approximately one billion years (on the radioactivity calendar).

2. Other continents have had quite different glacial histories.

Among the experts, one can find those who hold that only the Pleistocene glaciation (last million years) was real, and that all the earlier ones arise because of our inability to interpret the rocks correctly. On the other hand, there are those who profess to find glacial debris from all eras of history, suggesting that glaciation, on a quickly-recurring basis, is a normal event for our earth. The present writer takes, along with perhaps a large majority of geologists, a middle position. This position—with a few glacial ages at widely-scattered times—forces us to reject any idea that the Pleistocene ice age was unique, the result of long-term cooling of the earth into a perpetually-frozen state such as that of the planet Pluto.

The first widely-accepted glaciation for North America took place about two billion years ago, during the accumulation of Keewatin and Timiskaming rocks, in the Great Lakes area—approximately the locale of the Pleistocene ice age in which we now live. The second widely-accepted glaciation in North America occurred about one billion years ago, during the deposition of Huronian rocks, also in the Great Lakes area. The third widely-accepted glaciation in North America is the Pleistocene ice age.[9]

A number of geologists have reported glacial deposits of late Paleozoic age in North America. The best examples of these may be found in rocks in the Ouachita Mountains, not far from the Oklahoma-Arkansas line. The present writer has examined these supposed tillites, and does not see how they can be assigned a glacial origin. Furthermore, much other available evidence indicates that the climate, at that time, in what is now the Southwestern U.S., was tropical humid.

Glacial debris is, however, known from late Paleozoic rocks of many other continents, specifically South America, Africa, Asia (India), Australia, and Antarctica.[9] We conclude, therefore, that North America has undergone more-or-less cyclic glaciation (about once every billion years), but that other continents may have had different histories. This should not surprise anyone: Africa had no continental ice sheet during the Pleistocene, when North America, Greenland, Europe, and Antarctica were largely covered with ice.

*William F. Tanner is in the Geology Department of Florida State University, Tallahassee, Florida. Paper prepared for the 19th Annual Convention of the American Scientific Affiliation, August 1964, at John Brown University, Siloam Springs, Arkansas.

North America and Asia (excluding India), appear to have had similar glacial histories: both are now close to the North Pole, and both lie on the margin of the Pacific Ocean. South America, Africa, Australia, India, and Antarctica have had similar histories; they are all clustered about the South Pole. Europe's position isn't precisely clear, but its glacial history, over the long term, may have been like that of North America.

Pleistocene

Throughout Cenozoic time, the North American climate has been getting colder. The total drop has been about 20° F, over a period of perhaps 60 or 70 million years.[2] This is probably due to a migration of the poles; or, if you prefer to think of it this way, a migration of North America toward the North Pole.[8] This rather steady temperature drop does not support the popular concept that some important event took place, roughly one million years ago, which brought on the ice age. Rather, we have a history of a slow, long-term change from the sub-tropical conditions of Mesozoic time, through the temperate conditions of most Cenozoic time, into the glacial conditions of the Pleistocene.

Much geological thinking about the great ice age has been colored by the assumption that the advent of glaciation was sudden and unheralded. Hence we have, in the literature, a continuing search for a "key event," such as a major volcanic eruption, designed to put many cubic miles of volcanic dust into the atmosphere, thereby chilling the entire globe. The field evidence, however, supports the notion of a long, slow change, the culmination of which has been the development of four (or perhaps five) major ice areas.

The first of these (Antarctic) probably began to grow in middle Tertiary time, perhaps 30 or 35 million years ago. When it reached full size is not known, but once it did, it probably did not melt again, as did the North American ice sheet. The earliest appearance of a large ice cap in Canada has not been dated. Mountain glaciation, in the western part of the United States, increased more-or-less systematically throughout the Cenozoic, complicated by changes of elevation, in local areas, due to tectonic uplift here and there, or by reduction of mountains by erosion. There is at least a suggestion that a late Tertiary ice sheet existed in Canada, but it could not have been anything like as extensive as later continental glaciers in the same area.

The Pliocene-Pleistocene boundary is commonly drawn at that time when the first of four large sequential ice caps in North America began to expand to continental proportions. As has been stated above, this was essentially the culmination of a long history of gradual chilling. The precise date for this important event is unknown, and, in view of the nature of the growth of a glacier, probably not recoverable.

Traditionally, the Pleistocene has been allotted ap-

proximately 10^6 years and a few geologists have assigned to it two million years. More recently, geologists analyzing deep sea cores have observed that late Pleistocene rates of sedimentation were so fast that the entire epoch might not have lasted more than about 300,000 years.[4] And, even more recently, development of a new radioactivity dating technique[7] has permitted a reworking of Pleistocene history, with the conclusion that the original date is more nearly correct. It should be kept in mind, here, that we actually do not have suitable absolute dates for the Pleistocene: what we have is a set of inferences, which can, of course, be modified somewhat to give variable results.

Osmond's success in dating a Florida reef limestone has provided the basis for a reassessment of ice age history. He obtained a date of 130,000 years for a shallow-water coral reef remnant now about 8 meters above sea level, in the Florida Keys. The question is, What part of Pleistocene time does this date represent? At first glance, it might seem that almost any moment within the Pleistocene could be represented; on reconsideration, however, it becomes highly probable that this date identifies a single, brief part of the total ice age history. To make this clear, we must examine the Pleistocene in considerable detail.

In North America, the great ice age is typically separated into seven divisions: four of these are "glacials" and three are "interglacials." Geologists have given specific names to all seven; however, we can identify them just as accurately by using numbers. That is, we refer to the first glacial, the first interglacial, the second glacial, etc., in terms of the passage of time. Any geologist should be able to understand these terms, even though he doesn't ordinarily use them. Europe has had a similar Pleistocene history.

For approximately 5,000 years, climactic conditions have been almost stable. Although temperature and precipitation have fluctuated somewhat, the quantity of ice locked up in the world's glaciers has remained pretty much the same, and therefore sea level has held almost still.[4] There does not seem to be any evidence that the planet will warm up appreciably in the near future. In fact, most geologists have held either (a) That the Pleistocene is completely over, or (b) That we live in a fourth interglacial, with a fifth glacial still ahead of us. The former position does not seem tenable, in view of the fact that we still have two major ice caps (Antarctica; Greenland). Therefore we adopt the second position, committing ourselves to a prediction that the present interglacial (fourh interglacial) will be followed by a fifth glacial.

The observation that the ice age isn't really over (we still have two ice sheets, which show little or no sign of melting) leads to the suggestion that these two major ice caps are permanent features of the Pleistocene landscape. That is, Pleistocene history has three different aspects:

1. In non-glaciated areas, such as north Africa and the Amazon basin.
2. In permanently-glaciated areas, such as Antarctica and Greenland.
3. In areas where glaciers come and go, such as Canada and northern Europe.

From this analysis, we can move readily into an examination of the behavior of Pleistocene sea levels. Obviously, sea level will stand low when glaciers are well developed, and will stand high when glaciers are missing. Pre-Pleistocene M.S.L. was roughly 100 meters higher than at present. If the Antarctic and Greenland ice caps are "permanent" sea level has not returned to its "original" position during any of the interglacials. Actually, there does not seem to be any field evidence of such a high M.S.L. since the Pleistocene began.

Minimum sea levels, during the ice age, have been close to 130 meters below the present position. That is, the total fluctuation has been about 230 meters, but, since the Pleistocene started, the fluctuation of M.S.L. has been limited to about the lower 130 meters of this range. Present sea level is close to normal interglacial sea level. Hence we can draw the conclusion that the Florida coral (dated as being 130,000 years old), mentioned earlier, represents a former interglacial. The remaining question is, Which of the three available interglacials is represented? The most likely answer is, The latest (i.e., the third).

It is highly probable that corals have flourished in South Florida during each interglacial, when coastal waters were relatively warm, as they are now. However, high-level coral ridges which were built during the first interglacial would be severely eroded during the second glacial, when sea level was lowered and hill-side slopes were therefore steep. And during the second interglacial, remnants of these old coral ridges would be subjected to wave attack as well as to encrustration and burial by later growths. Modern (i.e., fourth interglacial) corals cover perhaps 100 to 1,000 times as much area as do all other interglacial corals. If we extend this ratio backwards into time, and use the conservative end of the range, we can postulate the following:

Modern corals	98.9899%
Third interglacial	1.0000%
Second interglacial	0.0100%
First interglacial	0.0001%

which is also an estimate of the probabilities. We therefore adopt the tentative conclusion that the 130,000 year figure represents the third interglacial. On this basis, the entire Pleistocene has continued for a period of time which falls somewhere between a minimum of about 600,000 and a maximum of 900,000 years. More detailed theoretical work, using a method which cannot be presented in the brief time available here, indicates that the longer end of the range may be more likely than the shorter. These results are in rough agreement with a chronology worked out from North Atlantic sea bottom cores.[3]

Regardless of our success in dating the Pleistocene, we have enough information from previous periods to know that North America has been undergoing systematic cooling for perhaps the last 100 million years. The ice cap in the vicinity of the South Pole was probably initiated some tens of millions of years ago. The Pleistocene, then, is the last half-million, or last million, years of a much longer history of dropping temperatures. On the basis of long-term trends alone, and suppressing later fluctuations which do not appear to have altered these trends, we can venture the opinion that even colder weather lies ahead of us.

Wisconsin

The fourth, and most recent, glaciation, was the Wisconsin. The fourth, and current, interglacial, is commonly designated as the Recent. Using C^{14} dates which are now available, it is possible to construct a fairly detailed history of late Wisconsin and Recent times. Glaciation was widespread (in the Wisconsin) up to about 20,000 years ago. Shortly thereafter, melting began. This continued, with a single important interruption, for about 15,000 years. The interruption, characterized by an ice advance in the Great Lakes area, occurred about 10,000 years ago. Melting was essentially over roughly 5,000 years ago, and sea level was within a meter or two of its present position. The great American and European ice caps had vanished completely.[4]

The interval from about 20,000 to about 5,000 years ago was the time of transition from the Wisconsin to the Recent. If we choose to draw the Wisconsin-Recent boundary at the time when the last part of the continental glacier melted, then this transition must be placed entirely in the Wisconsin glacial. Many older geologists would, however, put the transition entirely in the Recent.

The transition interval was a time of rising sea level, on a world-wide basis. During this time, M.S.L. went up by about 130 meters, or at an average rate of close to one centimeter per year. There were, however, short, sharp, fluctuations, some of which may have achieved rates as high as 10, or 100, cm per year. One of these fluctuations, affecting all of the coastal low-lands of the world, coupled with an unusually wet, stormy season and perhaps violent coastal erosion, is the best which the geologist can produce in an effort to match the Noachian deluge.[10]

In the United States, Wisconsin time was characterized by relatively low temperatures and high precipitation. As a rule of thumb, we can estimate that Wisconsin temperatures were about 10° F colder than those we know today[5] and rainfall was about two-to-four times as great. Southwestern states such as Texas were well vegetated (more rainfall), Florida was much bigger (lower sea level), and northeastern states were uninhabitable (covered with ice). The big climatic change, into the Recent, has been a tendency toward higher temperatures and reduced precipitation. We cannot, however, peg temperature and rainfall directly to the amount of ice. That is, we cannot say: Glacial, and hence wetter; or, conversely, Interglacial, and hence drier. This is because the feedback between glacier and climate is so complex that it would be quite possible to have either an increase or a decrease in precipitation correlated with any particular temperature change which might develop. Trying to understand the ice age snow budget strictly on the basis of a single parameter such as rainfall would be much more difficult than trying to understand your bank balance strictly on the basis of a single parameter such as deposits. Withdrawals might also affect the balance; you could, conceivably, either increase or decrease withdrawals, and yet get either an increase or a decrease in the balance. Despite this uncertainty, we can say, in general, that Recent time has been warmer and drier than was the Wisconsin, and that any future glaciation (in the present sequence) will be accompanied by lower temperatures and greater rainfall.

The chronology upon which this section is based has been obtained from C^{14} dates. Up until fairly recently, no radioactivity dates at all had been available for Pleistocene time. The Wisconsin chronology which was widely published a couple of decades ago was based largely on varve counts. The varve chronology, as published, is quite different from the C^{14} calendar.

Varves are thin couplets of sedimentary materials, deposited in meltwater or pro-glacial lakes. Each couplet consists of a coarse layer (silt) and a fine layer (clay). The coarse layer grades gradually upward into the finer layer; this couplet is separated from adjacent pairs by sharply-defined lines. In general, each set of two layers represents one year of deposition. The coarse layer is a summer deposit, when meltwater carries silt and perhaps even sand. The fine layer is a winter deposit, when clay particles settle out of suspension. Individual varves have thicknesses which, commonly, can be recognized in distinct, but near-by, lake deposits. That is, the varves in one lake can be matched, in many instances, with those in another lake roughly one kilometer away. If a sequence of varves can be identified in the sediments of one lake, and then matched in nearby lake deposits, one of the two sites probably extends into more ancient times, and hence the combined sequence may stretch over more than the span found in either one. Correlation with a third site may very well extend the sequence even more, toward either the present or the past.[5]

By making varve counts at geographic intervals of about one km, DeGeer was able to work out a fairly accurate chronology of late-glacial events in Sweden. Deglaciation, in that area, covered about 8,000 years, in the first study; later study added 8,700 years of post-glacial history, but did not bring the sequence down to historical times. The total period covered was 16,700 years, somewhat less than the 20,000 available (according to the C^{14} scale). Furthermore, the sequence was *not* continuous; there were several gaps, as DeGeer and his students moved from place to place,

where they were unable to correlate varves, and had to substitute estimates based on their general understanding of Pleistocene history.[5] (p. 394)

Antevs has been the leading proponent of varve-counting in North America. His early studies led him to the conclusion that the time elapsed since the ice sheet disappeared "can not even be estimated" with any degree of reliability. Later he estimated 28,000 years for the retreat of ice from Long Island to an important point in Ontario, and 12,000 additional years since then, making 40,000 years since the Wisconsin ice sheet began to melt. This is the chronology that many American geologists had accepted before the advent of C^{14} dating. Unfortunately, only 19,000 couplets were actually studied in the field; the other 21,000 "couplets" were interpolated in three big gaps, 80, 180, and 290 km wide. There was also at least one smaller gap.[5] (p. 396) This means that the 19,000 counts were made in 5 different (and uncorrelated) areas; hence the total elapsed time might be as small as 4,000 years.

In addition, there are two other complicating factors: there was no absolute date to tie the varve sequence to, and there is ample evidence that (during the stormy years), more than a single couplet may accumulate in one 12-month period. In other words, Antevs' total apparently needed reducing below the 19,000 actual count, and the reduced figure needed to be "anchored" to some known event. Even without any reduction, however, it should be noted that 19,000 is not as much as the 20,000 provided from C^{14} dates.

On the other hand, there is strong evidence to support the observation that ice appears to have been present over the site of Boston about 13,000 years ago.[6]

In general, Wisconsin time is considered to have included two major glacial episodes, with a brief warming trend between. C^{14} dates provide details for the melting of the second of the Wisconsin glaciers. According to the C^{14} calendar, this melting occurred largely between 20 and 10 thousand years ago, for North America, with some other melting, perhaps elsewhere, accounting for a slow rise of M.S.L. until about 5,000 years ago. The varve record can be made to conflict with this, but does not necessarily do so.

Summary

North America appears to have undergone approximately three major glaciations, at intervals of about one billion years. This is not the glacial history of some other continents, such as Africa, Australia, and South America, which have had important ice caps at other times. In general, this pattern of on-again, off-again glaciation, ever since there was enough water at the surface to form extensive ice sheets, does not support the theory of a gradually cooling earth. Instead, wide-spread ice cover seems to be due to the operation of some more-or-less regular (but perhaps complicated) mechanism on the earth itself. The ability of this mechanism, which must be very delicately adjusted, to produce successive ice ages over an interval of several billion years, indicates that the general temperature of the air has not fluctuated greatly during that time.

The most recent ice age is the Pleistocene. It is the culmination of a cooling trend, particularly in North America, which began (perhaps) in the Cretaceous period of the Mesozoic era, roughly 100 million years ago. This cooling produced mountain glaciers in the Rocky Mountains at various times since then, and may have been responsible for a succession of small continental ice sheets, in Canada, of which we no longer have any record. The Pleistocene started not more than 2 million years ago, nor less than about 300,000 years ago. A "best guess" is somewhere between 600,000 and 900,000 years ago. Earlier glaciations were pre-Pleistocene. As North America cooled, and glaciers began to form, sea level dropped. By middle Tertiary time, some 30 million years ago, an Antarctic ice cap had been formed. It is unlikely that sea level has returned fully to "normal" at any time since.

If we count the present as the fourth interglacial, the Pleistocene can be subdivided into four glacials and four interglacials. This statement presupposes that a fifth glacial lies ahead of us. All of the systematic (i.e., not *ad hoc*) hypotheses for the cause of the ice age require additional glaciations yet to come.

The present (i.e., fourth) interglacial is representative of the previous three, as far as temperature, rainfall, and sea level are concerned. It is unlikely that sea level has stood much higher than it does now, at any time during the Pleistocene. Although it may rise a few meters more, practically all of the evidence suggests that the next major change will be a drop, some time in the next few thousands or tens of thousands of years.

The fourth, or Wisconsin, glacial, was terminated by a melting which lasted, roughly, from 20 to about 5 thousand years ago. Noah's flood was, apparently, one event in that history of deglaciation. For the most recent 5,000 years, world wide temperatures have fluctuated only modestly, and sea level has remained within a meter or two of one position. All of well-known human history has taken place since melting reached a minimum and sea level has become fairly well stabilized. Melting today is on the order of some tens of cubic miles per year, which is negligible when spread over the surface of the ocean. Up until the last few years, at least, the climatic trend has been one of almost imperceptible warming; this can be expected to continue, with minor reversals, for some time yet.

REFERENCES

1. Arnold, J. R., *Nuclear Geology* (edited by Henry Faul), John Wiley and Sons, New York, 349-354, 1954.

2. Clark, Thomas H., and C. W. Stearn, *The Geological Evolution of North America*, Ronald Press, New York, 1960, p. 273.

3. Ericson, David B., Maurice Ewing, Goesta Wollin, and Bruce C. Heezen, "Atlantic deep-sea sediment cores," *Bulletin, the Geological Society of America*, 72, 193-286, 1961.

4. Fairbridge, Rhodes, *Physics and Chemistry of the Earth IV* (edited by L. H. Ahrens, Frank Press, K. Rankama, and S. K. Runcorn), Pergamon Press, New York, 99-185, 1961.

5. Flint, Richard F., *Glacial Geology and the Pleistocene Epoch*, John Wiley and Sons, New York, 1947.

6. Kaye, Clifford A., and Elso Barghoorn, "Late Quaternary sea-level change and crustal rise at Boston, Massachusetts, with notes on the autocompaction of peat," *Bulletin, Geological Society of America*, 75, 63-80, 1964.

7. Osmond, John Kenneth, personal communication, 1964.

8. Runcorn, S. K., *Continental Drift*, Academic Press, New York, 1-40, 1962.

9. Schwarzbach, Martin, *Climates of the Past*, D. Van Nostrand Co., Princeton, N.J., 1963.

10. Tanner, W. F., "Geology and the Great Flood," *Journal, American Scientific Affiliation*, 13, 117-119, 1961.

Continued from page 99

Man's desire to reach the Moon is a symptom of his spiritual condition, his spiritual immaturity perhaps. He seeks authentication of his divine nature and origin beyond the borders of his planet. Else why look for evidence of life? Why so much stress on other forms or evidence of life on the Moon or nearby terrestrial planets? Perhaps, the theologian has failed to relate God to man and man's inner yearnings. Perhaps the astronaut/scientist must in the end provide this link.

The classic theologian states that the purpose of life on Earth is to worship God. Some who are not theologians say that man's purpose is to learn as much as he can about the Universe and to thrill to the wonders that he finds.

Man, of all the animals, is the only one who can think and admire the glories which surround him. The more man knows, the more human he becomes. Thus for man to become more human he must constantly press forward beyond the frontiers of his knowledge. The purpose of man is to explore both himself and the physical Universe and extend his control and understanding over the forces and materials of nature.

What will evidence of life, human or otherwise, do to spiritual beliefs, and if it is not found will his spiritual beliefs be eroded or sustained? Will man retire to his laboratory to "create" his own image? Will he seek to find relevance in his technical achievements or will the theologian be able to interpret man's deepest yearnings to a culture already becoming blase about space travel. (The corned beef sandwich consumed by Grissom on a recent Gemini flight is symptomatic of the ho-hum attitude held by many, even, those very close to space activities.)

We must ask ourselves why is it that the theologians have been so reluctant to express an opinion on these matters. One heard, years ago at the beginning of manned space ventures, a modicum of verbalization by the clergy, mostly regarding man's "right" to space ventures, or lack thereof. Both the philosopher and sociologist have been strangely silent on this point. The lack of expression may represent a reluctance to express an opinion or an inability to articulate our own dissatisfactions. This is not merely an academic question, but one which is fundamental to all fields of human endeavor including the philosopher, theologian or scientist. Herein lies the great difficulty. One must first be willing to accept a divine creation of both Earth and man before one can accept a spiritual motive to man's space exploration programs.

Colonization of the Moon, or Mars for that matter, must not be just another escape valve for an exploding population. It must not be another glorification of man and his technical achievements. Nor must it be permitted to become a substitute for theological meaning and spiritual expression in our day. Rather, it must, it seems to me, be an extension of the revelation of God to man and a tribute to God's creative genius. It must cause man to ask again the question which has echoed and re-echoed down through the long corridors of time—What is man that thou art mindful of Him?

Thus man's space ventures must not result in glorification of man, but glorification of God, not in praise of man, but in praise of God who made man, not in honor to man or men involved in this venture but in honor to God who created man a little lower than the angels, made man in His own image and set him on Earth to have dominion over it. It is concluded that man will find new spiritual expression and understanding in the space age. New sensitivity to both cultural and spiritual influences may demonstrate that the greatest achievements in the space age will not be scientific but spiritual.

REFERENCES

1. Barre, R. L., "The Human Implications of Space Activities," Paper presented to the 1st Annual Meeting, American Institute of Aeronautics and Astronautics, Washington, D.C., 1964.

2. Cole, D. M., "Have We One Good Reason to Colonize Outer Space?" *Missiles and Rockets*, May 24, 1961, pp. 86-91.

3. *Outer Space: Prospects for Man and Society*, L. Bloomfield, Editor. The American Assembly, Columbia University, Prentice Hall, 1962, pp. 60-61.

Continued from page 108

So to use Kuiper's own words, truly this is a simple theory. The interdependence of the numerous subproblems makes the subject one of unusual fascination. One great surprise of course is that the planetary distances have changed so little during 3 billion years.

It is also most gratifying that this process of planetary formation is but a special case of the universal process of binary-star formation, which seems to be one of God's universal Laws. Also it is satisfying to realize that there are probably a billion systems like our own in our galaxy alone, not to mention the myriads of other extra galactic systems. The probability of the formation of such a system by this process is 100 million times the probability of formation by an approach or collision.

Truly God is in his Universe, and all will be right with the World. Thank you.

SOME LOGICAL PROBLEMS WITH THE THESIS OF APPARENT AGE

THOMAS H. LEITH*

This paper examines the assumption that it is logically possible that the knowable universe began with the appearance of an age greater than its actual age. While the assumption is considered to be understandable syntactically it is considered to be absurd. The criterion of absurdity is that no statement can be scientifically sensible when all pertinent possible evidence must fail either to corroborate or falsify that statement. The more complex Whitcomb-Morris thesis is then examined and criticized in the light of the above criterion. It is concluded that their hypothesis fails on the above criterion and that any non-scientific arguments introduced to escape this impasse are rational improbabilities.

This brief paper purposes to point up certain difficulties with a hypothesis at least as old as Gosse's *Omphalos* and experiencing a certain renaissance in some quarters. In its crudest form the theory may be found in a well-known remark by Bertrand Russell: "There is no logical impossibility in the hypothesis that the earth sprang into being five minutes ago, exactly as it then was, with a population that 'remembered' a wholly unreal past."[1] It is the assumption that the thesis is logically possible which the present writer takes to require careful exploration, for if the assumption is in error or even unclear the thesis may really carry many unwelcome concommitants for its advocates.

Lest someone complain that Russell's statement has certain inadequacies linguistically or in scope, let us restate the hypothesis in a quite general fashion which we shall take to be sufficient for much of our subsequent analysis: "There is no logical impossibility in the hypothesis that the knowable universe began with the appearance of considerable age at some time rather more recent than this apparent age." This statement avoids talking of the entire universe, if such is assumed to have greater spatio - temporal extent than any potentially discoverable portion of it, and it does not specify any bounds as to what is 'considerable' nor how far short of this the real age is taken to be. It leaves all questions of how the knowable universe began quite open so as not to prejudice the case in that regard, though it is a matter to which we must return. Finally, it leaves no room for the actual age to be discovered by comparison with anything physically external to what is being discussed.

Now it is not immediately apparent that this thesis regarding apparent age is logically possible as claimed. However much such statements are offered, and they are not infrequent across the range from Russell to fundamentalists, there is amazingly little clear defense of their claim. It is our argument that an examination of the major thesis will show that it is in fact *not* logically possible at all but rather that it is logically absurd.[2] Let us see just why, by examining such defence as the writer has seen offered.

The defence appears to take two modes, one implicit and the other explicit. The former is a claim that if the words have a sufficiently clear meaning and if the structure of the statement expressing the hypothesis is syntactically sound then, since we can understand what is being said, the entire thesis must be a logical possibility. However, while we may grant that the thesis is sufficiently understandable to enable us to see that it does not suffer from self-contradiction, is this enough to force us to grace it with logical possibility? Some might say that it is, but surely we can then ask them whether they would accept an in-

* Thomas H. Leith is Associate Professor of Natural Science, York University, Toronto, Ontario. Paper prepared for the 19th Annual Convention of the American Scientific Affiliation, August, 1964, at John Brown University, Siloam Springs, Arkansas.

ternally consistent statement which was inherently devoid of ever having any evidence in its favor or against it as still a logical possibility. Notice that we are not asking that the possibility of the statement rest on whether we are clever enough or diligent enough to find evidence for or against it and, far more important, we are not saying that its logical possibility rests on whether the universe is so constructed as to hide or destroy the evidence we need for all present and future time. We are instead saying that these matters are irrelevant here; that as soon as we comprehend the statement we see that it is logically impossible for us to corroborate or falsify it by virtue of, and this is quite sufficient, the logical requirements placed by it upon all evidence required for corroboration or falsification.

Just why this is so becomes clear when the explicit defence is examined. Since we began with a quotation from Russell we might continue the same quotation here, for it represents the sort of negative defence usually offered. Says Russell, "There is no logically necessary connection between events at different times; therefore nothing that is now or will happen in the future can disprove the hypothesis that the world began five minutes ago." We shall, therefore, never be able to falsify the thesis. But it is crucial that we cannot corroborate it either. Let us quote again from Russell, writing many years later: "If the whole world came into existence then (i.e., five minutes ago), just as it then was, there will never be anything to prove that it did not exist earlier; in fact, all the evidence that we now have in favour of its having existed earlier, we should then have."[3] It is what Russell does not notice here, that the same evidence must always both fail to corroborate and to falsify even though it is pertinent evidence and should therefore do one or the other, which lead us to believe that there is something radically wrong with what Russell thinks he is defending. Our restatement of his hypothesis is in no better a situation.

We have claimed, for the sake of argument, that it is logically possible for the knowable universe to have an apparent age indefinitely greater than its actual age. The only experiential data which we have left ourselves are the facts of the knowable universe. Now, if we follow Russell we must claim that this data can neither falsify the thesis that the knowable universe has an actual age less than its apparent age nor corroborate the same thesis. This writer believes that any thesis leading to such an impasse solely by virtue of its logical structure, must be considered irrational and without those attributes requisite to anything worthy of being called a hypothesis.

Perhaps another approach will make our point even clearer. To be a hypothesis it must be logically possible for something to serve as evidence for that hypothesis or against it. But look at our suggested candidate for this status: The knowable universe began with an apparent age considerably greater than its actual age. Unable to compare the knowable universe with anything outside of itself we discover that we have no standard of an empirical sort by which to test the hypothesis. If we want to defend the idea that something has gotten larger we cannot do so while maintaining that everything has grown in proportion and at the same rate. All relative sizes would remain constant: we have so constructed our problem that no evidence for or against the idea of something growing can ever be found. Likewise, if we want to defend the idea that something is younger than it appears, we cannot do so if we simultaneously claim that everything of the same maximum real age appears older by the same amount. We can find absolutely nothing, even if our search is exhaustive over the entire knowable universe, which can show us that the real and the apparent ages are different. An apparent age, indeed a universally apparent age for things at least as old as the presumed real age, will be the only age we can find. The presumed real age is just that; it is a presumptuous guess lacking any possible evidence.

Can we avoid our conclusion that our hypothesis of apparent age is logically impossible? We have already mentioned the idea that whatever can be seen to be without internal contradiction is logically possible and concluded that while this is a necessary condition it is not sufficient. We must ask also that some investigation of the facts covered by the thesis be relevant to testing it. It need not actually be investigated, but we must be able to imagine such a procedure being performed. Our suggested hypothesis *a priori* shows this to be an impossibility, not because we lack imagination but because the logic of our hypothesis precludes our ever imagining a test however long we wait and however clever we might be (even to the point of knowing all that is knowable from studying the universe). We may then persist in our hypothesis only by denying the relevance of this additional condition.

To do so would require breaking up our hypothesis into two distinct sorts of parts. There is no doubt the hypothesis can be broken for it makes two claims: the knowable universe began at some actual date (— t^1) *and* at that time its apparent age (— t^2) was considerably greater than its actual age. Such a conjunctive statement can be true only if both of its parts are true but can be false if either of its components, or both, are false. We have already seen that the truth or falsity of the second portion of the statement is logically unknowable if based upon any study of the facts upon which it bears; experience of the knowable universe must forever give us nothing but the apparent age. Consequently the entire statement is a logical impossibility which can be avoided solely by retaining only the first part of the conjunction, i.e. 'the knowable universe began at some actual date (— t^1)', and recognizing it as having a truth or falsity based on something other than empirical study which must always give us as its conclusion an 'actual age' which is not that above.

A few special cases which may come to mind as variants of our original hypothesis do not vitiate this conclusion. In one trivial case we might suggest that the knowable universe began with no built-in age. Any study of it will give only its actual age. However, to say this is not to avoid the fact that experience of the knowable universe can never show us that our suggestion is tenable not because, to make ourselves quite clear, we haven't explored it all or may make mistakes but because any evidence is logically excluded from the start. Something else must then be the source of our suggestion that the actual age and the age given by experience are the same.

Another more interesting case occurs if we suggest that in the beginning things had all the same apparent built-in age and not just, as we have implied up to this point, a variety of different apparent ages converging upon some maximum given by some parts of the knowable universe which began with the greatest built-in antiquity. We could then have a situation in which a sizeable body of data might seem to indicate an age of, let us say, ten billion years and another body of data indicating all sorts of ages up to ten thousand years ago where this date is the actual age of the knowable universe and the latter body of data covers those things beginning since that time and beginning without any age built into them. Were such a situation to occur we would, as scientists, report a universe in which nothing seemed to have an age between ten thousand and ten billion years, but would we then conclude that only the former limit was actual and that the latter was only an apparent but unreal age? To do so would be to go beyond the data in which both sets of dates are equally 'actual' as far as observation goes and to commit the blunder that it is logically possible to talk of the truth or falsity of a proposal that the ten billion-year-old things have only the appearance of antiquity and are all actually ten thousand years of age.

Of course we would take this data as suggesting an odd universe; one in which all processes of physical nature ceased for a very long interval only to take on the character we may now see them to have ten thousand years ago. It would be just as much beyond scientific possibilities of discussion to explain the sudden and recent initiation of physical processes as to explain the much earlier origin of many things. Advocates of most models in cosmology, those implying an initial origin to all the elements from which later things are made as well as those calling for a continuing origin of new material since then (or even those who plead for an endless series of continuing origins into the past), live with the same sort of problems today There are lots of subtle logical issues involved in talk of origins of any kind and we will make no effort to resolve them here. But all *scientific* talk leading to a first moment for anything must be based upon extrapolations from pertinent present data and processes using certain cosmological principles. Such talk would have an interesting character for the odd universe suggested above, and we hesitate to say what it would be like, but it would *not* involve itself in matters lying beyond the possibility of testing.

Lest all of our discussion be taken as rather artificial let us turn for a few moments to a contemporary example of an 'apparent age' thesis, that of Whitcomb and Morris[4]. Their variant is not easy to tie down since it seems to involve considering the earth and the universe to begin with an appearance of age far greater than what is actual[5] and it also involves a later fundamental change in the character of much of the earth's surface and in at least some of the operative laws together with a change in the rates at which all of these laws proceed.[6] On the assumption that the writer has correctly interpreted their position, does it suffer from the logical impossibility which we have been discussing?

Let us look first at the apparent age of the earth and the universe which we shall take to be whatever future science, operating on the same basic criteria as at present, comes up with. It is useless to make any other assumption since we are not prophets. Morris and Whitcomb take two tacks here; they raise various technical issues with current estimates of this apparent age so as to show it cannot now suggest the actual age and they claim that its actual age can be shown to differ from the apparent estimates on grounds prior to any scientific study of the earth and the universe. With the first of these we need not raise quibbles. Certainly, there was a time when the earth, or at least our galaxy, seemed too old for the models of the universe popular at the time. Even if we take this problem to be resolved at present, estimates of the age of the universe as we know it do vary as do those for the earth to a lesser degree. This is a trivial matter for our purposes, unless we assume that no widely—acceptable 'apparent' age will *ever* be obtained, for in that case science must remain silent on the matter. If Morris and Whitcomb want to conclude that, are they asking us to go on to the conclusion that if we can't agree on an empirical age we must conclude that the actual age is much less? If our earlier discussion has been fruitful we must see not only that this is a non-sequitur but that the conclusion is itself a logical impossibility as we have defined that term.

Of course, they do talk about entropy and its inability to cover the beginning of a universe, as they conceive that universe, in a manner rather like Abbé Lemaitre[7]. But as Lemaitre sees clearly, and Morris and Whitcomb should, this simply places the discussion of origins beyond scientific analysis. It does not require that the universe begin with a built-in age because initial orderliness, if that is desired, carries with it no indication that some past time appears to be present unless we assume what they deny, namely that entropic processes go on beyond the orderly state discussed so that we can discuss how it got that way and can give meaning to the direction of time in that prior period. Entropy then is no help in making tes-

table the distinction between actual and apparent age for the earliest universe.

Morris and Whitcomb may then fall back on the assumption that scientific conclusions in this area must always fail to give the correct age known on other grounds. This of course takes the matter outside of the area of our past discussion. It asks for a new definition of logical possibility unrestricted by the limits we have given it. There is no need to argue here whether their assumption is meaningful; such a debate about stipulative definitions might be fruitful (many philosophers are much exercised by it), but surely we can grant that logical possibility as we have defined it does not exhaust meaning. If so, to say 'the knowable universe began at (such and such) a date and its actual age is rather less than its apparent age' might well be meaningful though the latter portion is logically untestable under any and all physical attempts to verify the distinction or falsify it and the former portion must either be the apparent age, if it is to make scientific sense, or be based on some other source of information than scientific study. Certainly we can imagine deity knowing such things and even letting us in on the information, but if we claim to have this knowledge we must recognize that it is not meaningful within any present or future science (it is there logically impossible), that it just might be an erroneous claim, and that it is surely a weird world in which we live when one portion of its study is doomed to error as long as this portion is studied scientifically!

Let us turn finally to the Morris-Whitcomb argument that the earth's topography suffered a fundamental change at some date after its origin and that the operative laws were at least partially altered and the rates of action of all laws affected. The new feature in this is the rejection of uniformitarian extrapolations across this period of fundamental change because they do not take this period as actual. Formerly we had an argument wherein young things were made initially in the image of antiquity; now we have a thesis wherein the earth, which had this initial apparent old age, suffers catastrophic change in its appearance and processes so as to destroy (presumably) much of even this apparent built-in age. It is replaced, to this extent anyway, by yet another apparent age as calculated on uniformitarian grounds from present rates of change in the earth's appearance.

It is important to remember that uniformitarians are generally not opposed to theories calling for changes in the rate of various geological or biological processes if they see any good reason for them and if there are some fundamental processes (say those of physics and chemistry) which remain constant and thus provide a standard against which change in other rates can be measured and an explanation for these changes sought. Indeed, in some cosmological schemes, certain constants of even physical laws become variables, but here too a particular cosmological model is kept as an explanation and control as long as the model has evidence in its favor unaffected by this procedure. Whitcomb and Morris avow that they are not uniformitarians if it means the denial of a period of fundamental change during the earth's physical history. However, if there is such a period few uniformitarians will deny it as long as Whitcomb and Morris, or someone else, can give them empirical evidence. This demands providing a standard against which changes in this period can be compared.

Whitcomb and Morris assay to provide the evidence by pointing out what they see to be inconsistencies within the usual geological schemes and by offering a more consistent alternative. At both tasks many people find them thoroughly unsatisfying, but Whitcomb and Morris would likely put that down to these people's prejudiced geological training. Apart from the odd logical position into which this puts such a critique (it begs the question), this seems to accuse one of providing only *ad hoc* resolutions to the inconsistencies which the two men find, be these imaginary or real. The appropriate rebuttal is to show either that the inconsistencies are not really there or to show that the resolutions are not *ad hoc,* that is, that they have other empirical warrant than that which they seek to resolve. The writer is quite satisfied that both forms of rebuttal are quite feasible in the case of the Morris-Whitcomb thesis.

But there is a more serious problem than this. One might well have rivers erode, mountains form, and continents grow faster at one time than another with no change in fundamental laws. If, however, the laws change in kind or their constants change in size, Morris and Whitcomb must show us how they know this empirically. They do not: instead, they will likely respond 'but it is a sort of miracle'. We must never overlook the fact, however, that nothing will ever be taken to be a miracle, whether it is or not, unless it is very unusual. If Lazarus rose from the dead, it was taken as a miracle because people saw what doesn't normally occur. It is then necessary for Morris and Whitcomb to show us that these odd changes in the regularities we call 'laws of nature' occurred.

While on the subject of Lazarus we might point out that it is not an analogy in another sense. Let us suppose that we claim that Lazarus rose from being dead for three days but that the most careful later analysis of his body could show no sign of the event. Let us also assume that this is taken by someone as an analogy to the odd hiatus in the events of terrestrial nature so that they reply to our criticism above by saying, 'There need be no later experimental evidence of the occurrence of this hiatus'. There is a serious flaw here. If there is to be any empirical knowledge of the period of Lazarus' death it must arise from direct or reported observation under the limiting conditions above. Similarly, this is the only ground we would have for the hiatus in terrestrial processes claimed by Morris and Whitcomb. Some sort of history by an

observer would therefore be required to pass the information on to us.

Let us agree that we might have a history which *might* contain the required account. It becomes critical now to show that it *does* in fact, with a high degree of probability, contain what we wish. Showing this involves, the writer takes it, three things. Firstly the history must seem clearly to say that the hiatus occurred and had the nature we have given it. Secondly, the history must have the ring of authenticity. The writer will grant the second but deeply questions the first. Neither matter need delay us here, for there is a third requirement.

This requirement is that, if the history claims to be the authentic and coherent word of God, the character of God, His relationship to His creation, and the role of man in creation must be consistent with any interpretation which we give an isolated passage or set of passages. Thus, if we claim to find the account of the record of some miraculous and profound intervention into geology, biology, meteorology and their laws (and, we might add, for completeness, of an earth or knowable universe made with the appearance of age) it must be consistent with the above factors. The writer feels, frankly, that it is not, and the only tenable alternatives are to reject the first or second requirement in the paragraph above. He prefers to reject the first.

Why does he feel this way? First, because if science must err in as many areas as Whitcomb and Morris imply one wonders why we should remain scientists and of what use it is as an aid to better knowing the Creator. Secondly, one wonders what happens if the revelation of God fails to give us information excluded by their thesis from the purview of science. And, thirdly, one wonders why deity should be so malevolent (like a Cartesian demon) as to fool us on such interesting matters as much of the history of past events and the possible ages of many things, especially when it is the sort of delusion from which we poor mortals cannot escape! The writer must conclude that Morris and Whitcomb and those like them, where they are not talking logical impossibilities, are involved in these rational improbabilities. The philosophical atmosphere is indeed unhealthy.

1. *The Analysis of Mind*, Allen & Unwin, 1921, pp. 159-160.

2. We have found Marcus Singer's fine paper, "Meaning, Memory, and the Moment of Creation", *Arist. Soc. Proc.*, 1962-63, pp. 187-202 so much in sympathy with our own thoughts that we have made use of a number of his suggestions.

3. *Human Knowledge: Its Scope and Limits*, Allen & Unwin, 1948, p. 228.

4. H. M. Morris & T. C. Whitcomb, Jr., *The Genesis Flood*, Pres. & Reformed, 1961 and H. M. Morris, *The Twilight of Evolution*, Baker, 1964.

5. *The Genesis Flood*, pp. 215, 218-19, 232-33, 368-370.

6. *Ibid.*, pp. 200-211.

7. See his *The Primeval Atom*, Van Nostrand, 1950 and his "The Primeval Atom Hypothesis" in R. Stoops (ed.), *La Structure et l'evolution de l'univers*, Solvay Institute, Brussels, 1958. Morris & Whitcomb discuss their position in *The Genesis Flood*, pp. 222-224.

BOOK REVIEWS

MAN AND SCIENCE

by W. Heitler, F.R.S.

Translated by R. Schlapp

Basic Books, Inc.,

New York, 1963.

In this book a celebrated quantum physicist speaks out against the tendency of many scientists, especially in the non-exact sciences, to espouse a spiritually deadly world philosophy based on the principle of determinism, with a mistaken belief that it is supported by the successes of the exact sciences.

Dr. Heitler writes with passion and in attacking materialism follows arguments and utilizes terms which will please (not intentionally) many Christian ministers and offend many professional philosophers because they are not intermeshed with hair-splitting philosophical points. The latter situation is no deterrent to many physicists, amateurish in philosophy, who feel constrained to speak out at the misuse of some of the fruits of physics as an exact science in the construction and support of world-view philosophies (materialistic or not).

Heitler's main complaint is directed toward those biologists and social scientists who use "methods and modes of thought originally derived from the exact sciences and then transferred to something completely different, such as human relations." Thus it is Heitler's belief that the sciences of living things, in order to make progress, must not try to emulate physics (as has been the fad in this century) but must be willing to include new concepts nonderivable from physics, which may even be called non-materialistic and which suggest research along "teleological" lines. The introduction of the term "teleological" may seem to be a throw-back to pre-Galilean or scholastic natural philosophy but Heitler feels that an acceptance of such a term is mandatory in the life sciences because these relate more to the whole of life whereas in the physical sciences there was no necessity for such a term since they are more abstract and indeed it is considered to be a hindrance of the early development of physics. Thus Heitler feels that science must present a dual or complementary picture of nature, partly physical and quantitative, and partly non-physical and non-quantitative if apparent truths such as the existence of realities outside of quantitative science, the wholeness of living bodies, and reverence for life are to be preserved. This complementary view is shared by a number of outspoken physicists including Bohr and Born who believe all experience must be divided into two categories instead of trying to derive one all-embracing world-view. (cf. Max Born, "Natural Philosophy of Cause and Chance," Oxford Press, 1949—a much more technical and mathematical treatment leading to views similar to Heitler).

In presenting his thesis Heitler reviews interesting and pertinent historical events such as the opposing nature of the planetary theories of Kepler and Newton, the controversy of Goethe and Newton on the doctrine of colours, the limitations of physics as an abstraction, and quantum mechanics and its principles of complementarity or uncertainty. Although disclaiming any personal religious motivations, he concludes that evolution does not depend on chance, that there exists an intelligent extra-human being or principle, and that science as partial truth claiming to be the whole truth is immoral.

I believe this book ought to be comforting to most Christians and acceptable to most physicists, excepting doctrinaire logical positivists, who from a prejudiced self-view, are professionally expert in a very narrow field of knowledge but are humbled by an awareness of this narrowness and associated limitations and expect no similar or comparable coherent and abstract view to evolve in biology. Logical positivists, however, may share his exasperation with those who despite limitations in extrapolation to large time and distance, blithely predict the number of planets with intelligent beings without any possibility of meaningful contact through communication because of the enormous distances involved. These questions, considered meaningless by Heitler, are studied with great passion by some who avoid with disdain consideration of "meaningless" spiritual questions. The reaction of professional philosophers and life scientists is apt to be more critical but, in the mind of the reviewer, is unlikely to seriously disturb Heitler who should feel that he has answered the question of an Indian student who asked "how can we prevent this materialistic science, which we need so sorely, from at the same time destroying our spiritual life?" —Reviewed by *Dr. John Osepchuk, Principal Research Engineer, Raytheon Co., Waltham, Mass.*

EVOLUTION AND CHRISTIANS

by Philip G. Fothergill
Longmans, Green and Co. Ltd.,
1961, 395 pp.

This intriguing volume of 395 pages "is written for Christians who are interested in the biological theory of evolution and its implications. I have written as a Roman Catholic and hence my information—has been mostly obtained from Catholic sources." As permitted by his church, Dr. Fothergil closely examines evolution and, in general accepts it, harmonizing it, as he goes along, with standard church dogma. He points out the many assumptions upon which evolution is based and deals at length, here and there, with some objections. As he says, the theory is clearly proven at the species and genus level but at the higher levels, evidence is mosIty lacking and the matter becomes correlated with extrapolation. The author accepts the evolution of man's body but carefully draws the line at the "soul." He also believes in miracles, for example, "Divine intervention may still occur in evolution without necessarily upsetting the laws governing the process: no one seriously contends that the miraculous cures at, say, Lourdes upset the ordinary medical laws—."

The book is very scholarly and can be recommended to any student of evolution. —Reviewed by *Irving W. Knobloch, Department of Botany and Plant Pathology, Michigan State University, East Lansing.*

EVOLUTION

by Rémy Collin.
Translated from the French by J. Tester
Hawthorn Books,
New York, 1959.
Volume 30 of the TWENTIETH CENTURY ENCYCLOPEDIA OF CATHOLICISM.

Rémy Collin was the director of the Institut d'Histologie at Nancy, France, from 1920 until his death in 1957. Writing from the point of view of a Catholic scientist who is an evolutionist, he candidly examines some of the difficulties of the theory of evolution and also attempts to coordinate his scientific views with his religious convictions.

In an introductory critique of the use and the abuse of scientific theories, Collin issues the warning that "any claim that evolution is a *fact* constitutes an extrapolation, even today . . ." (p. 15) He includes in his stricture the well-known Catholic scholar, Father Teilhard de Chardin, who in his *The Phenomenon of Man* had proclaimed evolution as the universal law of the cosmos.

After a chapter on cosmogenesis, Collin discusses the progress that has been made toward the artificial creation of life. He forsees the possibility of creating macromolecules of nucleic acid, but also stresses the magnitude of the problem of developing anything that would remotely approximate the complexity of cellular organisms. He concludes that success in such experiments could be used to confirm the argument for the creation of life by intelligence as much as it could be used for the argument for a chance origin of life.

In a chapter on classification Collin points out the conceptual difference between organizational and formal categories—a point made by Vialleton in 1929. He notes that the lower categories, such as the species, families, and genera, represent formal types of recognizable entities. Organizational types—the phyla, classes, orders—on the other hand, are abstractions and cannot be observed as immediately recognizable

entities. It is perhaps not mere coincidence that the fossil gaps or discontinuities occur at such organizational levels. It would be helpful in our discussions of the subject, if we pointed out the increasing degree of extrapolation from evidence necessary when we go from micro-evolution (at the species or even general level) and from macro-evolution (at the genera and families level) to quantum or mega-evolution (at the organizational levels).

In this connection Collin might have pursued the possibilities of multiple neobiogeneses and the option of a polyphyletic scheme of evolution, as does John Keosian, for example, in his article, "On the Origin of Life," *Science* (February 19, 1960), p. 481-2:

> The discontinuities in the palaeontological evidence are explained away by the contention that some forms are not subject to fossilization, while many that are did not encounter the conditions favorable for fossilization, and, finally, the conclusion that many discoveries have yet to be made. Some of the discontinuities, however, can be viewed as the result of separate cases of neobiogenesis. The same may be said of the discontinuities in the taxonomic arrangement of existing organisms. The difficulty of placing viruses, bacteria, certain "algae," sponges, and so on, in a fitting place in any taxonomic scheme based on a monophyletic hypothesis may stem from the possibility that the discontinuities are real and represent the existence of separate lines of descent from independent instances of neobiogenesis at different times in the history of the earth down to the present.

Collin's chapter on anthropogenesis needs to be supplemented with a discussion of the finds by Leakey in Tanganyika since 1959, in particular, the tool-making Zinjanthropus, which he dated to 1,750,000 years before our era by means of potassium-argon dating. Moreover, now that Jane Goodall has observed that chimpanzees not only use tools but also make them (*Life*, February 12, 1965, pp. 54-55), we may have to revise our definition of man as any tool-making primate.

The writer devotes a chapter to the "Scientific Difficulties of the General Theory of Evolution." He concludes that, "Now *at present* nothing allows us to explain satisfactorily the origin of the higher groups: neither small *mutations* of the classical type, nor the various *genetic mechanisms* postulated to supply what is needed as a cause but for which no experimental proof has been possible . . ." (p. 93)

There follows a chapter on "Metaphysics and Evolution," in which Collin points out the presuppositions of certain "dogmatic" schools of evolution. In a concluding chapter on "Evolution and Christianity," he chides Catholic scientists who have simply accepted a theistic form of evolution without wrestling with some of the real problems involved in a Christian outlook. He says, "The fault of the Christian evolutionists we mentioned is that of adopting a purely phenomenological position without developing its ontological counterpart." (p. 132)

In conclusion, I would hasten to say that this is the most satisfactory volume that I have read on the subject of a Christian's view of evolution. The discussion by Collin, an evolutionist himself, of the scientific difficulties of evolution is a refreshing and an enlightening contribution, far removed from the "unlearned" refutations of some anti-evolutionists and from the dogmatic certitude of certain "evangelistic" evolutionists. —Reviewed by *Edwin M. Yamauchi, Department of History, Rutgers—the State University, New Brunswick, New Jersey.*

FAITH THAT MAKES SENSE

by J. Edwin Orr
The Judson Press,
Valley Forge, Penna., 1962. 109 pp., $2.75, paper, $1.50.

The author of this little book of apologetics is an Associate of ASA with a Masters degree in geography from Northwestern University and a Doctorate in history from Oxford as well as theological degrees. A mild-mannered evangelist who travels around the world lecturing in an anecdotal style, he has reproduced some of his lectures here, retaining much of the charm of his platform delivery. He first attempts to break through intellectual barriers as a prelude to a brief but effective presentation of basic doctrines of the Christian faith. In dealing with pertinent scientific quesions he steers a steady conservative course, on occasion eschewing but not ridiculing an extreme fundamentalist position such as a recent creation of the earth or a dictation theory of Biblical inspiration.

The introductory chapter begins with the argument from design but in an acceptable way, not to "prove" the existence of a divine Creator but to show that belief in God is a reasonable position for an intelligent person. Having shown that nothing in science makes belief in God unreasonable, he points out difficulties inherent in a deistic or pantheistic concept of God. He describes six possibilities for the origins of the world as we know it, discarding pantheistic eternal existence and atheistic spontaneous evolution, criticising theistic immediate creation and deistic mediate evolution, accepting theistic restitutive creation with reservations, and favoring theistic progressive creation. Some ASA members will thus think he has gone too far and others will think he might have included theistic evolution as another possibility.

A book that deals with profound questions chiefly by anecdote and analogy is liable to leave serious readers vaguely dissatisfied—after reading it one cannot recall the gist of the arguments. Yet, as Orr points out in the introduction, this is the way our Lord Himself taught. The great advantage of this light-weight style is that a non-Christian is swept past side issues and kept in the main current of thought long enough to

get the whole message of the Gospel in a single sitting. Then he can begin to ask questions. —Reviewed by *Walter R. Hearn, Associate Professor of Biochemistry, Iowa State University, Ames.*

HONEST TO GOD

John A. T. Robinson
Westminster, 1963. 143 pp., $1.65.

Bishop Robinson would convince us that we are living in a time when the proper defense of Christianity can be accomplished only by as complete a reinterpretation of its traditional formulation as was necessary for the Jews with respect to their religion in the days of the early Christian church. The Jews of that day were to hear a message preached which seemed to them to be a denial of the whole structure of their religious consciousness. Although the Law had been given to the Jews so that they might more perfectly know God, yet the Law had become a stumbling-block which kept them from knowing God. They were therefore called upon not to deny the Law, although to them it seemed that this is exactly what was demanded of them, but to see the Law revealed and fulfilled in a new and clearer light. They were called upon to believe that all the earthly promises which had been made to them by God, involving earthly blessings in the earthly land of promise, delivered from earthly dominion by an earthly King, were truly fulfilled in Jesus Christ who offered them none of these things, but the blessings of spiritual life and freedom from spiritual bondage to sin. Robinson would apply this to our day by casting the traditional statements of Christianity in relationship to us today, in the same role as the Law and the earthly formulation of the Gospel held for the Jewish people of Christ's day. He therefore calls us to a position which he advances, not as a denial of Christianity, although he is sure that to many it will seem nothing but this, but to a vision of Christianity which is unclouded and unencumbered by a conceptual framework which Robinson considers a vestige of man's cultural past and not a true part of intrinsic Christianity at all. In this pursuit he enlists the aid of three notable theologians of our day: Tillich, Bonhoeffer, and Bultmann.

Robinson's book is excellently written, and certainly one of its major contributions is that it takes the essence of these three sometimes unreadable theologians and presents it with a clarity which is usually vital. It is also a remarkable book, having many of the attributes of a theological cliff-hanger; it is difficult to lay the book down once it has been started. The questions which the book raises are fundamental and must be answered. It will not do for the Christian community simply to act as if they should never be asked. And yet it appears that the answers that Robinson offers suffer from at least three grave defects: (1) the reinterpretation in the times of Christ came with the authority of the person of Jesus Christ Himself; the reinterpretation of Robinson almost, but not completely, ignores the Biblical record, invoking it only in spots where it proves useful for the argument; (2) after the reinterpretation has been made, it is frequently difficult to tell just what remains of Christianity; this is particularly true in the section on the atonement, which this reviewer found impossible to paraphrase; and (3) after the reinterpretation has been made, it is necessary to stop and see if what is left is really Christian at all. .

The book has been soundly condemned by sincere and consecrated Christians, and a reviewer in a leading evangelical magazine does not hesitate to relegate it to the anathema of II Timothy 4:3,4. Obviously one's reaction to this highly controversial book will be fundamentally affected by whether one judges Robinson to be a Christian or not. This reviewer found in the book no reason to question the Christian motivational integrity of Bishop Robinson. However mistaken his conclusions may be judged to be, it must be granted that he has asked his questions in good faith. He repeatedly emphasizes the great emotional shock in some of his conclusions, not only to the Christian community but even to himself as well. He writes,

> It will doubtless seem to some that I have by implication abandoned the Christian faith and practice altogether. On the contrary, I believe that *unless* we are prepared for the kind of revolution of which I have spoken it *will come* to be abandoned. And that will be because it is moulded, in the form we know it, by a cast of thought that belongs to a past age. p. 123

In the following discussion, we shall attempt to see the questions asked and to analyze the answers given, on three main topics in Robinson's book: (1) the nature of God, (2) the nature of Christ, and (3) the Christian life.

God

Question 1: Where is God?

Christianity lists omnipresence as one of the attributes of God, and yet at the same time traditional Christianity persists in speaking of God as being "outside the world." Earlier references to God as "up there" have changed to references to God as "out there", and by and large these have also dropped the physical and spatial connotations, but the basic concept of God as a Being living separate, over, or above the world persists.

> Every one of us lives with some mental picture of a God 'out there', a God who 'exists' above and beyond the world He made, a God 'to' whom we pray and 'to' whom we 'go' when we die . . . This picture of a God 'out there' coming to earth like some visitor from outer space underlies every popular presentation of the Christian drama of salvation. pp. 14, 15

Robinson believes that this concept of a God "out there" represents a serious stumbling-block to the whole presentation of the Gospel today, and that the situation will rapidly become worse in the future. He traces this basic concept of a God "out there" to two other consequences, both of which he considers equally detrimental to the furtherance of Christianity. The

first of these is the development of quests for the proof of the existence of God, as though God were a being "out there" who either might or might not exist, like life on Mars. That the nature of God should be so compatible with the uncertainty of His existence, according to the traditional framework, troubles Robinson. The second consequence is that the whole drama of the Gospel account is cast into symbolic language (technical term: "mythological") which was meaningful to men in the past, but today is not only meaningless, but an actual stumbling-block to faith in Chirst. Take, for example, the account of the Incarnation:

> The Incarnation means that God the Son came down to earth, and was born, lived and died within this world as a man. From 'out there' there graciously entered into the human scene one who was not 'of it' and yet who lived genuinely and completely within it. . . . He looked like a man, he talked like a man, he felt like a man, but underneath he was God. . . . However guardedly it may be stated, the traditional view leaves the impression that God took a space-trip and arrived on this planet in the form of a man. Jesus was not really one of us; but through the miracle of the Virgin Birth he contrived to be born so as to appear one of us. Really he came from outside. pp. 64, 66

Although he does not use this argument explicitly, Robinson might argue that this kind of symbolism was applicable to the men who lived in the culture of 2000 years ago, just as the symbolism of earthly promises was applicable to the men who lived 4000 years ago. As the symbolism of earthly promises gave way at the time of Christ, so Robinson would argue that the symbolism of "spatial transactions" should be done away with today.

In these emphases, Robinson has put us on our guard in what can be a useful and constructive way. We must be constantly certain that our formulations of Christianity have a valid significance for today, that the essence of the Gospel is not obscured by modes of thought and expression which no longer speak to the present generation. If we think about God 'coming to earth' in Christ as some kind of a mystical space trip from some realm in 'outer space' to this little planet, we are in danger of pushing symbolic forms of expression to the point where they begin to destroy the credibility of the very message they were designed to describe. The answer to the question, Where is God?, has far-reaching implications, not only for Christian theology or metaphysics, but for practical Christianity as well.

Question 2: What is God?

Robinson argues not only for a rejection of the concept of a God 'out there' physically and spatially, but also of a God 'out there' philosophically. By this is meant the concept of God, however omnipresent He may be physically, who nevertheless is *a* Being who can be involved in acting upon the world from outside its physical and temporal boundaries. God, Robinson suggests in concord with Tillich and Bonhoeffer, is not *a* Being *at all,* whose existence may be called into question, but is rather ultimate reality itself. Tillich speaks of God as "the infinite and inexhaustible depth and ground of all being, of our ultimate concern, and of what we take seriously without reservation." Bonhoeffer speaks of God as "the beyond in the midst of our life, a depth of reality reached not on the borders of life but at its center, not by any flight of the alone, but, in Kierkegaard's fine phrase, by a deeper immersion in existence."

Thus Robinson no longer speaks of a personal God, since this concept is built upon the construction of a Person "out there", but reinterprets the statement "God is personal" to mean that "personality is of *ultimate* significance in the constitution of the universe." Or again Robinson argues that the Biblical text, "God is love" really means "to believe that in love one comes into touch with the most fundamental reality in the universe, that Being itself ultimately has this character."

Now any deepening of our understanding of the nature and universal presence of God is fervently to be desired. The simple Biblical definitions that God is Spirit, love, and light leave us without a detailed concept of how we ought to think about God. The exhortations of Robinson to see the source of all purpose, all meaning, and all depth in life, in the Being of God are well taken. The understanding of I John 4 as an experiential apprehension of God through the love relationship between human beings is another valuable insight. But the concept of God without personality is one that is not only inconsistent with the Biblical record but appears to be in direct contrast with it. That the word "God" is no more than the expression of ultimate concern leaves no room at all for the Biblical teachings on creation and providence. And the concept of an impersonal God leaves unanswered the basic question about the personality which we know and worship in Jesus Christ. It seems that at this point, where Robinson leans most heavily on Tillich, that he is carried away (and he comes near to carrying away the reader of his book with him) by the basic flaw that Tillich's theology bears no simple relationship to the teachings of the Bible.

Christ

Question 3: Who is Jesus Christ?

We have already pointed out how Robinson feels that the incarnation and work of Christ are presented in the Bible in symbolic language no longer applicable to our time. To defend his point of view at this juncture, he does go to the Bible to summarize its testimony about the person of Jesus Christ. (1) The Bible nowhere plainly says, "Jesus is God." Christ and God are not interchangeable terms in the Bible. (2) The New English Bible hits closest to the Greek intent of John 1:1 by translating it, "And what God was, the Word was." (3) Neither Jesus nor his apostles ever appealed to His Godhead to defend or establish His authority. (4) Jesus' principal claims refer not to Himself in His own right, but to what God is doing through Him. (5) Jesus does not claim to be God personally, but He does claim to bring God completely. (6) "It

is in Jesus, and Jesus alone, that there is nothing of self to be seen, but solely the ultimate, unconditional love of God." (7) Jesus reveals God, by not emptying Himself of His Godhead, but by emptying Himself of *Himself*. (8) The efficacy of Christ's work for us results not from His omnipotence, but from His weakness and suffering, because He bore our infirmities and our iniquities.

Robinson in effect proposes to remove the paradox of the divine personality and the human personality in one personality of Jesus Christ, by rejecting the reality of the divine *personality*. He finds in Christ the very essence of God; indeed God is truly seen only in Jesus Christ. Drawing the line in this area between orthodoxy and heresy is a difficult task, even without the complications of Robinson's altered definitions. The Biblical points summarized above about Christ do present a picture which is often partially neglected, and which we would do well to heed.

When Robinson goes on to discuss the significance of the atonement in terms of his reinterpretation, this reviewer was lost. We must be careful not to fasten on some particular formulation of the "atonement transaction" as dominant, as Robinson warns, but on the other hand if we forsake all Biblical insight into the nature of the atonement, it not only leaves us with the uncertainty of having forsaken the Christian Gospel, but may put us in a position where the reinterpreted formulation is as much or more of a stumbling-block than the original.

The Christian Life

Question 4: Must Christianity be religious?

It is evident that religion need not be Christian, and it may also be readily admitted that Christianity need not be religious, i.e., the proper exercise of Christianity need not always involve the religious element. Robinson argues that much of the religious consciousness answers a particular need in certain people, but questions whether everyone must share to the same extent in this religious consciousness to be Christian.

The main brunt of Robinson's attack here would be agreed with by this reviewer. Religious emphases do tend to pervert the true purposes of Christianity, in that they emphasize the withdrawing apart from the world to be with God, as though God could not or should not be properly met in the regular business of this life. Drawing apart to commune with God, a questionable practice in Robinson's scheme because of the impersonal nature of God, is to be sure an important phase in the Christian life, but this drawing apart is truly Christian only if it leads us to return to the world "more sensitive to the . . Christ in the hungry, the naked, the homeless, and the prisoner." Worship is not only withdrawing to "be with God'; it is meeting the holy in the common, seeing the sacred in the secular.

Robinson seems to miss an essential point, however, when he argues that Christianity can and probably must inevitably exist apart from any religious consciousness or need. It would seem that both the testimony of the Bible and the abundant psychological experience of life confirm a basic need in man apart from the fellowship which comes through Jesus Christ. Certainly this basic need, this lostness, this insecurity, this inability to communicate, this fear of personal commitment, this striving for the unknown—which results from the lack of unity between man and his God, and hence between man and his brother, this is a religious consciousness. To argue that the passage of time and the development of culture and civilization is making this religious need obsolete does not seem to stand on firm empirical ground.

Question 5: What is right and wrong?

The reflection of the theology of a 'God out there' in the realm of ethics, Robinson submits, is that way of thinking in which "the law" is "written into the universe . . . 'given', objectively and immutably. Certain things are always 'wrong' and 'nothing can make them right', and certain things are always 'sins'." This kind of thinking takes the Sermon on the Mount and makes of it a new Law to replace the old Law of Moses. The great weakness of this form of ethics is that it cannot answer the question, "Why is this right?" and "Why is this wrong?"

Most of the conclusions of Robinson in this realm of ethics have already found their place in evangelical Christianity. This is because they do not have a real connection with the concept of a 'God out there', but are simply the result of a more complete understanding of Biblical teaching. Christian love alone is the proper basis for Christian ethics, and the whole weight of the New Testament bears down on this point. The law is good and holy because it is an expression of those relationships which involve love between persons, whether between God and man, or between man and man. Jesus taught that compassion for persons overrides the literal statements of the law (Matt. 12:1-14), and Paul proclaimed love as the fulfilling of the law (Romans 13:10). There is only one evil, and that is lack of love. This reviewer would support similar claims, Biblically interpreted, without basing them on a detailed acceptance of Robinson's system.

In conclusion, it may be said that Robinson's book is a dangerous book and a refreshing book, a book to be put aside and a book to be carefully re-read, a destructive book and a constructive book. Regardless of how we respond, and each of us is certain to respond in such a way that a whole spectrum of reaction will result, certain questions must be answered. The questions are old, and yet the questions are new. There are old answers; are there new ones? Any Christian who thoughtfully considers this book will probably not be quite the same afterward. It is a good thing.

—Reviewed by *Dr. Richard H. Bube, Professor of Materials Science and Electrical Engineering, Stanford University.*

LETTERS TO THE EDITOR

PSYCHOLOGY BY DR. FINCH

I have read with interest John Finch's article, "The Need for a New Approach in Psychology," (JASA, Dec., 1964), and a reply to it by Michael Micherikoff and C. E. Walker, "The Need for a Better Understanding of Current Psychology . . ." (JASA, June, 1965).

If psychology is defined *a priori* as a "natural science" whose methodological presuppositions are logically restricted to physical phenomena, it would appear either that there should arise some discipline genuinely devoted to the investigation of the *mind,* or that current psychology (as a "natural science") should at least enlarge its boundaries to include investigations of man's mental life. And it is the latter alternative which Finch wants to suggest: "only a psychology which accepts *Weltanschauung* as germane to its concern can be considered valid for understanding man." This is not an unreasonable suggestion.

For many decades it has been very difficult to find in psychology or philosophy journals research bearing on the ontological status of ideas, or a non-materialistic investigation of the meaning of "meaning." This fact becomes paradoxical when viewed in terms of its implications.

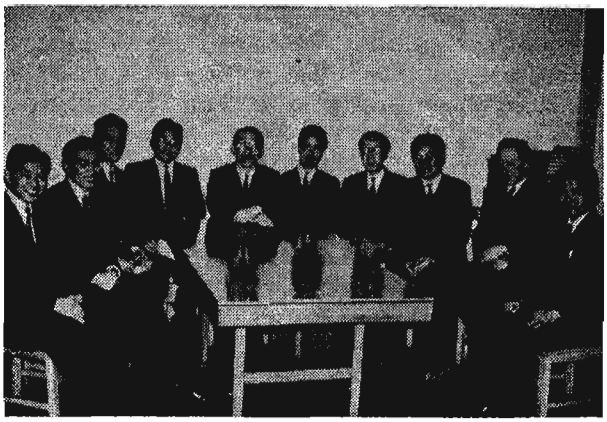
For example, when investigating the nature of "emotion," unless a given emotion is defined *a priori* as some physicalistic phenomenon, its investigation is psychologically irrelevant in the absence of methodological procedures entailing those entities which one becomes "emotional" about, namely, ideas. For, clearly, a person does not become emotional about some physical fact. Such physical phenomena simply do not exist in our minds. (Even Russell points out in regard to Berkeley: "To argue that the tree itself must be in our minds is like arguing that a person whom we bear in mind is himself in our mind," *Problems of Philosophy,* Oxford, p. 40). The point is that methodological procedures which are logically restricted to physicalistic interpretations of emotions can only yield physicalistic explanations as to their nature: Such arguments stand as *non sequiturs* from a psychological point of view, if psychology is understood as a discipline concerned with investigating the mind.

In the British Journal of Statistical Psychology, 17, 1, 1964, Cyril Burt makes a "plea for resuming the systematic study of consciousness as part of the task of psychology . . . Why assume that the only form of existence is material?" And whereas I do not regard Existentialism or Phenomenalism as significant contributions to the Logos of being (the object proper of philosophical inquiry), Finch's paper can be regarded as making a similar plea.

Dr. Daniel K. Stewart
Research Department
Campbell-Ewald Company
General Motors Building
Detroit, Michigan

JAPAN SCIENTIFIC AFFILIATION

On March 11th I met with a group in Tokyo who are very much interested in forming a "Japan Scientific Affiliation." Enclosed is a picture of these men who are identified as follows:



Left to Right

Mr. Takahashi, IVCF staff
Mr. H. Ariga, General Secretary of Japan IVCF
Dr. Hama, Meiji Gakuin University—Biology
Dr. Minato, Int. Christian University—Chemistry
Dr. Sugeno, Tokyo University—Physics & Metallurgy
Dr. Morita, Tokyo Institute of Technology—Control Engineering
Dr. Omura, Toritsu University—Philosophy
Dr. Yamamoto, Tokyo University—Medicine
Mr. M. Griffiths, Japan IVCF staff
Mr. Abe, Kanto Gakuin University—Engineering

I was much impressed with these men and their desire to learn more about the ASA. Further, I felt that the members of ASA would be much interested in this international influence they are having. The "spark plug" of this is TEAM missionary, Rev. John S. Schwab of the Ochanomizu Student Christian Center, 1 2-Chome Surugadai Chiyoda-ku, Tokyo.

F. Alton Everest
Moody Institute of Science
947 Stanford St.
Santa Monica, California

THE AMERICAN SCIENTIFIC AFFILIATION was organized in 1941 to investigate the philosophy of findings of science as they are related to Christianity and the Bible and to disseminate the results of such studies.

FELLOWS have a doctoral degree or its equivalent in experience in a biological, physical, or social science and have been elected from among the members.

MEMBERS have at least a baccalaureate degree in science and are currently active in some field of science (broadly defined to include mathematics, philosophy of science, history, engineering, and medicine). Others with an interest in the objectives of the ASA may become ASSOCIATES.

THE FOLLOWING STATEMENT OF FAITH is accepted by members: The Holy Scriptures are the inspired Word of God, the only unerring guide of faith and conduct. Jesus Christ is the Son of God and through His atonement is the one and only Mediator between God and man.

PUBLICATIONS include the *ASA News* (sent to members four to six times each year) and two symposia: *Modern Science and Christian Faith,* 1950, edited by F. Alton Everest; and *Evolution and Christian Thought Today,* 1960, edited by Russell L. Mixter.

SECTIONS have been organized to hold meetings and provide an interchange of ideas at the regional level. Information may be obtained from the persons listed below or from the national office.

CHICAGO — James Kennedy, The King's College, Braircliff Manor, New York North Park College, Chicago 25, Ill.

INDIANA — Donald Porter, Taylor University, Upland, Ind.

NEW ENGLAND — J. M. Osepchuk, Deacon Haynes Road, Concord, Mass.

NEW YORK CITY AREA — Wayne Frair

NORTH CENTRAL — Robert Bohon, 1352 Margaret, St. Paul 6, Minn.

OREGON — Ted W. Cannon, 633 N. 13th, Corvallis, Oregon

SAN FRANCISCO BAY — Richard Bube, 753 Mayfield Ave., Stanford, Calif.

SOUTHERN CALIFORNIA — David F. Siemens, Jr. 8222 Yarmouth Ave., Reseda, Calif. 91335

WASHINGTON-BALTIMORE — George H. Fielding, 5 Holiday Drive, Alexandria, Va.

WESTERN MICHIGAN SECTION — Albertus H. Elve 1519 Rosewood Ave., S.E., Grand Rapids, Mich.

WESTERN NEW YORK — Philip H. Harden, Roberts Wesleyan College, North Chili, N. Y.

Membership application forms, ASA publications and other information may be obtained by writing to: AMERICAN SCIENTIFIC AFFILIATION, 325 Brett Building, Mankato, Minnesota 56001.