Arthur Jones, "The Dogma of Evolution," *Faith and Thought* 98.1 & 3 (1970): 25-41.

The Dogma of Evolution

Arthur Jones B.Sc.

[p.25]

The subject of evolution has been discussed at the Victoria Institute for more than one hundred years. In a letter to Wallace in 1867, Darwin mentioned that his theory had been ably defended before the Victoria Institute ('a most orthodox body'), but he commented that the ensuing discussion was 'very rich from the nonsense talked!' What is remarkable is that we are still arguing today in 1970. It is a simple fact that arguments dealing with the scientific data rarely seem to be coercive and opinion has consequently generally followed the pronouncements of the latest evangelical bishops of science. It is this that I want to investigate. I shall argue that the scientific data occupies a very secondary place; that the conflict is rather philosophical and religious; and that for us it really is a matter of what the scriptures say. The aim of this paper is thus to demonstrate why we cannot appeal to science for help on this issue.

I would begin by suggesting that we have been so busy looking at the trees that we have failed to see the wood, that if we wish to see evolution in a true perspective we must first have a look at the structure and strategy of science as a whole.

The basic method of science is simple enough. As every schoolboy knows, the sciences are entirely empirical and thus philosophically neutral. The scientist begins by collecting facts in as unbiased a manner as possible. The inspection of these facts will reveal some features of order, allowing the scientist to formulate an hypothesis which relates them. If after further collecting the features of order are sufficiently clear-cut, the scientist will announce the discovery of a law of nature. This is the procedure which is our culture's messiah. *But every schoolboy is wrong!* However small the area of study may be, the scientist always faces a veritable avalanche of facts. If he ever tried to collect them as they presented themselves, he would be crushed. The scientist is always biased; he must come to his work

[p.26]

with a theory which will enable him to select the relevant facts. He has, as it were, a net with a certain size of mesh and what his net doesn't catch isn't fact. This alone undermines the belief in the neutrality of science, because we cannot separate fact and interpretation in the way the positivist would require. We only know facts as we place them in the context of a theory, that is, as we interpret them. This in very brief outline is what has become known as the hypothetico-deductive method—you invent an hypothesis, you deduce what would follow from it, and then you make observations in order to see whether the facts are what your hypothesis predicts. Unfortunately this is as far as many authors take it; but it is clearly unsatisfactory as it stands. As Medawar has put it: 'If it is a formal objection to classical inductivism that it sets no upper limit to the amount of factual information we should assemble, so also it is a defect of the hypothetico-deductive scheme that it sets no upper limit to the number of hypotheses we might propound to account for our observations. To exchange Whewell's system for Mill's, on the face of it, is to trade in an infinitude of irrelevant facts for an infinitude of inane hypotheses.' (1969 pp. 52-3). 'Any fact', wrote Poincare, 'can be generalised in an infinite number of ways, and it is a question of choice.' (1905 p. 146). There is not, I suspect, any formal solution to this problem for although many criteria, such as simplicity, have been put forward to restrict our choice, they cannot make it unique. There is,

however, one very important restricting factor which is often overlooked. Just as we select the facts by means of a theory, so we select the theories by means of a paradigm, a theoretical framework—a framework not now for facts but for theories. As examples of such paradigms we have logicism and formalism in mathematics; atomic and thermodynamic theory in physicschemistry; uniformitarianism in geology; and mechanism and organicism in biology.

Before we penetrate deeper into science we need to consider the question of scientific status—how do we determine whether a theory is scientific? By what standard do we distinguish between the propositions of chemistry and alchemy or between those of astronomy and astrology? Again there is no simple or

[p.27]

formal answer to this question because many factors are involved and not all of these are specifiable. However there is one factor of immediate relevance—Popper's demarcation principle (see Popper 1963). To be accepted as scientific, a theory must be so structured that we can indicate some critical observation which would refute it. The reason for this perhaps unexpected criterion is the logic of the situation: a theory can never be conclusively verified whereas it can be logically proven false. In this respect, science is the search not for truth, but for error.

But how do we criticize paradigms? Since they govern not facts but theories, no observation can refute them. Paradigms have a largely programmatic function (Kuhn 1962; Wisdom 1963)—they tell us what paths of research to follow and they prescribe limits to the kind of theory we should construct. As an example we can consider thermodynamic theory and in particular the principle of the conservation of energy. A specific form of this principle can be refuted, but faced by such an apparent discrepancy the unspecific form simply directs us to look for a new specific form possibly dealing with previously unknown forms of energy. To understand this situation we must delve into the structure of paradigms. The laws associated with theories are generally straightforward and observational, and the concepts employed are instantiative (cf. Wisdom 1957). As an example we can take Boyle's law that the pressure and volume of a gas vary inversely at a given temperature. The concepts employed, 'pressure', 'volume', 'gas', have instances—they refer to concrete things we can observe or experience. To test this law we make a deduction which takes the form of a simple syllogism, e.g.

1) All gases obey Boyle's law.
2) This object is a gas.
3) Therefore this object obeys Boyle's law.

The laws associated with paradigms, by contrast, are theory-laden and the concepts involved are non-instantiative. As an example we can consider the principle that if two animal species coexist in a particular region, they must be ecologically different. This principle involves the concept of environment—a concept which is non-instantiative in that an environment is

[p.28]

not something we can observe or experience. As it stands, the principle is irrefutable. But a specific form, such as the principle that two species cannot coexist if they compete for the same limited food resource, is falsifiable. It should be noted, however, that the specific form has *specified* a concrete aspect of the environment and thus contains only instantiative concepts.

So how can a paradigm be refuted? The answer to this question is really quite simple. Theories deal with facts and are consequently refuted by facts; paradigms deal with theories and are consequently refuted by theories. As an example (after Wisdom 1963, 1968) we can consider the principle that energy is continuous. This principle of classical physics is clearly irrefutable. If, like Planck, we discover phenomena of radiation which seem to be due to discontinuous processes (quanta of action), we cannot at all rule out the possibility that other quantities of action (to be discovered) might restore continuity. But Schrodinger's formulation of the wave-equation provided a theory with the deductive consequence that energy levels are discontinuous. Since this theory was independently tested (e.g. by the emission spectrum of the hydrogen atom), it refuted the assumption that energy is continuous. Similarly a theory with perpetual motion as a consequence would, if confirmed, refute the principle of the conservation of energy. However there is a snag here: refutation does not necessarily lead to rejection. All that a refutation does is to enhance the problematical tension of a paradigm and indicate the need of revising it. The refutation only has the necessary power to eliminate when it has the support of an alternative and better paradigm.

We are now back with a familiar problem—how do we select an alternative paradigm? Only in this case the problem is considerably more intractable. Theories are generally being compared with respect to a single paradigm which provides a stable meaning for the terms employed. Alternative pardigms, in contrast, may not have a single statement in common. This is because the facts to be explained will be so permeated by the conceptual structure of the paradigms, that these paradigms will never explain the 'same' thing. Consider, for example, the radically different meanings given to the terms

[p.29]

'space', 'time' and 'force' in Newtonian and modern physics. Kuhn has argued that the proponents of different paradigms 'practice their trades in different worlds'. They confront the same reality and know that they do so 'but in some areas they see different things and they see them in different relations one to the other.' (1962 p. 149). Thus when the protagonists argue they are bound to be fundamentally at cross-purposes because neither side will grant the non-empirical assumptions the other needs to make his case.

Now if 'competition between paradigms is not the sort of battle that can be resolved by proofs' (Kuhn p. 147) how do we select an alternative and how does this become accepted by the scientific community? The answer, I would suggest, is that there must be a philosophical conversion first. A paradigm always entails some fairly general assumptions about which nothing can be proved scientifically. These assumptions arise in the context of a new philosophy which helps to redetermine the problems which are to be tackled in our science and the types of answer which are to be admitted. This leads to a further question: How does a philosophy structure our scientific beliefs? I would suggest that it does so through being informed by the answers we give to three questions—questions which each practising scientist must answer even though he may not do so either explicitly or consciously:

1) What is the origin of all things?

2) What coheres and interrelates all the aspects of our experience?—whence the lawfulness of the universe?

3) What is the vantage point from which we can meaningfully view each individual fact and the integral totality of creation?

It is the answers to these questions that structure a scientist's philosophy and his philosophy, in its turn, directs his choice of a paradigm. The thing to notice, however, is that these are religious questions for the answers we accept determine the direction of the whole of our life. Our ultimate directive in science comes from our religious commitment. If we confine our attention to our western culture, we find that there are basically two commitments—the humanist and the Christian. The Christian

[p.30]

receives his answers from the Word of God—that the origin of all things is the God who is really there; that this God has created a lawful universe and that the vantage point is the regenerated believer whose sinful heart has been cleansed by God, reattuned to the lawful structure of his creation and confirmed in obedience to his Word and Will—at least that's how it should be! The humanist, however, can only plead that the facts are 'brute'—they are 'just there'; that the lawfulness in some sense relates to man and that the vantage point is the autonomous reason of the scientific man. Blackham writes that 'The faith of the humanist is first of all in reason.... The rationalism of the humanist is... a reliance on science' (1968 pp. 28, 32).

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All this may seem a rather long preamble, but it enables us to place evolution in a true perspective. Consider: if the aim of science is to know reality, to find unity in the multiplicity of phenomena, then how can this be achieved in line with the humanist commitment? What, in other words, can a humanist believe about reality which is consistent both with his humanism and with his belief in the attainability of unity in science? There would seem to be only one answer. Unity will only be possible if reality is a continuum, whereby each aspect is related with the others by evolution. Thus the Dutch philosopher Delfgaauw argues that 'The idea of evolution as such is... only a direct inference from the notion that observable reality is a unity.... There is the elementary unity that connects the sum of what is observable with the (potential) observing. It is in consequence of this that modern science bases itself on the postulate of the unity of observable reality.' (1969 p. 105). However he can only argue thus because he puts up a man of straw as the alternative—'that observable reality divides off into a number of unities or "spheres" *which have no reciprocal relation at all*.' (ibid. my emphasis). Clearly he has no intention of believing in anything else.

Evolution is neither a scientific theory nor a paradigm, but a metaphysical dogma of continuity—a dogma which is a basic

[p.31]

tenet of the humanist faith. Humanist scientists always, of course, mask the religious status of this dogma by referring to it as a 'law' or 'principle'

'Though no evidence worth anything has as yet, in my opinion, been advanced in favour of a living being, being developed from inorganic matter, yet I cannot avoid believing the possibility of this will be proved some day in accordance with the law of continuity.' (Darwin, 1903, ii, IV, my emphasis.)

'In any endeavour to trace the evolution of a highly specialized organ, a difficulty arises in the application of what may be called the principle of continuity. It is repugnant to reason to suppose that eye or ear appeared suddenly in evolutionary history. Their evolution must have been a continuous process...' (Pumphrey 1950 p. 5. my emphasis). The Dutch zoologist de Wit gives us the truer judgment: 'Although the doctrine of evolution presents itself as a pre-eminently scientific theory, it is not a scientific theory at all. Rather it expresses a specific *philosophical view* regarding the genesis and the structure, in space and time, of the living world. The basic element of the doctrine is the principle of *Transformation* and the theories of mutation and selection are superimposed on it in an attempt to give scientific status to a speculative metaphysical principle.' (1965 p. 405.) It isn't fashionable to admit this today, but the older scientists were more honest. The zoologist Watson said to the British Association in 1929 that 'Evolution itself is accepted by zoologists not because it has been observed to occur or is supported by logically coherent arguments, but because it does fit all the facts ... and because no alternative explanation is credible.' (1929 p. 88.) Similarly the physicist More wrote in 1925 'The evidence for the evolution of plants and animals is commonly said to be derived from many sources. When, however, we examine these causes for our belief we find that... most of them can be considered only as secondary reasons to confirm a theory already advanced.... Our faith in the idea of evolution depends on our reluctance to accept the antagonistic doctrine of special creation, because this view of creation is foreign to our belief in the continuity of law and order.' (pp. 117, 304.)

[p.32]

We now come to the paradigms which have been articulated within evolutionary philosophy. Essentially there are three alternatives: Lamarckism, Darwinism and Macro-mutationism. These are not scientific theories, but *frameworks for theories*. As such they are all factually irrefutable. This needs to be stressed as it has long been fashionable for evolutionists to say that they reject creationism as unscientific, because it cannot be tested. Thus the geneticist Bruce Wallace has written: 'wc reject special creation as an adequate explanation because we can think of no means by which we can put it to a valid test, because we can imagine no observation falling outside the capabilities of a Creator possessing unlimited ability.' (1967 p.5.) It is really quite ironical that we can rewrite this statement: 'we reject Darwinism as an adequate explanation because we can think of no means by which we can put it to a valid test, because we can imagine no observation falling outside the capabilities of natural selection!' Fortunately this has now become widely recognized. Amongst scientists one can mention von Bertalannfy (1952 p. 89); Birch and Ehrlich (1967); Murray Eden; Ernst Mayr; Alex Fraser and Marcel Schutzenberger (in Moorhead and Kaplan Eds. 1967) and amongst philosophers Sir Karl Popper (1963); A. R. Manser (1965) and A. D. Barker (1969).

Leaving aside, for the moment, the question of evolution itself, we can now ask whether the evolutionist can choose between these paradigms by means of their theories. The answer is in the negative because there neither are nor can be evolutionary theories. All the paradigms we dealt with before were concerned with the way things *are*, but evolutionary paradigms are historical interpretations—they deal with the way in which things *became as they are*. Evolution provides two types of historical explanation which Goudge (1961) has called 'integrating' and 'narrative'. Integrating explanations integrate the various biological diciplines by showing that the phenomena (homologies, vestigial organs, geographical distribution etc.) can be explained as the outcome of an historical process having continuity and direction. Narrative explanations analyse the continuity into an intelligible sequence of occur-

[p.33]

rences so as to produce a coherent narrative, a 'likely story'. Now these are valid forms of scientific explanation but they do their job without the aid of any general laws. The events are not deduced from a law or set of laws as instances of a kind; they are individual phenomena between which individual relations hold and they will not recur. *After they have taken place* events are explained by showing them to be the outcome of postsequences of events but nothing is deducible about phenomena yet to come. Our various paradigms can, of course, systematize these historical interpretations by rewriting them in terms of the categories provided (mutation, natural selection etc.), but this tells us more about the nature of the paradigms than about the phenomena.

We are now left with a puzzle. If evolutionary paradigms are both in observation—and theory—irrefutable, then why is it that, in Britain and America, Darwinism is accepted almost to the exclusion of the alternatives?

The answer, I would suggest, is to be found in the twin metaphysics on which Darwinism is based:

1) The atomist thesis that wholes are explicable by analysis into their parts—namely organisms into their genes.

2) The thesis that events are always explicable by preceding events which are their causes.

This ties in with what we were saying about the unity of science. Oppenheim and Putnam write that as far as they can see, 'the only method of attaining unitary science that appears to be seriously available at present is micro-reduction' (1958 p. 8). In connection with evolution they wrote: 'The reason for our regarding evolution and ontogenesis as providing indirect factual support for the unity of scientific hypothesis may be formulated as follows:

'Let us, as is customary in science, assume causal determination as a guiding principle; i.e., let us assume that things that appear later in time can be accounted for in terms of things and processes at earlier times. Then, if we find that there was a time when a certain whole did not exist, and that things on a lower level came together to form that whole, it is very natural to suppose that the characteristics of the whole can be causally

[p.34]

explained by reference to these earlier events and parts; and that the theory of these characteristics can be micro-reduced by a theory involving only characteristics of the parts' (p. 15). It is this attitude which draws from Marjorie Grere the just charge that Neo-Darwinism is 'a theory deeply embedded in a metaphysical faith; in the faith that science can and must explain all the phenomena of nature in terms of one hypothesis, and that an hypothesis of maximum simplicity, of maximum impersonality and objectivity' (1966 p. 199). Grere notes that the basic explanatory concepts of Darwinism are chance (random variation) and necessity (external compulsion of natural selection) which 'from Democritus through Hobbes to modern physicalism (are) the sole permitted instruments of reductivist explanation' (p. 191).

How else can the Humanist explain? Let us imagine that the universe comprised but four elements, A B C D, together with all their interrelationships as expressed in general laws. Now a humanist can clearly 'explain' this universe by micro-reduction, by analyzing it into its elements. But this explanation is inherently unsatisfying because it provides no answer to the questions: 'Why A B C and D and not any other elements?' and 'why these particular laws and not any of the multiplicity of other laws which could, without any violation of logic, be equally easily imagined?' The only 'way out' of this predicament is to defer the problem i.e. to explain the present situation in terms of the (assumed) simpler situation X years ago. But this is all that can be done because even an infinite regress will not allow a scientific explanation of the whole. But what it does do is serve as a palliative, because the scientist can forever immerse himself in reductivist investigations. I would suggest that these are the reasons why Darwinism is so much more popular than its less reductive rivals.

Now let us consider evolution itself. Evolutionary paradigms are irrefutable—irrefutable, that is, if we grant two assumptions:

1) That evolution has occurred, and

2) That scientific methods are applicable to the study of origins.

The second assumption is theologically unacceptable because

[p.35]

the applicability of scientific methods boils down to the assertion that the creative past can be explained in terms of present-day (scientifically-analyzable) phenomena. The German biologist Mainx puts it like this: 'The fundamental assumption of the doctrine of descent presupposes that all those processes which have led during evolution to change in the organic multiplicity in principle also takes place today.' (1955 p. 49.) This, of course, is the old heresy of explaining creation in terms of providence. But this is really a digression because we are primarily concerned with the first assumption.

We can draw together the threads of our discussion in the form of three statements:

1) The only way in which one can effectively criticize any evolutionary paradigm is by criticizing the whole philosophy of evolution.

2) The only way in which one can effectively criticize evolutionary philosophy is by confronting it with an alternative which can also provide paradigms.

3) You can only engage in such criticism if you are prepared to entertain the philosophical and religious beliefs entailed by such an alternative. If you are not so prepared then for you evolutionary science will become a dogmatic and completely petrified metaphysic. (Dare one suggest that for many scientists that is already the situation?)

I would suggest that, as Christians, we can draw the following lessons:

Firstly that the issue for us is primarily a Biblical one. We cannot allow science to control our exegesis of Genesis not only because that is a denial of the authority of scripture but because

science is, in any case, inherently incapable of helping us. We could only so use science if the humanist's beliefs were true.

Secondly that the only alternative is to follow scholars like Dooyeweerd and Mackay and argue that the early chapters of Genesis do not belong to our time scale and thus contain no data which is relevant to our scientific studies. But if you do this

[p.36]

you must remember that, in the absence of revelation, the only way in which one can scientifically evaluate and criticize palaetiological paradigms is by comparison with alternatives—in this case, creationistic alternatives.

Thirdly that the setting up of alternatives entails the consideration of an alternative philosophy. This is imperative in this case because we certainly cannot accept the currently-accepted philosophical and religious basis of evolution. In fact from our standpoint we can riddle it with holes!

Fourthly that we must be very careful as we compare paradigms. Since opposing paradigms cannot be compared in a directly refuting way, we will be comparing them primarily for consistency i.e., demonstrating that the creationist explanation of a phenomenon is consistent whereas the evolutionary one is not. We must also remember that opposing paradigms will be using terms such as 'evolution'; 'creation'; 'species'; 'variation' and 'mutation' in radically different ways. If these points had been recognized in the past, a great deal of futile argument might have been avoided. In some cases, for example, the evolutionist and the creationist will give what appears to be an identical explanation of a phenomenon. The actual differences will only become clear when the explanations are seen in the different conceptual frameworks. The moral, I think, is that if we are going to contribute usefully to the scientific argument then we are going to have to do a great deal of homework.

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The last thing I wish to do now is briefly to compare a creationistic and an evolutionary paradigm as regards the explanation of firstly the mechanism of evolution and secondly homologies.

A. The Mechanism of Evolution

a) Darwinism. Darwinisms argue that all existing and extinct creatures have evolved from primitive unicellular forms by a process of natural selection acting on random mutations.

[p.37]

But this dogma is in conflict with another dogma of modern biology, namely, that the gene (and its consequent enzyme) is highly specific, and different from virtually all other genes. But if the gene is really so unique then it is too unique to be produced by a Darwinian mechanism because these specific nucleotide sequences will not be produced rapidly enough. The discrepancy here amounts to tens or hundreds of powers of magnitude. I won't say more here as this issue has recently been well analyzed by Frank Salisbury (1969) and Murray Eden (in Moorhead and Kaplan 1967). What I will say more about, however, is mutation itself. With the elimination of other possibilities, the Darwinist now relies on mutation to provide

the variation for natural selection to utilize. This is a problem because the one thing that the paradigms have to account for is progressive evolution, whereas mutations seem to be anything but progressive. They seem to be a biological analogy of noise in a physical system—they occur spontaneously and randomly as the result of accidents in cellular or nuclear metabolism; they have no known cause and they decrease the integration and order of the system. There is no known mutation which can claim to be beneficial and also survive criticism.

b) Creationism. The creationist, of course, doesn't have the same problem. He asserts that an horizon is provided for our investigations by the fact that there are irreducibly different kinds of animal and plant. As to variation within these kinds the creationist can explain this according to normal genetic processes. In normal animal populations today there are about fifty independently segregating genes and most of these have five or six alleles. By recombination you can produce some 1,060 different forms. When you take into account the amount of hidden variation which can be released by breaking linkage groups etc., there is clearly more than enough potential (!) to account for the trivia which the evolutionist calls 'evolution in action'—the relevant variation was all there to start with.

B. Homology

a) Darwinism. Here the argument is that if we compare, say,

[p.38]

the forelimb of a crocodile, the paddle of a whale, the wing of a bird, the wing of a bat, the forelimb of a mole and the arm of a man, we find that although they perform different functions they nevertheless have a similar arrangement of bones, nerves and muscles. This the evolutionist explains by arguing that they all evolved from a common ancestor with this same basic structure. This is, of course, a very crucial argument for as de Beer puts it: 'This concept is at the root of all phylogenetic schemes, for it is by means of their homologous structures and the modifications which they have undergone that the ancestry and affinity of organisms are determined.' (1958 p. 146.) There are many criticisms of this so I can only give a few. Firstly the argument makes a very questionable assumption, namely, that whereas the particular features of any animal are adaptive to its particular mode of life, its general plan is not. What is amusing here is that this assumption conflicts with Darwinism itself. As a result several evolutionists have given it up. The zoologist Arthur Cain writes that: 'everything that is known of the power of natural selection and the nature of evolution strongly suggests that there has been ample time for the complete reconstruction of the older groups to make them better adapted to their modes of life if this had been necessary; their remarkable constancy of plan combined with plasticity in pretty well every detail of that plan over hundreds of millions of years almost forces us to the conclusion that they are as they are because that is what, in competition with all the other great groups, they need to be.' It is really quite entertaining for a creationist to watch all this—the evolutionists are continually putting up arguments and then later—without publicity—so toning them down that the creationist, after the necessary conceptual adjustment, can give the same explanation.

My second criticism of the evolutionary argument is more serious. The evolutionary explanation of homology has met a snag in the fact that homologous structures reveal no unity in production. At first it was thought that homologous organs would have a common embryological origin—but there are too many exceptions. So after the rise of genetics various attempts were made to explain homology in terms of common genetic

[p.39]

determination, but this, too, has failed as indeed have all other attempted explanations. By 1930 several biologists had given up trying. Writing in 1958, Sir Gavin de Beer refers to the 'interesting paradox' that 'while continuity of homologous structures implies affinity between organisms in phylogeny, it does not necessarily imply similarity of genetic factors or of ontogenetic processes in the production of homologous structures' (p. 153). He goes on to comment that, 'Since the developmental mechanisms of homologous structures can become changed, the wonder is not that morphological relations sometimes may vary, but that they are usually so remarkably constant'. The only possibility would seem to be that the plan of an animal body is entirely the product of the environment. But Alister Hardy argues that this is 'remembering the great variety of environments which a single species may encounter and the variety of different kinds of animals which may live in the same habitat... almost a reductio ad absurdum' (1965 p. 24). Stalemate!

b) Creationism. The creationist might expect similarities because since the animals were created for man, it is reasonable to expect that they should be classifiable. But the creationist might also expect that each animal would be structured the way it is because that is the best for it in relation to its way of life. Cain has shown that there is a substantial body of evidence to support this view.

These are just two brief illustrations of the way in which we can analyze the respective paradigms of evolution and creation. All that remains for me to do is to reassert the primacy of scripture. And I can do no better here than to quote some words of Calvin:

> 'It is vain for any to reason as philosophers on the workmanship of the world, except those who, having been first humbled by the preaching of the Gospel, have learned to submit the whole of their intellectual wisdom (as Paul expresses it) to the foolishness of the Cross (I Cor. i. 21)' (1965 p. 63)

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BARKER, A. D. Philosophy (*44:* 271, 1969)

de BEER, G. R. Embryos and Ancestors (O.U.P., 1958)

[p.40]

von BERTALANFFY, L. Problems of Life (Watts and Co. 1952)

BLACKHAM, H. J. Humanism (Penguin, Pelican, 1968)

CAIN, A. J. In Viewpoints in Biology (*3:* 36, 1964)

CALVIN, J. 1554 A Commentary on Genesis (The Banner of Truth Trust, 1965)

DARWIN, C. More Letters (2 vols. London, 1903)

DELFGAAUW, B. Evolution: the theory of Teilhard de Chardin (Collins, 1969)

GOUDGE, T. A. The Ascent of Life (George Allen and Unwin 1961)

GRENE, M. The Knower and the Known (Faber and Faber, 1966)

HARDY, A. C. The Living Stream (Collins, 1965)

KUHN, T. S. The Structure of Scientific Revolutions (University of Chicago Press, 1962)

MAINX, F. Foundations of Biology (University of Chicago Press, 1955)

MANSER, A. R. Philosophy (*40:* 18, 1965)

MEDAWAR, P. B. Induction and Intuition in scientific Thought (Methuen, 1969)

MOORHEAD, P. S. and KAPLAN, M. M. Mathematical challenges to the Neo-Darwinian Interpretation of Evolution. (Wistar Institute Press, 1967)

MORE, L. T. The Dogma of Evolution (Princeton University Press 1925)

NIDDITCH, P. H.(Ed) The Philosophy of Science (O.U.P., 1968)

OPPENHEIM, P. and PUTNAM, H. Minnesota Studies in the Philosophy of Science (Vol. 2 p. 3, 1958)

POINCARE, H. Science and Hypothesis (Walter Scott Pub. Co., 1905)

POPPER, K. R. Conjectures and Refutations (Routledge & Kegan Paul, 1963)

[p.41]

POPPER, K. R. Fedn. Proc. Fedn. Am. Socs. exp. Biol. (*22:* 961, 1963a)

PUMPHREY, J. E. Symp. Soc. exp. Biol. (*4:* 5, 1950) SALISBURY, F. Nature, (Lond. *224*: 342, 1969)

WALLACE, B. Chromosomes, Giant Molecules and Evolution (MacMillan, 1967)

WATSON, D. M. S. Rep. Br. Ass. Advmt. Sci. (88, 1929)

WISDOM, J. O. Brit. J. Phil. Sci. (*8:* 325, 1957)

WISDOM, J. O. Brit. J. Phil. Sci. (*13:* 303, 1963)

de WIT, D. J. J. in Philosophy and Christianity (p. 405 North-Holland Pub. Comp., 1965)