GENE DOMINANCE IN EVOLUTION AS IT MODELS REGENERATION*

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I. The Power of Analogical Thought

The Writings encourage us to confirm doctrinal truths with examples from nature, as long as natural truths are subordinated to spiritual truths.[1] This confirmation of doctrine can help us to understand it more fully. Seeing a thing in terms of something quite different strengthens our perception of it by giving us a stereoscopic mental view of it. Finding a single abstract idea in several incidental guises enables us to see it from more than one point of view, to distinguish the essential elements from the peripheral ones, and, as a result, to find a still wider application for it.

In dealing with complex ideas, the effort to fit as many specific elements of a pair of concepts as possible into a powerful, detailed analogy invites a more penetrating scrutiny of both sides." The analogy breaks down here," we may say, but perhaps a deeper understanding of it would enable us to push through the point of apparent breakdown—or even to rethink the whole construct in a more fruitful way.

Douglas Hofstadter, in his book *Metamagical Themas,* makes a distinction which I find highly useful, between the mapping of one complex entity onto another and the matching-up of individual roles within each entity.[2] This distinction came into play when, in the course of writing this article, I continually had to reexamine the question, "What is the analogical context for this particular correlation of ideas?"

A true correspondence, like that between the human soul and human body, is a perfect analogy, because each effect in the body,

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1 AC 129e, 2538:2, 2689:3.

2 Hofstadter, Douglas R., *Metamagkal Themas,* pp.547-603.

down to the smallest, subtlest form, originates from a spiritual cause.[3] Only our imperfect understanding limits our ability to see the parallel in its infinite richness of detail. Because we know the correspondence itself is complete, we can't blame our difficulties on it and complain that the analogy breaks down. Therefore a true correspondence creates an excellent opportunity to exercise and develop our stereoscopic understanding.

In the case of an analogy which we do not know from the Writings to be a true correspondence, how do we judge whether it is or not? Although it may be impossible to come to a certain conclusion, the Writings do offer some clues. First of all, correspondences are everywhere. "The whole natural world corresponds to the whole spiritual world, not only... in general but in every particular."[4] Therefore nothing in the created universe can be ruled out on the basis of subject matter—everything natural corresponds to something spiritual. Second, "the correspondence of all things of the universe with all things of man"[5] means that we can find an image of the human form in any aspect of nature—animal, vegetable or mineral. Not only do all things have a correspondence; they all have a correspondence with man, both individually and collectively. Each aspect of nature reflects an aspect of the human form and consequently the whole human form, for the human form itself is composed of smaller instances of itself.[6]

All this doesn't do much to narrow the field. But a more specific key to correspondence can be found in the concept of use. "...[A]lthough the heavens... do indeed correspond to the very organic forms of the human body,... they nevertheless correspond chiefly to the functions of these viscera or organs. The case herein is as with the organs or viscera themselves, in that their functions constitute a one with their organic forms; for no functions can be conceived of except from forms. . . . "[7] So spiritual things correspond to the external forms that clothe them only as far as these forms reflect their use. Thus "all bodily things of man correspond to all things of heaven" even though "the form of one's natural man differs greatly from the form of his spiritual man."[8] Swedenborg uses the reproductive cycles of animals to show the image of crea-

[3] AC 2997.

[4] HH 89.

[5] DLW 52.

[6] AE 11192.

[7] AC 4223.

[8] HH 99.

tion in the forms of their uses.[9] It is not a superficial similarity of form but a deeper congruence of use that indicates a correspondence. This follows from the truth that correspondences link different planes of creation together—planes which are separated by discrete degrees;[10] created entities which exist in the same degree cannot be conjoined by correspondence. For example, "Man is so created as to have a connection and conjunction with the Lord, but with the angels only an association" because "man is by creation like an angel."[11]

This reflects only a small part of the great wealth of material which the Writings present about correspondences, but I intend to bring up more of the points Swedenborg makes as I draw the necessary background for my analogy between regeneration and evolutionary genetics.

II. Introductory Concepts
A. Evolution as a Human Process

Although the Writings do not directly support the idea that the physical evolution of the human race corresponds to individual regeneration and the spiritual history of mankind, they do, it seems to me, admit the possibility and even offer considerable indirect support for it. Figure 1 is a diagram which shows how evolution fits into the scheme presented in the Writings. The truth that everything spiritual has a corresponding natural basis seems to require a "gestation process" for the human race. With evolution in the fourth corner, we have four processes which can be divided up in two ways: two spiritual and two natural, or two general and two individual. As the arrows show,they can generate six different pairs, two of which rest on direct support from the Writings (gestation/regeneration, regeneration/human history). All the other pairings follow from those two and from the extrapolation with evolution which I have made.

I discuss all six of these parallels in my previous article, "Correspondences of the Developing Human Form"[12] in which I review

[9] DLW 316.

[10] AC 1476.

[11] HH 304.

[12] Odhner, Linda Simonetti, "Correspondences of the Developing Human Form," *The New Philosophy,* Jan-March & April-June 1985.

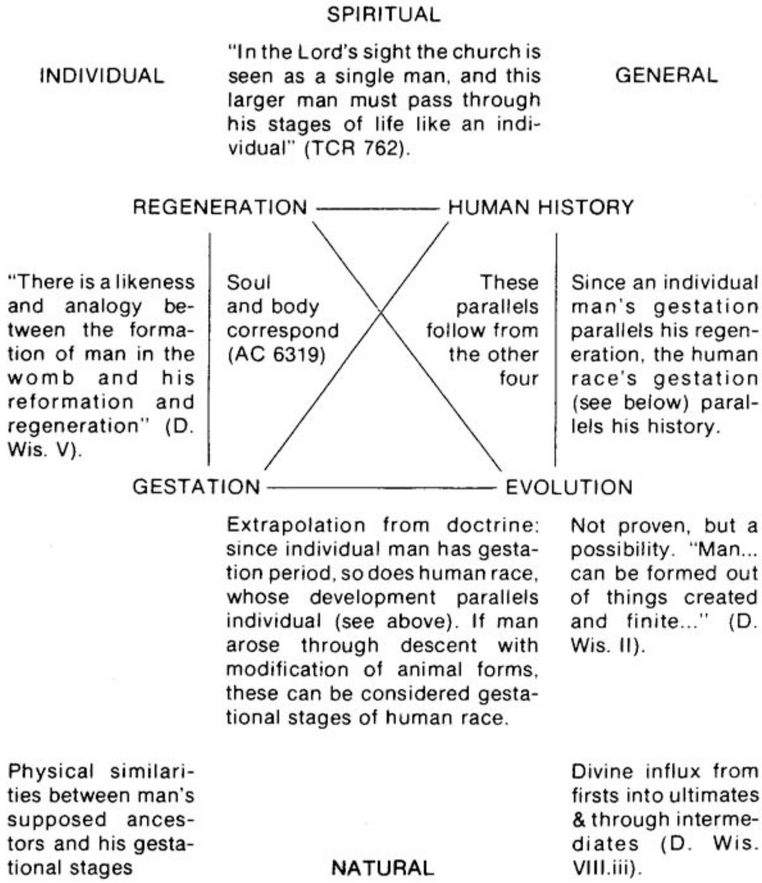

Fig. 1. Table showing four dynamic human processes and their parallels, illustrating the possibility that evolution occupies the fourth corner.

some of the doctrines in the Writings which bear on the cycle of the human form in creation, and show how they might apply to the correspondence between human gestation and regeneration. In that article I give the other parallels a much briefer treatment, touching only lightly on evolution. In the present article I will explore evolution in greater depth, in terms of both individual regeneration and human history.

This article rests on the assumption that evolution by natural selection working on genetically caused variations (synthetic Neo-Darwinism) is a true, though not necessarily complete, model. There is more general agreement that evolution really happens, and even that it's responsible for the staggering diversity of life forms on earth, than that natural selection (however broadly defined) is its sole or primary mechanism.[13] Its role in the domain of micro-changes in populations is fairly well established. What I present here is a study of these small changes in populations and a possible way to relate them to some of the doctrines in the Writings about regeneration; and I consider these changes in the context of a process which I believe to have been instrumental in the origin of the human race on earth. While I don't deal directly with the processes involved in macroevolution (whatever they might be), I do consider it an integral element of my construct. For a philosophical and scientific defense of my belief in evolution, see appendix A.

I wish to emphasize here that, aside from postulating a correspondence between evolution and human regeneration/history, I come to no original conclusions, either scientific or doctrinal; the originality lies solely in the nature of the connection between doctrine and science. Even the inferences I make at the end of the article, although inspired by the analogy, do not depend on it—they are based on doctrine. As to whether the analogy I make is a true correspondence or not, it may be helpful to keep in mind this statement from the Writings: "Representations are nothing but images of spiritual things in natural ones, and when the former are rightly represented in the latter, the two correspond."[14]

B. Form and Process in Evolution

When we regard evolution as a series of formal events, we focus on individuals. We see it as a succession of single creatures—"from

[13] Taylor, Gordon Rattray, *The Great Evolution Mystery*, passim.

[14] AC 4044.

amoeba to man," as the saying goes. Some of us probably have a picture in our minds of some of the vertebrates leading to man, all neatly lined up, perhaps sitting on various branches of a phylogenetic tree (fig. 2). But even the branched model can't fully take into account the untidy, sprawling, extravagant, wasteful, apparently aimless intricacy of evolutionary variation. The diverging branches of countless lines of descent generate such a dense and tangled bush that we need to step back and do a judicious bit of pruning to discern the underlying forms. It is the still-mysterious macro-changes, such as the emergence of legs and wings where none were before, that we see in terms of successive, discretely different individual forms.

When we take a closer look at how evolution works—the mechanisms that carry it from one generation to the next—we need to widen our focus from concentration on the individual to encompass communities of individuals: populations, as they're called in evolutionary genetics. We can define a population as a group of creatures which is reproductively isolated from other groups of its own species, but whose members interbreed and share genes among themselves, creating a "gene pool."[15] In genetic terms the population, rather than the individual, is the functional unit of evolution. An individual affects the course of evolution only as it relates to its population, most immediately its parents, mates, and offspring.

In the analogy which follows I compare the regenerating man with the genetically defined population, and thence a state of the regenerating man with a state of the population. Besides the general teaching that man is imaged in everything of nature[16], other teachings in the Writings support the validity of this comparison. Any unit of function, or use, can be compared with a man, for as D. Love V. iv states, man is the complex of all uses, and every use is like a man; and "in every use there is the idea of the whole, and thereby an image of man . . . . [17]" More specifically, any community of people who together perform a use is in the form of a single man:

> By man to whom uses have relation is understood not only an individual, but also an assembly of men, also a society, smaller or larger, as a state, kingdom, or empire, or the largest society which is the world, for each of these is a man.[18]

[15] Jenkins, John B., *Genetics,* p. 639.

[16] DLW 52.

[17] D. Wis. XIIe.

[18] DLW 328.

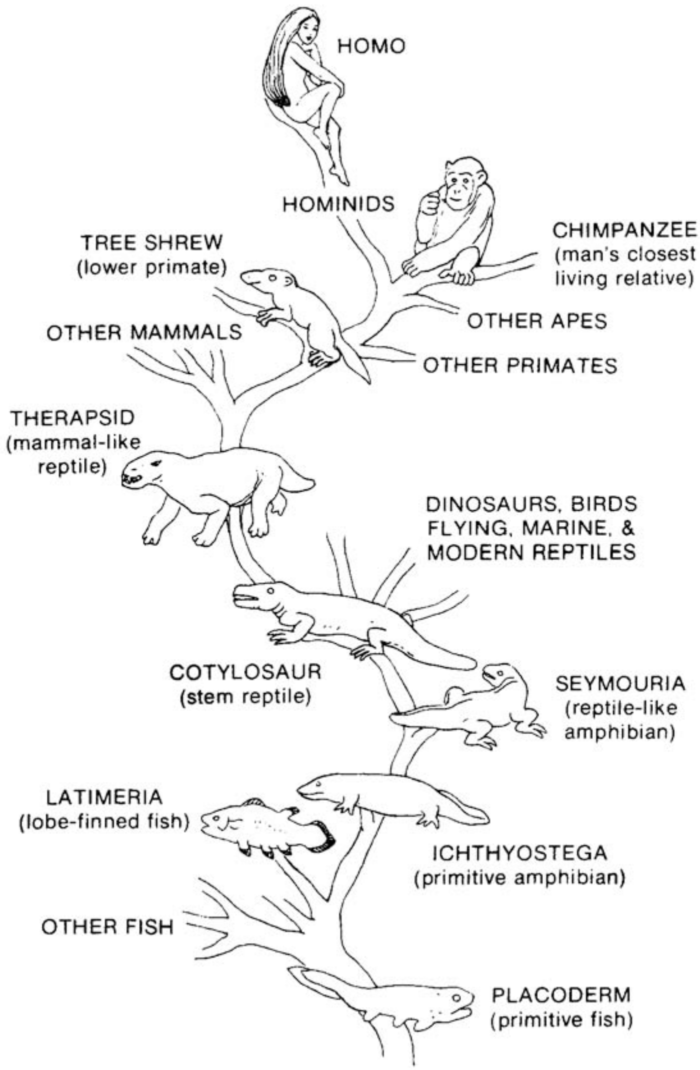

Fig. 2. Phylogenetic tree (hypothetical) showing some of the vertebrates on or near the line leading to man. Greatly oversimplified; not drawn to scale. Some are modern representatives of animal groups in man's ancestry. (Sources for individual drawings: Keeton, *Biological Science;* Curtis, *Biology;* Moody, *Introduction to Evolution;* American Museum of Natural History, New York.)

I think that seeing groups of animals in a similar, though more physical way, is a legitimate extension of this concept for analogical purposes. Even if it is not an actual correspondence, the gene pool of a population certainly reflects a natural use in evolution, and thus can be seen in the human form.

The distinction between form and process in our way of seeing evolution, and the related distinction between individual and population, can play a central role when applied to a spiritual view of evolution. The following example illustrates this point and forms the basis for my discussion of gene dominance.

C. Sexual Reproduction and the Posterity of the Most Ancients

My studies on human development keep leading me back to the separation of will and understanding in man which originated at the end of the Most Ancient Church. This event in human history profoundly affects the process of individual regeneration. In my article, "Correspondences of the Developing Human Form," I compared this separation to the change in circulation which accompanied the development of air-breathing in fishes.[19] This is an example of the focus on formal events in evolution.

Now I propose that the separation of will and understanding can also be compared to the evolution of sexual reproduction: the change from one parent to two, the separation of hereditary sources. This is an event, of course (actually a set of events), but an event not so much of form as of process; an event which profoundly affects the process and direction of evolutionary change. It is, so to speak, a change of form leading to a change of process, which illustrates the reciprocal relationship between the two: process generates form which in turn affects the nature of process.

The chief evolutionary significance of sexual reproduction is usually considered to be the increased adaptive possibilities of gene shuffling. As G. R. Taylor has pointed out,[20] gene shuffling confers no immediate advantage on a perfectly adapted species, because it decreases genetic stability and, in fact, causes a certain amount of genetic loss—each offspring inherits only half the genes of each of its parents. The advantage consists in the ability to respond to environmental changes with genetic changes. Therefore, like the

19 Odhner, *op. cit.*, No. 2, pp. 498-502.

20 Taylor, *op. cit.*, p. 197.

separation of will and understanding, the separation of genetic sources is useful when change becomes necessary to bring the organism (whether human or animal) back into proper balance.

The Most Ancients, being in proper relation to the Lord, each other, and nature—like a perfectly adapted species—had no need of an understanding separate from their will by which to be regenerated, as we do.[21] In the context of population genetics, I'm going to show that the way sexual reproduction aids evolutionary change parallels the manner in which the separate will and understanding make human regeneration possible.

D. The Diploid Genome

The development of sexual reproduction depended on the prior development of mitotic division—a mechanism which enables cells to keep large numbers (when necessary) of chromosomes sorted out and to divide them with consistent accuracy. To be able to handle the double dose of genes involved in sexual reproduction, cells also had to develop meiosis—reduction division, which reduces the number of chromosomes, and thus the amount of genetic material in the cell, by half. Otherwise each generation would possess twice as many genes as the previous one, and the genome, the genetic makeup of the individual, would soon become unmanageably large.[22]

All eukaryotes (organisms with true cell nuclei) undergo a cycle of meiosis followed by syngamy, which leads to meiosis again (figs. 3 & 4). This holds whether the organism is unicellular or multicellular, whether the gametes are identical or different, whether the species can be divided into distinct male and female types or not. (As it is generally defined, sexual reproduction requires two distinct types of gametes.)[23]

What changes as we go up the ladder of life is the rhythm of the cycle. The lowest eukaryotes (flagellate protozoans) spend most of their time in the post-meiotic state, which is called haploid because only a single set of chromosomes is present. When two haploid gametes fuse (syngamy) they generate a double set of chromosomes—the diploid number—one set from each gamete. In the protozoa, another meiotic division immediately reduces the

21 AC 8118.

22 Kirk, David, *Biology Today*, p. 50.

23 See def. of asexual rep. in glossary.

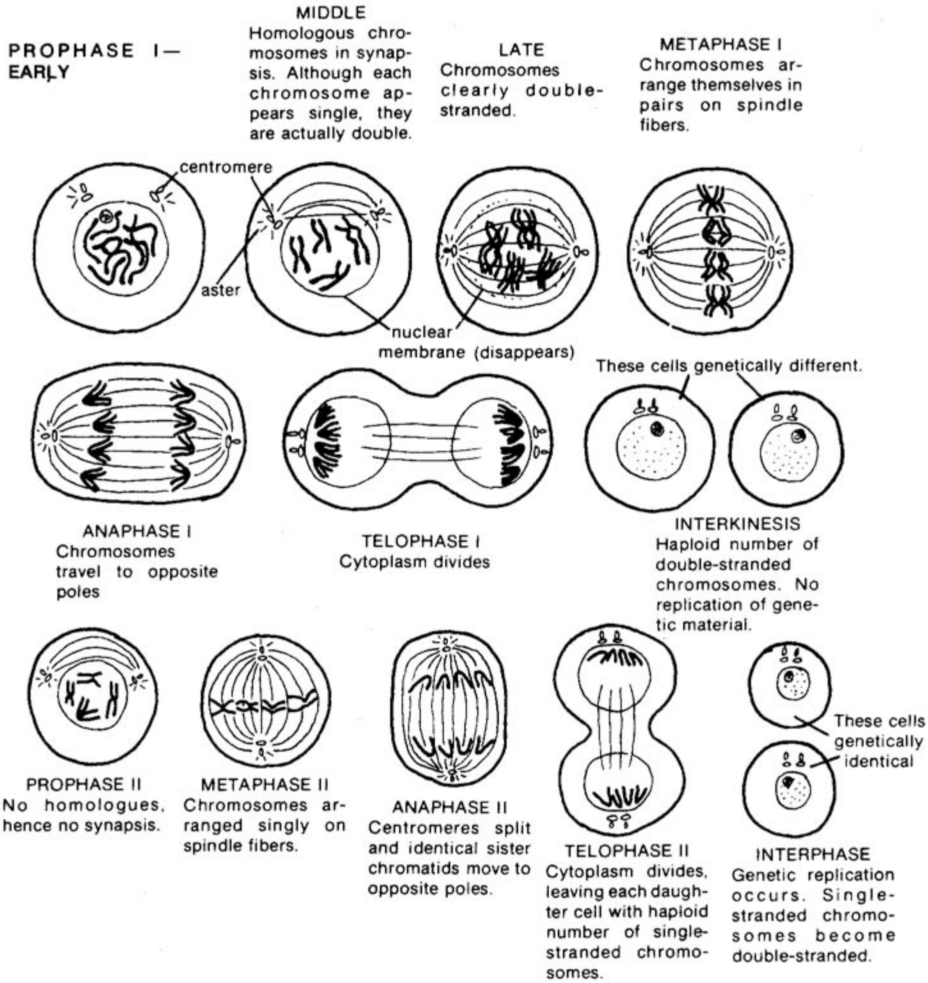

Fig. 3. Meiosis in animal cell. In the first meiotic division homologous chromosomes pair off (synapse) and one of each pair goes to each daughter cell. The second meiotic division is essentially a mitotic division involving the haploid number of chromosomes—splitting the chromosomes into their component chromatids. Chromatids are identical halves of a chromosome, joined at the centromere, which result from genetic replication during interphase. During the interkinesis between meiotic divisions, replication does not occur because the chromosomes are already double; chromosomes themselves do not split during the first meiotic division. In animals, after the second meiotic division, each cell in the male differentiates into a spermatozoon; one of the four cells produced by each meiosis in females becomes the ovum. In syngamy the diploid chromosome number is restored. (Adapted from Keeton, *Biological Science,* fig. 13.10; Curtis, *Biology,* figs. 12-3 to 12-7, pp. 187-190).

chromosome number to haploid again. But more complex organisms tend to spend more time in the diploid state. Many plants, like ferns, spend a significant amount of time in each state; the haploid form is quite distinct from the diploid form (fig. 5). In many of the higher organisms, such as man, fertilization (syngamy) begins before the egg completes meiosis, which means that, from the ovular point of view, we spend less than no time in the haploid state.[24]

E. Gene Dominance

Dominance is a relationship between genes which can only occur in the diploid genome,* because it only applies to genes whose functions are equivalent, governing the same process in the organism; and these related genes appear on the pairs of corresponding chromosomes—called homologous chromosomes—which characterize the diploid genome (fig. 6). These corresponding genes are said to be allelic to one another. Each parent contributes one chromosome to each homologous pair, so that, in general, each physical character is affected equally by genes from both parents.** At any given gene locus on any given pair of homologues, the two alleles can be identical,making the organism homozygous for that gene, or different, making the organism heterozygous for that gene.

Dominance is the ability of one gene to mask the effect of a different allele. When the effect of one gene covers up or neutralizes the effect of another gene which is allelic to it, the first gene is said to be dominant to the second; the second, recessive to the first. Consequently, a dominant gene will have the same effect on the organism in heterozygous form (single dose) as in homozygous form (double dose). Since the effect of a recessive gene will be masked by the dominant allele in the heterozygote, or heterozygous individual, the recessive gene makes its presence known only in homozygous form. This characteristic of heritable traits can be seen without any knowledge of the nature of genes and chromosomes, by means of controlled breeding experiments—as Mendel discovered (fig. 7).

[24] *Ibid.*, p. 53.

* Chromosomes occur also in polyploid form: triploid, tetraploid, etc., but this is beyond the scope of my discussion. Polyploidy is almost always confined to plants.

** Sex chromosomes are an exception. In man, for example, most loci on the X chromosome are not represented on the Y chromosome.

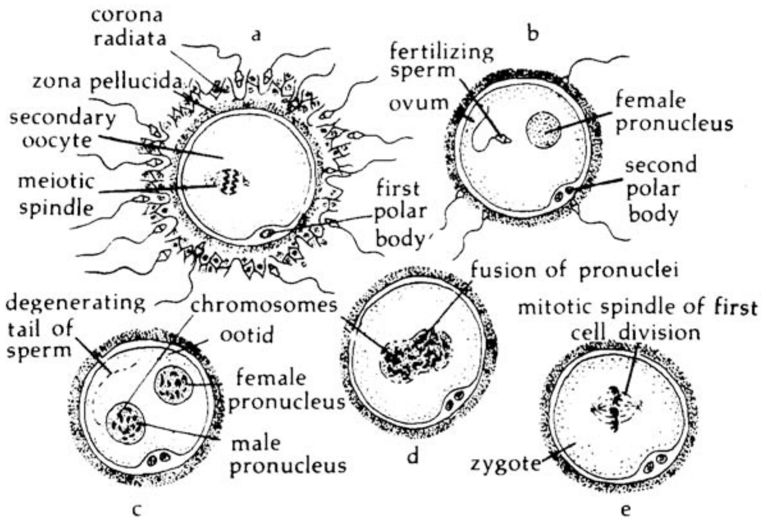

Fig. 4. Successive unions in fertilization. In (a), the secondary oocyte is still undergoing its final meiotic division, which is not complete until after the sperm has entered (b), and the second polar body is ejected. The corona radiata has disappeared. In (c), the sperm sheds its tail and its head enlarges to become the male pronucleus. In (d), the pronuclei are fusing to form the nucleus of the zygote (e), in which the chromosomes double and are aligned on a mitotic spindle in preparation for the first mitotic divsion.

Some of the more complex forms and aspects of gene dominance will enter into my discussion of its spiritual implications.

III. Spiritual Roles of Recessive Genes

A. Recessive Genes and Remnants

Gene dominance makes it possible for large numbers of genes to be stored unexpressed in the gene-complexes, or genomes, of organisms, in the form of recessive genes. In other words, variation in the genotype (the particular type of genome) is not always reflected as variation in the phenotype (the complex of physical characters in the organism). The potential variability of a species is almost always more than meets the eye, and thus the storing of recessive genes has great evolutionary significance.[25]

Recessive genes can be compared to remnants[†]: they play a role in evolution similar to the role of remnants in human regeneration. Remnants, as the Writings describe them, are all the goods and truths which the Lord gives to man from earliest infancy and stores up in his internal natural for use in regeneration.[26] The Lord stores them up in this way to protect them from being profaned when man's hereditary evils become active.[27] But He brings them out again to aid man in his fights against these evils;[28] ". . . . such a supply is drawn from them, as is conducive to the use of life."[29] In a similar way, recessive genes are stored away in the genome, masked by dominant genes and thus protected from natural selection in an environment which would not favor their expression. A recessive gene will have no direct effect on an individual which carries it in heterozygous form, but it may affect the nature of the offspring. It forms an important part of the population's gene pool.

In matching recessive genes to remnants, I am viewing the whole population as representing an individual man, as stated above. Man's life, and thus his regeneration, is a succession of states; so is the history of the human race. Man's biological evolution can be seen more outwardly (phenotypically) as a succession of animal forms, and more inwardly (genotypically) as a succession of populational gene pools. The former view of evolution enters into the comparison cited above concerning air-breathing fishes;[30] the latter view forms the biological side of the analogy I am now making. Bringing out remnants at a state in man's life when evils are uppermost may have a harmful effect on him, even though remnants are good. If he profanes them, mingling them with evils and falsities, he inactivates them completely and renders them useless for their intended purpose, as instruments for the Lord to use in leading him to good.[31]

[25] Allen, Garland, *Life Science in the Twentieth Century,* p. 131.

[†] In using the term "remnants" instead of the more familiar "remains" I am following the new Elliott translation of *Arcana Caelestia.*

[26] AC 737, 1050, 5135:4, 7601:2.

[27] AC 2284:2.

[28] AC 3336:3.

[29] AC 5984.

[30] Odhner, *loc. cit.*

[31] AC 571, 660, 661.

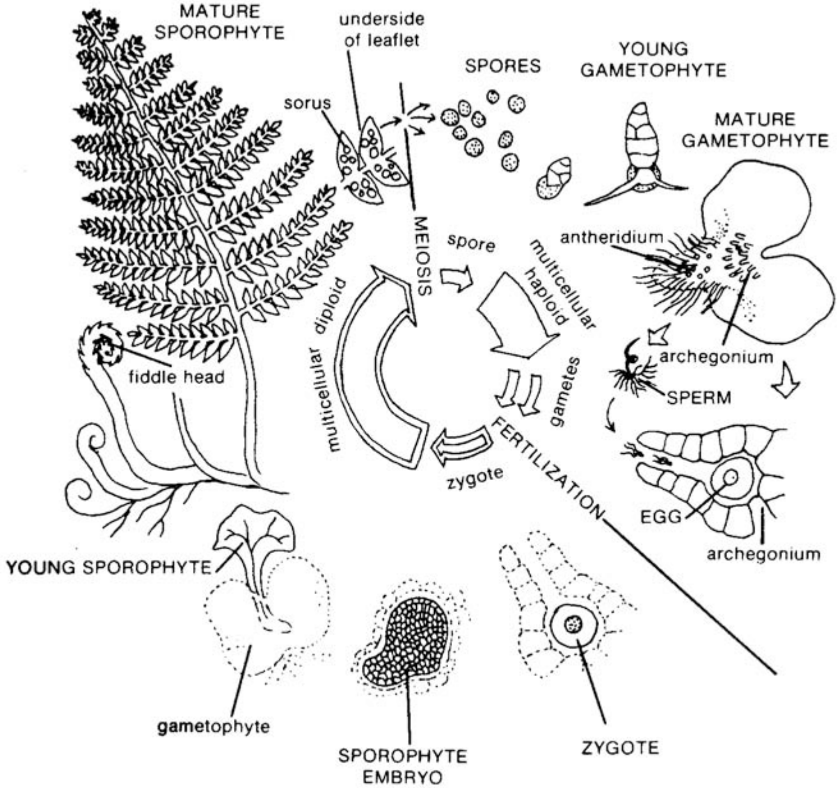

Fig. 5. Fern life cycle showing haploid (single arrow) and diploid (double arrow) stages. The diploid sporophyte produces haploid spores, which grow into haploid gametophytes; the gametophyte produces haploid gametes (egg and sperm) which fuse into a diploid zygote, which, in turn, grows into the diploid sporophyte. Haploid structures are shown in dotted lines on the diploid side. (Adapted from "Fern Life Cycle" sheet, Carolina Biological Supply Co., 1971; and Keeton, *Biological Science*, figs. 21.42 & 21.43.)

If a potentially useful but initially harmful gene mutation is dominant, it will give rise to damaging traits in a population and be eliminated by natural selection before it gets a chance to show its usefulness.[32] A recessive mutation, on the other hand, which only affects an individual in the homozygous state, is at least partly shielded from the effects of natural selection, just as remnants are shielded from harmful externals in man. Both recessive genes and remnants are stored away until the time is ripe for their use. An example from nature follows:

In *Drosophila pseudoobscura,* a species of fly, chromosome 3 appears in a variety of forms whose relative frequency in a given population varies dramatically with the seasons. One form equips the fly to thrive at high temperatures; another, at low temperatures; still another confers an advantage under moderate conditions. Each chromosomal form reduces viability and fertility "out of season," but only in the homozygous state. Therefore its frequency is reduced only to the point where few homozygotes are produced; the more numerous heterozygotes preserve the chromosome until changing temperatures bring it into its own.[33] Although this example deals with whole chromosomes rather than individual genes, the functions of dominance and recessiveness still hold.

Expanding the analogy to include the environment, we can note that natural selection and the struggle for survival which gives rise to it in evolution are highly suggestive of temptation. The rigors of the environment, such as cold, predators, or lack of food, could represent adversities from without which precipitate a state of temptation in man; the competition for resources and safety within the population would then represent the spiritual conflict itself—man's fight against the evils within him. The recessive genes which can aid survival resemble remnants: "cognitions of truth and good which never come to light or into daylight until external things have been laid waste."[34] It is changing conditions which challenge the adaptation of a species and tend to bring out the "cryptic variability" stored in its genes.[35] The "death of bodily and worldly concerns"[36] which introduces temptations is like the environmental changes

[32] Huxley, Julian Sorell, *Evolution: the Modern Synthesis,* p. 59.

[33] Moody, Paul Amos, *Introduction to Evolution,* pp. 365-368.

[34] AC 19.

[35] Allen, *loc. ext.*

[36] AC 8.

which may render some prevailing dominant traits useless or detrimental.

B. Recessive Genes and Hereditary Evils

Recessive genes can also illustrate the usefulness of hiding evils. When a mutation arises that is just plain damaging (and most mutations probably are),[37] it will do much less immediate damage if it is at least partly recessive (as most mutations probably are).[38] A harmful recessive mutation will remain hidden until its increasing frequency makes it likely that two carriers will mate and produce an offspring homozygous for the gene (still only one chance in four for any given offspring). In contrast, a harmful dominant mutation will cause problems for its bearers right away. This can remind us that the Lord does not permit all our evils to become active at once, so that we will not be swamped by them; He permits us to face our evils only when we are ready.[39] The recessive nature of most mutations helps to insure that a population won't have to cope with too many harmful genes at once. This might be especially important if the mutation rate were particularly high for any reason, such as radiation, which is often used experimentally to induce mutations in breeding experiments. The fact that harmful recessive genes cause no damage to their heterozygous carriers also illustrates that "no one is blamed for what is hereditary, but for what is actual."[40]

On the other hand, evils can only be faced and fought when they emerge into the open. Hidden evils which have no outlet would eventually poison a man to death. "But when a man is permitted to think the evils of his life's love, so far even as to intend them, they are cured by spiritual means, as diseases are by natural means"[41] A harmful recessive can increase in frequency unchecked in a population to the point where a significant number of homozygotes are produced. Only their low (or nonexistent) rate of reproduction will act as a check on the frequency of the gene. Conversely, a harmful dominant will be eliminated from the gene pool much more quickly and efficiently than a harmful recessive, because all of its carriers face a disadvantage. So we see that the survival of a population depends on a balance between dominant and recessive genes, much

[37] Moody, *op. cit.*, p. 357; Huxley, *op. cit.*, p. 83.

[38] Moody, *op. cit.*, p. 316.

[39] AC 2636:2; DP 277:4.

[40] AC 4563:2.

[41] DP 281.

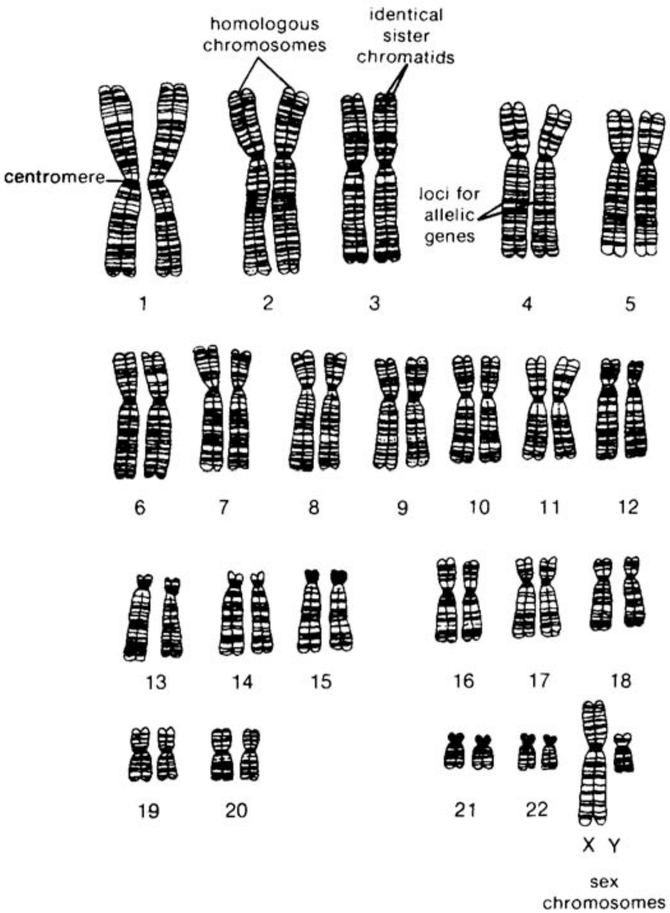

Fig. 6. Human male karyotype showing complete diploid set of genes, arranged in homologous pairs by size and banding pattern. One of each pair comes from each parent; of the sex chromosomes, the X comes from the mother and the Y from the father. In females there are two X chromosomes, one from each parent. The chromosomes are shown double-stranded, with each chromatid in evidence. During mitotic division, the identical chromatids separate; during the first meiotic division, chromatids stay together, while homologues pair off and separate. (Source: Jenkins, *op. cit,* fig. 5.8, p. 197).

as man's freedom depends on a balance between obvious and hidden qualities—the Lord keeps things hidden or brings them out in such a way as to preserve our freedom to choose good or evil. In fact, dominance enables a species to maintain a balance between stability and plasticity of adaptive response,[42] which reflects the equilibrium between permanence and changeability in our own lives. Freedom can mean nothing without the possibility of change, and only through remnants can we change, be regenerated and become fully human.[43]

C. Remnants versus Hereditary Evils

I realize that making an association of recessive genes with both remnants and hereditary evils raises serious questions. Obviously remnants and hereditary evils do not play an equivalent role in man's life in the sense of being exact opposites. Hereditary evils are present at birth, though dormant, and originate from the appropriation of evil by our ancestors,[44] while remnants are not hereditary, but are gifts given to us by the Lord throughout our lives. However, they are given to balance hereditary evils, and both kinds of influence have this in common: they are not originally willed or chosen by us, but instead are the raw materials, so to speak, with which we start when we begin the work of regeneration. They also share the quality of being internal to man's conscious life, for the most part; and when they are brought into our external lives we have the opportunity to make them our own intentionally. The equivalence of remnants and hereditary evils is not one of origin, but of function.

I think the fact that hereditary evils are hereditary and remnants are not, while all recessive genes are hereditary, would be more of a problem if I were comparing those spiritual elements with genes in the individual, rather than the population. (The cycling between latency and activity of genes in the individual is a subject I hope to address when I tackle developmental genetics.) The state of a population is inherited from its previous states—which are previous generations—but since it is still the same population, changing gradually, it is not quite like individual inheritance from a discretely different entity. A man's state can be said to be inherited from the qualities of previous states, but in a different way than his qualities and tendencies are inherited from his parents.

[42] Huxley, *op. cit.*, p.74.

[43] AC 565e, 660, 1050, 1906.

[44] See AC 313.

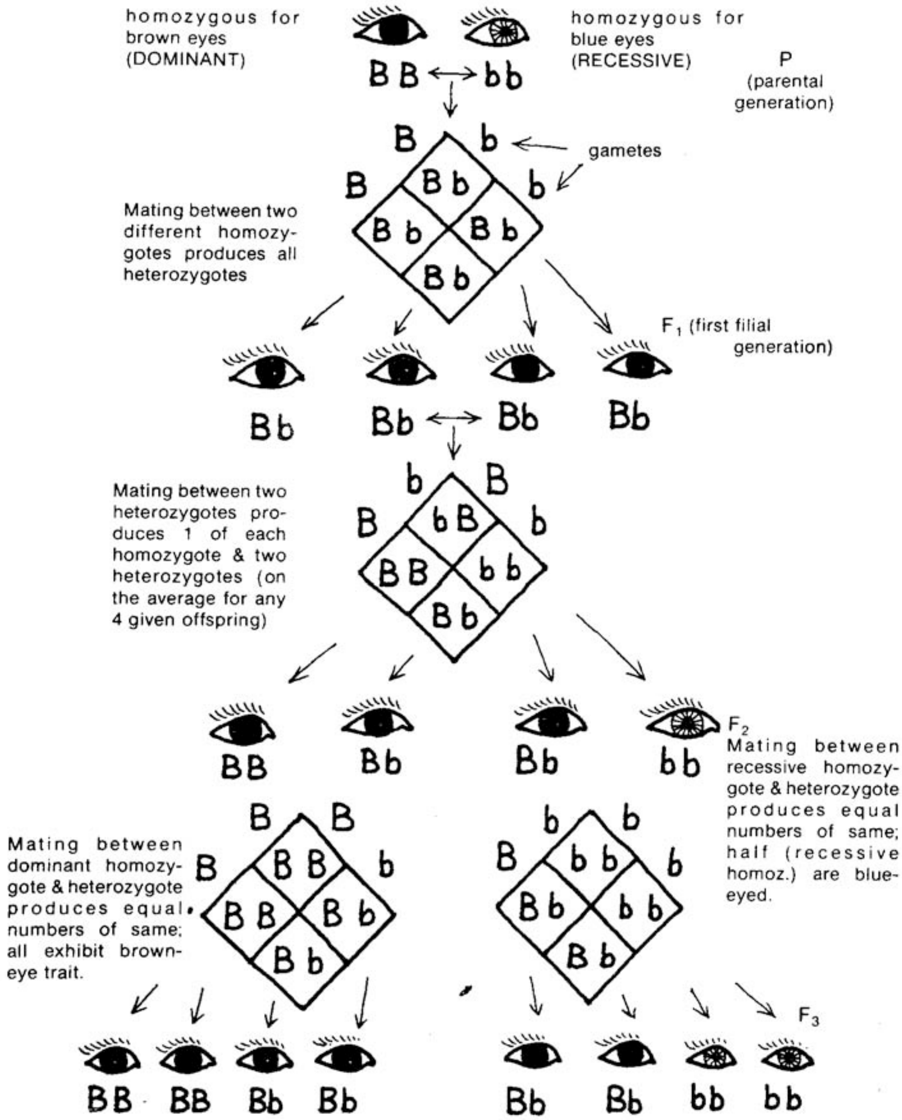

Fig. 7. Diagram showing Mendelian dominance of a single trait (brown eyes over blue, in man). Heterozygotes (having one of each allele) show the brown-eye trait. Where both genes occur with equal frequency, about 75% of the population will be brown-eyed and 25% blue-eyed.

If recessive genes can represent both hidden goods and hidden evils, how can we tell which represent which? Lets put it this way: a recessive gene that ultimately has positive evolutionary significance can represent remnants (even if it initially seems unpromising), while one that ultimately has negative evolutionary significance can represent a dormant evil. Unfortunately we can only make a real judgment about that in hindsight—but this is often true of influences in our own lives as well. Many experiences reveal their full value many years after they happen, as the story of Joseph and his brothers illustrates.[45]

But what constitutes positive or negative evolutionary significance? I'm comparing a process with great moral and spiritual importance—regeneration—with a process whose moral and spiritual implications are controversial, to say the least—evolution. I think evolution in itself is a morally neutral process, because after all it deals with creatures which lack free will, for the most part, and do not evolve consciously. Yet the comparison with a process which does involve a choice between good and evil reflects that polarity upon it. Evolution abounds with metaphors for the interaction of good and evil; predatory behavior is an outstanding example. Killing for meat involves the destruction of innocent life and causes its victims (at least among the higher animals) apprehension and distress which they cannot be said to deserve. Its effects resemble in a small way those of human perversity. Recall that in this discussion I'm correlating the physical life of a species or population with the spiritual life of a human being. The spiritual survival of a human being implies the possibility of regeneration, just as the physical survival of a population implies the possibility of its geographical spread, increase in numbers, and adaptive radiation. These are positive evolutionary events, but it does not necessarily follow that extinct species are evil, or that a species has a moral obligation to spread and diversify. Nor does a comparison of the approach to the physical human form in man's evolution with the approach to the spiritual human form in regeneration imply that a mammal is morally superior to a fish, although the mammal shares more qualities with man.

IV. What Is Evolutionary Progress?

Defining progress in evolution isn't an easy task. I, at least, am not postulating an accidental, Godless universe, which no absolute value

[45] Genesis, ch. 37-50.

can describe. I need not excuse my references to purpose in evolution as "teleological shorthand," as Sir Julian Huxley must.[46]

The purpose of creation is man,[47] and evolution may be one of the most vital instruments in carrying out this purpose and in providing a setting for man's earthly life. Many evolutionists (not all), of differing religious or philosophical convictions, agree that man is (at least so far) the noblest product of the evolutionary process, and that the line leading to the human race is the privileged axis of evolution.[48]. As far as this line is concerned, we can define progress fairly simply as the approach to physical humanity. But surely we can apply the concept of progress to the line leading to butterflies as well. We can do that by focusing on various individual qualities that, taken together, make up the necessary natural basis for humanity.

This natural basis is absolutely essential and its importance must not be minimized. Without it we could not exist as free, distinct individuals with the appearance of life as our own.[49] Divine life doesn't automatically turn into people as it descends; it must meet an appropriate foundation.[50] Creation proceeds from primes, through ultimates, to intermediates.[51] The outward form makes possible the reception of spiritual life. "Good and truth in created subjects are according to the form of each, because every subject receives influx according to its form."[52] "The Divine is not in one subject differently than it is in another, but one created subject does differ from another . . . . [E]ach thing is a different containant. On this account the Divine in its image presents a variety of appearances."[53]

Matter, being dead in itself, is much less responsive to spiritual forces than spiritual substances are. It has a fixity and inertia which resists change: "... the lowest of nature which make soils are dead, and are not changeable, varying according to states of affections and thoughts as in the spiritual world, but unchangeable and fixed—"[54] Natural forces must work together with spiritual forces to generate

[46] Huxley, *op. cit.*, p. 82.

[47] TCR 66e, 773.

[48] Dobzhansky, Theodosius, *The Biology of Ultimate Concern, 1967,* quoted in Young, Louise B., (ed.), *Evolution of Man,* p. 145.

[49] See D. Love II as quoted in Appendix A, section 1 (footnote 91).

[50] See DLW 3432.

[51] D. Wis. VIII.iii.

[52] CL 86.

[53] DLW 54.

[54] DLW 160; see also AE 1218:2.

and maintain a form receptive of life.[55] As an angel once said to Swedenborg, "In our world creation is from moment to moment, and in yours continues by propagation."[56] Possibly those physical traits which form the basis for human beings arose through the propagation of animal forms. Certain animals share some of these traits in some degree; not only do they share our bodily traits, but "they have also appetites and affections similar to man's natural appetites and affections. And they have connate knowledges corresponding to their affections, in some of which there appears something spiritual which is more or less in evidence . . . . "[57] While it may appear, especially from an evolutionary perspective, that those qualities actually originate from nature, such a a perspective does not necessarily exclude the idea that they are spiritual in origin, ultimately from the Divine Source of life, and only mediated by nature.

Increasing organization, and the increase in complexity and size which makes this possible, are some of the most essential of those qualities which set the stage for human life; organization involves the differentiation of cells into specialized forms for various purposes, and the patterning of those cells into tissues, organs and systems. The eukaryotic cell itself is highly organized, particularly in its devices for handling genetic information (see the section above on "Sexual Reproduction"). Other qualities made possible by a high level of organization include individual and species adaptability, intelligence, self-awareness, and cooperative social behavior. These qualities don't all necessarily go together. Ants and bees among the insects have raised cooperative behavior to such a pinnacle that we can regard an ant colony as a kind of super-organism[58] that in some ways prefigures the Grand Man of Heaven. However, they appear to achieve this at the expense of any significant degree of individual self-awareness, responsiveness, initiative, enjoyment, reflection, or any other qualities which make up the human experience. The same goes for the cockroach, which has gained a worldwide reputation for making itself at home in many of our favorite habitats. Birds can be regarded as the evolutionary apex in terms of locomotion and navigation—not to mention their musical accomplishments. And dolphins, despite their lack of manipulating members, possess brains

[55] See AC 3646.

[56] TCR 78:4.

[57] DLW 61.

[58] Hofstadter, Douglas R., *Godei, Escher, Bach: an Eternal Golden Braid,* ". . . Ant Fugue," pp. 311-336.

which rival ours in complexity and far surpass us in their ability to interpret their spatial environment by means of sound.

V. More About Gene Dominance

A. How Domninance is Modified

So far I've described some of the impact that gene dominance has on evolution. Now the impact of evolution on gene dominance remains to be considered. Dominance is not an absolute quality of a gene, but a relative one, depending on the genetic environment in which a gene finds itself. For example, the gene for the presence of horns in domestic sheep acts as a dominant in males, but as a recessive in females.[59] Sex-linked traits (i. e., those whose genes are located on the sex chromosomes) often behave in a way that appears similar. In the fruit fly Drosophila, the white-eye gene is recessive to the normal red-eye allele, but this relationship only applies in the female, for the male genome only accommodates a single dose of either gene. Whichever gene is carried will be expressed.

Dominance itself falls under the influence of natural selection—and artificial selection too, for a certain gene in the currant moth *Abraxas grossulariata* can be rendered completely dominant or completely recessive in only four generations of artificial selection^[0] This shows what a powerful effect modifying genes have on the dominance of a gene; in fact, if conditions demand it, modifiers can completely suppress the expression of a harmful gene. A mutation causing the production of eyeless fruit flies (which is recessive to the wild-eye allele) would be eliminated or greatly reduced in a wild population; but when a stock of flies pure for the eyeless gene is inbred for several generations, the eyeless character disappears, although the gene remains. Selection favors the combining of modifying genes which reduce and even eliminate the eyeless trait, moving the gene past mere recessiveness, as it were, to complete non-expression. But the gene still carries the potential to produce eyelessness, which reappears when the stock is outbred with normal wild flies, breaking up the combination of modifiers built up to neutralize the effect of the gene.[61] This illustrates that our evils, when we have conquered them, are apparently removed, but not actually destroyed.

[59] Huxley, *op. cit.,* p. 76.

[60] *Ibid,* p. 83.

[61] *Ibid..,* p. 70.

> Evil both hereditary and actual in a man who is being regenerated is not exterminated so as to vanish or become null and void, but is only separated, and, by the Lord's disposal, is rejected to the circumferences; and it remains so with the man even to eternity; but he is withheld by the Lord from evil, and is kept in good.[62]

In the above example, modifier genes withhold the harmful gene from expression and preserve the normal phenotype. In some places the Writings distinguish between paternal and maternal hereditary evil. 'The hereditary evil from the father is interior, and the hereditary evil from the mother is exterior. The former cannot be easily rooted out, but the latter can."[63] This is illustrated by the fact that harmful dominant genes (external evils) can be eliminated more easily than harmful recessives (internal evils) which, however, can be neutralized (made quiescent) by modifier genes.

We can construct a scenario, based on this capacity of modifier genes, which shows how remnants work, too. Imagine a population of animals more or less perfectly adapted to its place in the ecology. The environment changes considerably—let's say the climate gets quite a bit colder. A particular dominant gene which adapts the species to warmer temperatures reduces viability and fertility in a colder environment (like the fruit fly chromosome I mentioned earlier) and becomes a liability. The gene is virtually universal in the population and can't be quickly eliminated. Gradually, as one generation succeeds another, the genome adjusts to make the gene recessive. That is, those modifying genes will be favored which confer recessiveness on the gene. This greatly reduces the harmful effect caused by the gene, but the gene still remains in the population. If the climate warms up once more, it will select for the gene's dominance again to re-adapt the population to warm temperatures. This parallels the way the Lord gives goods and truths to man, especially in childhood, and later withdraws them when they are endangered by active evils, storing them in the internal man. When man is ready to be regenerated the Lord brings them out of storage.[64]

Gene expression, and therefore gene dominance, depend not only on the interaction between genes, but also on the environment external to the organism. Himalayan rabbits normally have black feet, tail, ears and nose on a white body, but black fur will grow

62 AC 4564:2; see also 868.

63 AC 4317:4.

64 AC 5135:4, 5207:2, 6156, 7943.

under an ice pack strapped to an animals back, because the gene that controls the synthesis of black pigment is only active at temperatures below about 92°F. Other factors that affect gene expression include sunlight, moisture, and diet.[65] Our environments too, both natural and spiritual, will influence which of our stored goods and evils emerge into the open.

B. Hybrid Vigor

Another interesting phenomenon related to gene dominance is heterosis, or hybrid vigor—the generally superior strength and viability of a highly heterozygous individual over a more homozygous one. The most obvious reason is this: when a particular line is inbred, a disproportionate number of recessive traits (many of which may be harmful) crop up in the offspring, because the genes for them are more likely to occur in homozygous form. Outcrossing will reestablish the wild dominants which are generally more advantageous to the species. The dominance of the wild type (genes commonly found in nature because of their usefulness) is usually selected for, because this enhances the phenotypic stability of the population in the face of mutations—which, as a result, are usually recessive to their wild alleles when they first appear. If a harmful mutation occurs often enough (and the same ones do pop up over and over again) selection may have a shot at making it recessive if it is not already so.[66] This can be compared to the gradual overcoming of evils as they are repeatedly activated by evil spirits and trigger the onslaught of temptations. While the presence of goods in man is a prerequisite for temptations (otherwise he would be unable to sustain them), it is only through his evils that the hells can attack.[b7]

But hybrid vigor involves more than this. In many instances the heterozygote tends to grow more vigorous than either the dominant or the recessive homozygote; this applies whether the most apparent trait regulated by the gene appears to be adaptively neutral or not.[68] The recessive "ebony" mutation in Drosophila confers a darker-than-normal body and reduced viability on the flies that carry it in homozygous form. But heterozygotes for the gene appear to possess an advantage even over those homozygous for the normal (wild) gene. In an experiment by L'Heritier and Teissier involv-

[65] Keeton, William T., *Biological Science,* p. 479.

[66] Huxley, *op. ext.,* p. 75.

[67] AC 737, 3696:2, 4248:2.

[68] Moody, *op. ext.,* p. 369.

ing the ebony gene, the proportion of ebony flies in a laboratory population never dropped much below 15% of the total.[69] Evidently those flies which displayed the ebony trait (homozygous) continued to be produced by the more numerous, adaptively superior heterozygotes. Remnants, even when hidden, exercise an influence which may correspond to hybrid vigor. The Lord moderates even our most evil states imperceptibly through remnants.[70] We communicate with the second heaven by remnants, which correspond to angelic societies there.[71] When remnants are first implanted, "angels from heaven approach nearer, and conjoin themselves with the man."[72] The angels withdraw when the man descends into worldly states, but the potential for conjunction with these angels remains. This shows that stored remnants confer spiritual vigor on man much as stored recessive genes confer hybrid vigor.

Even hereditary evils have a purpose which appears similar. With infants and children, when hereditary evil is present but not evident, it "yields them nourishment, or is as a nurse, until the time when they judge for themselves."[73] This nourishing can only occur while the child is innocent of actual evil.

C. Internals and Externals

Genes which actually express themselves in their organisms, whether dominant or homozygous recessive, resemble those tendencies which a man externalizes and therefore makes irrevocably his own. Characteristics which outside circumstances force on individuals, such as injury or disease and any consequent disfigurements, or stunted growth resulting from starvation, although they belong to the individuals involved, do not belong to the population in the same way, for they are not genetically caused and do not pass to succeeding generations. (I'm not ruling out all transmission of acquired characteristics, but I'm going to avoid the question if I possibly can.) These environmentally induced traits can be compared to a person's unpremeditated actions provoked by momentary circumstances, which he confirms neither by intention nor by self-justification, and therefore does not appropriate to himself.[74]

The relationship between internals and externals in man's mind is reflected much more clearly in the analogy with evolutionary pro-

[69] *Ibid.*, p. 364.

[70] AC 561, 1906.

[71] AC 5344.

[72] AC 4897.

[73] AC 4563:2.

[74] AC 1327:3, 9009:3, DP 78:2, CL 489.

cess than in the analogy with evolutionary form, because the process of evolution so vitally concerns the interaction between genotype and phenotype. Consequently the former analogy can also clarify the distinction, represented by the second day of creation, "between the things that are the Lord's and those that are man's own";[75] the things that are the Lord's being remnants, represented by useful recessive genes, and the things that are man's own being "bodily and worldly concerns," represented by the response of traits expressed in individuals to natural selection. The distinction between merely hereditary evils and those which make a person guilty is highlighted in a similar way. In contrast, the analogy with a progression of animal forms (as in fig. 2) is itself a comparison between internals (the human spirit) and externals (the human body and animal approximations to it). It turns on the correspondence between man's mind and every anatomical detail of his body, and requires a comprehensive knowledge not only of human anatomy, but also of comparative anatomy, to be fully appreciated. The different levels contained within each side of this comparison do not appear as immediately and dramatically as they do in the comparison with the evolutionary process.

VI. Gene Dominance and Sexual Reproduction

Now that we've seen in some detail how gene dominance can be related to the process of human regeneration, we can recognize more clearly how the difference between asexually and sexually reproducing organisms could represent the difference between those who lived before the flood and those who lived after it. (See fig. 8 for a chart summarizing the analogy.) The Most Ancients did not need to be regenerated as we do, because they had no evil tendencies to fight. They resemble a species perfectly adapted to its environment. The fusion of their will and understanding is suggested by the haploid genome of one of the more primitive organisms.

Did the Most Ancients have remnants? "Remnants... are all the good and all the truth with a person which lie stored away in his memories and in his life."[76] Certainly the Most Ancients received goods and truths from the Lord. The difference is that these goods and truths did not need to be hidden away in their internals and

[75] AC 8.

[76] AC 2284.

NATURAL	SPIRITUAL
Human Evolution	Human Regeneration
State of Population	State of Individual Man
Asexually Reproducing (Haploid)	Antediluvian Individual
Sexually Reproducing (Diploid)	Post-diluvian Individual
Separate genetic sources	Separate will & understanding
Expressed Traits (Collective Phenotype)	Qualities chosen & confirmed in action
Gene Pool (Collective Genotype)	Qualities resulting from heredity & experience
Dominant Genes	External Mind
Expressed	Ultimated in action
Recessive Genes	Internal Mind
In heterozygous form (hidden)	Latent goods or evils
In homozygous form (evident)	Active goods or evils
Potentially Useful	Remnants
Just Plain Rotten	Hereditary Evils
Environment	External Influences
Rigors of Environment (Cold, dryness, food shortage, predators)	External Hardships
Change in environment, leading to need for further adaptation	"Death of bodily & worldly concerns"
Competition within population (natural selection)	Internal Conflict—Temptation
Recessive genes, formerly hidden, increasing as they become useful	Remnants brought out of hiding by the Lord to help in man's fight against evil
Harmful genes reduced	Evils made quiescent through combat
Hybrid Vigor	Influence of Remnants when hidden

Fig. 8. Chart summarizing analogy between evolutionary process in a population and regenerative process in man. Highly speculative, but I find some of the parallels illuminating. Other variations and refinements of dominance exist which do not appear in this article, such as co-dominance, overdominance and epistasis.

stored there against spiritual famine. No evils existed in the Most Ancients from which goods would have to be shielded. The goods and truths which they received were all available to their conscious minds,[77] while the stored remnants of a fallen man "are interior to the sphere of his comprehension and perception."[78] Perhaps when the will and understanding are not separated the storing of remnants is impossible, just as genes cannot be recessive in a haploid organism which reproduces asexually—they can't hide behind dominant alleles that don't exist.

These primitive haploid creatures don't have the resources to cope with harmful mutations that diploid organisms do. In these circumstances a lethal mutation spells disaster for the individual in which it occurs, and it is immediately eliminated from the species. Even a mutation that merely confers a disadvantage is not likely to last long enough to show any potential usefulness it may have. This causes no problem for a perfectly adapted species, but what if conditions change radically? The species possesses no genes that might preadapt it to a different environment. This is is not to say that creatures cannot evolve without sexual reproduction—obviously they can and do, and vast numbers of them have succeeded well. But their potential is limited.

The posterity of the Most Ancient Church who chose to turn away from the Lord and become their own gods left themselves no path for being turned back to His way. They destroyed everything good and true in themselves which might have been preserved as remnants.[79] Having "celestial seed,"[80] they passed on their now disastrous inability to separate any part of themselves from their poisoned wills, and succeeding generations compounded the evil.[81] The Lord had to make a radical change in man's physical and spiritual makeup in order to save him from destruction; to separate the will and understanding so that man could, through his understanding, receive His blessings of good and truth without destroying them.[82] This entailed a change in man's breathing apparatus[83] and probably reorganization of the brain. Now remnants could be stored to prepare for the birth of a new will.[84]

77 AC 784.

78 AC 86 8.

79 AC 66 0 .

80 AC 310.

81 AC 933:4.

82 see AC 556.

83 AC 607:2,3, 608, 805:2,3.

84 AC 310:2.

The spiritual change from from the fused to the divided will and understanding can be seen in the evolutionary change from asexual to sexual reproduction. The resulting diploid genome, and the phenomenon of gene dominance which it makes possible, prefigure the merciful Providence which enables us, despite our hereditary evil, to be led back to the Lord. In order to clarify this idea still further, I'll quote a sentence from Kirk's *Biology Today* and then change it to a parallel statement of the spiritual counterpart.

First the quote:

> Because of the buffer it provides against deleterious mutations, the trend toward diploidy in sexual cycles has provided an increased reservoir of variation upon which evolutionary processes may act.[85]

Now the parallel statement:

> Because of the buffer it provides against perverted affections, the separation of will and understanding in man has provided an increased reservoir of remnants through which regenerative processes may act.

I'm actually combining two different analogies here: one between evolutionary process and individual regeneration, and another between a widespread event in evolution and an even more all-embracing event in human history. The two analogies fit together because what happens to all things affects every single thing (the converse also applies), and every single thing contains an image of all things.[86] The latter being the case, we can find a representation of the human race's separation of will and understanding in any individual; not at only one point in his life, but at many. The transition from infancy to childhood is one important corresponding change marked by many small events. As he grows the child begins to realize that a thought can lead him to act against inclination, and that he can in a measure separate himself from his impulses. The celestial angels who have associated with him in his infancy begin to withdraw, and with them his infant states of affection and delight.[87] Thus begins the storing of remnants.

[85] Kirk, *op. cit.,* p. 54.

[86] DLW *77-80.*

[87] AC 1450, 1906:2.

Appendix A: In Defense of Evolution

1. Evolution: Philosophical Concerns

The idea that "Science makes it hard for rational people to hold a world view that is grounded in a supernatural God,"[88] is surprisingly widespread in view of the confusion between final and instrumental cause on which it rests, and the resulting assumption that the two kinds of cause are mutually exclusive. Modern science may make it easier for those who wish to dispense with the Divine origin of all things, but has no conclusive argument against His existence. When final and instrumental causes are considered as alternatives to choose between, as long as there remains a phenomenon which science cannot explain, one must invoke a God to account for it—or at least some supernatural and mysterious force. In this case each new scientific breakthrough forces a Divine retreat, and finding a mechanism for the origin and diversity of life is a major blow struck for a Godless universe. And anyone who uses a phenomenon which confounds science as proof of the Divine runs the risk of having the rug pulled out from under his argument.

But why should the consistency and coherence of the universe argue against God's existence? "The created universe is a coherent work from love through wisdom . . . .[89]' If we admit even the possibility of a God, shouldn't we give Him credit for being clever enough to arrange His creation so that it fits together logically? Each new scientific advance can equally provide a chance to marvel afresh at the organic unity of creation, which embraces such incredible diversity and orders all of it into mutual uses. A scientific explanation, which indicates a mediate or instrumental cause, does not replace or rule out a Divine Source, but works in conjunction with it—in fact, in correspondence with it.[90] The lowest things of nature are just as essential to man's formation as spiritual substances are. Man cannot be formed immediately from the Divine, "for in such case he would be the Divine in itself; but he can be formed out of things created and finite, in which the Divine can be... ;"[91] "... out of the earth, forms of uses are continually raised by the Lord the Creator, in their order

[88] Barry Schwartz, "Knowledge and Morality from Darwin's Point of View," a book review appearing in *The Philadelphia Inquirer,* March 22, 1987.

[89] ISB 5:3.

[90] DLW 218.

[91] D. Love II.

up to man, who as to his body, is also from the earth."[92]

The idea that the diversity of earthly life arose through descent with modification from a common ancestor can provide sumptuous food for thought in contemplating the Divine, as well as making it easier to remove God from the picture. Evolution (as the process is commonly referred to these days) is a scientific theory and must be evaluated on a scientific basis, quite separate from its philosophical implications; and philosophically it is ambiguous. It does not force any philosophical position on its adherents. In the words of John R. Swanton, "There may have been an Evolver or there may not; the term by itself does not specify."[93] In light of these points the debate between Evolutionism and Creationism—as if it were a choice between two flavors of popsicle—strikes me as mightily wrong-headed. It's like debating between the two layers of a Creamsicle, and, as far as I'm concerned, we can have the whole thing.

2. Evolution: Scientific Concerns

Quite apart from philosophical and religious issues, evolution is full of unsolved problems, and likely to stay that way for a while. Several things make it more difficult to pin down the truth about evolution than to do the same with gestation, for instance. Evolution involves large numbers of individuals instead of only one; most of it remains beyond the reach of direct observation because so much of it has already happened (never to be repeated exactly), and because of its slowness (in most cases) in human terms. Inference and speculation must supplement the observations we can make about evolution, and disagreements abound. In addition, many biological events in different times and places come under the heading of evolution—a concept that serves as a unifying principle of biology. This sort of presumption would invite controversy even if it did not touch on religious issues.

The basic questions are these: did all the diversity of life on this planet arise by descent from a common ancestor? If so, how? What are the mechanisms, both for the origin and propagation of life forms? And if not, is there any other plausible explanation for the present state of life on earth and the fossil evidence of past states?

The striking similarity among the molecular structure of all known organisms is generally seen as a pretty strong argument for

[92] DLW 171.

[93] Swanton, John R, *Emanuel Swedenborg: Prophet of the Higher Evolution,* p. 3.

their relatedness. Despite great variations in external form, they all appear to use the same genetic code.[94] And a great many higher-level similarities between living forms which have no obvious adaptive value, like the prevalence of five-digit limbs in the vertebrates and the nearly universal traits of cell structure present in both animals and plants, support the idea of a common ancestry.[95]

If we reject the idea of common descent we are left with the problem of how else all those creatures could have arisen. Most versions of Creationism (and there is, if possible, even less agreement among them than among evolutionary theories) offer no scientific explanation of how living things came into being, and in these cases the term "Creation science" is a misnomer.[96] Those who postulate genes from outer space still need to tackle the problem of how these newcomers could fit into the existing biosphere.[97] And the definition of the different "kinds" of organisms which were originally created, and then reproduce themselves with "minor" variations, is a universal problem in Creationism.

So far the going isn't too hard, but now we're getting to the really sticky part. The trickiest question may well be how life forms originated and diversified on earth. It certainly hasn't yet been answered to everyone's satisfaction. I hope to comment on a recent theory of life's origin at a later date;[98] meanwhile the variation problem will keep us well occupied.

As the fossil record grows more complete it fails more dramatically to show the continuity which evolutionists expect—perhaps the strongest scientific argument in the hands of the Creationists, and certainly one of the most serious problems for evolution. As the gaps between different groups get harder to ignore, they render the hypothesis of gradual transitions (e. g., from fish to amphibians to reptiles, and especially from one phylum to another) less tenable.

[94] Jenkins, *op. ext.,* p.401.

[95] Wells, H. G., Huxley, J. S., & Wells, G. P. "Facts Supporting Evolution" from *The Science of* L//f,Doubleday & Co., New York, 1929; cited in Young, *op. ext.,* pp. 48-49.

[96] Raloff, Janet, 'They Call It Creation Science," *Science News,* Vol. 121, Jan. 16, p. 44.

[97] *Ibid.,* p. 45-46.

[98] See "The First Organisms" by A. G. Cairns-Smith, *Scientific American,* June 1985, pp. 90-100.

This difficulty applies equally to the natural-selection school of thought and the transmission-of-acquired-characters school of thought. The changes involved in these transformations may transcend in magnitude anything that could arise through the accumulation of micro-changes regulated by natural selection, or even more directly by need. Those family trees which are relatively complete and continuous, such as the well-known ancestry of the horse—from eohippus *(Hyracotherium)* to *Equus*—usually occur within orders or families of creatures. Homeotic mutations, i. e., mutations of regulatory genes which govern the operation of batteries of more basically functional genes, may be part of the key to macroevolution.[99] But these speculations exceed the scope of my knowledge and certainly of my present subject.

The main trouble with the transmission of acquired characters (Neo-Lamarckism) is that we don't have much solid evidence for it or a good explanation for how it would work. Without those things we can only speculate about it; it can neither be totally ruled out nor conclusively confirmed.[100] Natural selection (the struggle for survival), on the other hand, stands on a much firmer footing as a component of the evolutionary process.

Probably the most controversial aspect of natural selection has to do with its creative role in evolution. In the words of Stephen Jay Gould, "All evolutionists granted at least an executioners role to natural selection—the removal of the unfit/'[101] but Neo-Lamarckists in particular have long been questioning its role in the creation of the fit.[102] Since Mendelian genetics has been integrated into evolutionary theory, and particularly since the molecular basis of inheritance has started coming to light, the question can be stated thus: Can natural selection mold random mutations into a creatively adaptive response? Dobzhansky points out that "random" may be a misleading term when applied to mutations, in that it does not take into account their non-random aspects. The range of possible mutations, and particularly likely ones, at any given gene locus, is fairly

[99] Taylor, *op. cit.,* p. 176; NOVA: "How Babies Get Made," broadcast on PBS; Walter J. Gehring, "The Molecular Basis of Development," *Scientific American,* October 1985, pp. 153-162.

[100] Taylor, *op. cit.,* p. 38.

[101] Gould, Stephen Jay, *Ontogeny and Phytogeny,* p. 425.

[102] Cope, E. D., *The Origin of the Fittest,* Macmillan,New York, 1887, p. 226, cited in Gould, *op. cit.,* p. 81.

strictly circumscribed by the nature of what's already there. Dobzhansky puts forward the more precisely descriptive term "adaptively ambiguous" to describe the nature of mutations.[103]

In recent years computer simulations have supported the ability of natural selection to orchestrate adaptive mutations into organized adaptive responses.[104] However, even if natural selection can make an oyster into a better oyster or a different oyster, that doesn't prove that it can turn a dinosaur into a bird, or make the leap from single to multiple cell structure. This is the unsolved problem of macroevolution. When we try to cover all of evolution with the blanket of natural selection, as the proponents of the Modern Synthesis do, we still find its feet sticking out. But even though natural selection fails to explain many things, it is still a force to be reckoned with in evolution.

Appendix B: Glossary of Genetic Terms (Based on definitions in Jenkins' Genetics, pp. 733-744; natural selection definition from Kirk, Biology Today, p. 820.)

Allele (short for allelomorph; adj., allelic): one of two or more forms of a given gene, i. e., a given locus on a chromosome.

Asexual Reproduction: any type of reproduction that does not involve the union of gametes from two sexes or mating types.

Chromosome: in eukaryotes, a DNA-protein complex which is a linear array of genes; in prokaryotes and viruses a molecule of DNA or RNA.

Diploidy: the condition, following syngamy, in which each chromosome (with the possible exception of the sex chromosomes) hasologous partner.

Dominance: a relationship between two alleles in which one allele masks the effects of the other allele. Where multiple alleles (three or more for one gene locus) are present in a species, a given gene can be dominant to one allele and recessive to another.

Eukaryote: an organism with cells that contain true nuclei and undergo meiosis.

Gamete: a haploid germ cell.

[103] Dobzhansky, *op. ext.*, in Young, *op. ext.*, p. 144.

[104] Niklas, Karl J., "Computer-Simulated Plant Evolution," *Scientific American*, March 1987, pp. *78-86.*

Gene: the basic unit of inheritance that occupies a specific locus on the chromosome and has a specific function.

Gene pool: the total of all genetic information possessed by a sexually reproducing population.

Genome: all of the genes carried by a haploid gamete, or all the genes carried by a prokaryote; can also refer to all the genes in a diploid organism.

Genotype: the genetic constitution of an organism.

Haploid number: the number of chromosomes found in the normal gamete; no homologous pairs are present.

Heterozygous: in a diploid organism, characterized by two different alleles at a specific locus on a pair of homologues.

Heterosis (or hybrid vigor): The increased vigor expressed by a hybrid from two highly inbred lines.

Homologous chromosomes (or homologues): chromosomes that pair during meiosis and possess corresponding gene loci (possibly excepting sex chromosomes); allelic genes occur on homologous pairs.

Homozygous: in a diploid organism, characterized by identical alleles at a specific locus on a pair of homologues.

Macroevolution: the evolution of groups above the species level.

Meiosis (also known as reduction division): the process of cell division by which chromosomes replicate, form homologous pairs, and then segregate into different nuclei to produce the haploid condition.

Microevolution: evolutionary changes that occur in a population over a relatively short period of time.

Mitosis: a process of cell division in which the chromosomes replicate and divide equally so that identical daughter cells are produced, each with the same genetic constitution as the parent cell.

Natural selection: the process whereby the frequency of heritable variations that better adapt members of a population to the environment increases from generation to generation, as a result of increased reproductive success of the individuals possessing these variants.

Phenotype: the observable properties of an organism, produced by the interaction of the genotype with the environment.

Population: a group of organisms which is reproductively isolated from other groups of its own species, whose members interbreed and share genes among themselves, creating a gene pool.

Prokaryote: an organism lacking a well-defined cell nucleus which does not undergo meiosis.

Recessive: in a diploid organism, the allele that is expressed only when it is homozygous and masked when heterozygous with an allele dominant to it.

Sexual reproduction: reproduction that involves the fusion of haploid gametes produced by meiosis.

Syngamy: fusion of gametes.

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