Embryology and Evolution

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Some teachers and textbooks still are presenting a simplistic nineteenth century Darwinian hypothesis that a developing embryo summarizes the evolutionary history of that organism. Mainstream embryologists have rejected this view, called *recapitulation*, for more than one-half century.

The main promoter of recapitulation was antitheistic Ernst Haeckel who was guilty of falsifying illustrations in order to support his views. Even today some authors unwisely continue to use some of these misrepresentations in evolution sections of textbooks.

Because of studies on developmental processes including homeotic genes, our understanding of the origin of life forms is changing rapidly. Design with Divine creation of unrelated types is becoming an increasingly more viable option.

Current Issue

Recently a college student wrote to the Creation Research Society asking about the status of embryology with relation to evolution because his zoology professor had presented the so-called "biogenetic law" to their class. This "law" states that as embryos develop they pass through the various stages attained by their ancestors as they climbed the "evolutionary ladder".

Considerations in Earlier Years

I empathized with this student because in the spring of 1947 when I was a freshman taking my first semester of zoology at the University of Massachusetts in Amherst, I had a similar experience. My professor, Gilbert L. Woodside, a Harvard–trained embryology Ph.D. and then a leader in this field, presented to our class the embryology argument for evolution. Usually this concept is called recapitulation because the developing embryo is assumed to "summarize" or "epitomize" the entire history of its race. When certain embryonic observations are presented in a convincing way, the argument compels acceptance of a macroevolutionary sequence of animal or plant species. I recall thinking after that class, "How could anybody possibly doubt evolution when they understand this evidence?"

I was driven to know more biology, and so I switched my major from psychology to zoology, taking physiology and entomology in my sophomore year. I had become a Christian while in the Navy before my collegiate education, but after two years at the university my Christian beliefs were being challenged in ways that were difficult to handle. I was slated to be a laboratory assistant in the physiology class the next fall, and would have enjoyed that greatly, but I transferred to a Christian college (Houghton in New York), majoring in zoology along with minors in Bible and in chemistry. I obtained a BA degree in 1950, and in the summer of 1951 a BS degree, also in zoology, from another Christian college (Wheaton in Illinois). In the latter I expanded my science and theology backgrounds. Then I taught science to middle and high school level students for one year at the Ben Lippen School which was then in North Carolina. In 1952 I returned as a graduate student to the University of Massachusetts where I obtained teaching and research assistantships.

Change of View

To my surprise I found myself in an experimental embryology course with Dr. Woodside, who now was Chairman of the Department of Zoology and of the Graduate School. I became captivated by Dr. Woodside and his field of embryology. I did research and wrote a master's thesis on chick embryology and the first cancer-inhibiting drug, 8-azaguanine (see Frair and Woodside, 1956).

During my reading and research I became determined to plumb the depths of embryonic recapitulation, but to my utter amazement I learned from Dr. Woodside that the "biogenetic law" was dead! So the man who had convinced me of the importance of recapitulation when I was a freshman, then five years later was convincing me of the opposite. Dr. Woodside not only disbelieved it, but also he virtually despised it. Recapitulation no longer could be

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Received 11 June 1999; revised 24 July 1999.

any more than a hypothesis at best, and he wanted me to have nothing to do with it.

Professor Woodside believed that embryology as a discipline was retarded because of recapitulation. He told me that by the mid-20th Century no informed embryologist could accept the recapitulation concept. Many investigators had given up their work in disgust because they ran into dead ends trying to fit their embryological data into an evolutionary context. Professor Woodside also believed that there had been *only* one Nobelist in embryology (Hans Spemann) because so many other good embryology investigators had been focusing on evolution and failing. An example of the many exceptions to the hypothesis of recapitulation is that in an evolution scheme the spinal cord is present before the brain, but in embryology the brain develops first. But, has not evolution been the thread that holds all of biology together? At least we knew 50 years ago, and still realize today, that Darwinian recapitulation is not part of any such thread (see Bergman, 1999; Wells, 1999a).

Ernst Haeckel

Charles Darwin often has received credit for ideas he promoted even though these thoughts actually had originated in the minds of other people. This is true of recapitulation which appears to have had its earliest roots among the Greeks more than one half a millennium before the time of Christ (see Osborn, 1929). Some thoughts regarding recapitulation were expressed in the eighteenth century, but the most famous popularizer of recapitulation was the German zoologist and philosopher, Ernst Haeckel (1834–1919). He was Charles Darwin's most prominent dogmatic and outspoken supporter of evolution in Germany, but his influence spread around the world. Having met Darwin in 1866, Haeckel tried to place not only science but also philosophy and religion under an atheistic evolutionary umbrella (Jenkins-Jones, 1997).

It is interesting to realize that since the 1860's it has been known that Haeckel falsified his illustrations used to "prove" recapitulation. The most comprehensive treatment of the topic in English is the 1915 book by Assmuth and Hull. These authors refer to a massive amount of material revealing that members of the scientific community recognized that in promoting his views Haeckel relentlessly and shamelessly perpetrated frauds and forgeries. Significant exposures of these date back to 1908, 1875, and at least as early as 1868. Many scientists joined in this condemnation of "the methods of Haeckel, in the instances which had been exposed ...by eighty-three men [a group of 46 plus another of 37] of good position in various branches of science and learning, besides others who published their condemnations apart" (Assmuth and Hull, p. 23). Also see Rusch, 1969. The many dozens of Haeckel's frauds and forgeries included embryology *and* other fields of science.

Scientists during the time of Haeckel and today have recognized that researchers need to be free to construct their hypotheses and theories on the basis of the empirical evidence. But they uniformly have recognized as improper the support of these concepts by unidentified imaginary data or misrepresentations of facts collected or presented by others. As examples of Haeckel's misdeeds see Plates I and II (Figures 1 and 2) from Assmuth and Hull.

Haeckel's endeavors (other than possibly his actual scientific research in systematic zoology) seem to have been so intimately yoked with his philosophy that it appears impossible to separate his actions from his attitudes. For example when someone objected to the embryological contentions of Haeckel and his followers they would be told:

> "This affair belongs to embryology, and therefore you, who are not embryologists, are incompetent to form a judgment in the matter." Even if their opponent happened to be an embryologist, they would still discredit him if he retained the slightest vestige of belief in God, freewill or the human soul. He would immediately be dubbed a theologian, a clerical obscurantist, whose dualistic superstitutions deprive him of the free use of his reason. Haeckel's pages are peppered over with this sort of "ruling out of court"... (Assmuth and Hull, p. 54).

One outspoken critic of Haeckel was J. Reinke, Professor of Botany at the University of Kiel.

> In a pamphlet entitled *"The Latest about Haeckelism"* (Heilbronn 1908) Reinke fills seven pages with parallel columns; the one containing "what Haeckel says," the other "what the truth is". He gives twenty-four instances of misrepresentation perpetrated by Haeckel, and adds: "These are samples taken at random. It would be possible to multiply their number many times" (Assmuth and Hull, p. 31).

But Haeckel, the *popularizer*, apparently failed to profit from such exposures and maintained his misleading maneuvers into his later years, sometimes trying to justify himself by claiming to be following standard biological procedures. As a result, countless scientists and students of science including many authors have been misled, an influence lingering to the end of the twentieth century. Even though many current scientists tend to believe that the demise of the "biogenetic law" was a

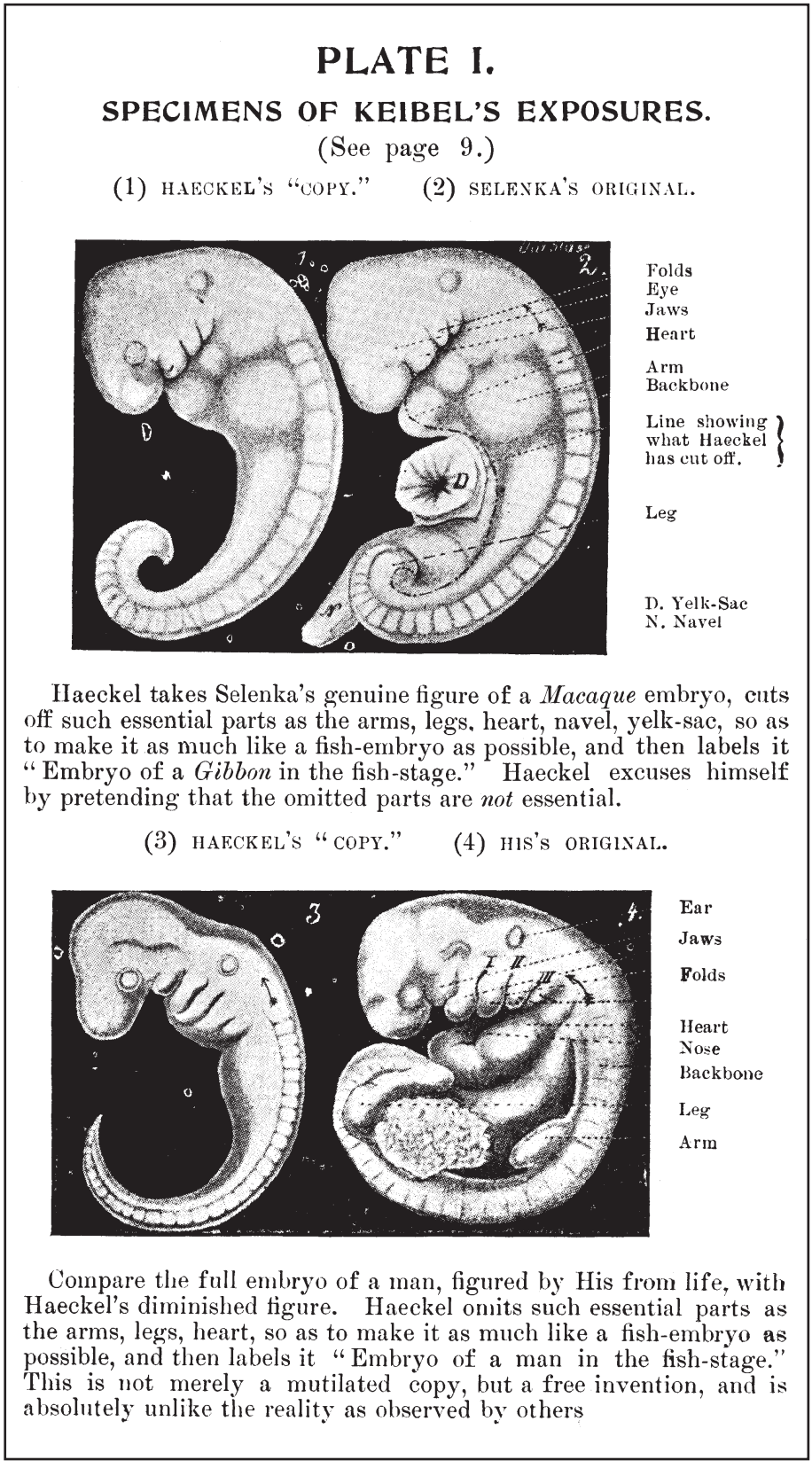

Figure 1. Haeckel's fraudulent copies of embryos (1 and 2) compared to the originals of Selenka (2) and His (4) (Assmuth and Hull, 1915).

middle-to-latter twentieth century phenomenon, even as early as 1915 it was possible to make the following very clear statement:

> Hardly any scientist of note will be found today who accepts the law as it stands. The convincing reason is because recent research has clearly proved that the exceptions to this law are far more frequent than the realisations of it. The majority of the stages through which the individual embryos of different animals pass, do not for the most part correspond to the gradations which, according to the evolution theory, make up the history of the development of life (Assmuth and Hull, p. 98).

Haeckel likely was aware of these difficulties, for he distinguished embryonic changes leading to evolutionary progress ("palingenesis") from other deviations ("coenogenesis"). But so called coenogenetic changes are so numerous, they do not support the "law" but disprove it.

As indicated at the beginning of this paper some teachers still are presenting the "biogenetic law" in support of macroevolution, moribund as it has been for decades in the light of the teachings of many leading scientists including the late Canadian biologist, W. R. Thompson, who in 1956 published an "Introduction" for a reprint of Darwin's *Origin of Species*, noting:

> When the 'convergence' of embryos was not entirely satisfactory, Haeckel altered the illustrations of them to fit his theory. The alterations were slight but significant. The 'biogenetic law' as a proof of evolution is valueless (pp. xv–xvi).

In the past several years Haeckel's illustrations again have been in the news because some textbooks in support of evolution still have been republishing Haeckel's bogus material (see Richardson, et al., 1998).

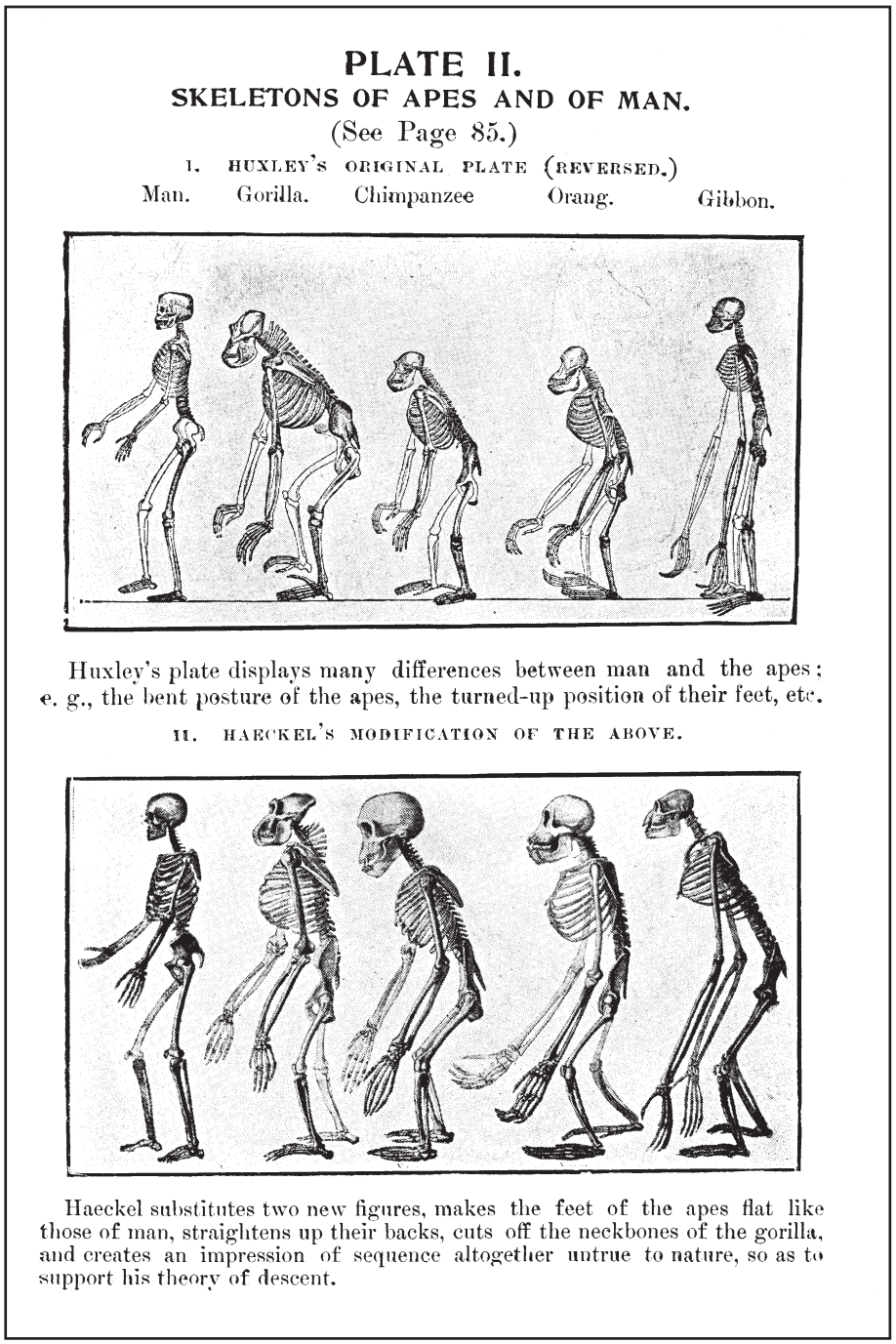

PLATE II.

SKELETONS OF APES AND OF MAN.

(See Page 85.)

I. HUXLEY'S ORIGINAL PLATE (REVERSED.)

Man. Gorilla. Chimpanzee Orang. Gibbon.

Huxley's plate displays many differences between man and the apes; e. g., the bent posture of the apes, the turned-up position of their feet, etc.

II. HAECKEL'S MODIFICATION OF THE ABOVE.

Haeckel substitutes two new figures, makes the feet of the apes flat like those of man, straightens up their backs, cuts off the neckbones of the gorilla, and creates an impression of sequence altogether untrue to nature, so as to support his theory of descent.

Figure 2. Haeckel's fraudulent drawings (II) misrepresent Huxley's original plate (I). Haeckel's skeletons are drawn to look more alike, thus suggesting an evolutionary sequence rather than a heterogeneous group as Huxley more realistically drew them (Assmuth and Hull, 1915).

Sir Gavin de Beer

Sir Gavin de Beer (1899–1972) was a British zoologist and evolutionist who was well-known and influential in the field of embryology. He was Director of the British Museum (Natural History) 1950–1960. In 1930 he published a book, *Embryology and Evolution*, in which he rejected the embryonic concept of recapitulation. He published enlarged versions of his anti-Haeckel views in *Embryos and Ancestors* copyrighted in 1940, 1951, and 1958. Gavin de Beer, 1958, referred to Haeckel's theory as outworn and "a mental straight-jacket which has had lamentable effects on biological progress" (p. 172), and he concluded that "evolution does not explain embryology" (p. 173). For example, according to phylogeny teeth came before tongues, but in mammalian embryos tongues develop before the teeth (p. 7). With chick embryos the heart functions very early in development, but in the frog (which supposedly is closer to ancestral stock) the heart appears much later in development. Specifically the dissimilarity is related to the developing chick's need to receive yolk; whereas the frog egg has much less yolk. Therefore, the differences are based upon structural and functional conditions within the two animals, not their presumed evolutionary relationship.

Often a considerable period of time is required before established views in science are modified on the basis of new evidence. This is illustrated by Perry, 1952, who seems to have understood that the biogenetic law had been falsified; but when writing his general zoology textbook he appears to have been rather restrained in referring to recapitulation.

> Several facts have been discovered which are contradictory to the theory of recapitulation, or at least are difficult to interpret in this light. Many reputable biologists today question the significance of the seemingly apparent agreement of some of the facts with the theory (p. 519).

Gavin de Beer used many examples to show how so-called homologous (structurally similar) organs could come from very different embryonic regions among various embryos. Also, he disclosed that homologous structures commonly are not determined by identical genes (see de Beer, 1971). A recent evaluation of this topic by Wells and Nelson, 1997, emphasizes that:

> Subsequent research has overwhelmingly confirmed the correctness of de Beer's observation. Homology, whether defined morphologically or phylogenetically, cannot be attributed to similar developmental pathways any more than it can be attributed to similar genes (p. 17).

In other words, similar organs in the bodies of different organisms apparently would not be produced by similar nucleotide sequences in the DNA of the genes. Recent research appears to be leading toward some greater comprehension of a solution to this conundrum.

Homeotic Genes

For about two decades there has been an expanding understanding regarding homeotic genes which are small nucleotide sequences behaving somewhat like *master switches* to control the development of various parts of the organism. The homeotic genes play critical roles in the production of arms, legs, eyes and other body parts within developing animals of many kinds. In each homeotic gene there characteristically is a particular sequence of about 180 base pairs of DNA which are very similar to the sequence in the corresponding homeotic genes of other animals whether mouse, man, fruitfly, or amphioxus. For example, in a fly a particular type of gene will affect the antenna, and in a mouse a very similar gene influences the hindbrain. Another homeotic gene appears to be a master controller for development of eyes including the compound eyes of insects and the greatly-different visual organs of squids and even humans (see Wells, 1998).

Each homeotic gene produces small protein molecules which serve to switch on the transcription of other genes by attaching to their promoter loci. As a result there is a cascade of chemical events which lead eventually to the formation of a body structure such as an eye or a leg.

During recent past years it has been baffling to learn that genes and their mutations are not coupled to structural components of the body. For example, a spectacular illustration of this discrepancy has resulted from DNA hybridization experiments indicating an estimated 98–99% similarity of DNA in chimpanzees and humans; whereas people morphologically and physiologically would be more like some 70 to 80 percent like apes. The DNA would be located in the 48 chromosomes of chimps and the 46 chromosomes of humans. Therefore, in addition to the basic nucleotide sequences in DNA there must be other factors which very significantly influence development. These factors could include effects related to the different arrangements of the DNA in the chromosomes of chimps and people (see Hopkin, 1999).

Discussion

One of the earlier *Drosophila* researchers exploring homeotic mutants was W.J. Ouweneel who analyzed evolutionist and creationist perspectives on the subject. He concluded that views of older evolutionists such as Goldschmidt, Schindewolf, and Nilsson were preferable to neo-Darwinism. He considered classical neo-Darwinists naive to perceive "the impressive complexity of biological systems...to have originated by random processes" (1975, p. 153).

In a recent creationist paper, developmental biologist J. Wells, 1998, discusses the serious problems with macroevolutionary conceptions of the origins of homeotic genes and the adaptions they control. Most homeotic genes are theorized by evolutionists to have arisen early in evolution *before* the adaptions they influence had been selected. This is a problem for Darwinists. Wells is opposed to "reductionistic DNA-based neo-Darwinism". In addition to DNA, he discusses other factors which supply developmental information. Within the cytoplasm there are at least three important influences: the cytoskeleton, membranes, and regionalization of other components. DNA is pictured as indicating what building materials are needed; and other features determine how the materials will be assembled. Although these processes are only vaguely understood at this time, Wells feels that recent developments in embryology are best understood using a design approach (Wells, 1999b).

So the issue centers on whether the data fit better into an evolutionary pattern in which homeotic genes would be "conserved"(phylum to phylum) over long periods of time, or if they fit better into "end-directed" processes. Perhaps now is the time for a shift toward a teleological paradigm which will enable us to conceptualize development in a new way. We may be on the threshold of opening a new vista of thought which will unveil laws which so far have escaped our realization.

Consideration should be given to a creation alternative which states that God created separate types of physically unrelated plants and animals (see Frair and Davis, 1983). Genetic research (including homeotic genes) has revealed what most creationists would recognize as the work of God who employed similar genes for different organs in a diverse array of organisms.

In my response to the college student who in 1999 was having the same problem I had 52 years before, I shared with him much of the above information. So what further advice can we give to our students of science today? We should try to dig up all possible relevant facts, weigh them carefully, and be prepared to change our mindset when the data and their implications so indicate. As is true of science in general, we must maintain a degree of tentativeness regarding our conclusions.

Acknowledgements

Dr. Jerry Bergman volunteered important literature and helpful suggestions useful for this manuscript. In addition to suggestions on this paper Dr. George Howe provided printed material as well as his own very helpful unpublished writings on homeotic genes.

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