"ONTOGENY RECAPITULATES PHYLOGENY"

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The history of the so-called "law of Recapitulation" is briefly examined from its inception down to Ernst Haeckel who finalized it as the "Biogenetic Law." Because of many short-comings discovered since Haeckel's day, the idea of "Recapitulation" is no longer generally recognized as a "Law" and some modern texts on evolution omit all reference to the topic. Some post-1960 textbooks, however, still present the illustrations of supposed embryological stages by Ernst Haeckel as support for the theory of evolution.

Original criticisms of the honesty of Haeckel's arguments and illustrations are presented here, based on translated excerpts from the original German reviews by L. Rutimeyer, professor of science at the University of Basel, and early critic of Haeckel. These original sources indicate that Haeckel's woodcut series illustrating ova and embryos were fraudulent. Articles by Wilhelm His, Sr., embryologist and anatomist of the University of Leipzig, also demonstrate that Haeckel's works contained distortions that were evidently perpetrated with the direct intent to deceive.

It is suggested that future editions of science texts eliminate all use of Haeckel's questionable materials. Perpetuating these distorted drawings as true representations of the embryos in question and as having weight in the argument for evolution is certainly regrettable.

Introduction

The concise dictum expressed in the article title is known as the "Law of Recapitulation" as well as the "Biogenetic Law," Many years before Darwin advanced his theory of evolution, the superficial resemblance of the young of higher animals to the adults of lower animals had attracted the attention of zoologists. Various views, often very naive, had been advanced to account for these resemblances.

Although Needham[1] mentions that Aristotle had some thoughts on this matter, T. H. Morgan[2] considers Kielmeyer to have been the first to have expressed a view on recapitulation, when in 1793 he noted the resemblance of the tadpole of the frog to an adult fish. Meckel (1781-1883) seems to have been the first to suggest that higher animals repeat or recapitulate in their development the adult stages of various lower animals.

Karl Von Baer (1792-1876) differed from Meckel's view when he concluded the following: 1) in the development of an organism from the egg, the general characters appear before the special characters; 2) from the more general characters, the less general, and finally the special characters are developed; 3) during its development an animal departs more and more from the form of other animals; and 4) the young stages in the development of an animal are not like the adult stages of other animals lower down the scale, but are like the young stages of those animals.

While examining a couple of embryos he had preserved in a spirit solution, von Baer was unable to determine whether they were reptilian, mammalian or bird. However, among older specimens, the resemblance between the early stages diminished. It should also be noted that von Baer only compared embryos of the same **phylum** with each other, and stated that there are no grounds for comparisons between embryos of different phyla.

Despite von Baer's criticism of Meckel's view, Darwin and the Darwinians incorporated into the theory of evolution the concept that the embryo of higher forms recapitulated the series of ancestral adult forms through which the species had passed supposedly. This belief was concisely stated as "ontogeny recapitulates phylogeny" or "the development of the individual repeats the development of his race."

Haeckel Elaborated on Darwin's Ideas

Darwin's interpretation was elaborated and elevated to the status of a law by Ernest Haeckel (1834-1919), which he named "the Biogenetic Law" (Biogenetische Grundgesetz). Haeckel, as the Huxley of Germany, was Darwin's most enthusiastic supporter and salesman, and he wrote a number of books dealing with evolution in general and with man in particular.

In all these works, his Biogenetic Law occupied a position of extreme importance. For example, it is well known that Haeckel felt that since nearly all metazoa pass through a gastrula stage, therefore the adult ancestor of the metazoa was a gastrula, or gastraea as he called it. The Coelenterata of today were held to be the present-day representatives of this gastraea.

Such was Haeckel's persuasiveness that embryologists for many years after him examined embryos primarily to establish evidence of phylogenetic relationships. As a result, in most cases, recapitulation was considered to be sufficient cause for the various stages in embryological development. Many agreed with Haeckel's view that phylogeny was the mechanical cause of ontogeny.

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Even Smith-Woodward,[3] a paleontologist addressing the Linnean Society in 1923, proclaimed himself "convinced that whenever he is able to trace lineages he finds evidence of the recapitulation of ancestral characters in each life-history" and "he is equally convinced that the phenomena he observed when tracing lineages can only be explained by assuming that acquired characters are inherited."

Specific Difficulties Noted

However, difficulties began to appear, of which Huettner has pointed[4] out the following. It was noted that mammals never have a true blastula or gastrula. Some organs apparently do not develop in the proper order required by the law. For example, in the mammalian embryos, the tongue develops before the teeth. It is also known that "environmental conditions will change the orderly sequence of differentiation in the embryo," which drives one to the conclusion that "recapitulation is subject to change." These and other difficulties have led to the general abandonment of the Biogenetic Law by modern biologists.

However, a more serious aspect of the Biogenetic Law is represented by the fraudulent activities that Haeckel engaged in to substantiate and support it. These were first drawn to my attention as having a solid basis in fact by Dr. W. R. Thompson[5] when in 1956 he wrote the following in his "Introduction" to Darwin's *Origin of Species:*

> "A natural law can only be established as an induction from facts. Haeckel was of course unable to do this. What he did was to arrange existing forms of animal life in a series proceeding from the simple to the complex, intercalating imaginary entities where discontinuity existed and then giving the embryonic phases names corresponding to the stages in his so-called evolutionary series. Cases in which this parallelism did not exist were dealt with by the simple expedient of saying that the embryological development had been falsified. When the "convergence" of embryos was not entirely satisfactory, Haeckel altered the illustrations to fit his theory. The alterations were slight, but significant. The "biogenetic law" as a proof of evolution is valueless.

Today the "biogenetic law" itself is generally discredited as a law. A number of modern texts on evolution no longer refer to the idea at all. When Garbowski[6] once wrote: "Most of what is generally ascribed to the action of the so-called 'Biogenetic Law' is erroneously ascribed to it; because everything that is undeveloped and incomplete must be more or less alike," he was pointing out another inherent weakness in the whole argument of Haeckel. Many biologists agree with the current evaluation of the law by Ehrlich and Holm[7]:

> This generalization was originally called "the Biogenetic Law" by Haeckel, and it is often stated as "ontogeny recapitulates phylogeny." However, this crude interpretation of embryological sequences will not stand close examination. Its shortcomings have been almost universally pointed out by modern authors, but the idea still has a prominent place in biological mythology.

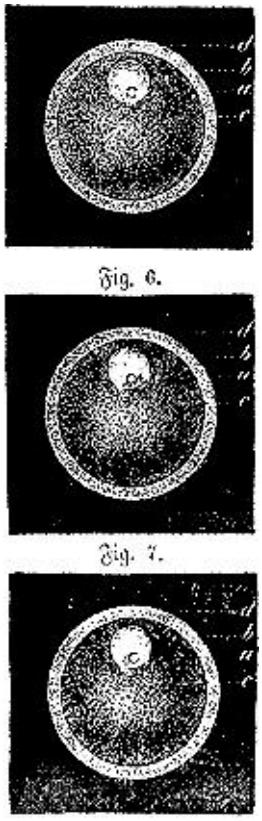
However, it is necessary to investigate the validity of Haeckel's illustrations on which the law is based, since these illustrations are still published as one of the diagrammatic "evidences" for evolution in some contemporary textbooks. Despite the regrettable activities of Haeckel that are dealt with in the following, inspired no doubt by his enthusiasm for evolution, it should also be remembered that Haeckel was an excellent morphologist. For example, his monograph on the Radiolaria is considered to be one of the great works on this subject, as is his publication on the calcareous sponges.

Haeckel Resorted to Distortions

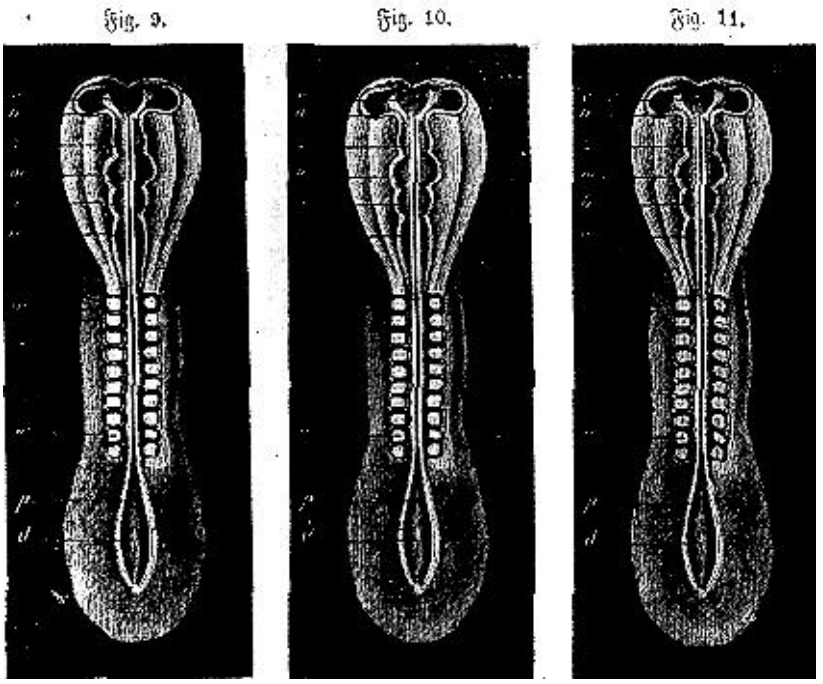
But it still remains true that, in attempting to prove his law, Haeckel resorted to a series of dishonest distortions in making his illustrations. Branding them as dishonest is not too harsh, since Haeckel mentions where he originally procured some of his drawings, without mentioning the alterations he made. This left his readers under the misapprehension that the drawings of these embryos were unchanged from the original sources. These appeared in two of Haeckel's works, one being his *Naturliche Schopfungsgeschichte (Natural History of Creation)* and the other, his *Anthropogenie.*

The first edition of Haeckel's *Natural History of Creation* was published in 1868. In it Haeckel stated that the ova and embryos not only of different vertebrate animals, but also of man, are at certain periods of their development, all perfectly alike. In proof of this assertion he inserted side by side, on page 242, three woodcuts purported to be of ova of man, monkey and dog, respectively, each enlarged 100 times. As one can see from the photocopies taken from Haeckel's work, the three eggs look identical (Figs. 1, 2 and 3). This would indeed be a very striking proof of a common origin for the three.

On page 248, three woodcuts of embryos are found, supposedly those of dog, chicken and tortoise (Figs. 4, 5 and 6). Again one can observe for himself the complete lack of difference between the three. Accompanying text on page 249 pointed out that, in neither case was any difference discovered between the three, which



Figures 1, 2, and 3. Haeckel's drawing of ova of dog, monkey and man (same woodcut printed 3 times).



Figures 4, 5, and 6. Haeckel's drawings of embryos of dog, chicken and tortoise (same woodcut printed 3 times).

everyone looking at the illustrations would certainly take to be a fact. This statement caused some sensation in the ranks of the embryologists and anatomists of that day and soon led to a thorough examination by some investigators.

The result of this examination was rather startling. L. Rutimeyer,[8] professor of zoology and comparative anatomy at the University of Basel, stated the following in a review of two of Haeckel's works, one being his *Natural History of Creation:*

Referate

E. Haeckel, *Uber die Enstehung und den Stammbaum des Menschengeschlechts,* Berlin, von Virchow und Holtzendorff, 1868.

E. Haeckel, *Natwrliche Schopfungsgeschichte,* Gemeinverstandliche wissenschaftliche Vortrage uber die Entwickelungslehre im Allgemeinen und diejenigen von Darwin, Goethe und Lamarck im Besondern usw. Berlin, 1868.

Both publications are essentially expansions of several parts of a previous work of the same author *(Generelle Morphologic der Organismen,* 2 volumes, 1866). However, these works are aimed at the general public. The previous work assumed that those who could grasp the assumptions of the author, and follow his reasoning therefrom, would be in a position to judge the validity or lack of validity of the propositions presented.

These works of Haeckel's propose to follow the scholarliness demonstrated in the works of Darwin, Goethe and Lamarck, who are mentioned in the title. These works have been called a kind of new literature, that up till now has been difficult to classify. Haeckel claims these works to be both easy for the scientific layman to follow, and scientific and scholarly. No one will quarrel with the first evaluation of the author, but the second quality is not one that he seriously can claim. These are works, clothed in medieval formalistic garb. There is considerable manufacturing of scientific evidence perpetrated. Yet the author has been very careful not to let the reader become aware of this state of affairs. . . . But the most important illustrations from a critical standpoint, are those inserted into the body of the text. These original illustrations, which are few, are really new. Particularly the drawings on page 240, and above all, the woodcuts on page 248, are worthy of critical attention.

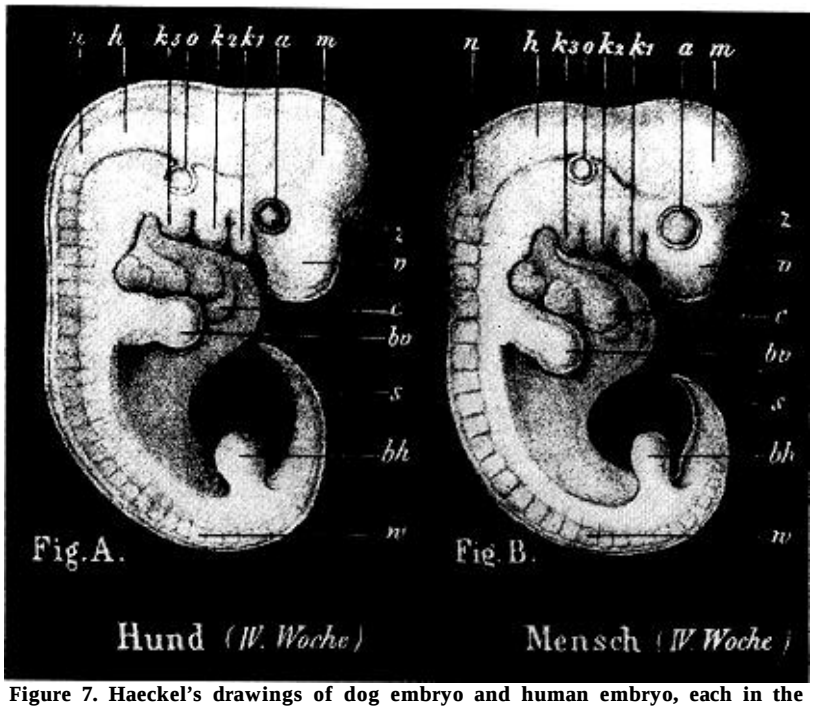


Figure 7. Haeckel's drawings of dog embryo and human embryo, each in the 4th week (From *Natural History of Creation).* Note alterations from originals, Figures 8 and 9.

That we have originals here, no one can deny. Yet one might expect that a research worker will not make models and generalizations for speculative purposes as has occurred with Haeckel's drawings on page 240, particularly when such wide-ranging conclusions are to be built on them. Under such circumstances, greater scrupulousness and conscientiousness are required. But on this page we find comparisons of the drawings of a dog embryo (4th week) taken from Bischoff, a human embryo taken from Ecker (4th week) (see Figure 7 and compare with originals, Figures 8 and 9), and a tortoise taken from Agassiz. Rather than being accurate, these drawings have been generalized to prove the author's point. But much worse is found on page 248, where the same woodcut is printed three times as separate illustrations, with a, different title under each printing (Figures 4, 5, and 6). These are labeled as the embryos of a dog, a chicken, and a tortoise. When these are marshaled before the reader as being factual, this can only be termed as playing fast and loose with science as well as the reading public. When a microscopist of ability such as the author writes what is purported to be a scientific "schopfungsgeschichte," but doesn't point out the schematic nature of his illustrations, and then in his text states as he does on page 249, "when the embryos of the dog, chicken and tortoise in figures 9, 10 and 11 are compared (see Figures 4, 5, and 6), one finds that one is not in a position to tell the difference" it is then in place to protest.

(Editor's Note: The above excerpts are taken directly from a translation made by Prof. Rusch of the article in question, since, to his knowledge, no English translations are available.)

Today, the question might well be asked, Who was Rutimeyer, of whom few scientists today have even heard? What qualified him to pass judgment on the work of such a well-known "giant of biology" as Haeckel, particularly when in almost all American references to Haeckel's work, such activities of his are not even hinted at?

As stated before, Rutimeyer was professor of zoology and comparative anatomy at the University of Basel. In addition, he was a regular contributor and correspondent of the *Archiv fur Anthropologie* and his name appears on the title page of each volume published about that time. To the best of my knowledge, the review of Rutimeyer was never published in America, nor have I ever encountered any reference to it in any English language publication. Two residents of British India, Assmusth and Hull, produced a little known work entitled *Haeckel's Frauds and Forgeries.* This was published by the Bombay Press in 1911 or thereabouts. However, it does not seem to be available in this country.

Figure 8. Original drawing of dog embryo (4th Week) taken from Bischoff.

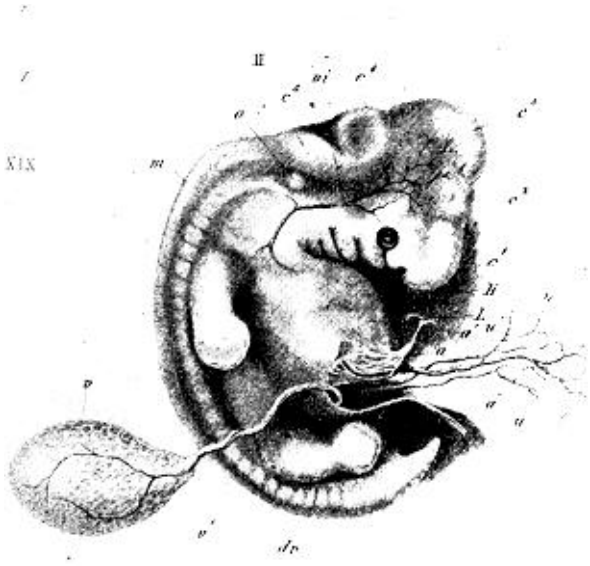


Figure 9. Original drawing of human embryo (4th week) taken from Ecker.

His, Sr., Corroborates Rutimeyer

Rutimeyer was apparently the first scientist to discover Haeckel's misrepresentations and report them. In any case, Rutimeyer did not stand alone. William His, Sr. (1831-1904) was a famous comparative embryologist and professor of anatomy at the University of Leipzig. He was the first to insist, contrary to the majority opinion of his day (including that of Haeckel), that the course of embryological development was influenced by the physiology and activities of the cells, rather than by the mechanical activities of folding and migrations of the structures.

A check of university libraries will reveal many a card for embryological works of Wilhelm His, Sr. He was the author of the first great work which stands as the foundation of our modern knowledge of human development, *The Anatomy of Human Embryos,* published in 1880.

He also perfected the technique of making serial sections so important to embryo study. Along with Born, he perfected the wax plate method of making accurate scale reconstructions from such sections. Thus His appears to have been thoroughly qualified to pass judgment on matters embryological. (To avoid confusion, it should be mentioned that he had a son, Wilhelm His, Jr. (1863-1889) who was also a noted comparative embryologist. His, Jr., discovered what is called the Bundle of His, more commonly referred to as the A-V bundle.)

Among the works of Wilhelm His, Sr., is a collection of letters to Carl Ludwig on the celebration of his 25th anniversary as a teacher. These letters were published in Leipzig under the title *Unsere Koperform und das Physiologische Problem Ihrer Entstehung.* The fourteenth letter, entitled "Das Biogenetische Gesetz," deals with Haeckel's activities. Here His refers to the 5th edition of Haeckel's *Natural History of Creation.* As previously stated, Haeckel used Bischoff's illustrations of a 25-day-old dog embryo and Ecker's 4-week-old human embryo.

Haeckel Manufactured Evidence

W. His refers[9] to the liberties Haeckel took with these illustrations to manufacture evidence for his law, viz., pointing out that he had added 3.5 mm to the head of Bischoff's dog embryo, took 2 mm off the head of Ecker's human embryo, reduced the size of the eye 5 mm, and doubled the length of the posterior. In this case, to say nothing about figures freely invented, even copies are altered so as to give false support for the hoped-for identity of forms.

As he proceeds, His refers to Haeckel's *Anthropogenie.* Referring to page 272, he notes that two figures of human embryos are shown with the allantois clearly visible although this is the blastula stage, and, as a competent embryologist, he points out that this structure is never seen in that stage.

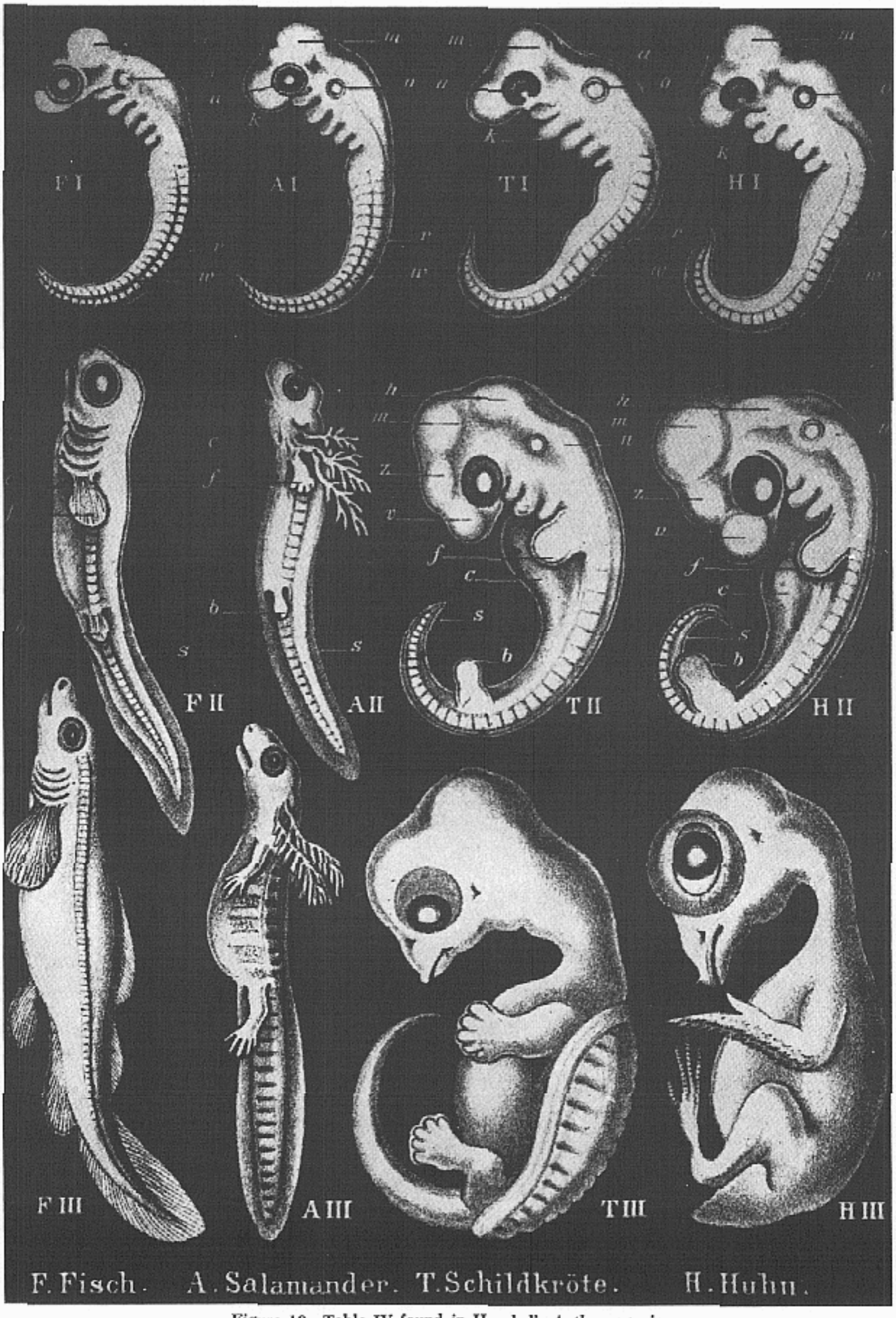


Figure 10. Table IV found in Haeckel's Anthropogenie.

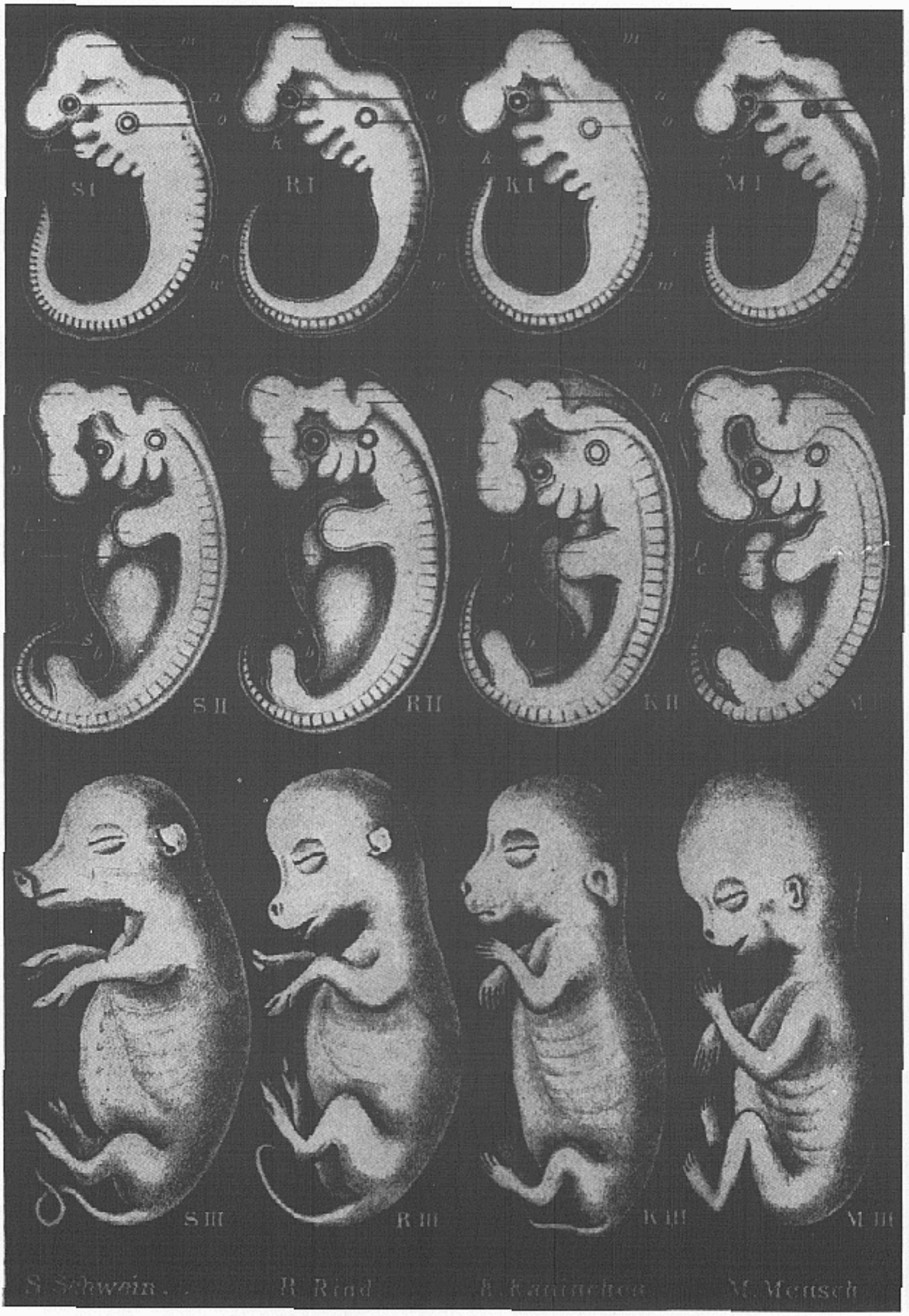


Figure 11. Table V found in Haeckel's *Anthropogenie*.

In this same work, His points out where Haeckel on pages 256 and 257, Tables IV and V, put together not less than 24 figures made up of 3 stages of eight different animals (see Figures 10 and 11). His condemns the whole set as being gross distortion, not consistent with the facts. Yet he points out that the figures are placed together with the intention, clearly expressed in the text, to prove factual similarity of the stages.

On page 253, Haeckel states that there is not a shred of observable difference between the human embryo and the embryo of any other vertebrate in the stage represented by the top row of figures. However, His[10] outrightly condemns Haeckel on this point as straying from the truth in both his text and his drawings.

Conclusions

In conclusion, His points out that Haeckel was located at Jena, where the excellence of the optical equipment available there left Haeckel with no excuse for his distortions. Haeckel could not plead lack of drawing ability, since many methods, e.g. camera lucida, were available to provide for exact reproductions. His' conclusion is that one who engages in such blatant fraud, forfeits all respect, and so even though others praise and honor Haeckel, His feels Haeckel has eliminated himself from the ranks of scientific research workers of any stature.[11]

Although other scientists of the day protested against Haeckel's misrepresentations, as well as his "Biogenetic Law," e.g. Albert Fleischmann,[12] as documented by Rutimeyer and His, Haeckel continued to publish them, and operated under the principle that the best defense is attack. His makes reference[13] to the fact that Haeckel vilified those who exposed him without answering the charges, being particularly vicious in the case of Rutimeyer.

However, despite the severe criticism by His and others, the set of 24 figures, referred to by His, appeared in many works in those days and thereafter. Among such works was a two volume publication entitled, *Darwin and After Darwin* by George Romanes, published in 1892. On pages 153 and 154 of Vol. I, Haeckel's drawings are presented, with the legend title underneath giving credit to Haeckel, stating[14] they were taken from his *Natural History of Creation.* However, actually they appear in Haeckel's *Anthropogonie!*

Most current biology works no longer use Haeckel's fraudulent drawings. Unfortunately, however, there are some post-1960 texts that still do, which is the justification for this article; titles of examples are listed as references 15, 16, 17, 18, 19.

A charitable view would be that those who have used these illustrations are unaware of the history and judgment behind them. In one text,[20] the caption under the drawings states that they were taken from Romanes. Even so, these drawings are still Haeckel's works, as can be seen by a comparison with Figures 10 and 11.

One hopes that future editions will eliminate the use of such questionable material. Perpetuating these distorted drawings as true representations of the embryos in question and as having weight in the argument for evolution is certainly regrettable.

References

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[10]*Ibid,* p. 170.

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[19]Villee, Claude, Warren Walker, Jr., and Frederick Smith. 1968. General zoology. Third Edition. Saunders, Philadelphia. p. 677. (Source of drawings not given–note caption and compare with Figures 10 and 11.)

[20]Bloom and Krekeler, *Op. cit.,* p. 442.