

Countering revisionism—part 1: Ernst Haeckel, fraud is proven

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For more than a century, one of the foremost bastions of Darwinian evolution has been that embryos of different animals pass through a similar stage in which they resemble one another very closely. Although embryologists had long known this to be false, a bomb exploded in 1997 when an embryologist actually published real photos of embryos, showing many more differences than previously thought. The embarrassment to the evolutionary community was severe. But now a historian has made a serious attempt to rehabilitate Haeckel by revising both the history and the science around his claims.

Ernst Haeckel (1834–1919) was a professor of zoology and marine biologist, as well as a qualified medical doctor who was involved at the University of Jena during most of his academic lifetime. Besides his interests in biology, he was also a passionate artist who paid attention to many fine details in his artworks. His artwork was mainly about living creatures. But Haeckel is perhaps best known for his deception, using his wonderful talent as an artist combined with his authority as a scientist to convince people that Darwinian evolution is a fact. This specifically applies to sets of embryos which Haeckel drew and published in his very popular works *Natürliche Schöpfungsgeschichte*¹ and *Anthropogenie*². Ever since the publication of these sets, it has been controversial, and fellow scientists felt it was at best a misrepresentation of reality, at worst deceptive and fraudulent. (The latter was ultimately shown to be the case.)

Despite the controversy, textbook authors and teachers of evolutionary theory keep on using these diagrams, or versions of them,³ in order to convince students of evolutionary truth, even in the 21st century!⁴ In 1997, a ‘bomb’ exploded in the face of all those evolutionists who so fondly kept on using this evolutionary ‘icon’, when embryologist (and evolutionist) Dr Michael K. Richardson and his colleagues published a variety of *real* photographs of the relevant embryos.⁵ These drawings of Haeckel were later compared directly to the actual photos, and they were found to be *far* more different than everybody even thought. Richardson also published photographs of species additional to those which appeared in Haeckel’s popular embryo plates. This showed that Haeckel conveniently used those which tended to look more similar, while ignoring those which were different.

Although a minority of honest evolutionists have appreciated Richardson’s work, such as Stephen Jay Gould, Scott F. Gilbert (author of developmental biological books) and Paul Dombrowsky (a specialist in rhetoric), the embarrassment was just *too* severe and the iconic embryos too beloved among textbook authors to let things stay as they were. Robert John Richards, a professor of history at the University of Chicago, made a concerted attempt to rehabilitate not only the history around Haeckel, but also the very embryo sketches themselves. In 2008/9 Richards

published a book and a paper in which he made some serious attempts to clear and clean up the name of his hero, Ernst Haeckel. My paper will look mainly at the works of Haeckel and the scientific issues around them, specifically set out in Richards’ paper named *Haeckel’s Embryos: Fraud not proven*.⁶ Where necessary, related issues will be discussed.

Michael Richardson and his co-workers’ photos of *actual* embryos had shown just *how* far Haeckel’s illustrations were from reality. It is thus no surprise that Robert Richards tries every possible thing to disprove Richardson and others’ work and critiques it as “logically mischievous, historically naive, and founded on highly misleading photography” (p. 148). His target is fully set on the photos of Richardson *et al.*

So just what exactly is technically wrong with Haeckel’s illustrations? What did Haeckel do in order to make his embryos look much more similar than they really are in general (and perhaps fish-like in particular)? From a fresh point of view, we can also find additional errors that have not previously been pointed out.

Technical errors with Haeckel’s illustrations

Heart Bulges

One of the first problems with the illustrations in the first row of Haeckel’s comparative embryo plates in his work *Anthropogenie* is that he drew many embryos, including the human and chick embryos, without either pericardial or heart bulges, where they possess these in reality. In humans, the cardiovascular system is one of the first entities to develop in the early embryo. This is so because the growing embryo needs a constant supply of oxygen, and nutrients. Very early in embryonic development, diffusion becomes insufficient for oxygen supply.⁷ So from even as early as 25 days old, the human embryo already displays a clear pericardial bulge, soon becoming a heart bulge (figure 1). In the earliest row of illustrations in *Anthropogenie* (figure 4 below, first row), Haeckel’s human sketches lack these heart bulges. This is the case not only of the above mentioned work, but also other works, including the late editions (for example the 12th edition) of *Natürliche Schöpfungsgeschichte*, and a book drawn up as a collection of popular lectures called *Last Words on Evolution*.⁸ In the 4th and 5th editions of *Anthropogenie*, the

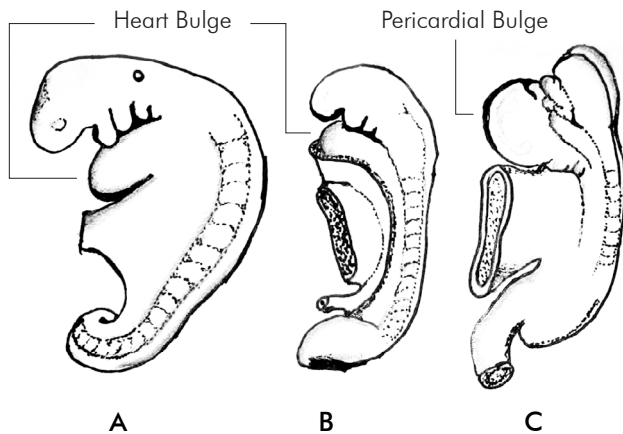


Figure 1. Illustration of the development of the human heart. **A** – Human embryo at 28 days (stage most commonly used for comparison). **B** – Human embryo at 25 days. **C** – Seven somite human embryo. All of these stages (reduced to same size) show either a heart or pericardial bulge, always omitted by Haeckel when comparing to other mammals. (Adapted from Langman⁴¹.)

error keeps on being repeated. We should at this stage make the important observation that Haeckel was a fully qualified medical doctor, and he was thus well acquainted with human biology. So he is *without excuse* for misrepresenting human physiology in this way.

The same principal applies for some other animal groups as well, specifically the chick embryo. In the chick, the blood starts circulating at the 16-somite⁹ stage (about 36–37 hours old) where the ventricle is already visible. A bulge (consisting of the ventricle and atrium) becomes clearly visible at the 19-somite stage (about 43 hours old) and is even more pronounced at the 26-somite stage (about 51–53 hours old).¹⁰ Haeckel's chick embryo in the 1st to 3rd editions of *Anthropogenie* matches best the last-mentioned stage, except that *no sign* of the cardiovascular system is visible in these editions of the plates.

The problem is not just for the human and chick embryos. Some other classes of vertebrates have the same problem, whilst other classes of vertebrates, like certain species of fishes and amphibians, may not display heart bulges at all (at least visibly). This is the first clear distortion by Haeckel in order to make these embryos look more similar.

Limb buds in embryos

Another thing which seemed to have surfaced as erroneous with Haeckel's illustrations is the fact that embryos lack limb buds at certain places where they should show them. But first, biologist Scott Gilbert draws our attention to something important:

“Interestingly, there was some discussion as to what exactly this stage was (Richardson 1995). This conserved stage was sometimes considered the neurula stage (Wolpert 1991), the ‘pharyngula’ stage (characterized by the branchial arches; Ballard 1981), the tailbud stage (Slack *et al.* 1993), or the stages between those of headfold and tailbud (Duboule 1994).”¹¹

Gilbert goes on to explain that heterochrony (the phenomenon of *different timing* in the appearance of structures) is another problem in general. Specifically, at whatever stage is selected for comparison, some species' embryos will display limb buds, whilst others may not at all. This is actually seen in more of the photos which Richardson *et al.* have published.¹² Naturally, the question arises whether Haeckel himself was aware of this. The answer is a remarkable ‘yes’, at least for two reasons. First, Gilbert further points out: “Interestingly, this knowledge [of heterochrony] appears to be ‘old hat’ among German biologists.”¹¹ Second and more importantly, though, there seems to be clear evidence that Haeckel purposely removed limb buds from embryo drawings of his sources, in order to make them look more similar. In a correspondence to the editor of *Nature*,¹³ Richardson and Keuck explain, and show pictures of, how Haeckel purposefully removed the limb buds from an *echidna*-embryo drawing. His source was a work¹⁴ of Richard Semon, who used the original drawing in at least two works. Haeckel himself used this limbless drawing in at least two places as well, the 5th edition of his *Anthropogenie* and the late editions (such as the 12th) of *Natürliche Schöpfungsgeschichte*. We can thus clearly see how Haeckel intentionally distorted embryo drawings in order to make them look more similar (figure 2).

Richards is aware of this paper, and tries to make yet another excuse for Haeckel's deliberate deception.¹⁵ He tries to argue that Haeckel adapted the embryo drawing for an earlier stage of development than the one in which Semon's illustration was. But if that were the case, then Haeckel should have also adapted other morphological features, which he did not (as Richards admits in his book, thinking he is doing Haeckel a favour). The more we go back in the early embryonic stages from the relevant point, the lower the somite number would have needed to be (in fact, another way of measuring the stage in which an early embryo is, is

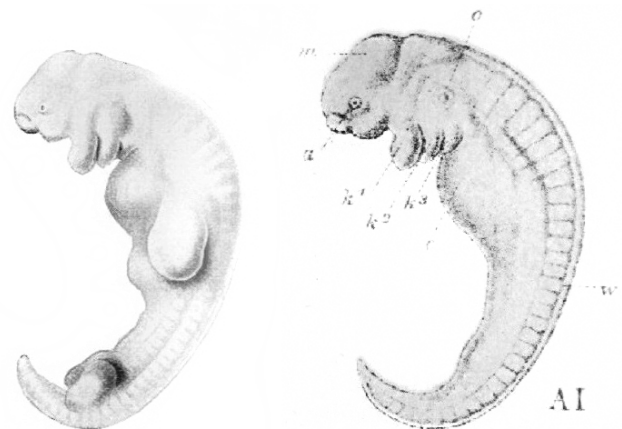


Figure 2. Clear evidence showing that Haeckel purposefully removed the limb buds of the echidna embryo from his source. On the left, Richard Semon's original echidna embryo illustration.⁴² On the right, Haeckel's doctored illustration from his *Anthropogenie* (5th ed.). He also used it in the late editions (such as the 12th) of *Natürliche Schöpfungsgeschichte*.

referring to the amount of somites present in the embryo). Also, the pharyngeal arches would be less pronounced, and other features more generalized (as per the embryonic principles of Karl Ernst von Baer (1792–1876), with whom Haeckel was *also* familiar). Haeckel must have known all the above. He was very familiar with early embryonic development, and even coined what we know as ‘Gastraea Theory’ (describing even *earlier* embryonic development). Haeckel adapted none of these features, especially not the pharyngeal arches, which he so fondly referred to as ‘gills/gill slits’. Richards’ excuse simply falls flat, and turns out to be a convenient *ad hoc* theory.

If the above is not enough, Richardson and Keuck found yet another example of Haeckel removing limb buds.¹⁶ This time it was from a tuatara (*Sphenodon punctatus* from New Zealand) embryo which he seemed to have copied from Arthur Dendy¹⁷ (1865–1925). Again, there can be no excuse for this deliberate misrepresentation.

To come back to the original point, we know from history, as well as photography *and* theoretical knowledge, that the problem of limb buds is a general one, and not just limited to the echidna and tuatara. And second, that Haeckel seemed to deliberately have removed these limb buds. Richardson and Keuck found several other examples of Haeckel’s removing limb buds from original sources as well.¹⁸ The error is also often repeated in modern textbook drawings of the iconic embryos.

Yolk and photography

In order to save Haeckel from the obviously clear falsehood(s) demonstrated by Richardson *et al.*’s photos, Richards makes a full-fledged attack on the photography by desperately trying to make an argument regarding the yolk.

But first it should be firmly noted just how differently yolk is incorporated in the development of embryos of different types of animals. One insightful source mentions, for instance, the following differences:

“Many animals (e.g. many insects, octopuses, fish, reptiles, marsupial mammals) use yolk sacs to feed the embryo ... But there are also a number of animal groups (e.g. nematodes, sea urchins *and almost all amphibians*) that *do not* develop a yolk sac. In such organisms, the yolk is less conspicuous and is perhaps best defined as the nutritional reserves provided by the mother, including yolk platelets, fat droplets and glycogen [emphasis added].”¹⁹

Even among mammals, there exists noticeable variety:

“Monotremes, such as the platypus, and marsupials, such as kangaroos, have large, yolky eggs [since they actually lay eggs]. Placental mammals, *by contrast*, have small eggs without yolk platelets. ... Even placental mammals still form *extraembryonic yolk sacs and these are by no means useless vestiges* [emphasis added].”²⁰

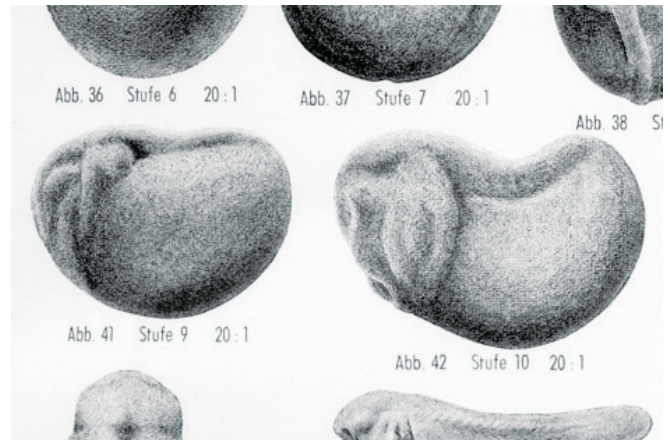


Figure 3. A frog embryo more or less at the tailbud stage (species not given). Originally from Michael Richardson’s website, mk-richardson.com.

So we can safely conclude that the development of yolk is yet another important *difference* in embryonic development. But Robert Richards makes specific claims about the yolk (which he does not really seem to understand anyway):

“... several (but not all) of the photographed embryos retain the attached yolk sack and other maternal material; this exaggerates their differences from Haeckel’s images The bulge of the salamander is not part of the embryo; rather, it is the yolk sack, as is the case for the fish and the human embryos (though not for the chick and the rabbit, from which the yolk sacks [*sic*] have been removed)”²¹

First of all, in the original Richardson paper we are told that:

“The extra-embryonic membranes were either missing or were removed by us. However the allantois was preserved where present.”²²

So this team of *biologists* actually *were* careful with extra-embryonic materials. And *contrary* to what this *historian* (Richards) says, the bulge (not a typical yolk *sac*, in the biological sense of the word) of the salamander *is* part of, and attached to, the body of the embryo, *unlike* human embryos where a yolk sac is outside of the embryo itself. In many other species as well, it would be impossible to separate the yolk from the body of the embryos without doing violence to the structure of the embryo, and misrepresenting it. So, exactly contrary to what Richards says, by removing these properties, the *similarities* are *exaggerated* between these embryos. This is thus yet another embryonic feature which Haeckel distorted, as we have seen. Moreover; the very usage of a salamander embryo as representative of the class of amphibians speaks of convenient selective reporting by Haeckel. Frogs and toads represent the overwhelming majority of the class of amphibians, and their embryos completely break the common visual similarity pattern at the tailbud stage of embryogenesis—refer to figure 3 to see just how pattern-breaking frogs in general are.

Returning to the yolk issue, the development of yolk adds greatly to the variety in the development and appearance of different embryos of species. Richards's arguments to discredit the photography of Richardson *et al.*, and to salvage Haeckel, thus fail. We must also point out that yolk cannot be written off as irrelevant to embryonic development. The way embryos of different species undergo cleavage is much determined by the yolk. It also determines how later stages follow. A lot of yolk means the embryo goes directly to a little adult, while little yolk means that it develops into various larval stages.²³

Richards then took some of Dr Richardson *et al.*'s photographs which appeared in Elizabeth Pennisi's article²⁴ in *Science* (also widely used by creationists to expose the myth^{25,26}) and re-engineers them according to what *he* thinks they should have looked like (figure 4). Yet in doing so, he too, astoundingly enough, produces exactly the same errors as did Haeckel himself! The most important of these is the heart bulge of the human embryo, which is completely removed in Richards' re-engineering. Such a removal cannot by any means be justified. Other tactics include straightening out the chick embryo's *torsion* and *flexion* (literally 'twisting' the body), which is significant in the development, as well as the re-engineering of the salamander body, in order to get rid of the bulge. As for Haeckel's own distortion of the torsion and flexion, the excuse is dished up that those processes occur at a somewhat later stage of development. But comparing other features of Haeckel's chick embryo to the relevant literature reveals this as yet another fact-free excuse.²⁷ Since Haeckel's chick embryo had both visible developing eyes and pharyngeal arches, this cannot be true, and embryos with no flexion and torsion are clearly in a too-early stage to match that of Haeckel. Richardson *et al.* also carefully picked their chick embryo to be at the *correct* developmental stage, so Richards' doctored chick embryo *does not exist in nature*.

Issues with editions of *Anthropogenie*

Richards whines about the set of embryos that was used for comparison to actual photos by Michael Richardson *et al.* Richardson had used the illustrations from the 1874 (first) edition of *Anthropogenie*. Richards implies that it was unfair of Richardson to use these, and tells us:

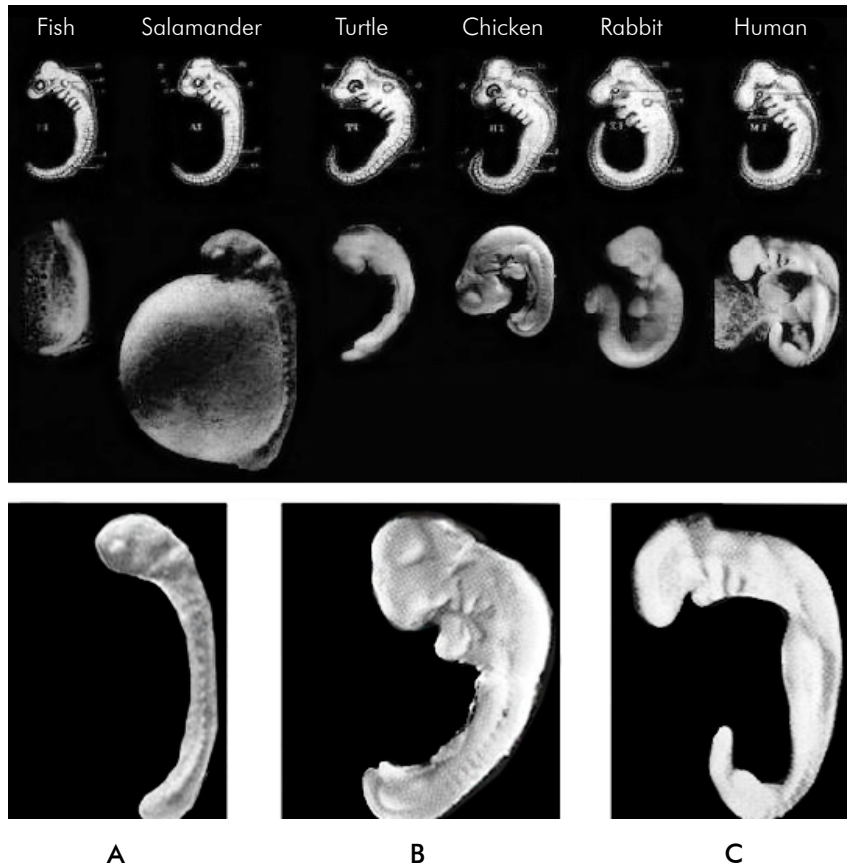


Figure 4. First row, Haeckel's original 1874 *Anthropogenie* embryo sketches. Second row, some of Richardson's published photos of embryos,⁵ showing Haeckel to be off the mark. Third row, three of Richards' doctored versions of the photos, in order to save Haeckel. **A** – Salamander, with yolk removed. **B** – Chick, illegitimately straightened out. **C** – Human embryo, also with the heart bulge removed, making the same 'error' as Haeckel. The first two rows are commonly used in creationist literature as an exposé, and will now have to be defended.

"In the subsequent editions, the images grew ever more refined, so that even by the 4th edition (1891), the differences among them became more pronounced ..."²⁸

But this gives an entirely wrong impression of gradual improvement. Richards *fails to mention* that the original sketches are found even in the 3rd edition! Seeing the fact that the book only went through five editions, it represents the majority of them. Using the 1st to 3rd editions' drawings is further justified, because those sketches were used in countless textbooks ever since. A major and important example is George Romanes' book *Darwin and After Darwin*.²⁹ This book gave authors³⁰ the option of citing these embryo drawings from Romanes, thus 'sanitizing' them from Haeckel's name.³¹ The only differences between Romanes' version of them and Haeckel's are that Romanes removed annotations and used a white background, where Haeckel used a black or dark background, but they are structurally *identical*. Many evolutionists argue that we should make a distinction between Haeckel and Romanes, but there is no valid reason for doing so. Some authors³²

shamelessly use Haeckel's 1874 sketches directly! Recently (2010) these dubious sketches were even on the front page of the prestigious journal *Nature*.³³ Furthermore, the tradition of using the same animal sequence (we cannot even say *species* in this regard because of over-generalization) for comparison in textbooks, as did Haeckel in his original *Anthropogenie* sketches, has carried on, even in the 21st century. The sequence is: fish, salamander, tortoise, chick, hog, rabbit, calf and human. Sometimes authors conveniently leave out those which they know don't fit. Hickman *et al.*, in their *Integrated Principles of Zoology* (2008), and Sylvia S. Mader's *Biology* (10th edition), are good cases in point of authors still using the 1874 Haeckelian sequence and selection of animals, which is conveniently selective. Both of these above editions were recent when this paper was written.

After the above quote, Richards refers us to embryo drawings from the 4th edition of *Anthropogenie*, which is supposed to show us that Haeckel pronounced the differences much more, thus improving them. But it is precisely here that we find probably the *most dubious* aspect of Richards' paper. To explain, in the 4th edition Haeckel presented not embryos of 8 species of animals (like in the 1st to 3rd editions), but 14 species of embryos in four plates reaching over four pages (or two double pages). To illustrate his point, Richards gave his readers what seems to be one of the double-page illustrations, but *Richards has put the wrong plates together*, giving us the two right-hand ones ('B' and 'D' in figures 5 and 6, not belonging together on the same page) without giving the slightest hint about it to his readers! *Of course* the differences would look more pronounced! See figures 5 and 6 to understand why. Such disingenuous selective reporting hardly shows either Haeckel's or Richards' intentions in a good light.

As one can expect, the more Richards' work is becoming known among members in the evolutionary community, the more anti-creationists are eager to use this as an antithesis for creationist books and work. Shockingly, but not surprisingly, the pretentiously named National Center

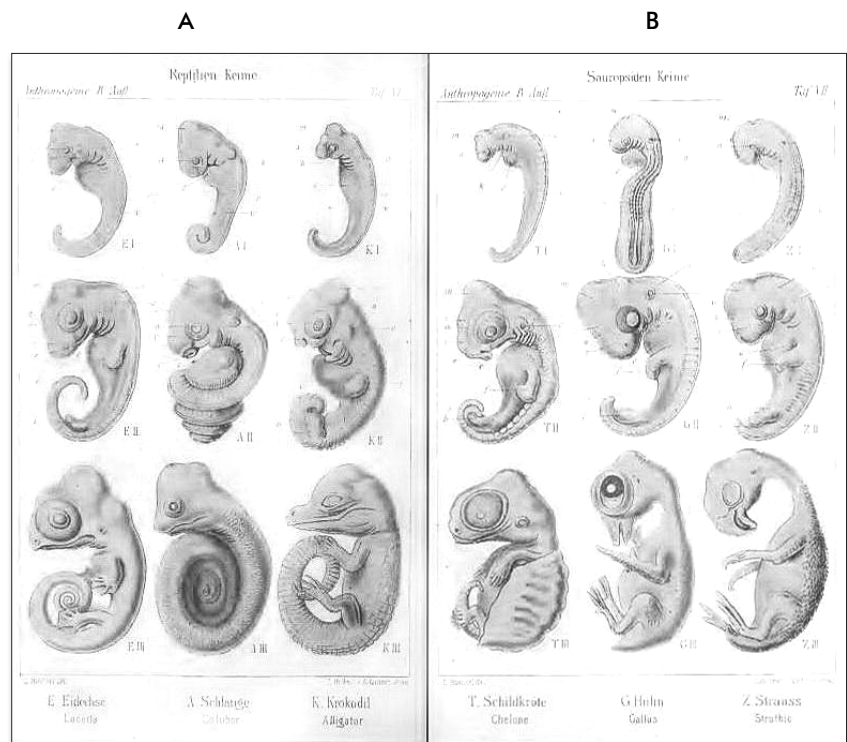


Figure 5. Plates VI and VII of the original set of original embryo plates out of Haeckel's 4th ed. of *Anthropogenie*, just after p. 351 of the book. Labels for plates are as follows: **A** – Reptiles, **B** – Sauropsids.

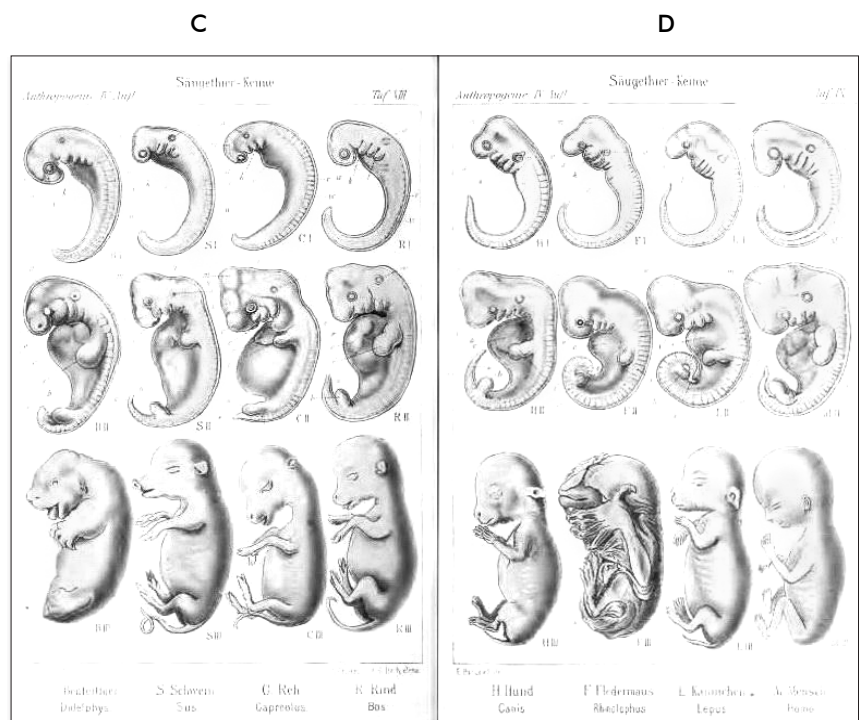


Figure 6. Plates VIII and IX of the original set of original embryo plates out of Haeckel's 4th ed. of *Anthropogenie*. Also just after p. 351 of the book. **C** and **D** – Mammals. R.J. Richards conveniently put the *wrong* plates together. But looking at the plates as they should be, and comparing them *generally* and *specifically* to the *original* Richardson *et al.* paper (ref. 5, p. 102), we can see, for example, that the similarities in mammalian embryos are still too exaggerated. The human embryo (on the far right) is also *still* without a heart bulge. Thus, in principle, Haeckel did not improve in many critical areas.

for Science Education has already picked this paper up,³⁴ quoting Richards on several places and using Richards' wrong illustrations just as they are.³⁵ Creationists should be ready to point out this extremely sloppy, not to say dishonest, scholarship.

Richards does not show us the additionally added embryo drawings of the 5th (and latest) edition of *Anthropogenie* in his paper, only in his book. But might we point out that amongst these additional embryo sketches in the 5th edition, the limbless echidna as well as the tuatara are to be found, once again suggesting deliberate inaccuracies. The human embryo is also still without its heart bulge in the 5th edition.

Issue with sizes of embryos

Another complaint being made against Richardson *et al.* is one about size. Richards tells us:

“... Richardson suggested that Haeckel ‘fudged the scale’ of the embryos, even though there was a tenfold difference in magnitude among them. Haeckel, however, quite explicitly stated in the caption to his illustration that he reduced all of the images to the same size to facilitate structural comparisons ...”³⁶

Haeckel did indeed *mention*, in brackets in the explanatory descriptions of the plates of *Anthropogenie*, that he reduced all the embryo illustrations to the same size for comparison. So, this may be one of the only *valid* objections by Richards. However, complaints about sizes of some embryo comparisons in earlier editions of *Natürliche Schöpfungsgeschichte* may still not have been too unreasonable, since some of the information about sizes was not quite correct. With the *Anthropogenie* sketches, however, we must let Haeckel off the hook with this one, which was never one of the most serious complaints to begin with.

Other issues

Richards writes as if everyone in past and present is so extremely unfair to ‘poor old’ Haeckel. He makes points on which we must both agree and disagree. We are told:

“Parity of reasoning should logically have required another conclusion: if the indictment of fraud should be made against Haeckel because of too-similar images, then it ought to be brought also against His and the many modern embryologists whom Richardson and his colleagues cited, since they, too, supposed a phylotypic stage in embryogenesis [then citing the embryologists also cited by Gilbert, ref. 7].

“They maintained that not only did Haeckel’s images misrepresent the actual state of embryos but so did those of Wilhelm His, perhaps the most famous embryologist of his day and Haeckel’s bitter enemy. His, they contended, also exaggerated the similarities of embryos and ignored their differences.”³⁷

We can agree that it is not only Haeckel that should be held responsible. Many textbook authors who so shamelessly use too similar drawings and repeat errors are also guilty, although in *some* cases only of trusting previous works, not intentional deception. But the problem with Richards’ reproach to Richardson and other authors who then wrote articles about it in other journals (following Richardson’s original paper) is that they *do* blame other people besides Haeckel! Paul Dombrowsky³⁸ (an expert in rhetoric), Stephen Jay Gould,³⁹ and even Richardson, in a letter to Gould⁴⁰ (which got published), for instance, *do* hold many others responsible.

Furthermore, the charge against Wilhelm His is *most odd*, because Richardson and Keuck tell us *exactly the opposite* about Wilhelm His’s work:

“Haeckel’s young embryos look similar, whereas His’s look different.”¹³

They explain that whereas Haeckel’s embryo drawings stressed the similarities, His’s embryos tended to stress the differences. Although Richardson and Keuck feel that His’s embryos were not always accurate either, they point out that the issue becomes a question of *intent*. They haven’t found evidence that His *deliberately distorted* his embryos, whereas with Haeckel, they clearly have (by tracing Haeckel’s sources in this instance. See the removed limbs of the echidna, earlier). Yet this very paper (of Richardson and Keuck) is referred to and discussed in Richards’ book (in regards to the limb buds)! Why does he not inform his readers about *this* aspect in his paper?

Conclusion

The photographs of Dr Michael Richardson *et al.* are as valid as when they were first published. But creationists will now have to rely on more than just the visual illustration of these powerful photographs and also be capable of explaining *why* Haeckel’s original work is based on ideology and dishonesty. R.J. Richards’ attempts fall flat under closer investigation, and his scholarship is often extremely sloppy, and does not represent the facts accurately. The impression is frequently given that everybody (creationists and evolutionists) were just so unfair to ‘poor old Haeckel’, but this is not the case. On investigating Haeckel’s illustrations technically, it becomes clear just how many things Haeckel distorted in the embryo illustrations. His dishonesty can thus not be denied.

Finally, after having looked closer at some of the issues at hand, it is reasonable to maintain the position that Haeckel’s fraud is proven.

Acknowledgements

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