

# Is Common Descent an Axiom of Biology?

*This discussion paper was written for the conference, "The Darwinian Paradigm: Problems and Prospects," held June 22-25, 1993, at the Pajaro Dunes beach community on Monterey Bay, near Watsonville, California. The conference was organized by Phillip Johnson. Attendees included Doug Axe, Michael Behe, Walter Bradley, John Angus Campbell, William Dembski, Dean Kenyon, Stephen Meyer, Paul Nelson, David Raup, Siegfried Scherer, Jonathan Wells, and Kurt Wise.*

To: Pajaro Dunes Conference Participants  
From: Paul Nelson and Jonathan Wells  
Date: 15 June 1993  
Re: Discussion paper for Topic Area I (homology, etc.)

This paper is intended to highlight key points in the readings (being sent to the participants by Phil Johnson), and to suggest some general issues for discussion. The issues we raise do not, of course, exhaust the possibilities.

The readings are:

1. Thomas Jukes and Syozo Osawa, "Recent Evidence for Evolution of the Genetic Code," in *Evolution of Life*, eds. S. Osawa and T. Honojo. New York: Springer-Verlag, 1991, pp. 79-95.
2. V. Louise Roth, "The Biological Basis of Homology," in *Ontogeny and Systematics*, ed. C.J. Humphries. New York: Columbia University Press, 1988, pp. 13-29.
3. G.P. Wagner, "The Biological Homology Concept," *Annual Review of Ecology and Systematics* 20 (1989): 51-69.
4. E.B. Wilson, "The Embryological Criterion of Homology," *Biological Lectures Delivered at the Marine Biological Laboratory of Wood's Holl*, Summer Session of 1894. Boston: Ginn & Co., 1895.

## I. The Neo-Darwinian Explanation for Homology

We start by reviewing some familiar ground. The conventional neo-Darwinian explanation for homology (call it the conventional explanation) is clearly outlined by Romer and Parsons:

Homologous organs are those which are identical – the same – in the series of forms studied. But what do we mean by "the same"? One tends, unthinkingly, to believe that the same actual mass of material, the very same limb or leg or bone, has been handed down, generation to generation, like an heirloom. This is quite absurd, but such a concept has obviously influenced, unconsciously, the minds of many workers.

In reality, of course, every organ is re-created anew in every generation, and any identity between homologues is based upon the identity or similarity of the developmental processes which produce them.

The development of the science of genetics has given us a firm base for the interpretation of these processes. They are controlled by hereditary units, the genes....If the genes remain unchanged from generation to generation, the organ produced will remain unchanged (apart from environmental effects upon an individual which may be obvious, but are not inherited by the next or later generations), and the homology is absolute.

Changes, however, do occur in genes, as mutations; these mutations produces changes in the structures to which the genes give rise....In a sense, a study of organ homology is merely a study of phenomena produced by genes. If the genetic constitution of all animal types were well known, the determination of homology between structures might well rest upon the degree of identity of the genes concerned in their production. What then are the best criteria for the establishment of homology?...Best of all is similarity in developmental history. Embryologic processes in vertebrates tend to be conservative, and organs which are very different in the adult condition may reveal their homology through similarity in embryonic stages.<sup>1</sup>

The conventional explanation can be represented more schematically as follows:

- A. Main Principle: Descent with Modification**  
(Material Continuity from a Common Ancestor)
- B. What Descends are Genes**  
(Homologous Replicators)
- C. Genes Control Development**  
(Homologous Developmental Processes and Patterns)
- D. Development Constructs Phenotypes**  
(Homologous Structures) (Q.E.D. )

And the conventional explanation is often embedded in the following story. When Darwin arrived on the scene in the mid- nineteenth century, natural historians were puzzled by the remarkable patterns of similarity they had discovered, such as the pentadactyl limb or the vertebrate body plan. Darwin provided a material causal explanation for the origin of these patterns, in the principle of descent with modification from common ancestors (with all living things descending, ultimately, from a single common ancestor). After the discovery of the rules of inheritance in Mendelian genetics, the picture Darwin left unfinished was completed, and "the problem of homology" was solved – a major scientific advance gained by the Darwinian revolution. As Ronald Brady observes,

We must remember that, for the minds of his contemporaries, much of the strength of Darwin's hypothesis lay in its ability to account for the patterns of

natural history....Since that time, one may well agree with Dobzhansky (1973) that "Nothing in biology makes sense except in the light of evolution," for without the theory of evolution we would stand again before the interlocking patterns of common plan, homology, hierarchy, ontogenetic parallelism and divergence, etc., without a causal hypothesis. The experience is now so distant that it may be difficult to imagine.<sup>2</sup>

Some elements of the Darwinian interpretation of homology, such as the theological suboptimality argument against the independent creation of homologous patterns, are more properly the bailiwick of Topic Area 4. Still, we note the following.

"Nothing can be more hopeless," Darwin argues of the pentadactyl limb pattern, "than to attempt to explain this similarity of pattern...by utility or by the doctrine of final causes." Nowadays this has become, in Ayala's hands, for instance, "an engineer could design better limbs in each case"<sup>3</sup>, meaning, of course, a Really Competent Divine Engineer. We expect that John Campbell will have illuminating things to say about this aspect of Darwin's rhetorical program. And Paul Nelson will be bringing copies of his paper on evolutionary theological arguments. As far as Paul has been able to discover, the suboptimality of the pentadactyl limb pattern has never been empirically demonstrated, but merely assumed. Darwin's evidence for suboptimality, when the thread is wound to its end, turns out to be only Richard Owen's unhappiness with the pentadactyl pattern. The pattern squares...little," Owen opines, "with our idea of the simplest mode of effecting the purpose."<sup>4</sup> The fact that Richard Owen would have designed animals differently is helpful, perhaps, for learning the content of Owen's mind – but says nothing about the optimality or suboptimality of actual tetrapod limbs.

## **II. Problems with the Conventional Explanation of Von Baer's Laws, I: The Evolutionary Interpretation**

Now Brady implies that the patterns Darwin united by the theory of common descent really do "interlock," and that after Darwin, there is a kind of evidential inevitability in the matter, leaving reasonable investigators with only one conclusion to draw. Such massive congruence of morphology, embryology, and genetics can only be explained by material descent (whether the process was governed or mediated by a Creator is a separate question). There really is a tree of life, with a single root.

But do the patterns interlock? That is, does a consistent mapping obtain between levels B, C, and D of the conventional explanation schema, in good accord with expectations generated by the theory of monophyletic descent (level A)? Those who enter very far into the subject will find an astonishing degree of confusion, and differences of opinion striking enough to awaken the philosopher of science in anyone.

Take, for instance, early embryonic similarity in the vertebrates. Ayala sketches the received view as follows:

Vertebrates, from fishes through lizards to humans, develop in ways that are remarkably similar during early stages, but they become more and more differentiated as the embryos approach maturity. The similarities persist longer between organisms that are more closely related (man and monkey) than between those less closely related (man and shark). Common developmental patterns reflect evolutionary kinship.<sup>5</sup>

But this is simply not the case. The earliest developmental patterns in vertebrates appear quite diverse:

Indeed, *X. laevis* [frog], *G. domesticus* [chicken], and *M. musculus* [mouse] are radically different in such fundamental properties as egg size, fertilization mechanisms, cleavage patterns, and morphogenetic movements. This presents us with a conundrum: If early embryogenesis is conservative [that is, functionally constrained; see below], how did such major changes in the earliest events of embryogenesis occur?<sup>6</sup>

In fact, the most obvious structural characteristics of either the eggs or the cleavage stages of a shark, a salmon, a frog, a bird, or a mammal are unique each to its own class, not generally shared. We would not consider them very much alike unless we had been taught so at a very early age....Each class of vertebrates (in mammals we might almost say each particular order) develops and then loses its own set of temporary structures like the parade ground "formations of maneuver" during this period. The plain fact is that evolutionary divergence has taken place at every stage in the life history, the earliest no less than the latest.<sup>7</sup>

Empirically speaking these embryologists are not even in hailing distance of Ayala. Nor is this unusual. The status of the evolutionary interpretation of von Baer's laws of embryonic similarity<sup>8</sup> (the received view; see Ayala, above) remains unresolved nearly a century after the embryologist Adam Sedgwick urged that the interpretation "falls to the ground."<sup>9</sup>

Stephen Jay Gould, for instance, writes of "von Baer's triumph," claiming that "his laws, in refurbished evolutionary dress, are now more widely accepted than ever before."<sup>10</sup> "These empirical laws," write Raff and Kaufman, "retain their validity today and may be observed in operation in the development of any vertebrate."<sup>11</sup> Peter Medawar argues that the laws (which he thinks are true) were important to the general acceptance of descent:

There is an element of truth in the so-called law of recapitulation, and it's embodied in Von Baer's law. This affirms that the embryos and young of related animals resemble each other more closely than the adults into which

they develop. ... Similarities between mammalian embryos generally and fish embryos in such things as the possession of yolk membranes by the human egg were thought by Thomas Hunt Morgan, and also Thomas Henry Huxley, to be evidence sufficient in itself to justify the acceptance of the evolutionary hypothesis.<sup>12</sup>

Properly restated, Løvtrup argues, von Baer's laws are not only true, but are "the most parsimonious generalisation ever stated in biology."<sup>13</sup>

Others are unpersuaded. "We see the reality of von Baerian recapitulation," Wake and Roth demur, "as an open research question."<sup>14</sup> Michael Ghiselin is less politic. "Von Baer's (1828) laws, which are false," he writes, "were replaced by historical formulae of equally dubious status."<sup>15</sup> Developmental biologist Lewis Wolpert waves von Baer aside, stating that, of the laws, "both the first and third are just wrong: general characters, as we have seen, do not, in early development, necessarily appear before special characters, and neither does an animal depart more and more, during development from the form of other animals."<sup>16</sup> Reviewing what Løvtrup calls "von Baer's theorem" – "during their ontogenies the members of twin taxa follow the same course up to the stage where they diverge into separate taxa"<sup>17</sup> [note the agreement with Ayala's argument above] – Dohle complains:

Everybody who is even slightly acquainted with ontogenetic facts knows that there are hundreds of examples to which this theorem does not apply. In many polychaete and prosobranch genera one species develops through a planktonic larva, whereas another species has direct development. The telolecithal cephalopod eggs cleave in a bilateral manner without any similarity to the spiral cleavage of other related Mollusca. Triclad eggs have a blastomeric anarchy, whereas the adults very closely resemble the polyclads which show spiral cleavage. This list could easily be elongated.<sup>18</sup>

### **III. Problems with the Conventional Explanation, II: The Ontogenetic Criterion of Homology**

Or consider another persistent difficulty, closely related conceptually to the question of von Baer's laws, namely, the ontogenetic criterion of homology.<sup>19</sup> In the glossary (not written but approved by Darwin) appended to the sixth edition of the *Origin of Species*, one reads, under "Homology":

That relation between parts which results from their development from corresponding embryonic parts, either in different animals, as in the case of the arm of a man, the foreleg of a quadruped, and the wing of a bird; or in the same individual, as in the case of the fore and hind legs in quadrupeds, and the segments or rings and their appendages of which the body of a worm, a centipede, &c., is composed.<sup>20</sup>

The ontogenetic (or embryological) criterion of homology widely accepted by the early Darwinians:

Huxley (1869, p. 137) considered the embryonic criteria to be the decisive ones in the relationship of homology, for he defined it as follows: "Homology, the relation between parts which are developed out of the same embryonic structures...Gegenbaur (1878) changed his early views in order to adopt the ancestral criterion of homology while emphasizing the importance of embryological correspondences. Thus he wrote...homology "is the name we give to the relations which obtain between two organs which have had a common origin, and which accordingly have also a common embryonic history."<sup>21</sup>

In his treatment of the "biogenetic law," Gareth Nelson argues as well that "mode of development itself is the most important criterion of homology."<sup>22</sup> Early in her research, V. Louise Roth (currently one of the leading students of the concept of homology), went further: "A *necessary* component of homology is *the sharing of a common developmental pathway*."<sup>23</sup>

In 1895, however, E.B. Wilson (reading 4) warned that "similarity of embryological origin," even when read with "great latitude," failed as a criterion:

It is a familiar fact that parts which agree closely in the adult, and are undoubtedly homologous, often differ widely in larval or embryonic origin either in mode of formation or in position, or in both. Innumerable cases will suggest themselves to any embryologist of hollow organs that arise either by invagination or delamination; of paired organs that arise from either single or paired foundations, and vice versa. No one is disposed to question the homology of the spinal cord of a teleost with that of a shark on the ground that one arises as a solid cord, the other as an infolded tube. (pp. 107-8)

Citing this paper with approval several decades later, Nicholas Jardine writes, "the Recapitulation Theory is now discredited, and with it the embryological criterion of homology,"<sup>24</sup> – a conclusion reinforced in 1971 by Gavin de Beer. In a short monograph that has become something of a minor classic, de Beer gives examples, such as the alimentary canal in vertebrates, which violate the ontogenetic criterion.<sup>25</sup> He then scolds Darwin, and, by implication, certain of his intellectual heirs:

It is therefore necessary to give the lie direct to the entry on 'Homology' in the glossary by W.S. Dallas which Darwin most unfortunately appended to the 6th edition of the *Origin of Species*. It defined homology as 'That relation between parts which results from their development from corresponding embryonic parts.' This is just what homology is *not*.

In his recent review of the homology concept (reading 3) Gunther Wagner confronts the problem directly:

Homology is still the basic concept of comparative anatomy....However, there are also quite problematic aspects of the current homology concept, which has been in use since the time of Darwin. This is here called the historical homology concept, since it is defined by *historical continuity of descent from a common ancestor*....a large body of developmental data seems to contradict certain implications of the current homology concept. (p. 51; second emphasis added)

Roth (reading 2) points up these problems as well. In 1988, having abandoned the embryological criterion of homology, she argued:

Intuitively (and with some rational basis), biologists look to genetics and developmental biology for the foundations of homology. Yet genetics and development can provide inconsistent pictures. Homology becomes an elusive concept when one attempts to tie it to specific biological processes or relationships or mechanisms. (p. 4)

Both Roth and Wagner urge that the various levels of homology in the conventional explanation be decoupled. Roth proposes the notion of "genetic piracy" (p. 7), and Wagner, "epigenetic traps" (p. 65), to account for the anomalies. Whatever the merits of these proposals (and we might perhaps discuss them), we should note that neither biologist regards the anomalies they have uncovered as casting any doubt on common descent. That possibility never enters the conceptual picture.

#### **IV. So When is Common Descent at Risk Observationally?**

This brings us to a significant problem. How is the theory of common descent put at risk observationally?

One way of conceiving the empirical content of common descent (CD) is according to the following schema:

**(a) CD + Independent auxiliary theory → Observational expectation**

Here, common descent yields observational consequences via the "inferential medium" of independently derived theories. In developmental biology, for instance, we observe that disruptions of ontogeny are (generally speaking) increasingly severe or deleterious the earlier they occur. The reason, as Van Valen argues, is that development "ramifies out; later developmental decisions depend on earlier ones which are much fewer and have consequences which interact."<sup>26</sup> Earlier developmental decisions or events are thus "entrenched" relative to what lies

causally downstream from them, and carry a heavier "generative" responsibility. As Leo Buss puts it,

It is axiomatic that a random alteration introduced early in ontogeny will likely be manifested in a cascade of subsequent morphogenetic events, whereas a modification introduced later in ontogeny can have relatively minor effects. The validity of this interpretation can hardly be doubted. A random error in the manufacture of the central processing unit of my computer would unquestionably preclude any hope of my using it to write, while the various marketing decisions reflected in the design of the exterior case have provided me with only minor inconveniences.<sup>27</sup>

We might adopt Wimsatt's nicely evocative term, "generative entrenchment" (GE), to describe this theory.

What follows when generative entrenchment is coupled theoretically with common descent? D.T. Anderson argues that

the highly integrated stepwise nature of animal development [GE] causes it to be in many respects an extremely conservative process. Basic developmental events established during the early evolution of a group are maintained repetitively over hundreds of millions of years, since any change in them would spell extinction.<sup>28</sup>

This may be represented schematically as

**(b) CD + GE → Conservation of early development**

But as we have just seen, early development – in the vertebrates, for example (not to mention throughout the Metazoa generally) – looks pretty diverse, not highly conserved. "Eggs, cleavage, gastrulation and germ layer formation are very different in amphibians, bird and mammals" note Rudolf Raff and his colleagues.<sup>29</sup> (Raff, as some of you may know, is a leading researcher in this area.) Thus, there must be some way, Raff *et al.* conclude, of escaping the functional constraints entailed by generative entrenchment – because, plainly, "early development does evolve, and sometimes dramatically."<sup>30</sup> Surveying the similar conclusions of Keith Stewart Thomson, Van Valen concurs:

One heretical conclusion which Thomson comes to must, I think, be accepted. This is that evolution occurs at all stages of development, often at early stages of programs leading to the adult. His most conclusive argument for this reminded me a bit of Descartes: Early development does often change; therefore it can....At least such evolution can no longer be rationally dismissed as Goldschmidt's folly.<sup>31</sup>



What has happened to the auxiliary theory, generative entrenchment? It seems to have gone to the wall, blindfolded, for a last cigarette:

(c) **CD + GE ? ← Non-conservation of early development**

In this schema, which reflects the practice of evolutionary theorists, it is generative entrenchment that is imperiled by the observations, not common descent. The problem now however is that common descent's empirical content, vis-à-vis the phenomena of development, is indeterminate. One really can't say what follows observationally from the theory.

The grounds for the view that "early development does often change" are, of course, almost wholly *comparative*. That is, given common descent, the existence of radically differing ontogenetic patterns is *prima facie* evidence that early development can indeed evolve. It then becomes a research problem to learn by what mechanisms early development can be freed from its functional entrenchment.

*Experimental* evidence that "early development does often change" has not been readily forthcoming, however. As Jeffrey Levinton observes,

As a general rule, major developmental mutants give a picture of hopeless monsters, rather than hopeful change. Epigenetic and genetic pleiotropy both impart great burden to any major developmental perturbation....The cyclops mutant of *Artemia* is lethal. The homeotic mutants of *Drosophila melanogaster* suffer similar fates....But any geneticist interested in major developmental mutants would be delighted to find viable hopeful monsters in the laboratory, given the various tricks usually necessary to keep developmental mutants in laboratory cultures. But, alas, major developmental mutants are invariably sickly and show pervasive deformities. From both theoretical and empirical points of view, hopeful monsters have led only to hopeless mooting.<sup>32</sup>

Under common descent, however, our responsibility for discovering the mechanisms of macroevolution is not discharged by pointing out that earlier inquiries were not successful. Don't forget, common descent is a fact! Shoulder to the wheel!

## **V. The Universal Genetic Code Argument for Common Descent**

Lest it be thought that this pattern of reasoning – namely, sacrificing the auxiliary theory to save common descent – is an isolated example, we offer another, perhaps more striking case.

Most of us are familiar with the universal genetic code argument for common descent. The argument first appeared in the mid to late 1960s, after the structure of the code was elucidated. It is now widespread.<sup>33</sup>

Here are two formulations:

If organisms had arisen independently they could perfectly well have used different codes to connect the 64 trinucleotide codons to the 20 amino acids; but if they arose by common descent, any alteration in the code would be lethal, because it would change too many proteins at once. Hence the finding of the same genetic code in microbes, plants and animals (except for minor variations in intracellular organelles) spectacularly confirms a strong evolutionary prediction.<sup>34</sup>

The universality of the code is easy to understand if every species is descended from a common ancestor. Whatever code was used by the common ancestor would, through evolution, be retained. It would be retained because any change in it would be disastrous. A single change would cause all the proteins of the body, perfected over millions of years, to be built wrongly; no such body could live....Thus, we expect the genetic code to be universal if all species have originated from a single ancestor.<sup>35</sup>

As in the developmental example above, we can conceive the empirical content of common descent as following from its linkage with an independent auxiliary theory. In the universal genetic code argument, the auxiliary theory is the necessary functional invariance (FI) of the code:

This theory states that the code is universal because at the present time any change would be lethal, or at least very strongly selected against. This is because in all organisms...the code determines (by reading the mRNA) the amino acid sequences of so many highly evolved protein molecules that any change to these would be highly disadvantageous unless accompanied by many simultaneous mutations to correct the "mistakes" produced by altering the code.<sup>36</sup>

Consider what might happen if a mutation changed the genetic code. Such a mutation might, for example, alter the sequence of the serine tRNA molecule of the class that corresponds to UCU, causing them to recognize UUU sequences instead. This would be a lethal mutation in haploid cells containing only one gene directing the production of tRNAs<sup>er</sup>, for serine would not be inserted into many of its normal positions in proteins. Even if there were more than one gene...this type of mutation would still be lethal, since it would cause the simultaneous replacement of many phenylalanine residues by serine in cell proteins.<sup>37</sup>

The universal genetic code argument may thus be represented schematically as follows:

(d) **CD + FI → Universal genetic code**

It should be clear that the theory of functional invariance is what gives the deduction from common descent its empirical specificity. That is, if the code were *not* functionally invariant, we might expect that over time any number of different codes could have evolved. Functional invariance, however, gives common descent considerable predictive strength. It is, as it were, a strong lever or medium of inference, projecting the theoretical and unobservable concept of common descent into the molecular phenomena.

## **VI. Theoretical Consequences of the Discovery of the Non-Universality of the Genetic Code**

But life is never so simple. The genetic code now appears not to be universal. (See Jukes and Osawa, reading 1.) The first variants, discovered in 1979, occurred in the mitochondrial code, where "it was found that the code in vertebrate mitochondria differed from the universal code by using codons AUA for methionine and UGA for tryptophan."<sup>38</sup> As Fox argues, however, "mitochondria could be thought of as exceptions that prove the rule: their genetic systems produce only a very limited number of proteins and so might tolerate changes."<sup>39</sup>

Yet variants in the nuclear code discovered more recently, are, Fox argues, of a different order: "Some 'real' (nuclear) exceptions have come to light in both eukaryotic and prokaryotic free-living organisms, and the notion of universality will have to be discarded."<sup>40</sup> For instance, "in at least four species of ciliated protozoa, the codons UAA and UAG [stop codons in the universal code] occur in nuclear genes and are translated as Gln during cytoplasmic protein synthesis."<sup>41</sup> In the bacterium *Mycoplasma capricolum*, UGA encodes Trp, rather than termination (stop) as in the universal code.<sup>42</sup> Other variants are given in the Jukes and Osawa article. Researchers now expect to encounter further variants. "It seems obvious," Caron argues, "that the number of cases of deviations observed will increase rapidly in the future."<sup>43</sup>

But what of the theory of functional invariance? Recognizing that, in the face of variant codes, one cannot assume the truth both of common descent, and functional invariance, nearly all researchers working on the problem have, either explicitly or implicitly, rejected functional invariance:

Variations in codon assignments must arise as a result of mutations affecting the codon specificities of tRNAs or the interactions between tRNAs and aminoacyl tRNA synthetases. In either case the immediate result of such mutations in a genetic system must usually be wholesale changes in the

proteins produced by that system, adversely affecting at least some and leading to a selective disadvantage or inviability. *Nevertheless, such variations have occurred during evolution.*<sup>44</sup>

Postulating that such fundamental variations occurred is, however, very far from knowing *how* they occurred. "Direct replacements of one amino acid by another throughout proteins," argue Osawa *et al.*, "would be disruptive in intact organisms and even in mitochondria."<sup>[45]</sup> That is, we should not think that the body of molecular knowledge motivating functional invariance can be jettisoned at will. (Yes, if common descent is true, and variant codes exist, functional invariance has to go to the wall. Yet functional invariance still seems to be true, or at least highly probable.) Rather, taking common descent as given, we are now faced with another novel research problem: "How could non-disruptive code changes occur?"<sup>46</sup> As Caron notes,

The scenarios have to answer the question: how, with our current knowledge of molecular mechanisms, can we imagine a termination codon becoming a glutamine codon or a leucine codon, a serine codon?<sup>47</sup>

Schema (e) illustrates the conceptual relation:

(e) **CD + FI → ? ← Non-universal genetic code**

Note that, as with the earlier example concerning development, in this schema the empirical content of common descent – now, *vis-à-vis* the genetic code – is indeterminate. That is, the content of the theory awaits the outcome of the new research program, to which the observational anomalies (the variant codes) have been referred. But nearly all investigators (we know of only one exception; see note 44) regard the finding of variant genetic codes as fully consistent with common descent.

## VII. What Should We Make of All This?

So what is the empirical content of common descent, anyway? The theory is certainly easy enough to state:

Evolution asserts that the pattern of similarity by which all known organisms may be linked is the natural outcome of some process of genealogy. In other words, all organisms are related.<sup>48</sup>

But is this – not to put too fine a point on it – a testable proposition?

Or perhaps we should rather ask, do evolutionists (in practice) treat common descent as a testable proposition? There are many indications that the answer is "no, not really." On this view of the theory (which we offer for discussion), common

descent is actually something like an axiom or formal principle, which is presupposed by evolutionary theory – but is itself not at issue. This view – call it the axiom thesis – is not as outlandish as it may appear, and helps to make sense of the scientific practice of evolutionary theorists, as in the examples given above. When reconciling a theoretical bundle (common descent + independent auxiliary theory) with observation, evolutionists act to conserve the truth of common descent. As philosopher of science Harold I. Brown observes,

In science, not all propositions are treated as testable empirical hypotheses. It is only because a large body of knowledge is taken as paradigmatic that we can isolate individuals propositions for purposes of testing, and what conclusions we draw from a particular test depends on what propositions we take as paradigmatic.<sup>49</sup>

Kevin de Queiroz and Michael Donoghue argue that "the principle of common descent" unifies the "patterns of living things in space, in time, and in form under a single general theory."<sup>50</sup> But, as they also argue,

The theory of common descent...is "evolutionary" only in the most general sense, for it does not even refer to change. It certainly is not tied to any particular model of the evolutionary process, nor is it at odds with the results of systematic analysis.<sup>51</sup>

In other words, we need not worry that anything in our biological experience will ever run afoul of the theory.

Suppose Darwin had it right, namely, that "all the organic beings which have ever lived on this earth have descended from some one primordial form."<sup>52</sup> The existence of this "one primordial form," the common ancestor, establishes a theoretical domain that logically subsumes all biological and paleontological phenomena. That is, even if life had multiple origins, we will be unable, having assumed the truth of common descent, to provide any evidence for that possibility: all observed organisms, whether recent or extinct, will necessarily lie within what might be called the "common ancestor horizon."

If this seems counter-intuitive, try the following thought experiment. Assume the truth of common descent, and then attempt to construct an empirical argument against it. No imaginable evidence one might bring to bear, however striking – e.g., organisms for which no transitional stages seem possible, multiple genetic codes – will be able to overturn the theory. If there really was a common ancestor, then all discontinuities between organisms are only apparent, the artifacts of an incomplete history. An ideally fine-grained history would reveal the begetting relations by which all organisms have descended from the common ancestor.

If the axiom thesis is correct, then the theory of common descent will indeed be refractory to the evidential challenges thrown up by biological experience. One can see the point in Mayr's recent claim that common descent

has been gloriously confirmed by all researches since 1859. Everything we have learned about the physiology and chemistry of organisms supports Darwin's daring speculation that "all the organic beings which have ever lived on this earth have descended from some one primordial form..."<sup>53</sup>

One wonders what we could have learned about organisms, since 1859, that would not have confirmed common descent.

We offer the axiom thesis, not because we are persuaded of its truth, but to provide a starting point or focus for discussion. How, really, do the patterns of living things count for, or against, the notions of primary continuity (common ancestry) or primary discontinuity (polyphyly)? If common descent cannot be dislodged by the "evidence," then how should we go about evaluating it?

## References

1. A.S. Romer and T.S. Parson, *The Vertebrate Body* (Philadelphia: W.B. Saunders, 1977), p. 9-10.
2. Ronald Brady, "On the Independence of Systematics," *Cladistics* 1 (1985): p. 123.
3. F.J. Ayala, "The Theory of Evolution," *Encyclopedia Britannica* 15th ed. (1988) Vol. 18, p. 987.
4. Richard Owen, *On the Nature of Limbs* (London: John Van Voorst, 1849), p. 40.
5. Ayala, "Theory of Evolution," p. 987.
6. Richard P. Elinson, "Change in Developmental Patterns: Embryos of Amphibians with Large Eggs," in *Development as an Evolutionary Process*, eds. R. Raff and E. Raff (New York: Alan R. Liss, 1987), p. 3.
7. William Ballard, "Problems of Gastrulation: Real and Verbal," *BioScience* 26 (1976): p. 38.
8. As stated by von Baer, these are: (a) The general features of a large group of animals appear earlier in the embryo than the special features; (b) Less general characters are developed from the most general, and so forth, until finally the most specialized appear; (c) Each embryo of a given species [literally Thierform], instead of passing through the stages of other animals, departs more and more from them, and (d) Fundamentally, therefore, the embryo of a higher animal is never like [the adult of] a lower animal, but only like its embryo. Translation from *Entwicklungsgeschichte der Thiere* [Borntreger, Königsberg, 1828], 224; trans. S.J. Gould in *Ontogeny and Phylogeny* [Cambridge, Mass: Harvard University Press, 1977], p. 56.)
9. Adam Sedgwick, "On the Law of Development commonly known as von Baer's Law; and on the Significance of Ancestral Rudiments in Embryonic Development," *Quarterly Journal of Microscopical Science* 36 ([N.S.] 1894): p. 38.

10. Gould, *Ontogeny and Phylogeny*, p. 59
11. Rudolf Raff and Thomas Kaufman, *Embryos, Genes, and Evolution* (Bloomington, Indiana: Indiana University Press, 1991), p. 9.
12. Peter Medawar, "The Evidences of Evolution," in *Darwin's Legacy*, ed. C.L. Hamrum (San Francisco: Harper & Row, 1983), p. 50.
13. Søren Løvtrup, *Darwinism, the Refutation of a Myth* (London: Croom Helm, 1987), p. 378; italicized in original.
14. David Wake and Gerhard Roth, "The Linkage between Ontogeny and Phylogeny," in *Complex Organismal Functions*, eds. D.B. Wake and G. Roth (New York: John Wiley, 1989), p. 363.
15. Michael Ghiselin, "The origin of molluscs in the light of molecular evidence," *Oxford Surveys in Evolutionary Biology*, Volume 5, eds. P. Harvey and L. Partridge (Oxford: Oxford University Press, 1988), p. 84.
16. Lewis Wolpert, "The evolution of development," *Biological Journal of the Linnean Society* 39 (1990): p. 120.
17. Løvtrup, *Darwinism*, p. 378.
18. Wolfgang Dohle, review of *Darwinism: The Refutation of a Myth*, by Søren Løvtrup. *Journal of Evolutionary Biology* 1 (1988): p. 285.
19. "Homology" should here be understood phylogenetically: "The definition of homology most commonly used by biologists...uses phylogeny as a defining criterion, and can be expressed as follows: Homologous features (or conditions of the features) in two or more organisms are those that stem phylogenetically from the same feature (or condition) in the immediate common ancestor of these organisms" (Walter Bock, "The homology concept: its philosophical foundation and practical methodology," *Zoologische Beiträge Neue Folge* 32 [1989]: 331).
20. Charles Darwin, *The Origin of Species by Charles Darwin: A Variorum Text*, ed. Morse Peckham (Philadelphia: University of Pennsylvania Press, 1959), p. 765; emphasis added.
21. Alan Boyden, "Implications of Homology and Recommendations in Regard to Uses," Chapter 5 in *Perspectives in Zoology* (New York: Pergamon, 1973), p. 111.
22. Gareth Nelson, "Ontogeny, Phylogeny, Paleontology, and the Biogenetic Law," *Systematic Zoology* 27 (1978): p. 335.
23. V. Louise Roth, "On homology," *Biological Journal of the Linnean Society* 22 (1984): p. 17; emphasis in original.
24. Nicholas Jardine, "The Concept of Homology in Biology," *British Journal for the Philosophy of Science* 18 (1967): p. 127.
25. "Structures as obviously homologous as the alimentary canal in all vertebrates can be formed from the roof of the embryonic gut cavity (sharks), floor (lampreys, newts), roof and floor (frogs), or from the lower layer of the embryonic disc, the blastoderm, that floats on top of heavily yolked eggs (reptiles, birds)" (Gavin de Beer, *Homology, An Unsolved Problem*, Oxford Biology Readers No. 11, eds. J.J. Head and O.E. Lowenstein [Oxford: Oxford University Press, 1971] p. 13.)
26. Leigh Van Valen, "How do major evolutionary changes occur?" *Evolutionary Theory* 8 (1988): p. 173.
27. Leo Buss, *The Evolution of Individuality* (Princeton: Princeton University Press, 1987), p. 33.

28. D.T. Anderson, "Developmental pathways and evolutionary rates," in *Rates of Evolution*, eds. K.S.W. Campbell and M.F. Day (London: Allen & Unwin, 1987), p. 149.
29. Rudolf Raff, Gregory Wray, and Jonathan Henry, "Implications of Radical Evolutionary Change in Early Development for Concepts of Developmental Constraint," in *New Perspectives on Evolution*, eds. L. Warren and H. Kopyrowski (New York: Wiley-Liss, 1991), v. 189.
30. Raff *et al.*, "Implications," p. 145.
31. Leigh Van Valen, "A morphogenetic basis for macroevolution," *Evolutionary Theory* 9 (1988): p. 329.
32. Jeffrey Levinton, *Genetics, Paleontology, and Macroevolution* (Cambridge: Cambridge University Press, 1988), pp. 252, 254.
33. See A.G. Cairns-Smith, *The Life Puzzle* (Edinburgh: Oliver & Boyd, 1971) 148; Theodosius Dobzhansky, "Nothing in biology makes sense except in the light of evolution," *American Biology Teacher* 35 (1973):125-129; John Maynard Smith, *The Theory of Evolution* (New York: Penguin, 1975), 82; Theodosius Dobzhansky, Francisco Ayala, G. Ledyard Stebbins, and James Valentine, *Evolution* (San Francisco: W.H. Freeman, 1977), 28; Douglas Futuyma, *Evolutionary Biology* (Sunderland, Mass.: Sinauer, 1979), 38; Ernst Mayr, "Darwin, intellectual revolutionary," in *Evolution from Molecules to Men*, ed. D.S. Bendall (Cambridge: Cambridge University Press, 1983), 30-31; David Raup and James Valentine, "Multiple origins of life," *Proceedings of the National Academy of Sciences USA* 80 (1983): 2981; Bernard Davis, "Molecular Genetics and the Foundations of Evolution," *Perspectives in Biology and Medicine* 28 (1985); 256; Richard Dawkins, *The Blind Watchmaker* (New York: W.W. Norton, 1986), 270; Mark Ridley, *Evolution and Classification* (London: Longman, 1986), 119-20; Colin Patterson, "The impact of evolutionary theory on systematics," in *Prospects in Systematics*, ed. D.L. Hawksworth (Oxford: Clarendon Press, 1988), 61; Elliot Sober, *Reconstructing the Past* (Cambridge, Mass.: MIT Press, 1988), 9; Antoni Hoffman, *Arguments on Evolution* (Oxford: Oxford University Press, 1989), 8-9; Ernst Mayr, *One Long Argument* (Cambridge, Mass.: Harvard University Press, 1991), 23.
34. Davis, "Molecular Genetics," p. 256, emphasis added.
35. Mark Ridley, *The Problems of Evolution* (Oxford: Oxford University Press, 1985), pp. 10-11; emphasis added.
36. Francis Crick, "The Origin of the Genetic Code," *Journal of Molecular Biology* 38 (1968): p. 369; emphasis added.
37. James Watson *et al.*, *Molecular Biology of the Gene*, 4th ed. (Menlo Park, California: Benjamin/Cummings, 1987), p. 453; emphasis added.
38. Syozo Osawa, Akira Muto, Thomas Jukes, and Takeshi Ohama, "Evolutionary changes in the genetic code," *Proceedings of the Royal Society of London B* 241 (1990): p. 19.
39. Thomas Fox, "Diverged genetic codes in protozoans and a bacterium," *Nature* 314 (1985): p. 132.
40. *Ibid.*
41. Thomas Fox, "Natural Variation in the Genetic Code," *Annual Review of Genetics* 21 (1987): p. 77.
42. *Ibid.*



43. F. Caron, "Eucaryotic codes," *Experientia* 46 (1990): p. 1111.
44. Fox, "Natural Variations in the Genetic Code," p. 84; emphasis added. As far as we know, only Hubert Yockey has suggested that the discovery of multiple codes may imply multiple origins of life. "The pervasiveness of the standard genetic code," he writes, "has often been cited as evidence of a single origin of life event (Mayr 1982). The other side of the coin is that the existence of several different genetic codes is evidence of a number of independent origin of life events" (*Information theory and molecular biology* [Cambridge: Cambridge University Press, 1992], pp. 202-203).
45. Osawa, Muto, Jukes, and Ohama, "Evolutionary changes," p. 21.
46. *Ibid.*
47. Caron, "Eucaryotic codes," p. 1113.
48. Niles Eldredge and Joel Cracraft, *Phylogenetic Patterns and the Evolutionary Process* (New York: Columbia University Press, 1980), p. 2.
49. Harold I. Brown, *Perception, Theory and Commitment* (Chicago: University of Chicago Press, 1979), p. 106.
50. Kevin de Queiroz and Michael Donoghue, "Phylogenetic Systematics or Nelson's Version of Cladistics," *Cladistics* 6 (1990): p. 62.
51. *Ibid.*, p. 61.
52. Charles Darwin, *On the Origin of Species*, 1st ed., p. 484.
53. Ernst Mayr, *One Long Argument* (Cambridge: Harvard University Press, 1991), p. 163.

Copyright 1993, 2001 Paul Nelson and Jonathan Wells. All rights reserved.  
International copyright secured.