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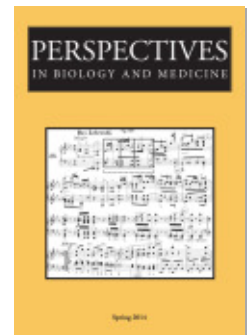
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## Owen's Vertebral Archetype and Evolutionary Genetics-A Platonic Appreciation

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# OWEN'S VERTEBRAL ARCHETYPE AND EVOLUTIONARY GENETICS—A PLATONIC APPRECIATION

SCOTT F. GILBERT\*

## I

Sir Richard Owen (1804–1892) is often cast as evolutionary biology's foremost villain. A believer in the successive emergence of organic life, he has been seen as a traitor to the idea of natural selection, a concept which he came close to formulating himself. Thus, he is presented, as his career rapidly declines, as a jealous man whispering antievolutionary calumnies into the anxious ear of Bishop Wilberforce [1].

Owen's demise at the hands of Darwin and Huxley was a public spectacle, and it is usually this aspect of his career which is given attention. But Owen's own theory of species formation, for which he fought so hard and in which he invested so much of himself, is fascinating in its own right. He was both a scientist and a philosopher, an English adherent to Germanic *naturphilosophie* whose theory concerning the origin of species represents a deftly integrated synthesis of paleontology, comparative anatomy, and Christian Platonism. It was this majestic aesthetic system which was one of the first casualties of Darwinism; for natural selection explained all too well the phenomena upon which Owen based his theories. Although resembling evolutionism in its advancement of the concept of successive speciation, it was in most other ways its opposite. Indeed, if Darwinism represents the replacement of type thinking by population thinking, Owen's theory was the epitome of the former. It was perhaps the culmination of that typological thinking ("essentialism") which Ernst Mayer has called the hardest obstacle that Darwinism faced [2].

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Owen's theory of the vertebral archetype can be seen as bridging the gap between the last modifications of the Great Chain of Being and the first statements of natural selection. Moreover, his way of thinking may have reentered modern biology—for his theories exhibit some remarkable “homologies” to current hypotheses for the molecular basis for evolution.

When Owen published *On the Archetype and Homologies of the Vertebrate Skeleton* (1848), he found it necessary to place his work in the context of those continental “philosophical anatomists” whose work preceeded his own. Using his general introduction and historical critique to launch into his own theories, Owen placed himself as the heir to the traditions of Cuvier (his acknowledged master whose view of nature he wished to expand) and of those interpreters of nature, Goethe, Geoffroy St. Hilaire, Vicq d'Azyr, and Lorenz Oken.

It is in this introduction to comparative anatomy that Owen best summarizes his own position. Without venturing into the evidence that Owen calls upon, we may state his conclusions below. First, he defines two terms critical to his discussion. “Homologue,” which he had expanded from G. St. Hilaire's discussions (and to which St. Hilaire refers us back to “la philosophie Allemande”), pertains to “the same organ in different animals under every variety of form and function” [3, p. 6]. From this, he distinguishes the “analogue,” that “part or organ in one animal having the same function as another part or organ in a different animal” [ibid]. For instance, “the hard parts of the leg of a Crab or an Insect may be *analogous* to the bones of the limb of a quadruped,” Owen declared, “but they are not *homologous* with them.” However, he would triumphantly conclude that “the arms and legs in Man, the fore- and hind-limbs of Beasts, the wings and legs in Bats and Birds, and the pectoral fins and ventral fins of Fishes . . . all are homologous.”

Next, Owen describes the three types of homologies evident in the vertebrates:

- I. *Special homology*: the “correspondency of a part or organ, determined by its relative position and connections, with a part or organ of a different animal; the determination of which homology indicates that such animals are constructed on a common type.”
- II. *General homology*: where “a part or series of parts stands to the fundamental or general type, and its enunciation involves and implies a knowledge of the type on which a natural group of animals, the vertebrates for example, is constructed. . . .”
- III. *Serial homology*: where “as in the vertebra, any given part of one segment may be repeated in the rest of the series in the same skeleton” [3, p. 7].

Using these categories, Owen claimed to have discovered the basic plan of vertebrate anatomy. First, all vertebrae (among which he emphatically and unfortunately included the skull) of a given vertebrate body were all

serially homologous to one another. That is, despite their modification into thoracic vertebrae, tail vertebrae, skull, etc., they are homotypically identical. Second, each vertebra of every fish, amphibian, reptile, and mammal was seen to be a general homologue of each other. Moreover, since Owen was able to show the same relationships between the limbs of all vertebrates, the limb appendages being both serially homologous within individuals and generally homologous between all groups of vertebrates, he stated his third, and unifying, conclusion: The limbs were specially homologous to the diverging regions of the vertebra. The shoulder blade, for instance, was seen as a special homologue to the pleurapophysis protruberance of the vertebra (and therefore, a modification of the rib). By these three conclusions, Owen believed that he had demonstrated the common pattern to all vertebrate bones and felt that his research had uncovered the basic plan by which the Creator had formed this branch of the animal kingdom [3, p. 127].

Indeed, Owen had envisioned a unified plan of structure pervading the diversity of vertebrate organisms. All vertebrates were derived from a common archetype from which each species would be teleologically modified in order to survive in its environment. He even reconstructed a probable Urbuild—called *Archetypus*—which he noted might have a structure similar to the contemporary lungfish, *Lepidosiren* [4, p. 5].

But Owen was not content merely to observe such great manifestations of order. He postulated a mechanism which could account for such unity among the diverse vertebrates. First, vertebrae were homotypic by virtue of some “vegetative repetition of a single vertebral element” [3, p. 87]. Each of these serially repetitive vertebral elements could then be teleologically modified independently of each other until it became evident only to the most trained observer that certain of the parts are homologous. Such a scheme is presented in figure 1.

Owen felt that he had discerned the form that must have been conceived in the mind of God. Moreover, to discover the forms by which the Creator placed life on earth was exactly what Owen believed to be the highest goal of comparative anatomy: “The beautiful simplicity of the fundamental basis of these adaptations of structure . . . is descanted upon in all our popular theological treatises. But the higher law governing the existence of special homologies has attracted little attention in this country. Yet the inquiry into that more general principle of conformity to type which it has pleased the Creator of organic forms to restrict the manifestations of the variety of proportion and shape and substance and even relative position in limbs . . . is one that by no means transcends the scope of the comparative anatomist” [3, p. 127].

Richard Owen made no apologies for his theory being so charged with philosophy and aesthetics; rather he delighted in that he could unify the beauty of Platonic forms with the objective truth of anatomy. “General

anatomical science reveals the unity which pervades the diversity, and demonstrates the whole skeleton of man to be the harmonized sum of a series of essentially similar segments, although each segment differs from each other and all vary from their archetype" [3, p. 141]. Adept at classics, Owen extended his findings through those Platonic categories most useful to him. He envisioned the entire succession of vertebrates as being generated by two antithetical forces, thereby producing a gradient. At one pole lay "the Platonic  $\iota\delta\epsilon\acute{\alpha}$ " represented by the archetype of the series. This  $\iota\delta\epsilon\acute{\alpha}$  is "in antagonism with the general polarizing force" which seeks to modify the form to the exigences of its environment [3, p. 172]. This model can be illustrated in figure 2 by two interpenetrating cones whose vases indicate the opposing forces.

The extent to which the adaptive force is able to modify the archetypal pattern becomes "the index of the grade of such species, and is directly

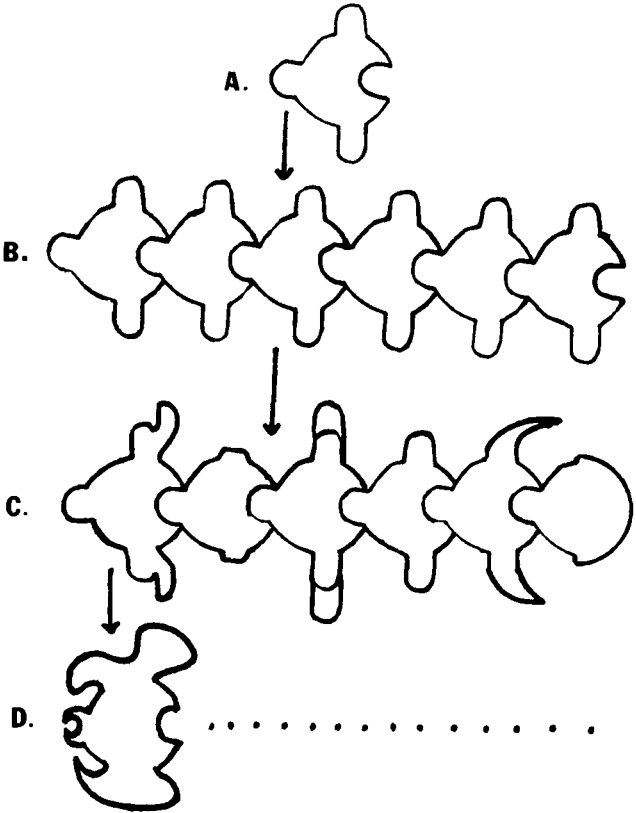


FIG. 1.—Schema of Owen's model for the origin of vertebrates. Original archetypal vertebra (A) undergoes "vegetative repetition" to form a series of identical vertebrae (B) which can then undergo independent modification (C). Some modifications may become so extreme as to hardly be recognizable as part of the homologous group (D).

as its ascent in the scale of being" [3, p. 172]. Therefore, the more modified the organism from the archetype, the higher its position in the ranks of nature. Eventually, furthest removed from the archetype of any vertebrate, one finds Man, "the highest and most modified of all organic forms, in which the dominion of the controlling and specially-adapting force over the lower tendency to type and vegetative repetition is manifested in the strongest characters" [3, p. 132]. Yet even here, says Owen, "We find the vertebrate pattern so obviously retained."

Owen was enamored with the new order of nature that he had "proven," and, extended from its scientific foundations, it became a source of aesthetic as well as scientific value for him. He felt that the discovery of archetypal relationships and the contemplation of such patterns as they continually reappear both within an organism and between species were great sources of joy for the civilized man. He expounded upon the "satisfaction felt by the rightly constituted mind" when it discovers the "harmonious concord with a common type" [4, p. 38], and he exclaimed "with what new interest must the human anatomist view the little ossicles of the carpus and tarsus when their homologies have been determined!" [4, p. 38]. Indeed, there is a grand beauty in the order of nature which opens at the touch of scientific contemplation: "A perfect and beautiful parallelism reigns in the order in which the toes successively disappear in the hindfoot with that of the forefoot . . ." [4, p. 33]. "Consider the beautiful and numerous evidences of unity of plan which the structures of the locomotor members have disclosed . . ." [4, p. 39].

As might be expected, Owen's Platonism, extended from its scientific basis, penetrated well into his private aesthetic appreciations. He found, for example, great beauty in the pedal extremities of Greek statuary where the Greeks' "insight into the archetypal law . . . guided them to an

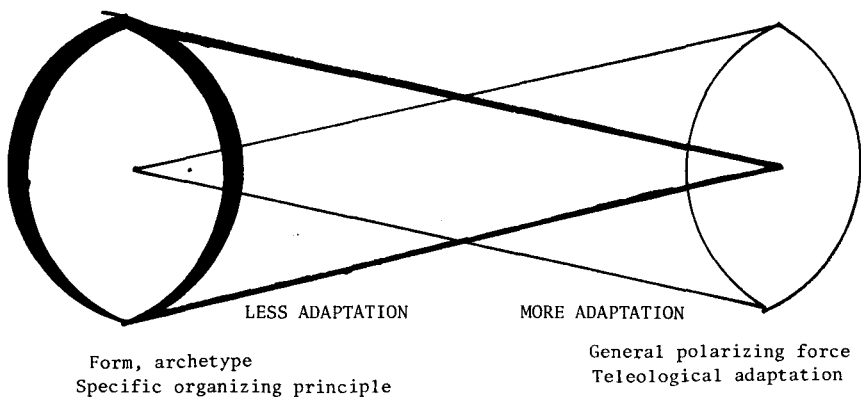


FIG. 2.—Owen's bipolar model for a gradient of modifications

exact and beautiful indication of the affinities of the three middle toes as contrasted to the first and fifth . . ." [ibid.]. Even his letter signet displayed his Platonic zeal, for Owen wrote his sister, Maria: "I enclose with pleasure a wax impression of my adopted cognizance. . . . It represents the archetype, or primal pattern—what Plato would have called the Divine idea on which the osseous frame of all vertebrate animals—i.e., all animals that have bones—have been constructed. The motto is 'The One in the Manifold,' expressive of the unity of plan which may be traced through all the modifications of the pattern, by which it is adapted to the various habits and modes of life . . ." [5].

In discovering the "Divine idea" through which all vertebrate species had been formed, Owen believed he had scored a philosophical as well as biological breakthrough; for it would rescue mankind from the alternative view—that of the anonymous author of the *Vestiges of the Natural History of Creation*—that "organic atoms concurred fortuitously to produce such harmony." This latter alternative, Owen characteristically declared, is but an "Epicurean slough of despond" from which "every healthy mind naturally recoils" [4, p. 40]. (Indeed, Owen may have been correct. According to Fleming [6], Darwin never did crawl out of the slough and underwent severe depression, eventually hating both art and science. Owen's myth sustained his artistic interests well after his scientific career.)

Sir Richard, of course, was not alone in his deriving aesthetic and philosophic values from anatomy. We have already seen that he mentions the teleological theologians and states that they stopped too far short. These commentators merely called attention to one aspect of the grand plan, and not even the most important part. Indeed, teleology was necessary, but it was not at all sufficient for Owen. Why should an inventor manufacture a wing, a leg, and a paddle all on the same basic design? The teleologists had their place, but in the attempt to discover a higher truth, "we feel the truth of Bacon's comparison of 'final causes' to the Vestal Virgins, and perceive that they would be barren and unproductive of the fruits we are laboring to attain, and would yield us no clue to the comprehension of that law of conformity of which we are in quest" [4, p. 40]. Since teleology could not explain the unity within all the diverse limbs of the vertebrates, Owen abandoned it for his theory of a vertebral archetype with secondary teleological modifications.

Owen's Platonism, as we have seen, is fully compatible with Cuvier's fragmentation of the Great Chain of Being into diverse "embranchments," placing new emphasis on individual species. Upon this structure, Owen was able to superimpose his theory of archetypes and other modifications which had been formulated to explain the lacunae in the chain's continuity [7]. Owen explained that each section of the chain had its own archetype and does not have to be temporally complete. Certain



intermediate species may exist either in the past or the future: "The possible and conceivable modifications of the vertebrate Archetype are far from having been exhausted in the forms that have hitherto been recognized, from the primaevial fishes of the palaeozoic ocean of this planet up to the present time." Indeed, it is here that Owen speaks of the "successive introduction of specific forms of living beings on this planet" [3, p. 106].

Not only are Owen's embranchments temporalized, they are also spatialized. Following Leibnitz's belief that only certain species could coexist harmoniously on the same planet, Owen freely speculated that other groups of compossible vertebrates could inhabit other worlds. Therefore, some of the missing modifications of the vertebral Archetype might exist on those other worlds. "The beneficent Author of all, who created other revolving orbs, with relations to the central source of heat and light like our own, may have willed that these should be the seat of sentient beings. . . . The eyes of these creatures, the laws of light being the same, would doubtless be organized on the same dioptic principle as ours; and if a vertebral column be there . . . it may be subject to modifications issuing in forms such as this planet has never witnessed, and which could only be perceived by him who has penetrated the mystery of the vertebrate archetype . . ." [3, p. 102].

Owen also discussed archetypal law in embranchments other than the vertebrates. In his first major work, *Memoir on the Pearly Nautilus*, he defended Cuvier's theory of embranchments against those notions of Geoffroy St. Hilaire, who envisioned a strictly linear chain [8, p. 1]. Owen envisioned many chain segments, each having its own archetype, and he considered the pearly nautilus to be "the living, perhaps sole living, archetype of a vast tribe of organized beings, whose fossilized remains testify their existence at a remote period" [8, p. 2].

According to Owen, the straight chambered shells (such as *Orthoceras*) represented now only as fossils had been produced by a gradual uncoiling of the archetype nautilus [9, p. 806]. These derived species are higher on the scale of nature than the archetypal species, and this concept of descent from a primitive species and modification by environmental necessities sounds like an anticipation of Darwinism. But the similarity exists more in vocabulary than mechanism. Owen's continuity was that of type, not descent. His species were degenerations of the ideal archetype, not the product of natural selection. In Owen's plan, Platonism is a major element, and in the majestic conclusion to *The Nature of the Limbs* Owen's Platonic system is seen in fully glory:

Now, however, the recognition of an ideal Exemplar for the Vertebrated animals proves that knowledge of such a being as Man must have existed before Man appeared. For the Divine mind which planned the Archetype also foreknew all

its modifications. The archetypal idea manifested in the flesh, under divers modifications, upon this planet, long prior to the existence of animal species that actually exemplify it. . . . We learn from the past history of our globe that she [Nature] has advanced with slow and stately steps, guided by the unfailing archetypal light amidst the wreck of worlds, from the first embodiment of the Vertebrate idea under its old Ichthic vestment until it became arrayed in the glorious human form. [4, p. 85].

## II

Owen's theory could be presented merely as an excellent example of an interaction between aesthetics and biology or as an illustration of Huxley's dictum that science often destroys some beautiful theories. Yet as Platonically charged as Owen's theory was, even it fell short of the unity-amidst-diversity inherent in the world view of contemporary molecular biology; for while Owen saw unities of form within various groups of organisms, molecular biology, by studying the genetic and biochemical rather than the osseous skeleton, has been able to uncover a deeper unity underlying all the diverse organisms on earth. Every organism, be it bacterium, plant or animal, has as its genetic skeleton one or more molecules of deoxyribonucleic acid (DNA). The only exceptions are those viruses using ribonucleic acid (RNA) for their hereditary material. Moreover, the four constitutive bases of the DNA are the same in each organism as are the components of the RNAs for which they code.<sup>1</sup> The sequences coding for the amino acids are identical in all known organisms, including the RNA viruses. Indeed, much of the original research on the nature of the genetic code utilized the RNA phages.

Not only is the genetic code and its components universal throughout all the organic kingdoms, but so are the 20 amino acids which constitute the proteins of each organism; and although the diversity of organic life is enormous, it is estimated that 93 percent of the known mammalian enzymes are also found in bacteria [10]. Reflecting on such discoveries, Jacques Monod has written: "To the biologists of my generation fell the discovery of the virtual identity of cellular biochemistry throughout the entire biosphere. By 1950 research pointed to it as a certainty, and each new publication added further confirmation of it. The hopes of the most convinced 'Platonists' were more than gratified" [11, p. 103].

The elucidation of the genetic code and semiconservative replication provided a means of explaining the generation of diversity from the underlying unity and its subsequent transmission. The DNA sequence of

<sup>1</sup>To be sure, this and the following pages are a simplification of an enormous amount of research. Certain bacteriophages, for example, incorporate uridine instead of thymidine into their DNA, and transfer RNAs contain numerous modified nucleotides. However, the general rule still holds. Since this essay does not attempt to review the literature concerning the biochemical analysis of evolution, I have referred to general works whenever possible.

the gene consists of four bases in triplet register which become transcribed onto RNA and then translated into a specific protein. In this way, the DNA determines the primary sequence of the polypeptides which are the structural and catalytic agents of the organism. Moreover, if any of the component bases of a gene are changed, the amino acid sequence of the encoded polypeptide may reflect that switch.

The responses to such mutations may not always be the same. In some portions of the protein such a change may render the molecule incapable of executing its role in the body chemistry. If serious enough, the organism will not survive. In other positions, the protein may be altered to an extent which makes it only partially functional, and there are other positions where a mutation probably has no effect at all [12]. These last-mentioned mutations should be able to accumulate in time if they become transmitted from generation to generation. As we shall see, they have been used as a measure of species divergence.

The current theory for the molecular basis of evolution is based on the genetic continuity of living organisms and the ability to measure the mutation-produced diversity between the nucleic acids and proteins of different species. It will be seen that molecular biology, having established the underlying unity of all organisms, proposes a model for explaining their diversity which is almost identical with that which Owen used to explain homologies in bones. Indeed, while one is tempted to call attention to the "homologies" between these two hypotheses, an important caveat must be made. If homologies do exist (and I hope to show that they do), the homology is not by descent.

It is not my endeavor to say that molecular genetics is in any way indebted to either Owen or Plato or that Platonism had any influence on the development of the molecular hypotheses for evolution. I do wish to show, however, that these two separate entities, Owen's model of speciation and contemporary models for molecular evolution, had to explain the same phenomenon—an underlying unity amid apparent diversity both within a single organism and between different species—and did so by constructing similar hypotheses. Certain differences must also be kept in mind. Whereas modern biology posits that organisms and their macromolecules evolve from precursor forms through a process of natural selection, Owen postulated that speciation arose from the teleological degradation of organisms from divinely conceived archetypes. Thus, there is no historical link between these two hypotheses whose structures will be shown to be constructed on very similar principles.

First, one must determine if there exists any "homology" between Owen's usage of the term "homologous" and that same word as used by molecular biologists. "Homology," states Roy Britten [13], one of the first scientists to propose a biochemical model of genetic evolution based on DNA sequence analysis, refers to "the degree of similarity between the

nucleic acid sequences of different species.” Unlike bones, however, these sequences cannot be readily observed by simple dissection. One method of detecting and measuring similarities between DNA sequences is to compare the amino acid sequences of similar proteins in different species. Since the amino acid sequence of a protein is determined by the nucleic acid sequence of the DNA coding for it, differences in protein structure should give a lower bound on the differences that had occurred at the gene level.

The proteins composing the globin portion of hemoglobin are without doubt the best studied. Each individual has several different hemoglobin proteins, and these proteins are characteristic of the species. In humans, the  $\alpha$ ,  $\beta$ ,  $\delta$ ,  $\gamma^A$ , and  $\gamma^G$  hemoglobin chains resemble one another but are different in certain characteristic ways. The  $\gamma^A$  and  $\gamma^G$  globin chains differ in only one amino acid.

Between species, similarities are also evident. Even though horse and human  $\alpha$  globin chains are chemically and physically distinct, they differ in only 17 amino acids in 141. The only difference between human and gorilla  $\alpha$  chains occurs at the twenty-third amino acid where the glutamic acid in the gorilla globin is replaced by aspartic acid in the human protein [14, p. 70].

Since the various hemoglobins within the body are similar in structure and are believed to be derived from some common ancestral sequence, they would conform to Owen's category of serial homology. The fact that such similarity exists between species indicates that Owen's "special homology" is a valid characterization here. The general homology of hemoglobins to one another implies knowledge of their function. The function of hemoglobin is oxygen binding and release, and one of the best known examples of structure/function relationships is that of the hemoglobins. A very exact structure is needed for hemoglobin to carry out the gas exchanges in the lungs and tissues, and certain portions of every hemoglobin molecule are essential to that function. Even other oxygen transport molecules such as myoglobin must have these essential sequences, and myoglobin is believed to share a definite homology to the hemoglobin proteins. Indeed, a contemporary scientist has concluded that "the genes responsible for the production of the globin portion of the hemoglobins and myoglobins are all derived from a common archetypal piece of DNA, probably containing 486 base pairs" [15, p. 153]. Like Owen's postulated vertebral archetype, all the genes for hemoglobin and myoglobin throughout the vertebrate subphylum show serial, special, and general homology. They can be related to an archetypal structure from which they all descended. Similar conclusions have been reached with numerous other proteins such as immunoglobins and serine proteases [14, p. 70].

Perhaps the most important data on homology come from studies on the nucleic acids themselves. These investigations can be done by extracting DNA from organism A, separating the two DNA strands from one another, and immobilizing them on agar [16] or on a treated filter [17]. Highly radioactive DNA from species B can then be prepared, sheared to a small size, and incubated on that DNA-bearing filter. Only those sequences of the radioactive DNA which are very similar to those on the filter should remain bound, and the quantity of radioactive DNA remaining on the filter should give a quantitative value of the homology between the DNAs of the species. Furthermore, the degree of homology can be tested by raising the temperature of incubation solution. The better the complementarity, the more resistant the hybrid helices are to temperature. For example, a recent paper [18] on echinoderm evolution concluded that 71 percent of the DNA of *Stroglyocentrotus droebachiensis* is homologous with that of *S. purpuratus* and has no detectable mismatching. They are thus assumed to have diverged from each other only recently. However, when the DNA of the *S. droebachiensis* sea urchin is compared with that of the sand dollar (*Dendraster excentricus*), only 4 percent of the DNAs were found to have common sequences, and these were poorly matched. Note that the homologous sequences need not be identical and can have considerable differences between themselves. Similarly, Owen felt that some vertebrae, such as the skull, were scarcely recognizable as vertebrae any longer.

In 1964, Roy Britten and co-workers at the Biophysics Section of the Carnegie Institute of Washington's Department of Terrestrial Magnetism observed that certain DNA sequences were present in the genome at a much higher number than others. The "extremely rapidly renaturing fraction" of mouse DNA consists of a sequence of 300–400 base pairs and is present at  $10^5$ – $10^6$  copies per mouse genome. It alone accounts for roughly 10 percent of the mouse DNA [19]. Throughout the genome of the mouse and other animals, single-copy DNA has been found interspersed with DNA of various repetition [20].

The model of Britten and Kohne [21] is probably the most accepted hypothesis to account for the formation and divergence of homologous sequences of DNA. Acknowledging that "the results presented imply the existence of a common genetic material that has been conserved during the course of vertebrate evolution" [19, p. 76], they posit that the basis for the phenomenon is the "saltatory replication" of a nonrepeating DNA sequence to produce a tandem family of identical sequences. The individual members of this large family, being released from some of the selective pressures placed on the single copy, can undergo mutation independently of each other. This produces a family of similar though not identical sequences. Each of the members of such a family can con-

tinue to acquire mutations until it is no longer recognized as homologous to other members of the family. Such a sequence would be considered as single-copy.

This procedure is summarized in figure 3. Comparing it with Owen's model (fig. 1), certain "temporal homologies" stand out. The first step in both systems is the tandem multiplication which Owen called "vegetative repetition" and which Britten and Kohne call "saltatory replication." The end result in both cases is the formation of identical structural units. The next step in both these models is the independent divergence of the component members. Owen's repetitions of the archetypal vertebra become the skull bones, the thoracic vertebrae, etc.; Britten and Kohne's repetitive sequences become a family of similar but by no means identical homologues. Hence, from an original unity of structure, a homologous group arises. Finally, both models postulate that the homologous elements may continue to diverge so greatly that they can hardly be recognized as homologous.

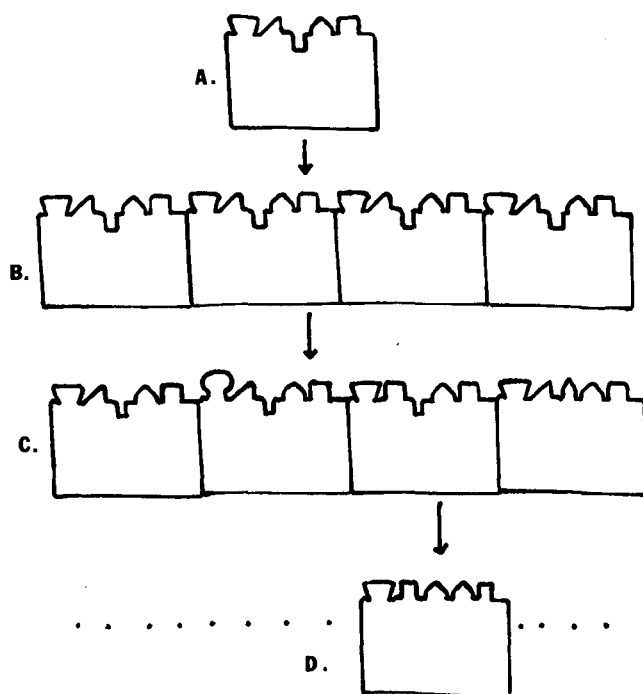


FIG. 3.—Schema of the Britten and Kohne model for the production of repeated DNA sequences and new genes. Original single-copy gene (A) undergoes "saltatory replication" to form a tandem series of identical sequences (B) which can then undergo independent mutation (C). Some sequences may accumulate numerous mutations such that they may be considered as single-copy genes no longer recognizable as part of the homologous group (D).

Both Richard Owen and modern molecular biologists acknowledged a unity of form throughout the organisms they were investigating. It is therefore not too surprising that they would develop the same mode of explanation to account for the production of diversity out of unity. To be sure, the archetype of the modern biologist is far different from Owen's notions. Whereas Owen's vertebral archetype was a Platonic ideal organism whose modifications were preordained by the Creator for its survival, the archetype of the molecular biologist is a sequence of nucleic acid from which other sequences evolved in a trial-and-error encounter with the changing milieu of both organism and environment. Still, Owen's grandiloquent summary concerning the homologies of vertebrates is as true today as in 1848:

To trace the mode and kind and extent of modification of the same elementary part of the typical segment throughout a large series of highly organized animals, like the vertebrata; and to be thus led to appreciate how, without complete departure from the fundamental type, the species are adapted to their different offices of creation, brings us, as it were, into the secret counsels that have directed the organizing forces, and is one of the legitimate courses of inquiry by which we may be permitted to gain insight into the law which has governed the successive introduction of specific forms of living beings on this planet [3, p. 106].

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somewhere else to wait

a niche is somewhere else to wait  
if you prefer not to be ate.  
the zooplankton loathes the mud  
and much prefers an algal bud.

the copepoda as we know  
selects a niche in which to grow  
by standing on its little toe.  
the ostracod is more discreet,  
besides it hasn't any feet.

the daphnia, a filter feeder  
becomes the most prolific breeder.  
though march and april pass sequential  
the daphnia is exponential.

the whirligig is often found  
pretending that it has not drowned,  
and going round and round and round.

the amphipod attracts its prey  
by looking off the other way.  
the unsuspecting microphyte  
is thus depleted by the bite.

a niche is somewhere else to wait  
if you prefer not to be ate.

CANDACE GALEN