

## f26 Phyletic gradualism < uncommon >

*Natura non facit saltum* (“Nature does not make leaps” or as Shakespeare put it: “Nature does nothing by starts and leaps, or in a hurry.”)<sup>1</sup>

‘If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down. But I can find no such case.’ [—Darwin] ... nor has anybody since, ... —Dawkins<sup>2</sup>

*Phyletic gradualism* is the evolutionary history of some fossil rodent lineages,<sup>3</sup> ammonites,<sup>4</sup> and in the speciation of some microfossil genera,<sup>5</sup> such as the radiolaria. But it is *not* a common fossil-recorded feature of evolution. This surprise finding for evolutionary paleontologists was one that few chose to emphasize before the true nature of genetic inheritance became well understood. Some gradualistic evolutionary tales, as for titanotheres (**Figure f26.1**), are so oft told that as fairy tales (classified in both the Dewey decimal and the Library of Congress systems as nonfiction!) they, in the psyche, are folklore.<sup>6</sup> For example, Darwin’s wrote nothing about the length of giraffe’s neck (Wallace did, see **Footnote f26.1**). T. H. Huxley recognized a like problem with his theory-driven Darwinian account of the evolution of the horse, that had become famous for its reasonableness and for his memorable telling of it, before he discovered that the four genera of horses that he had described (**Footnote f26.2**) never had in reality the opportunity to evolve one from the other. While visiting America on a lecture tour in 1876, he had occasion to see Marsh’s collection of American fossil horses.<sup>7</sup> From that vastly more complete fossil evidence, he realized that the European genera that he had strung together as an evolving lineage, had been migrants to Europe from America and that in the bush of the horse’s evolution each were offshoot branches that had gone separately extinct.

Louis Pasteur had proposed a lock and key model for how vaccines worked. (In 1881, he was the first to vaccinate sheep against anthrax).<sup>8</sup> Geneticists originally conceptualized gene replication as being somewhat similar. A protein molecule of a specific shape served as a template for the construction of another protein containing a negative image of it. This then serves as a template for the construction of a molecule of roughly the original’s shape. This emphasis on shape likens the process to how an existing analogue record of say Enrico Caruso’s voice could be used, instead of the original master, to make another. Each copy of a copy, however, is less perfect than the original.<sup>9</sup> Even so, until the 1950s, life’s unknown underpinning allowed, as Barbara Ehrenreich puts it, in “science fiction and the late-night musings of undergraduates, whiffs of vitalism, yearnings for a numinous life force to explain it all. Then came the Watson-Crick double helix [1953], and the secret of life seemed to be revealed, once and for all, in the arrangement of nucleotides on a DNA strand and the snappings of hydrogen bonds as the strands unzipped themselves and got down to work. The mists receded, and living matter began to look, at bottom, like Tinker Toys or pop-it beads: neat, digital and potentially subject to human control.”<sup>10</sup>

After Watson and Crick, geneticists realized that an analogue mechanism is *not* how genetic information is passed on from one generation to the next. In *River Out of Eden* (1995), Richard Dawkins (**Figure f26.2**) emphasizes that the genetic code is digital rather than analogue. The code can be altered by being rearranged, added to, or knocked out, but it cannot fade. He also makes clear that the metaphor of a blueprint is wrong for DNA which is better thought of as a recipe.<sup>11</sup>

Darwinian evolution is gradual change over time in populations because some individuals have acquired (neo-Darwinists insert here, “by genetic mutations”) features more conducive, than the day’s run of the mill ones, for successful survival and reproduction. “In this [pre-neo-Darwinian] view, evolution is essentially a slow process of ‘fine tuning’ of organisms to and by their environments; and it provides,” Ian Tattersall wryly remarks, “a perfect foil for reductionist storytelling, since with enough imagination almost any characteristic of an organism can be identified as an ‘adaptation’ with a distinctive role to play in the evolutionary scenario.”<sup>12</sup>

Phyletic gradualism that has a consistent trend over millions of years<sup>13</sup> is hard to explain by point mutations of structural genes. Structural genes are the templates for proteins and are those which determine the broad division of life to which an organism belongs. Manifest in the earliest embryonic stages, their persistence down the ages also argues for their stability and antiquity. When a reconstructed historical narrative does find for phyletic gradualism, it could reflect rearrangement of the programs of genetic expression layered on, more than incremental changes in, the structural genes themselves. It may also be that the layered-on genes guarantee either the integrity of the structural genes, or their extinction, and that is why phyletic experimentation occurred only at the beginning of the Phanerozoic. Ernst Mayr in his ninetieth year pondered this in his book *This is Biology* (1997).<sup>14</sup>

In the above, the focus is on the individual species. This loses sight (can't see the woods for the trees) of the fact that species are part of ecosystems. Either species will be held in check, or several will change together. Sven Erik Jørgensen writes, "One species cannot change the properties of the other species directly, but all species must consider all the other species in their effort to find a feasible combination of properties that offers a higher probability of survival. This explains how species become adapted to each other (coevolve) and can cooperate on the joint goal of ... highest biomass for most of the species, at least on a long-term basis."<sup>15</sup> So when a species (a population of individuals) does change, for what ever while that is, gradualism is an expected result of this reality.

### Ring Species

After all, experiment is the final arbiter of whether nature has the good taste to follow our theoretical ideas. —John Ellis.<sup>16</sup>

To convince that one species can gradually diverge into two, was Darwin's goal. A conceptually simple scenario (since found) of his is of a species that shows gradual variation in opposite directions around (but not across) a barrier so that where the two mingle at the far extremity neither subspecies recognize each other for mating purposes. Should it come about that the rear population becomes extinct then these two subspecies will continue to diverge and in time become species for which even hybridization is no longer an option.

Such a "ring species," as Stebbins named it, was that of coexisting but rarely interbreeding different colored salamanders *Ensatina eschscholtzii* in southern California. Reverse traced to either side Central Valley of California the color patterns of these change gradually to where they meet in the north as a population little differentiated by color.<sup>17</sup>

Few ring species have been found that convince.<sup>18</sup> Of bird *Rassenkreis* (a group of races) are two:

The Arctic Ocean polar ice cap limits to its periphery the species range of Sea Gulls. Of these, races from Siberia freely interbreed with races from America. Races from America freely interbreed with races from Europe. Going the other way, Races from Siberia freely interbreed with races from the Caucases. However, Western European herring gull (*Larus argentatus*) do not interbreed with the lesser black-backed gull (*Larus fuscus*) from Central Europe where these races of Sea Gulls occur together in northern Europe. So, all along the ring that circumnavigates the globe about the Arctic there is gene flow but where the two ends of the ring meet in Europe there is no gene flow.

The Tibetan Plateau, which is treeless and uninhabitable, limits to its periphery the species range of the greenish warbler, *Phylloscopus trochiloides*, a songbird that breeds in forests throughout much of temperate Asia. Darren E. Irwin, Trevor D. Price, and Staffan Bensch, describe 15 populations of the greenish warbler in a continuous ring of gradually changing behavioral and genetic characteristics encircling the Tibetan Plateau. This ring is broken by a species boundary at only one place, in central Siberia, where two forms of the bird do not recognize each other's songs (which are critical in the selection of their mates) and so are

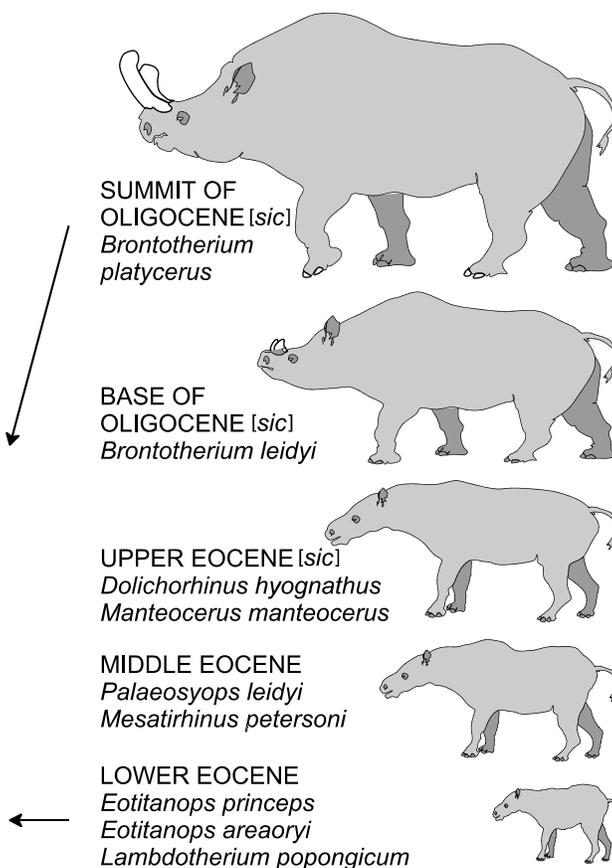
non-interbreeding. Irwin explains: “Apparently, as the birds moved north along two pathways into the forests of Siberia, their songs became longer and more complex, perhaps because females in the north rely more strongly on song when choosing a mate. But the forms of complexity differed between west and east Siberia, because there are more ways to be complex than simple.”<sup>19</sup>

**Figure f26.1 Gradualism in the evolution of the extinct titanotheres after Osborn, 1929.**<sup>20</sup>

The ages assigned by Henry Fairfield Osborn (1857-1935) for titanotheres at different stages of their (supposed linear) evolution have since been revised.<sup>21</sup>

The time range of the titanotheres is Eocene:

Sub-epochs	North American Land Mammal Ages	
Late Eocene	Chadronian	Late Early
	Duchesnean	Late Early
Middle Eocene	Uintan	Late Early
	Bridgerian	Late Middle Early
Early Eocene	Wasatachian	



**Figure f26.2 Clinton Richard Dawkins (1941-)**<sup>22</sup>

has long argued that evolution as an active force driven by reproductive competition that operates at the level of the gene. He vividly describes successful genes as “selfish.” Natural selection is that each generation is a sieve: successful genes tend to fall through the sieve into the next generation. In his reductionist view, “The universe we observe has precisely the properties we should expect if there is, at bottom, no design, no purpose, no evil and no good, nothing but blind pitiless indifference. ... DNA neither knows nor cares. DNA just is. And we dance to its music.”<sup>23</sup> Note however: a *selfish* gene for its survival in the genome can contribute to a phenome that *behaves* altruistically.<sup>24</sup> In *The Ancestor's Tale*, 2004, Dawkins runs the tape of human evolution history in reverse finding on the way 40 “concestors” (each a putative common ancestor to us and other species) from a human-chimpanzee concestor (the last) back, pausing at such as early mammals, sponges, plants, and eubacteria, to the imagined first concestor, a naked molecule of RNA.<sup>25</sup>



**Footnote f26.1** <sup>26</sup> In the 1858 Darwin-Wallace Paper, Wallace finds no need for Larmark's mechanism of evolution given the "undisputed fact that varieties do frequently occur." (He does not say how, as selection changes the mean, variations come to be, and are, for a species in existence at any time. That this is an empirical law, is enough.)

The hypothesis of Lamarck—that progressive changes in species have been produced by the attempts of animals to increase the development of their own organs, and thus modify their structure and habits—has been repeatedly and easily refuted by all writers on the subject of varieties and species, and it seems to have been considered that when this was done the whole question has been finally settled; but the view here developed renders such an hypothesis quite unnecessary, by showing that similar results must be produced by the action of principles constantly at work in nature. The powerful retractile talons of the falcon- and the cat-tribes have not been produced or increased by the volition of those animals; but among the different varieties which occurred in the earlier and less highly organized forms of these groups, those always survived longest which had the greatest facilities for seizing their prey. Neither did the giraffe acquire its long neck by desiring to reach the foliage of the more lofty shrubs, and constantly stretching its neck for the purpose, but because any varieties which occurred among its antitypes with a longer neck than usual at once secured a fresh range of pasture over the same ground as their shorter-necked companions, and on the first scarcity of food were thereby enabled to outlive them.

**Footnote f26.2** <sup>27</sup> **An example of Huxley's reasoning in his essay *Palæontology and the Doctrine of Evolution* (1870):**

... Let us now endeavour to find some cases of true linear types, or forms which are intermediate between others because they stand in a direct genetic relation to them.

... arrangements must be regarded as provisional, except in those cases in which, by a fortunate accident, large series of remains are obtainable from a thick and widespread series of deposits. It is easy to accumulate probabilities—hard to make out some particular case in such a way that it will stand rigorous criticism. After much search, however, I think that such a case is to be made out in favour of the pedigree of the Horses.

The genus *Equus* is represented as far back as the latter part of the Miocene epoch; but in deposits belonging to the middle of that epoch its place is taken by two other genera, *Hipparion* and *Anchitherium*; and, in the lowest Miocene and upper Eocene, only the last genus occurs

... The process by which the *Anchitherium* has been converted into *Equus* is one of specialisation, or of more and more complete deviation from what might be called the average form of an ungulate mammal. In the Horses, the reduction of some parts of the limbs, together with the special modification of those which are left, is carried to a greater extent than in any other hoofed mammals. The reduction is less and the specialisation is less in the *Hipparion*, and still less in the *Anchitherium*; but yet, as compared with other mammals, the reduction and specialisation of parts in the *Anchitherium* remain great. Is it not probable then, that, just as in the Miocene epoch, we find an ancestral equine form less modified than *Equus*, so, if we go back to the Eocene epoch, we shall find some quadruped related to the *Anchitherium* as *Hipparion* is related to *Equus*, and consequently departing less from the average form? ...

If the expectation raised by the splints of the Horses that, in some ancestor of the Horses, these splints would be found to be complete digits, has been verified, we are furnished with very strong reasons for looking for a no less complete verification of the expectation that the three-toed *Plagiolophus*-like "atavus" of the horse must have had a five-toed "atavus" at some earlier period. [Note: This prediction, repeated when Huxley viewed Marsh's equine materials at Yale in 1876, was followed two months later by Marsh's description of a four-toed "dawn horse" (*Eohippus*)!<sup>28</sup> and so, the correct identification belatedly of *Hyracotherium*. The next sentence yet stands.]

No such five-toed "atavus," however, has yet made its appearance among the few middle and older Eocene *Mammalia* which are known.