# The Hippo in a Gorilla’s Brain

**For these efts are nothing else but the water-babies** who are stupid and dirty, and will not learn their lessons and keep themselves clean; and, therefore (as comparative anatomists will tell you fifty years hence, though they are not learned enough to tell you now), their skulls grow flat, their jaws grow out, and their brains grow small, and their tails grow long, and they lose all their ribs (which I am sure you would not like to do), and their skins grow dirty and spotted, and they never get into the clear rivers, much less into the great wide sea, but hang about in dirty ponds, and live in the mud, and eat worms, as they deserve to do.

But that is no reason why you should ill-use them: but only why you should pity them, and be kind to them, and hope that some day they will wake up, and be ashamed of their nasty, dirty, lazy, stupid life, and try to amend, and become something better once more.  For, perhaps, if they do so, then after 379,423 years, nine months, thirteen days, two hours, and twenty-one minutes (for aught that appears to the contrary), if they work very hard and wash very hard all that time, their brains may grow bigger, and their jaws grow smaller, and their ribs come back, and their tails wither off, and they will turn into water-babies again, and perhaps after that into land-babies; and after that perhaps into grown men.

— Charles Kingsley, *The Water Babies*[[1]](#endnote-1)

The Reverend Charles Kingsley held no quarrel with the idea of Darwinian evolution. In his story of the *Water Babies* he accepted Darwin’s premise of descent with modification and even turned this premise into a metaphor for a journey in faith. At the same time, in parody of a famous debate, he ridiculed his contemporaries as they traded insults in arguing over evolution.

Kingsley was unable to fathom what the existence of a “hippopotamus major” (a humorous reference to the hippocampus) in the brain of a gorilla had to do with being related to humans. Expressing himself in satire, Kingsley doubted whether finding one in an ape’s brain could make an ape human or lacking one define humans as a type of monkey. One hundred and fifty years later, school board members in Dover, Pennsylvania, felt puzzled by this same dilemma—not the existence of a hippopotamus in a gorilla’s brain exactly, but the very idea that people and non-human primates have a common ancestry, with the evidence being in the form of shared traits. They came to insist that district textbooks waffle on this issue; a federal judge ruled otherwise.[[2]](#endnote-2)

## Devolution

Kingsley took scientists to task for claiming that things unseen could not exist—the human soul, for instance. Published just three years after *The Origin of Species*, his *Water Babies* parodied the arrogance of British class structure and scientific certainty. His fanciful story explained how Tom, a chimney sweep who drowned and was mistaken by otters for a lowly eft, magically turned into a water baby, a tiny gilled-human. In his journeys as a water baby, Tom rose above his lowly origins and found redemption through learning to control his selfish wishes and to care about the fate of others, especially that of his cruel master, Mr. Grimes.

Reverend Kingsley recognized, in Darwin’s thinking, the promise of uplift from brute origins to spiritual redemption.[[3]](#endnote-3) The idea of evolutionary uplift held value to Kingsley as a metaphor for becoming truly human. Uplift required moral lessons. Kingsley also recognized the possibility of devolution: descent from angelic to barbarous nature through vice and immorality. When applied to becoming human, his Darwinism was symmetrical. For Kingsley, separation from civilizing influences and failure to strive towards redemption carried a heavy price. It turned one into an eft, the reversal of the story of evolution from tetrapod ancestors to anatomically modern humans.

Tom’s commitment to his lessons—to learning about goodness and purity—kept his skin from growing prickles all over and thereby turning him into an eft. Tom learned to groom his soul. Failing to do so would mean condemnation to a life of feeding on worms and burrowing in mud. Even for an eft, given the will to amend a sinful state, there remained the promise of becoming a water baby again, or even a fully grown person. Kingsley had found in Darwinian evolution a metaphor for Christian hope.

Kingsley sympathized with the desperate plight of the working poor in British society. Tom, the exploited, dirtied, orphaned chimney sweep, symbolized this sympathy. Tom’s life contrasted with that of the aristocratic Ellie, with whom he eventually found love but not marriage, an institution unable to breach the class divide. In common with Darwin, Kingsley believed that “If the misery of our poor be caused not by the laws of nature, but by our institutions, then great is our sin.”[[4]](#endnote-4) The key to ending the degrading circumstances forced upon the poor lay in the reform of institutions, in reforms espoused by Christian Socialists. These reforms would bring improvement to the lower classes—as natural a process as evolution, or so believed the Reverend Charles Kingsley.

Darwin had seen the course of evolution in the anatomy of living creatures and the fossil records of their ancestry. As a cleric, Kingsley had faith in things unseen. As a Darwinian, he accepted that the bodies of amphibious forbearers might yield the bodies of primate progeny—exactly what Darwinians concluded. However, for him this process had no bearing on belief in things unseen. Efts may evolve into men, just as chimney sweeps may change into water babies. Yet both science and magic left untouched the importance of the unseen. Kingsley, quoting William Wordsmith, believed that “. . . trailing clouds of glory do we come, From God, who is our home.” Immersed in such belief, he held that “the great fairy Science, who is likely to be queen of all the fairies for many a year to come, can only do you good, and never do you harm.”[[5]](#endnote-5) For Kingsley, the soul made the body, not vice versa. Given union with God by means of the soul, he reasoned, science can never do one harm. *What matters most is the process of cleansing the soul by seeking to do what’s right.* However bodies came to be, therefore, had no bearing on matters of faith in things unseen.

Ostensibly a child’s book, Kingsley’s parody and satire, cloaked in religious allegory, tweaked Britain’s privileged classes while at the same time overtly reflected their prejudices. Unfortunately, the book’s sharp tinges of racist sentiment precludes it from today’s canon of acceptable children’s literature.

The Rev. Kingsley was a reform-minded, Christian Socialist and, along with Thomas Huxley, a member of Darwin’s inner social circle. Almost immediately upon reading *The Origin of Species*, Kingsley was able to make peace between his theology and his understanding of evolution. While accepting of descent with modification—thus implicitly agreeing with a common ancestry for apes, chimps, monkeys, orangs, gibbons, *and* humans—he vehemently objected to classifying beings as humans solely on the basis of anatomical structures shared or not shared with other beings. Evidence of descent was not, to him, conclusive of type. *Descent could not fully define what being human meant.*

## The Hippopotamus Test

At one point in the story, Tom, the water baby, was netted by “a very wise man indeed—Professor Ptthmllnsprts.” Although holding the water baby, Professor Put-them-all-in-spirits (the proper pronunciation), denied its existence, for such things were contrary to Nature. Being that the wise but rather pedantic professor was well versed in “Necrobioneopalaeonthydrochthonanthropopithekology” (necrobio for short—the biology of dead things), he knew his pickled specimens well. None were water babies. No child, let alone a child 3.87902 inches in length equipped with feathery, external gills could possibly exist. His belief in the impossible prevented him from accepting the reality in his net.

Being rather ignorant of things contrary to Nature, the ersatz erudite Professor Ptthmllnsprts “held very strange theories about a good many things. He had even got up once at the British Association, and declared that apes had hippopotamus majors in their brains just as men have.” The learned professor presumed the definitiveness of the hippopotamus test as means for distinguishing between and apes and humans. The test was quite simple. As the narrator of the *Water Babies* explains, “If you have a hippopotamus major in your brain, you are no ape, though you had four hands, no feet, and were more apish than the apes of all aperies. . . . the one true, certain, final, and all-important difference between you and an ape is, that you have a hippopotamus major in your brain, and it has none.” Humans had ’em and apes didn’t. The very thought of confirming the presence of the human-specific hippopotamus major in an ape’s brain was appalling. Such confirmation would erase the unbridgeable distinction between human and ape.[[6]](#endnote-6)

Kingsley’s hippopotamus test parodied Victorian era debate over “The Great Hippocampus Question” between Darwin’s trusted bulldog, Thomas Huxley, and Darwin’s detested nemesis, Sir Richard Owen (a distinguished vertebrate anatomist and coiner of the term, “dinosauria”). Professor Ptthmllnsprts had dared to utter blasphemy. Based on careful dissection, he determined that apes had “hippopotamus majors in their brains just as men have.” If true, then men were apes or apes were men—“a shocking thing to say.” Gorillas with hippos in their brains! Such a threat was Ptthmllnsprts’ science to right-thinking folk.

The disbelieving narrator, echoing Sir Richard’s anatomical dogma, not only objects to the factual basis of Professor Ptthmllnsprts conclusion, but even argues that if found in an ape’s brain the hippopotamus major would simply be something else. By virtue of being present in an ape, the structure could never be a hippo. The logic, though compelling, feels twisted—the Darwinian explanation of common ancestry unties the knot. The common ancestor of gorillas and humans had a hippo in its brain.

Owen argued the opposite conclusion quite stridently: no ape ever had a hippopotamus major in its brain nor ever would. Nor had any ape brain two other features that distinguished humans from them: the projection of the posterior cerebrum’s occipital lobes past the cerebellum and the horn-shape of the lateral ventricles also in the posterior part of the brain. Sir Richard attributed humanity’s dominion over Creation to these structures. (Modern neuroscientists ascribe much of the capacity for complex thinking to the frontal lobes of the cerebrum.)

The chasm between apes and men was unbridgeable; the presence or absence of a hippopotamus in the brain was, in today’s jargon, an irreducible complexity, a concept embraced by members of the Dover School Board. For followers of Own, humans were safe in their self-defined importance, sole proprietors of hippopotamus major infested brains. There was no mistaking its presence or absence; hippopotami, whether major or minor, were quite obvious. And, according to Owen, they were always missing in ape brains.

Kingsley parodied this debate because he found the idea of using a single anatomical trait to separate humanity from apes in particular or beasts in general to be astoundingly illogical and dangerously oversimplified: “You may think that there are other more important differences between you and an ape, such as being able to speak, and make machines, and know right from wrong, and say your prayers.” Matters of “faith, hope, and charity of immortal millions” were dismissed in favor of “the great hippopotamus test.”[[7]](#endnote-7) Human identity seemed to totter between Huxley and Own’s deeply entrenched their positions:

But if a hippopotamus major is ever discovered in one single ape’s brain, nothing will save your great-great-great-great-great-great-great-great-great-great-great-greater-greatest-grandmother from having been an ape too.  No, my dear little man; always remember that; . . . nobody but men have hippopotamuses in their brains; so, if a hippopotamus was discovered in an ape’s brain, why it would not be one, you know, but something else.[[8]](#endnote-8)

What Huxley and Owen argued over was not a hippopotamus, of course, but folds and structures deep within the brain. Huxley, by displaying the brain anatomy of a spider monkey during a public lecture, wished to ridicule Owen’s incompetent characterization of the gorilla’s brain. Monkeys, apes and humans did, in fact, possess the hippocampus minor. Discrediting Owen was Huxley’s objective; anatomical classification simply the sword in their combat.[[9]](#endnote-9)

In the wake of The Great Hippocampus Question other features for distancing humans from their near-human forbearers have come and gone. For example, anatomically modern humans lack pronounced brow ridges and have recognizable chins, features that distinguish them from Neanderthals.[[10]](#endnote-10) A creature with a chin is human and that’s that. No non-human ever had a chin nor ever will—that would be contrary to nature. What might Kingsley make of this fact? Most likely, he would find a way to parody it as “The Great Chin Question.”

Evolution occurs and descent from a common ancestor is real. The relationships through time entailed by this science, however, need not define us. There is more to being human than hippos in the brain. Even without one, a human would be as human as ever, and still just as different from a gorilla as commonly supposed. Dissent from, displeasure over, and disquiet with placing humans in common category with apes and monkeys has resounded ever since Darwinism appeared on stage, especially among those who conclude that such classification denies to humanity a spiritual level of existence. Admirably, in the Reverend Kingsley’s mind, the dilemma dissolves.

## The Striving Turnip

Since the fateful year of1859, many people have come to believe that accepting descent with modification by means of natural selection inescapably contradicts faith and undermines morality. Darwin’s *Beagle* mentor, Captain Robert FitzRoy, certainly thought so, even though he had firsthand access to all of the evidence gathered during the voyage of the *Beagle* and was himself a highly trained scientist. However, the Reverend Charles Kingsley, the scholarly cleric, did not. For Kingsley, faith in the existence, origin, and destiny of the human soul secured acceptance of Darwin’s notions. In *The Water Babies’* great gorilla brain debate, he made light of scientific pretense without rejecting scientific truth.

For FitzRoy, Darwin’s pernicious science fomented harm. Present on June 30, 1860, at the meeting of the British Association for the Advancement of Science at Oxford University, FitzRoy listened painfully as “Darwin’s bulldog,” Thomas Huxley, rebuffed Bishop Samuel Wilberforce’s (“Soapy Sam”) assault on *The Origin of Species*.[[11]](#endnote-11)At this meeting of the British Association, both Soapy and the Bulldog acted very un-apishly. They talked. Unlike apes, declared by “Victorian humorists” to be “more intelligent than men because they at least knew when to keep silent,”[[12]](#endnote-12) Soapy Sam asked rhetorically, “Is it credible that a turnip strives to become a man?”[[13]](#endnote-13) To which Huxley famously replied by expressing his preference for “a miserable ape for a grandfather” over a man “of great means and influence, and yet who employs those faculties for the mere purpose of introducing ridicule into a grave scientific discussion.”[[14]](#endnote-14)

Wilberforce found a leap from turnip to man no different from the evolution of an ape into human; they were crazy, preposterous, unsubstantiated, and un-philosophical assertions. The “gaps” were too big; intermediate forms were implausible and illogical. The “strivings” he imagined necessary to turn a turnip into a person defied common sense. Of course, “inner strivings” played no role in the Darwinian conception of descent with modification. Natural selection did.

Wilberforce did not picture himself as a creature with an inner fish, let alone an inner turnip. His dismissal of Darwinism was so fundamental that cerebral arguments about anatomical details of the brain held no salience for him. Nor had he any appreciation for the true scale of geologic time; nor did Huxley, for that matter. Turnips, surprisingly or unsurprisingly, depending on one’s knowledge of evolutionary biology, do claim common ancestry with animal life at about 1.3 billion years ago, or about the middle of the Mesoproterozoic Era, whether we wish to acknowledge that claim or not.[[15]](#endnote-15) Life changed, but not because ancestral turnips strived to become something more soulful. Mutable life’s journey through time, endlessly struggling for existence in the competition for resources, left a wake of countless extinctions and speciations, the constant reorganization of bodies and communities. It’s a wonderful story, worthy of any schoolbook, even in Dover, Pennsylvania.

In this story Andean scale mountains and Amazonian scale basins blink in and blink out of existence, sometimes the former replacing the latter. Earthquake by earthquake continents dissemble and reform. Slices of California make their way towards Alaska. Seafloors sit everywhere, expansive ones freezing into existence from molten mid-ocean ridges and fragmented remnants perched on mountain peaks.

Neither Darwin, Huxley, Owen, Wilberforce, Kingsley, nor anyone else living in Victorian England had any sense of such vastness in time, of such wholesale transformation of the earth. Darwinians anticipated such insights, confident that on earth’s ancient and mutable stage from simpler beginnings sprang more complex organisms over immense spans of time. They just had no way to determine neither how old nor how dynamic the earth truly was.

Today, such knowledge is within reach of every young citizen in every school district across the nation. It’s quite a heritage, a super-spectacular story that need do no harm to well-rooted reverential belief. The comings and goings of landmasses and species bear no more upon the challenging task of becoming fully human than do the supposed presence of hippos in human and gorilla brains. The geologic and evolutionary history of the stage on which people strive to live lives of compassion and justice ought to inspire awe, cultivate humility, and promote responsible caretaking, essential ingredients of any moral education.

As nineteenth century religion vs. science debates evolved into twentieth century trials, Huxley’s “ape for a grandfather” quip found traction; Wilberforce’s “human turnip” image did not. However, good grasp of geologic time and sound knowledge of natural selection continue to challenge public understanding of science. The scale of change permits presumably preposterous things to happen. Lobe-finned fish sprouted limbs; whales reabsorbed them. Feathered dinosaurs took flight. Entire ocean floors formed from lava, scooted across large portions of the globe, and descended beneath the crust, reclaimed by their molten state. Appreciation of these changes, in contrast with their fearful rejection, promises satisfying, yet humbling, insight. Appearances “may suggest eternity,” but “what we sense as stone is an elusive flicker in a blur of change . . . a sharp comment on our fragile accident of life.”[[16]](#endnote-16)

Thinking of stone as an “elusive flicker” and life as a “fragile accident” does not come easily, nor does the idea that turnips, fish, and apes may lay claim to humanity’s family album. The scientific community generally accepts that an ancestor common to turnips and people inhabited the earth about 1.3 billion years ago, roughly the span of time for the assembly and destruction of two supercontinents (Rodinia and Pangea), the origin of multicellular bodies, and the colonization of land by plant and animal life. Of course, the date might be off a bit—by a hundred million years or so. What’s a hundred million years when turning a microbe into a monkey, not to mention its turnip kin? Not surprisingly, some of the records of these changes—the intermediate forms that along the way inhabited forgotten landscapes—are now missing.

Deep time and evolution combine in claims that run counter to everyday ways of experiencing the world. They are often un-reconciled with faith and hence stoke antagonism towards teaching Darwin’s science. Soapy Sam’s objections just won’t go to rest, no matter the skill of Huxley’s successors in establishing the primate pedigree of humanity, not to mention the evolutionary roots humans share with turnips. Dissenters dwell on “gaps”—the missing intermediate forms indicative of an unbroken chain of descent.

## The Gap According to Mivart

Into the twentieth and twenty-first centuries, as Darwinism went to school, disagreement repeatedly has landed parties in court. Consider the best known example of the issue. In 1925, John Scopes of “Monkey Trial” fame was found guilty of teaching a banned text that included evolution and fined $100. In 1968 the United States Supreme Court ruled that banning the teaching of evolution was an unconstitutional imposition of religion on public education.[[17]](#endnote-17) Subsequent court decisions in the 1980s, *McLean v. Arkansas Board of Education* (U. S. District Court) and *Edwards v. Aguillard* (U. S. Supreme Court) made teaching creation science unconstitutional as well.[[18]](#endnote-18) The courts declared teaching creationism an imposition of religious doctrine in clear violation of the establishment clause.[[19]](#endnote-19) Science teachers are bound to teach what scientists do and scientists do not do “creation science.”

Justice Scalia and Chief Justice Rhenquist, however, wrote dissenting opinions to *Edwards v. Aguillard*. In effect, they invited school boards and citizens to continue to parry over the teaching of evolution using arguments similar to St. George Mivart’s classical challenge to Darwinism. Mivart focused on the structure of the eye. How could an organ so exquisitely fashioned in every detail, he reasoned, spring into being piecemeal? Mivart, a devout Catholic and initially a supporter of Darwin’s theory, raised his objection in *On the Genesis of Species*. His book provided Darwin doubters with a persuasive refutation of natural selection. Note the non-accidental allusion to the Bible in Mivart’s title and the parallelism in rhetorical form to Darwin’s own title. Mivart advanced his objection to the idea of “incipient organs.” He stressed the uselessness of “half a wing,” for example.

Mivart made the “gap” or absence of intermediate forms a theoretical issue by focusing attention on the unsuitability of wings or eyes or limbs or any complex structure in-the-making. Intermediate forms, unfinished structures, he argued were mal-adaptive. Transitions must fail. He even turned Darwin’s idea of natural selection against the possibility of evolution, arguing that natural selection would weed out the weaklings, the incomplete, and the inadequate intermediates. Poor eyesight, in the struggle for existence, would necessarily be a liability. Only independently created, fully operational creations made sense to Mivart, who ironically accepted the reality of natural selection. In his universe, however, natural selection brought evolution to a halt. The origin of species required creation, and creation, a Creator.

Modern opponents of descent with modification repeatedly marshal the argument of design (or Mivart objection) down to the molecular level of structure, not just in terms of gross anatomy (limbs, eyes, wings). Complicated biomolecules in complex orchestration prove to them the independence of origins by means of design. Intricate, masterful design, not helter-skelter tinkering, governs the molecules of life and the structures of cellular scale. Descent with modification is impossible; the designs function only when all the components are present and working in concert.

Adherents of intelligent design argue, in true Mivartian style, that many of life’s tiniest machine-like structures cannot be reduced to simpler parts able to function successfully or independently of one another. Simplified and intermediate contraptions en route to a complex construction necessarily fail, favored analogy being a mousetrap. Either there exists a fully functioning mousetrap or not. No mousetrap device, composed of trigger, spring, bait, catch, platform etc., could catch a mouse unless fully formed. Remove just one part to create an intermediate mousetrap and there is no functional mousetrap at all. Such contraptions never entered the marketplace. By analogy, only complex, fully formed eyes, with all the necessary parts, can function successfully. Intermediates are presumably dysfunctional.

This concept of “irreducible complexity” updated Wilberforce’s gap skepticism and thus molecular structures inherited the wind of his argument. Gaps offer evidence. They record the absence of intermediate forms. Novelty happens, but only in finished form, according to design. Novel creations do not build piecemeal upon small changes. An intense focus on things deemed not to exist becomes evidence of supernatural agency, making descent with modification contrary to Nature. Recast as “intelligent design” theory, this style of reasoning elevates the Mivart question into prominence at every level of organic structure.

Remember that dissenting opinion in *Edwards v. Aguillard* has invited champions of creation science to seek evidence that scientists in fact do creation science. Authors of intelligent design theory supposedly had exorcised the creator from creation science and had placed empirical phenomena (gaps and irreducible complexity) under scientific scrutiny. These two accomplishments appear to have given seekers of balanced treatment for non-Darwinian biology the inroad into public education sought ever since the Scopes monkey trial.

## The Gap Goes to Trial

By means of judiciously applied cut-and-paste maneuvers, enthusiasts of intelligent design confidently expunged religious doctrine from creationist text, *Of Pandas and People*[[20]](#endnote-20) and replaced such doctrine with respectable science actually conducted by scientists. In Dover, Pennsylvania, the school board, with the clear intent of referring students to study *Pandas* and learn about “Intelligent Design.” concocted an evolutionary disclaimer to read to its high school biology students. In reference to “Darwin’s Theory” the disclaimer claimed that “Gaps in the theory exist for which there is no evidence.”[[21]](#endnote-21) With a few words read at the beginning of class, the board had wedged irreducible complexity and the Mivart objection into classroom discussion. As a result, fellow citizens of Dover, Pennsylvania, found themselves in court as both plaintiffs and defendants in the case of *Kitzmiller et al. v. Dover Area School District*.[[22]](#endnote-22) Debate turned on the issue of overcoming the Mivart objection, the idea of un-breachable gaps and irreducible complexity. Ultimately, Judge John E. Jones ruled against the school board and in favor of a group of citizens led by Tammy Kitzmiller. Flagellistic reasoning dominated the proceedings.

Among the paragons of irreducible complexity at the micro-scale lurks the problematic flagellum, a Mivartian’s dream. Few places in America are as familiar with flagella as the citizens of Dover. The flagellum is a whip-like organelle attached to a cell and the means of locomotion among certain microorganisms, as well as a structure found lining the skin and internal membranes of some macro-organisms. Movement of the flagellum requires an organized cascade of biomolecular activity sometimes described as analogous to a rotary motor. A cell with a single flagellum swims; a skin composed of flagellated cells moves current over its surface. The flagellum is a virtual organic micro-robot, a busy contraption amenable to many uses, provided all its parts are in working order. The flagellum reeks of irreducible complexity, yielding the rhetorical question, “What good is a flagellum not yet a flagellum?” Flagellistic engineering has replaced ocular complexity as the poster child of the Mivart objection, this miniscule organelle becoming the whip of choice for flagellating naive evolutionists in 21st century court.

During the trial of *Kitzmiller v. Dover* to the chagrin of the intelligent design cadre, biologist Kenneth R. Miller summarized research refuting reasoning modeled on the Mivart objection. His testimony confirmed the functional utility of intermediate forms of flagellum structures—the simpler precursors to a more complex flagellum. He described the existence and utility at biomolecular scale of each stage of gradation from protein to organelle. His argument paralleled the Darwinian response to the supposed problem of the transitional eye—a well-documented and widely accepted account of functional eyes at every level of complexity from pigmented cell to lens-focused organ.[[23]](#endnote-23) Professor Miller had filled in the flagellum’s antecedent gaps.

The Dover school board had attempted to introduce intelligent design theory into high school biology simply by means of requiring students to listen to the school board’s mandated, one minute statement. Tammy Kitzmiller, a local parent, objected. Her daughter had voiced a sincere interest in evolution. In the atmosphere of charged debate, this interest earned her taunts of “Monkey Girl” as students adopted the prejudices of their evolutionarily illiterate parents. Incensed that the school board’s minute had created conditions leading to the taunting of her daughter, Tammy Kitzmiller brought national attention to Dover, Pennsylvania and took her fellow citizens to trial.

This folk-wisdom assertion by the Dover School Board of “gaps in the theory” garbles the concept of “theory” and confounds the meaning of “gaps.” Either “no evidence” refers to “the theory” or “no evidence” refers to the “gaps” in the theory. Most likely, the school board intended to refer to the presumption of “gaps” in the fossil record—to a presumed lack of intermediate forms linking, for example, fish to frogs. Logically speaking, “no evidence for gaps” (meaning the discovery of evidence “filling in the gaps”) equates with support for Darwin’s view: continuous transition.

The Mivart strategy finds fault in evolutionary thought by arguing that the transitions are impossible; only finished, complete form—endpoints—function adaptively. Hence, “irreducible complexity” abounds. In this sense, the focus on “gaps” identifies what has always been conceptually and psychologically difficult to grasp when learning Darwin’s science: what good is an eye not yet an eye, a fluke still not really a fluke, a wing still needed as a limb?

Testimony in *Kitzmiller v. Dover* showcased how scientists interpret evidence of heritable similarities to support descent with modification while ruling out similarities that result from the convergence of traits from different antecedents. The “gap” on trial in Dover is the Mivart objection Darwin had to answer. In *Kitzmiller v Dover*, a judge ruled once again that anti-evolutionists were imposing religious doctrine. But trials and elections are improper ways for deciding the usefulness of Darwin’s science. Study of specific evolutionary trajectories illustrates how prior existing parts and configurations have transformed into novel adaptations. Gill arches have become jaw bones; jaw bones, inner ear bones. The evidence obtained from fossils, strengthened by comparative anatomy among living creatures, and confirmed at the molecular level, convinces both scientists and judges. The Darwinian approach to solving problems bears fruit; similarities are clues. Whether about eye, limb, hippocampus, or flagellum, evolutionists argue quite convincingly that every gradation en route to the new feature (or species) has proven advantageous within one particular environment or another.

That’s a good thing, too, because environments vary on virtually all time scales. At one moment in earth history, walking shorelines might suit a pre-whale quite well. Sometime later, life mostly at sea in pursuit of fish may have an edge, with land the place to haul out and bask. Geological disturbances, climate shifts, changes in the abundance of prey might advantage the cousin who swims a bit better. Life must adapt to supercontinents assembling and breaking apart. It’s a dynamic world.

Over the course of tens of millions of years backboned, nostrilled and finned creatures moved from shore waters inland, as nature experimented with egg-laying, live birth, limb structures, jaws, and every other aspect of the body and its metabolism. The Reverend Charles Kingsley implicitly realized that the body does not make the human fully human—neither does the story of its evolutionary descent. What might Kingsley make of The Great Flagellum Debate? It’s not a simple “yes or no” issue—a debate over whether a creature has or does not have flagellated cells, with implications for affinity to other creatures.

At stake in Dover and for Bishop Wilberforce was the position espoused by intelligent design thinking: creation of beings by a Creator through divine intervention, separated by un-evolvable intermediaries. Whether the separation pertains to biomolecular engineering or to the structure of the eye, the perception of a threat to received dogma persists. Anti-evolutionists reject the idea of incipience—of organs or species prepotent with the means of becoming something else entirely.

## The Soul of the Debate

The Rev. Charles Kingsley, in refusing to reduce his humaneness to no more than body parts, found no harm in Darwin’s science. He embraced the existence of “something else entirely,” regardless of how bodies may have evolved. He held what he called the human soul in his embrace. The maturity of his theology, its rendering unto science that which belongs to science, stands in marked contrast with the mustering of ignorance illustrated by creation science. At the end of *The Water Babies*, the narrator expresses the belief that competition, circumstances, and selection capable of turning beasts into men are equally capable of turning men into beasts.

Teaching Kingsley’s personal reconciliation of belief in a human soul with Darwinian evolution remains proscribed in public education. Schools cannot teach in science class what Reverend Kingsley believed any more than they can read the Dover School Board’s one minute disclaimer about evolution to all ninth graders. Anatomical trends exist without moral purpose or ordained end in mind, a difficult proposition to grasp if the history of life is deemed a sacred text. For a Reverend Kingsley, moral agency, more so than any anatomical trait shared or not shared with monkeys and apes (or a biochemical process shared with a turnip), makes humans human. This is an adult way of wrestling with a profound question, not a school board’s bureaucratized, anti-intellectual, statement.

Kingsley was secure in his faith and held no fear of science. In contrast, members of the Dover School Board felt their faith threatened by science and they therefore acted to impose biblical literalism on adolescent learners. The ridicule of students and conflict among parents they engendered exploited the same imagery that animated acrimonious debate between scientist and cleric 150 years ago. Even in that moment of the origin of modern origins stories, Kingsley resolved the tension between material evolution and spiritual belief with sage advice: “Whatever their ancestors were, men they are [now]; and I advise them to behave as such, and act accordingly.”[[24]](#endnote-24) Humans we are, whatever any particular structure in the brain indicates about the recency of descent from an ancestor held in common with the great apes or whatever biomolecular signature makes us as distant cousins to turnips. “Acting accordingly” means allowing for many interpretations of what makes humans human while also figuring out our descent. Science has no call to teach a child there is no more to being human than having a body similar to, yet different from, that of other primates. Science offers an explanation of why this is so; its truth need not negate another.

Tammy Kitzmiller’s daughter and her fellow students deserve to find out about the winged descendants of feathered dinosaurs and the evolution of whales from walking ancestors. Rather than being disparaged with monkey epithets, interest in Darwin’s view of life ought to yield among students the rapture of pure intellectual delight, lest “their skulls grow flat, their jaws grow out, and their brains grow small, and their tails grow long”—a fate well suited to ignorant members of school boards in Dover or anywhere else.

1. Charles Kingsley. *The Water Babies: A Fairy Tale for a Land-Baby* (originally published serially for MacMillan’s Magazine, 1862-1863), 140-141. Accessed March 12, 2013, at Project Gutenberg, http://www.gutenberg.org/catalog/world/readfile?fk\_files=1444325&pageno=141. [↑](#endnote-ref-1)
2. Edward Humes, *Monkey Girl: Evolution, Education, Religion, and the Battle for*

   *America’s Soul* (New York: HarperCollins Publishers, 2007). [↑](#endnote-ref-2)
3. Jonathan Padly, “Marginal(ized) Demarcator: (Mis)Reading The Water-Babies,” *Children's Literature Association Quarterly* 34, no.1(2009): 51-64. Accessed March 12, 2013, at Project Muse, http://muse.jhu.edu/journals/chq/summary/v034/34.1.padley.html, doi: 10.1353/chq.0.1898. [↑](#endnote-ref-3)
4. Charles Darwin, *The Voyage of the Beagle* (Santa Barbara, CA: The Narrative Press, 1845/2001), 525. [↑](#endnote-ref-4)
5. Charles Kingsley. *The Water Babies* (originally published serially for MacMillan’s Magazine, 1862-1863), 34-35. Accessed March 12, 2013, at Project Gutenberg, http://www.gutenberg.org/catalog/world/readfile?fk\_files=1444325&pageno=35. [↑](#endnote-ref-5)
6. Charles Kingsley. *The Water Babies* (originally published serially for MacMillan’s Magazine, 1862-1863), 61. Accessed March 12, 2013, at Project Gutenberg, <http://www.gutenberg.org/catalog/world/readfile?pageno=61&fk_files=1444325>. A modern anatomist would describe the anatomical structure subject to debate as the calcar avis, formerly termed the hippocampus minor, and distinct from the hippocampus major, now referred to simply as the hippocampus. Both are structures deep in the brain beneath the cerebrum and the ventricles filled with cerebral fluid. [↑](#endnote-ref-6)
7. Charles Kingsley. *The Water Babies* (originally published serially for MacMillan’s Magazine, 1862-1863), 61. Accessed March 12, 2013, at Project Gutenberg, http://www.gutenberg.org/catalog/world/readfile?pageno=61&fk\_files=1444325. [↑](#endnote-ref-7)
8. Ibid. [↑](#endnote-ref-8)
9. Janet Brown, *Charles Darwin*. *Vol. 2*, *The Power of Place* (New York: Alfred A. Knopf, 2002), 158-161. [↑](#endnote-ref-9)
10. Chris Stringer, *Lone Survivors* (New York: Times Books/Henry Holt and Company, 2012). Originally published in the United Kingdom in 2011 as *The Origin of Our Species*. [↑](#endnote-ref-10)
11. Jenson, J. Vernon, “Return to the Wilberforce-Huxley Debate.” *British Journal for the History of Science* 21 (1988): 161-179. [↑](#endnote-ref-11)
12. Janet E. Browne, *Charles Darwin.* Vol. 2, *The Power of Place* (New York: Alfred A. Knopf, 2002), 158. [↑](#endnote-ref-12)
13. Janet E. Browne, *Charles Darwin.* Vol. 2, *The Power of Place* (New York: Alfred A. Knopf, 2002), 121. [↑](#endnote-ref-13)
14. Janet E. Browne, *Charles Darwin.* Vol. 2, *The Power of Place* (New York: Alfred A. Knopf, 2002), 122. [↑](#endnote-ref-14)
15. Richard Dawkins, *The Ancestor’s Tale: A Pilgrimage to the Dawn of Evolution* (New York, Houghton Mifflin, 2004), 507. [↑](#endnote-ref-15)
16. David Leveson, *A Sense of the Earth* (Garden City, NY: Natural History Press, 1971), 159. [↑](#endnote-ref-16)
17. *Engel v. Vitale*, 370 U.S. 421 (1962); in Edward Humes, *Monkey Girl: Evolution, Education, Religion, and the Battle for America's Soul* (New York: HarperCollins, 2007), 55. [↑](#endnote-ref-17)
18. McLean v. Arkansas Board of Education 529 F. Supp. 1255, 1258-1264 (1982); Edwards v. Aguillard, U.S. 482 U.S. 578 (1987). [↑](#endnote-ref-18)
19. Ford Morishita, “Teaching About Controversial Issues: Resolving Conflict Between Creationism and Evolution Through Law-Related Education,” *The American Biology Teacher* 53, no. 2 (1991): 91-93. [↑](#endnote-ref-19)
20. P. William Davis, Dean H. Kenyon, and Charles B Thaxton, *Of Pandas and People: The Central Question of Biological Origins* (Dallas, TX: Haughton Publishing Company, 1993). [↑](#endnote-ref-20)
21. Edward Humes, *Monkey Girl: Evolution, Education, Religion, and the Battle for*

    *America’s Soul* (New York: HarperCollins Publishers, 2007), 103. [↑](#endnote-ref-21)
22. *Kitzmiller et al. v. Dover Area School District*, 400 F. Supp. 2d 707 (2005). [↑](#endnote-ref-22)
23. Kenneth R. Miller, “The Flagellum Unspun: the Collapse of ‘Irreducible Complexity,’” in *Debating Design: From Darwin to DNA*, eds. William A. Dembski and Michael Ruse (New York: Cambridge University Press, 2004). [↑](#endnote-ref-23)
24. Charles Kingsley. *The Water Babies* (originally published serially for MacMillan’s Magazine, 1862-1863), 99. Accessed March 12, 2013, at Project Gutenberg, http://www.gutenberg.org/catalog/world/readfile?fk\_files=1444325&pageno=99. [↑](#endnote-ref-24)