History of Evolutionary Thought

Part VI: Objections Sustained?

BIOL 4415: Evolution
Dr. Ben Waggoner

Objections. . .

- By about 1870, the idea of evolution through *some* kind of natural process, which science could study objectively, was accepted by almost all scientists who had studied the matter.
- BUT. . . Darwin's idea of natural selection was *not* widely accepted for about another 50-60 years.
  - Julian Huxley (Thomas Henry's grandson, and a great biologist in his own right) called this "the eclipse of Darwinism"
  - So why the eclipse?

Objections sustained. . .

- The Earth couldn't be old enough for slow, plodding natural selection to have produced the entire diverse spectrum of living things.
- Favorable variants couldn't be selected for, because interbreeding would "wash out" variation in the population.
- Darwin had no explanation for where variation comes from, or how it can be inherited.
- Natural selection didn't seem like a good scientific law with predictive value—it was "the law of higgledy-piggledy", as one detractor called it.

Fleeming Jenkin

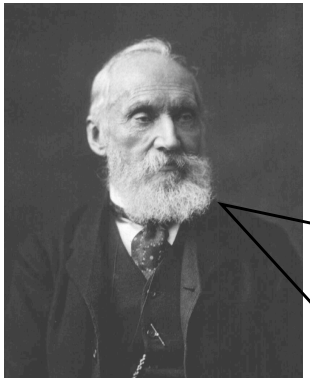
(1833-1885)

A Scottish engineer and economist—he invented supply and demand curves, and helped develop underwater telegraph cables—Jenkin also pointed out a serious flaw in the theory of natural selection, coming from what he called "blending inheritance".

The "blending inheritance" problem

- In a population of organisms, "favorable variants" do sometimes occur—but whom do they mate with?
- They can only mate with normal individuals—and their offspring will be a blend of parental characteristics, and won't completely show the favorable trait that their parent had.
- Over generations, the favorable trait will become fainter and fainter (like a drop of red paint mixed into a bucket of white paint).
- Any favorable variation will be "swamped out" by interbreeding with members of the population that don't have it.

Sir William Thomson, Lord Kelvin (1824-1907) was a rather more formidable opponent. . .



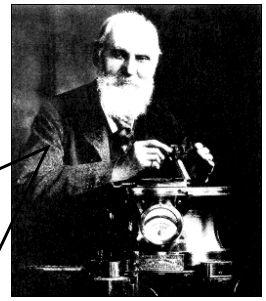
The limitation of geological periods imposed by physical science. . . does seem sufficient to disprove the doctrine that transmutation has taken place through 'descent with modification by natural selection.'

Kelvin's reasoning went like this:

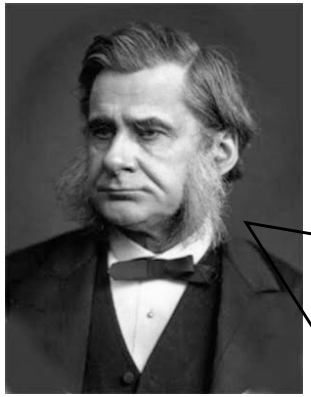
- The Earth has internal heat (as shown by volcanoes, the heat in deep mines, etc.—temperature increases with depth by 1 °F/ 70 ft).
- A warm body in cold space must radiate that heat away to space, at a rate governed by the laws of thermodynamic physics (which Kelvin had worked out).
- For the Earth to be at its current temperature and losing heat at its current rate, it must have been molten recently—too recently for Darwinian evolution to have had any effect.

The Earth must have solidified only about 20 million years ago—and life must be even younger.

But I think we may with much probability say that the consolidation [of the earth] cannot have taken place less than 20,000,000 years ago, or we should have more underground heat than we actually have, nor more than 400,000,000 years ago, or we should not have so much as the least observable underground increment of temperature.
—"On the Secular Cooling of the Earth", 1864



Huxley defended the possibility of a much older Earth. Still, Kelvin's words carried a lot of weight.



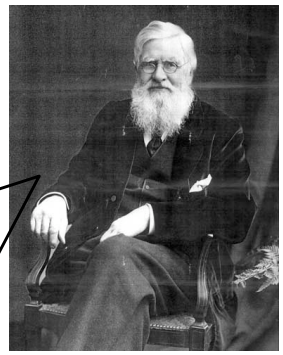
Mathematics may be compared to a mill of exquisite workmanship, which grinds your stuff to any degree of fineness; but, nevertheless, what you get out depends on what you put in; and as the grandest mill in the world will not extract wheat flour from peascod, so pages of formulae will not get a definite result out of loose data.
—"Geological Reform", 1869

Jenkin's, Kelvin's, and others' objections supported alternative evolutionary theories that could take place on shorter time scales.

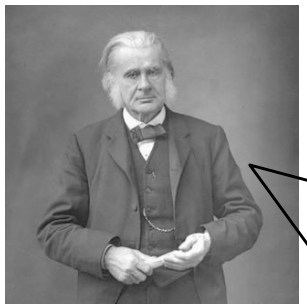
- directed variation—natural selection may work, but organisms don't vary randomly. Something (God? some law of nature? *Both?*) causes purposeful change over time
- Neo-Lamarckianism—a revival of Lamarck's ideas about the inheritance of acquired characters
- saltation—species are not formed gradually, but in sudden bursts of change—possibly in only one generation
- orthogenesis—species evolve because of some sort of "internal drive" that has nothing to do with the environment

A number of scientists—including Alfred Russel Wallace! —accepted evolution by natural selection up to a certain limit, but invoked something else to explain major changes, or human uniqueness. . .

I hold that there was a subsequent act of creation, a giving to man, when he had emerged from his ape-like ancestry, of a spirit or soul. Nothing in evolution can account for the soul of man. The difference between man and the other animals is unbridgeable.
—Interview, 1910

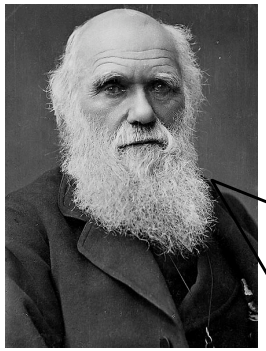


Huxley argued that species might change by sudden, discontinuous changes in one generation, not slowly and gradually—a theory known as *saltation*.



I see you are inclined to advocate the possibility of considerable "saltus" [jumps] on the part of Dame Nature in her variations. I always took the same view, much to Mr. Darwin's disgust, and we used often to debate it.
—Letter to William Bateson, 1894

Darwin himself never ruled out Lamarckian evolution, and accepted a greater role for it in his later years, in response to the criticism that natural selection by itself was too slow to explain all change.

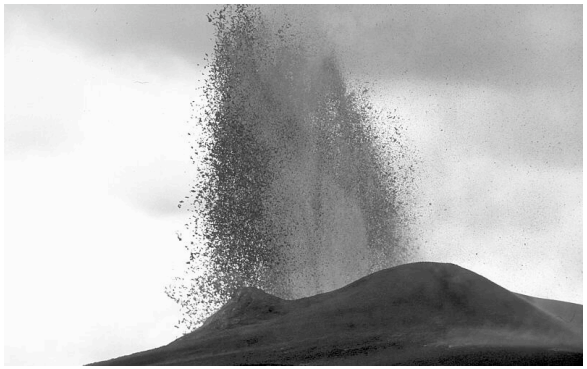


Variability is governed by many unknown laws. . . Something, but how much we do not know, may be attributed to the definite action of the conditions of life. Some, perhaps a great, effect may be attributed to the increased use or disuse of parts. The final result is thus rendered infinitely complex.
—*Origin of Species*, 6th ed., 1872

Yeah, BUT. . .

Beginning in 1895, physicists discovered and began to study a strange new phenomenon: *radioactivity*. Here are Marie and Pierre Curie with their great discovery: the new, rare, and highly radioactive element *radium*.

Natural radioactivity in the Earth causes about 80% of the Earth's heat. The Earth isn't cooling down, as Kelvin had thought, because it has an internal source of heat!



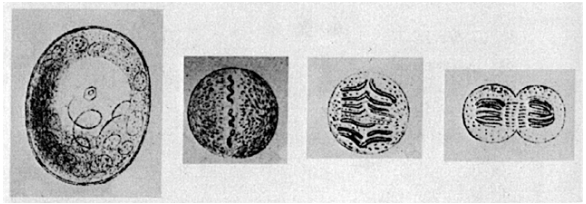
As for "blending inheritance": the answer had been worked out by this man—but nobody paid much attention at the time.

. . . the constant characters which appear in the several varieties of a group of plants may be obtained in all the associations which are possible according to the laws of combination, by means of repeated artificial fertilization.
— "Experiments in Plant Hybridization", 1865

August Weismann (1834-1914) was a German biologist who argued strongly against neo-Lamarckian ideas. . .

- Weismann hypothesized the existence of "germ plasm"—some sort of physical material of inheritance
- "Continuity of germ plasm": The hereditary material in the gametes is set apart from the rest of the body (*Weismann barrier*). Lamarckian evolution isn't possible.

In 1873, Friedrich Schneider discovered chromosomes—and by 1885, Weismann and others had concluded that the chromosomes *were* the "germ plasm".



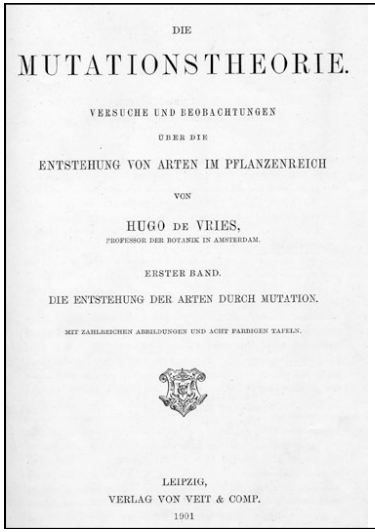
". . . there is an hereditary substance, a material bearer of hereditary tendencies. . . contained in the nucleus of the germ-cells, and in that part of it which forms the nuclear thread, which at certain periods appears in the form of looops or rods." —Weismann, 1887

The Dutch botanist Hugo de Vries (1848-1935), who'd been impressed by *Origin of Species* as a student, began experimenting with breeding and crossing plants (unknowingly repeating some of Mendel's work).

Working with a species of flower known as the evening primrose, De Vries noticed what he later called *mutations*—sudden changes in color or shape from one generation to the next. He argued that traits must be inherited as units (which he called *pangenes*), rather than as blends. . .

The Great Coincidence

- In the first half of 1900, within a few months, *three* scientists independently rediscovered Mendel's work: Hugo de Vries, Carl Correns, and Hugo Tschermak.
- The idea of "genes" as independently assorting particles ultimately disproved Jenkin's "blending inheritance"
  - At first it wasn't clear how genes could be responsible for continuously variable traits. There was a long controversy between the Mendelians and the "biometricians".


DIE

MUTATIONSTHEORIE.

VERSUCHE UND BEOBACHTUNGEN

ÜBER DIE

ENTSTEHUNG VON ARTEN IM PFLANZENREICH

VON

HUGO DE VRIES.

PROFESSOR DER BOTANIK IN AMSTERDAM.

ERSTER BAND.

DIE ENTSTEHUNG DER ARTEN DURCH MUTATION.

MIT ZAHLREICHEN ABBILDUNGEN UND ACHT FARBIGEN TAFELN.

LEIPZIG,
VERLAG VON VEIT & COMP.
1901

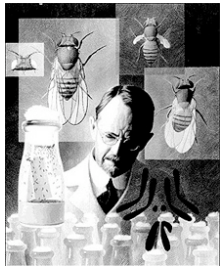
De Vries explained mutations as changes in the "genes" in his book, *Die Mutationstheorie*. De Vries was *not* a supporter of natural selection, however—he was a saltationist, and thought that new species spontaneously appeared by mutations in a single generation. (As we'll see later, he wasn't entirely wrong. . .)

In the early 1900s, there was much dispute between the Mendelians (who attributed everything to single discrete genes) and the *biometricians* (who emphasized continuous traits).

Opposed to the Biometrical army is the Mendelian. More recent in origin, less martial in organisation, but very vigorous, the Mendelian army has already turned the flanks and pierced the centre of the older one opposed to it. For signs of surrender on one wing, and or retreat, very skilfully covered, on the other, are visible in the biometrical ranks.

—Anonymous, *The Mendel Journal*, 1909

The American biologist Thomas Hunt Morgan and his students, working with fruit flies in the 1910s, went on to clinch the case that genes are carried on chromosomes. . .



. . . and to complete the link with radioactivity, H. J. Muller showed in the 1920s that mutations could be caused by radiation—they resulted from physical damage to a chromosome.

Skipping over a great deal of complex controversies and history. . . by about 1930, Mendelian genetics had joined with Darwinian natural selection to produce a powerful theory known as "Neodarwinism" — or

The Modern Synthesis