The Sins of the Father, Take 2

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By Sharon Begley

Alas, poor Darwin. By all rights, 2009 should be his year, as books, museums, and scholarly conclaves celebrate his 200th birthday (Feb. 12) and the 150th anniversary of "On the Origin of Species" (Nov. 24), the book that changed forever how man views himself and the creation. Teamed with genetics, Darwin's explanation of how species change through time has become the rock on which biology stands. Which makes the water flea quite the skunk at this party.

Some water fleas sport a spiny helmet that deters predators; others, with identical DNA sequences, have bare heads. What differs between the two is not their genes but their mothers' experiences. If mom had a run-in with predators, her offspring have helmets, an effect one wag called "bite the mother, fight the daughter." If mom lived her life unthreatened, her offspring have no helmets. Same DNA, different traits. Somehow, the experience of the mother, not only her DNA sequences, has been transmitted to her offspring.

That gives strict Darwinians heart palpitations, for it reeks of the discredited theory of Jean-Baptiste Lamarck (1744-1829). The French naturalist argued that the reason giraffes have long necks, for instance, is that their parents stretched their (shorter) necks to reach the treetops. Offspring, Lamarck said, inherit traits their parents acquired. With the success of Darwin's theory of random variation and natural selection, Lamarck was left on the ash heap of history. But new discoveries of what looks like the inheritance of traits acquired by parents—lab animals as well as people—are forcing biologists to reconsider Lamarckism.

The lab mice, of course, came first. Since 1999 scientists in several labs have shown that an experience a mouse mother has while she is pregnant can leave a physical mark on the DNA in her eggs. Just to emphasize, this is not a mutation, the only way new traits are supposedly transmitted to children. Instead, if mother mouse eats a diet rich in vitamin B12, folic acid, or genistein (found in soy), her offspring are slim, healthy, and brown—even though they carry a gene that makes them fat, at risk of diabetes and cancer, and yellow. It turns out that the vitamins slap a molecular "off" switch on the obesity/diabetes/yellow-fur gene. (Don't try this at home: no one knows which human genes soy, B12, and folic acid might silence.) This was the first evidence, now confirmed multiple times, that an experience of the mother (what she eats) can reach into the DNA in her eggs and alter the genes her pups inherit. "There can be a molecular memory of the parent's experience, in this case diet," says Emma Whitelaw of Queensland Institute of Medical Research, who did the first of these mouse studies. "It fits with Lamarck because it's the inheritance of a trait the parent acquired. There is even some evidence that the diet of a pregnant mouse can affect not only her offspring's coat color, but that of later generations."

Inheriting a DNA-silencing mark that your mom acquired is not as dramatic as giraffes passing on elongated necks to their kids. And the new Lamarckism doesn't mean that human moms who work out will pass along toned abs to their children, or that human dads who dye their hair red will have red-haired children. But preliminary evidence suggests that Lamarckism acts in people,

too. In 2005, scientists in London found that the grandsons of men who had abundant food when they were boys (the study was done on men in a small town in northern Sweden) were much more likely to have diabetes and to die an early death than were the grandsons of men who suffered food shortages as boys. A 2006 study by the same scientists found that when fathers smoked as young boys, their sons tended to be more obese than did the sons of men who did not smoke as boys. Similar to the lab mice, the experience of the parents is visited upon the children and even the grandchildren. If the results hold up, says Whitelaw, "it would signal a paradigm shift in the way we think about the inheritance" of traits.

The existence of this parallel means of inheritance, in which something a parent experiences alters the DNA he or she passes on to children, suggests that evolution might happen much faster than the Darwinian model implies. "Darwinian evolution is quite slow," says Whitelaw. But if children can inherit DNA that bears the physical marks of their parents' experiences, they are likely to be much better adapted to the world they're born into, all in a single generation. Water fleas pop out helmets immediately if mom lived in a world of predators; by Darwin's lights, a population of helmeted fleas would take many generations to emerge through random variation and natural selection. The new Lamarckism promises to "reveal how the environment affects the genome to determine the ultimate traits of an individual," says Whitelaw.

Some of these studies will not hold up, as is typical with revolutionary new science. And resistance to what is being dubbed "the renaissance of heresy" is firm; one scientist called a paper on this stuff "a misguided attempt at scientific humor." But evidence for the new Lamarckism is strong enough to say the last word on inheritance and evolution has not been written.