e8 Tests of Lamarck's inheritance of acquired characteristics hypothesis < Lysenko; Weismann, mice's tails >

Weeds never perish —*Belgian proverb.*[1]

Organisms are remarkably well adapted to their natural environments. To explain this, Lamarck suggested that organisms during their lifetimes acquire traits and characteristics that they pass on to their offspring. This is certainly the case for learned survival strategies among sentient (choice making) creatures that nurture the young and so the generalization of this as a mechanism of evolution has its appeal. Indeed, Charles Darwin's grandfather Erasmus Darwin (1731-1802), pockmarked, rotten-toothed, and grossly gormand fat (as too was his son, Charles's father) had promulgated before Lamarck a mechanism of evolution by inheritance of acquired physical characteristics that resulted from the coping reaction of ancestors to the environment.[2] Charles himself came to rejected the notion but, lacking an alternative mechanism for evolution of novelty, had to live with the knowledge that his theory of evolution was incomplete.[3]

USSR "academician" (peasant plant-breeder) T. D. Lysenko (***Figure e8.1***) tested the Lamarckian hypothesis then compatible (else, the gulag and vanishings) with Lenin/Stalin Marxist-philosophy of Ivan Vladimirovich Michurin (1855-1935) that plants and animals could be changed in desirable ways by exposing them to new environments.[4] The results he obtained, 1938-65, for "environmental determinism" were inconclusive and unrepeatable and his unlettered subversion of genetic inheritance, regrettable, in that his program had earlier precipitated the 1932-33 Ukrainian terror famine deaths of 7,000,000 people.[5]

In France (one does not know whether to laugh or cry), only in the 1960s was Lamarck's mechanism of organic evolution by the inheritance of acquired characteristics abandoned as official dogma promulgated by the Academie de Sciences.

August Weismann (1834-1914) conceived beginning in 1885 that, from its start as a zygote (a single cell of mated germ cells (as Eduard Strasburger (1844-1912) had characterized in 1884), cell divisions are such as to produce a body that is divisible as germ cells (which can transmit hereditary information) and somatic cells (which cannot). To prove the lack of any influence of the body's acquired characteristics on the germ cells (now referred to as the Weismannian barrier)[6] he experiment to demonstrate that the disuse of an organ led to no diminution in succeeding generations (so refuting neo-Lamarckism). In the "Weimer experiment," for 19 generations, white mice had their tails removed at birth. No trend for shortening of the tails was found in the generational issue of mutilated mice.[7] Nor has the rite of circumcision of Jewish boys, faithfully performed for thousands of years, ceased for lack of anything to practice upon.

Even so, the coming into being of large, and small, stable flax genotypes (***Figure e8.2***) during the growth from seed to maturity of a single plant can be demonstrated to be in response to two clearly different environmental conditions: one with a N-P-K (nitrogen, phosphorous, and potassium) fertilizer and the other a N-K fertilizer. Such different fertilizer treatments given to the flax Stormont Cirrus by A. Durrant, beginning in 1953, and to the flax Lyral Prince have established the validity of this finding.[8] How can it not be Lamarckian?

An evolutionary scenario could be the natural selection by *different* environments for two flax varietal types, say A and B (each distinct as to phenotype size, cell DNA mass, etc.). This Darwinian preparatory condition makes what can then ensue (and observed for the flax, above) un-Lamarckian.[9] Hybridization of A with B produces a type, *distinct for its phenotype size, cell DNA mass, etc*., which can live in conditions ideal for neither A nor B (but not necessarily fatal for them). Given conditions ideal for A, the hybrid during its growth (somatic divisions) turns on its genes for A and turns off its genes for B. In the inducing condition, the germ cells that then develop favor in the process of their meiosis genes for A and leave suppressed (but still present) genes for B. Reciprocal would be conditions ideal for B. In the absence of the other, each varietal type continues true (through times too short for noticeable evolution) even when conditions for it are unfavorable.

Induced chemical defenses that persisted in the progeny of infested plants are not uncommon. For example, caterpillars (*Pieris rapae*) set to browse on wild radishes (*Raphanus raphanistrum*) are found to gain 20% less weight on seedlings whose "parents" were so damaged than on seedlings whose "parents" had not been browsed.

Transgenerational induced defenses have also been found for animals.[10] For example, midges (*Leptodora kindtii*) prey upon the even tinier water flea (*Daphnia cucullata*). Raised in the proximity of the midge predator, and chemical clues that the midges inadvertently give off, the flea prey are triggered to grow extra-large protective helmets (***Figure e8.3***). Thereafter for several generations (at least three as reported in 1999 by Ralph Tollrian and Anurag A. Agrawal),[11] female asexually produced female offspring (in the wild they reproduce with sex only about one brood, of many, in a year) continue to grow the helmets. The helmets are observed to halve predation-mortality rates.

The water flea's inheritance is not Lamarckian, it is epigenetic as the trait expressed in the phenotype is not due to gene change but is due to switching on (or off) existing genes that produce the defense against predation. The mother provides the chemical signal to the offspring even in the absence of the midge predator, or its chemical tainting of the water. The same is true of the radish "mother" plant that houses and nourishes the seed as it grows before it is shed. Still, selection operates on the phenotype and in Agrawal's words "induced defense across generations," is "on the edge" of being Lamarckian. And Tollrian states that "induced defenses turn up in species from one-celled pond ciliates to humans with their fancy immune systems." ❑

Figure e8.1 **Trofim Denisovitch Lysenko** (1898-1976) [12]
Lysenko's theory: Plants of the same species were supposed not to compete with one another, and foresters, as well as farmers, were advised to grow their plants or trees in clusters for mutual aid. Plants were believed to 'assimilate' the environmental condition in which they were grown and intricate systems of 'training' were devised in order to influence the hereditary properties of young seedlings. One of the systems was to graft the seedlings on to another plant belonging to a different variety, species, or even genus and so the old belief in graft hybrids, current in earlier centuries, was revived. The fact that many of them had been shown by cell studies to be chimeras, or cell mixtures, rather than true hybrids, was conveniently ignored by Lysenko, who had a singular capacity for overlooking facts that did not suit him. —*The Times* obituary.[13]

The 1920s and 1930s, often seen as a time of lunatic obsession with genetic determinism, was also a time of lunatic obsession with environmental determinism: the belief that man could be remade entirely into new man just by education, propaganda and force. Under Stalin this Lockean faith in changing nature was even applied to wheat. Trofim Lysenko argued, and those who gainsaid him were shot, that wheat could be made more frost-hardy not by selection but by experience. Millions died hungry to prove him wrong. —Matt Ridley *The Origins of Virtue*, 1999.[14]

Figure e8.2 Fourth generation flax plants of two extreme varieties induced in the first generation by fertilizer (left, N-P-K; right, N-K) treatments (not repeated for the succeeding generations). Hybridization of these two, however, reproduces the first generation type.

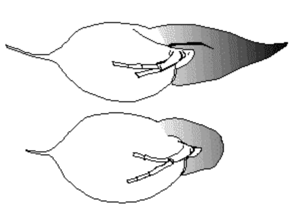

Figure e8.3 [15] Sketch of an electron micrograph of predator-induced enlarged head shield (top) of *Daphnia cucullata* to typical size (bottom).