BOOKS: HISTORY OF SCIENCE

The Republican Temple of Nature

Pascal Duris

By decree of the Convention Nationale on 10 June 1793, Paris's Jardin du Roi, founded at the beginning of the 17th century, was transformed into a Muséum d'Histoire Naturelle. Within a few years, this new scientific establishment, the only one to survive the storms of the French Revolution, became the world's leading center for natural history. In *Utopia's Garden*, historian of science E. C. Spary examines how the naturalists of the Jardin du Roi recast their discipline as a critical source of French prosperity and republican virtue.

Utopia's Garden French Natural History from Old Regime to Revolution
by E. C. Spary
University of Chicago Press, Chicago, 2000. 337 pp. $70, £44.50. ISBN 0-226-76862-7. Paper, $25, £16. ISBN 0-226-76863-5.

The fame of the Jardin du Roi under the Old Regime was closely linked with that of Georges-Louis Leclerc de Buffon, its intendant from 1739 until his death in 1788. Spary shows how Buffon converted the scientific and social credit he gained from his best-seller work, the *Histoire naturelle, générale et particulière* (1749–1789), into posts for naturalists. The Jardin was a part of the patronage structures that stretched downward throughout 18th-century French society in a network of complex ramifications. Negotiations over power and official posts were played like games, and Buffon used every opportunity to advance his own protégés. But, Spary points out, Buffon was far from being the only player in this game and he was not always successful. For example, his attempt to install Félix Vicq d'Azyr as the Jardin's professor of anatomy was defeated by his own patrons.

André Thouin, the Jardin's head gardener from 1764 to 1793 and one of Buffon's chief protégés, illustrates the nature of old-regime patronage. Thouin established a worldwide network of botanical correspondents, which at its height in 1786 included more than 400 individuals. (Such botanical networks were important parts of the 18th-century colonial efforts of European nations.) Many sources for obtaining botanical exotica were recruited by the Jardin in the 1780s. Merchants, travelers, voyaging naturalists, and diplomats formed the "moving elements" which fed the Jardin's collections. The travelers were what Spary calls "a telescope" through which the naturalist at the network's center could see things at a distance. Moreover, Thouin wrote many memoirs for the guidance of his traveling gardeners, so that his protégés "took France with them" on shipboard. Along with the growth of Thouin's network between 1774 and 1786, the number of seeds being sown annually at the Jardin increased from over 1000 to 2200. Spary notes that as individuals succeeded in controlling more plant resources, they moved upward in the patronage scale.

The French Revolution dismantled the former patronage society. Between 1790 and 1793, the Jardin naturalists used both communal behavior and individual patronage relationships to regulate their own interactions and their exchanges with the rapidly shifting centers of political power. In 1790, the savants working at the Jardin produced one of the most radical sets of reforms proposed for any scholarly institution during the Revolution. Their plan equalized the status and remuneration of each professor and transferred control of the establishment to the naturalists themselves. The post of intendant was to be abolished. These reforms were adopted three years later, when the Jardin was reconstituted as the Muséum d'Histoire Naturelle. The institution's preservation can be attributed to the naturalists' strategy and the perceived utility of the establishment to the new nation.

Symbolic device. The logo of the MNHN was designed in 1793 by the Muséum's professor of iconography, Gérard Vanspaendonck. The vines and corn refer to the agricultural role of natural history, the Phrygian cap symbolizes republican liberty, and the beehive represents the professoriate. (Bees were models of industry, utility, and social harmony.)

As a center for the acclimatization of plants, the Jardin was closely involved with the study of the interaction of nature and culture. Climatic concerns led 18th-century savants to explore the effects of external physical conditions upon the characteristics of living beings. *Utopia's Garden* shows how discussions about the relations between culture and climate became particularly prominent in Revolutionary debates over the best ways to manage society. For the Revolutionary legislators, agriculture and natural history were important routes to the improvement of the French nation. Hence the dual significance of the Jardin naturalists' 1790 appeal for a national Muséum d'Histoire Naturelle: "Shall the tree of liberty be the only one which cannot be naturalized at the Jardin des Plantes?"

For many naturalists and their publics of the Jacobin period, natural history was the science of sensibility par excellence. The Muséum naturalists presented their discipline in terms of a particular sensory epistemology. The limits of vision, explains Spary, could define the limits of the naturalist's investigation. The choice of the writer Bernardin de Saint-Pierre as the Jardin du Roi's last intendant confirms that sentimental nature exemplified in the work of Rousseau could be identified with the nature studied by natural historians. Throughout 1793 and 1794, Revolutionary propaganda streamed from the new establishment. According to Spary, the naturalists became an official voice for Nature within the Republic, and the Muséum became a privileged center for the representation of France's republican future to its citizens. Natural historical concerns of the Muséum's scientists were replicated throughout republican France, expanding the Muséum's boundaries to encompass the nation. With the political developments after 1795, it would become of prime importance to the Muséum's future that its institutional existence and meaning were separable from the republican context of its creation.

Spary demonstrates that 18th-century natural history is not solely a set of theoretical debates. For her, classification, the subject of a considerable literature, is an "epiphenomenon" of economic and improvement activities. As Joseph Banks in England shows, one did not have to be a renowned classifier to be a famous naturalist. Spary's account of the Jardin's transformation into the national Muséum through Jacobin agency pays particular attention to activities (including collecting, preserving, describing, naming, and cultivating) often ignored or devalued by most historians of science. Collections, greenhouses, herbaria, and journals are as important as theoretical developments. Furthermore, Spary's picture of natural historical practice as a network lets us consider not only the naturalists themselves but all (gardeners, diplomats, curators, students, minis-

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ters, and the king) involved in the practice of natural history.

This well-documented and well-edited book demonstrates Spary's great knowledge of French Revolutionary sources (both manuscript and published) and the French language. The fresh and lively account in *Utopia's Garden* offers valuable perspectives on the shaping of natural history in late 18th-century France.

BOOKS: EVOLUTION

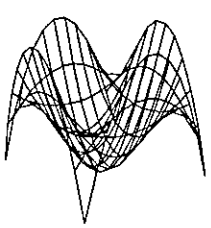
Holy Landscapes!

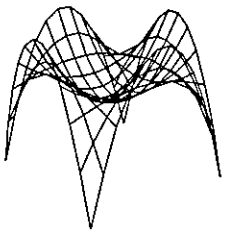
James Mallet

A number of intractable controversies in evolutionary biology date from the 1930s, and the topic of this book is one of them. Epistasis exists when the effects of substitution at one locus depend on alleles at other loci, so that genes interact in their effects on fitness. At first glance, it is hard to know what the fuss is about, because epistasis must be virtually universal. Every complex adaptation, such as the vertebrate eye or flight, always requires synergy among genes. Unfit hybrids between any pair of species also demonstrate epistasis because the genes causing sterility and inviability work just fine on their normal parental background.

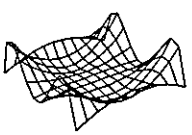
Epistasis and the Evolutionary Process
Jason B. Wolf, Edmund D. Brodie III, and Michael J. Wade, Eds.
Oxford University Press, New York, 2000. 344 pp. $85, £62.50. ISBN 0-19-512806-0.

The controversy is therefore not whether epistasis exists or is important, but about how it arises in evolution and whether it can throw additional light on other topics, such as molecular evolution or the evolution of sex. Classically, epistasis and other nonadditive effects are unimportant in the construction of adaptations: epistasis is noise, a mere "interaction term"; only the additive or "main effects" contribute to evolution by natural selection. Darwin used essentially this argument when he proposed advantages for each small step in the evolutionary construction of the vertebrate eye, and in 1930 Ronald A. Fisher formulated a quantitative genetic model of the same idea. Fisher's great rival, Sewall Wright, almost immediately proposed an alternative argument in which epistasis was crucial. Wright imagined a rugged "adaptive landscape," with multiple peaks representing high-fitness gene combinations. Classical additive evolution would get stuck on local adaptive hillocks and be unable to explore peaks of greater fitness. Wright's solution was his "shifting balance" theory, in which genetic drift, idiosyncratic selection, and spatial population structure allowed different adaptive combinations to be explored in different parts of a species' range. (Stated like this, who can deny that the shifting balance, in some form, is likely?)

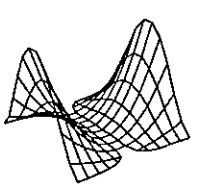




Curiously, *Epistasis and the Evolutionary Process* hardly covers the recent flurry of papers on the shifting balance, but instead explores newer topics. An excellent introductory chapter by P. Phillips, S. Otto, and M. Whitlock defines epistasis as a deviation from multiplicative (rather than additive) fitness as being the most natural measure and summarizes several of the book's main themes. In contrast, E. Brodie's introductory overview was spoiled for me perhaps because I am not a "Deadhead"; actual examples of epistasis such as in mimicry would have been more edifying than the analogy of Jerry Garcia's guitar music in different rock bands.

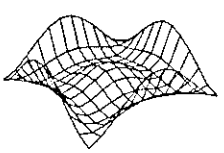


Among the theoretical chapters, I thought the discussion by J. Kelly about the buildup of linked epistatic modifiers particularly fascinating. Where a polymorphism is maintained by balancing selection, linked epistatic modifiers are expected to evolve; these can eventually produce a multiple-component, epistatic "supergene." The idea that the sex chromosomes characteristic of the heterogametic sex (such as the mammalian Y chromosome) degenerate over evolutionary time is an extreme example of this general argument. In contrast to classical and still unproved ideas about mimicry supergenes, Kelly's ideas do not require evolution of linkage, but merely the co-opting of variation in already linked elements. These ideas can explain some hitherto puzzling linkage disequilibria in molecular data such as the alcohol dehydrogenase (*Adh*) region of *Drosophila*.



Although a large part of the book is theoretical, I particularly enjoyed some of the empirical surveys. A. Templeton demonstrates epistasis in a variety of human genetic diseases, including some (such as sickle-cell anemia) classically termed "single-locus" polymorphisms. I also liked the evidence presented by S. Rice for interactions in morphology between vertebrate skull elements. A number of useful chapters demonstrate divergent exploration of adaptive peaks in spatially separated populations or species. The existence of epistatic peaks in the adaptive landscape is, however, unsurprising and neither confirms nor disproves the idea that epistasis contributed to their evolution, which could have proceeded via additive selection, ever upwards in a monotonic but "holey" adaptive landscape (to use Sergey Gavrilet's metaphor). The adaptive "holes" are revealed when populations are crossed to produce unfit hybrids, but they are not necessarily waystations in the divergence process.

In a chapter relevant to this question, L. Meffert reviews the well-known experiments on houseflies in which population bottlenecks caused increased additive genetic variance. She demonstrates that this is probably due to conversion of epistatic variance. Nonetheless, although the increase in additive variance may not be due to an increase in the frequency of simple recessive deleterious alleles as suggested by some critics of these experiments, epistatic and dominant effects are nonadditive interactions of a fundamentally similar kind. An increase in additive variance could simply reflect an increase in frequency of deleterious epistatic alleles, and would then be as irrelevant for adaptative progress as simple deleterious recessives.



One of the most interesting empirical chapters was M. Palopoli's review of the molecular interactions within meiotic driver systems, particularly the segregation distortion system in *Drosophila*. Segregation distortion is usually harmful and seems always to require tightly linked epistatic elements. As shown by A. Peters and C. Lively, recombination can be advantageous by breaking down genetic combinations deleterious to the organism as a whole. Thus, it is even possible that sex evolved primarily to police Mendelian segregation.

I learned a great deal from *Epistasis and the Evolutionary Process*, and I congratulate the editors on an excellent choice of authors. Graduate students and other scientists will find the book a very useful smorgasbord of recent research into theory and facts of epistasis. The volume does not attempt to resolve the 70-year-old controversy about the importance of epistasis and shifting balance. Instead, it shows that epistasis plays a central role in a much wider and more interesting variety of evolutionary problems than seemed possible even ten years ago.

SOURCE: J. CHEVERUD/WASHINGTON UNIVERSITY, ST. LOUIS

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