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Book Reviews

Environment rules

Developmental Plasticity and Evolution by M.J. West-Eberhard. Oxford University Press, 2003. £79.50, hbk (720 pages)
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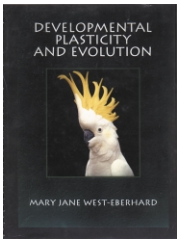

'Environment leads, genes follow'. This is the thread that runs through and ties together Mary Jane West-Eberhard's treatise on phenotypic evolution. Her central theme is that the process of phenotypic evolution is most often initiated, not by mutation, but by environmentally induced phenotypic change, and it is these changes that form the basis for subsequent adaptive evolution. She supports these ideas profusely with examples, from the parallel evolution of similar genitalia in Japanese carabid beetles to the evolutionary fixation of alternative phenotypes in lampreys, aphids and ants. Her favorite case, emphasizing the remarkable flexibility of development and morphology, is that of the two-legged goat: lacking forelimbs, it adjusted successfully to bipedal life through plasticity of behavior (hopping like a kangaroo) and morphology (many elements of the skeleton and musculature were radically changed).

Arguments about the relative influence of genetic versus environmental effects on phenotypes wax and wane, but the increasing sophistication of molecular biology has pushed the pendulum deep into the genetics zone. The 1990s produced pro-environment advocates (e.g. Rollo, Sultan, Scheiner, Schlichting and Pigliucci), who have argued that the importance of phenotypic plasticity requires movement of the pendulum back towards the center: 'the role of the environment [in the process of evolutionary change]…has been glaringly underestimated' [1].

West-Eberhard presents a fresh perspective on the role of environmental factors. Her plethora of examples is intentionally impressive in promoting the plausibility of her thesis. But, indeed, Schmalhausen's and Waddington's genetic assimilation was, in spite of its lack of acceptance, already a plausible hypothesis for this type of evolutionary scenario. The strength of West-Eberhard's exposition lies in her focus on pushing beyond 'plausible' to 'likely'. She enumerates the reasons that environmentally induced phenotypes are more probable initiators of evolutionarily important novelty than are mutational variants: they can be reliably produced in numerous individuals with appropriate stimuli; expression only under certain environmental conditions exposes the phenotypes to consistent selection pressures (they are hidden when conditions change again); and environmental stimuli recur much more frequently than do mutations.

If environment rules, what then is the role of mutational change? By and large, it is relegated to fine-tuning in the service of reinforcing the reliable context-dependent production of the alternative phenotypes. After selection favors the plastic responses, the new trait is then genetically accommodated by means of adjustments in form or regulation, and reduction of deleterious pleiotropic effects. Developmental plasticity also enables the storage of mutational variation.

Although there are many individual pieces that I could take issue with, overall West-Eberhard is persuasive in her often passionate arguments for a primary role for environmental modifications as both initiators and facilitators of evolution. There are clearly still unanswered questions – some members of our seminar to discuss this volume were disgruntled about the lack of detail concerning mechanisms, such as how do genetic accommodation and character release evolve? Although West-Eberhard tends to fall back on the old 'modifier gene' explanations, this is not really her fault, because few details are actually available about the process of genetic change from one adapted state to another (but see [2–6]).

West-Eberhard demonstrates that examples supporting her thesis are not just recent: she interprets (or re-interprets) significant examples going back over 100 years. Breadth of coverage is conceptually and taxonomically wide; but this might contribute to weak spots in literature coverage. Citation and discussion of recent conceptual literature is limited, and some exemplars of particular points seemed eccentric. Chapters range in quality from those bursting with both concepts and examples (e.g. development, environmental modifications and speciation) to some that appear to be vestigial remnants of the original outline, left behind by the evolution of West-Eberhard's own ideas (e.g. heterochrony

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and heterotopy). For those interested in using the book for a time-limited seminar class, Part II is likely to be the most expendable.

Does she go too far, or not far enough? My guess is that the majority might favor the former. However, being predisposed to accept such a world view, I might opt for the latter, pushing even more strongly for the idea that all developmental innovation might ultimately be derived from plastic responses to novel environmental conditions [1,7,8]. Regardless, fascinating examples abound, and you are likely to come away with an enhanced appreciation of the roles played by the environment in evolution. And, perhaps, as West-Eberhard hopes, you will recognize the need for an alternative evolutionary synthesis of environment, development and genetics.

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Life

The Story of Life by Richard Southwood. Oxford University Press, 2003. £19.99 hbk (264 pages) ISBN 0 19 852590 7
Origin and Early Evolution of Life by Tom Fenchel. Oxford University Press, 2003. £25.00 hbk (180 pages) ISBN 0 19 852635 0

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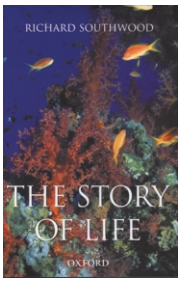

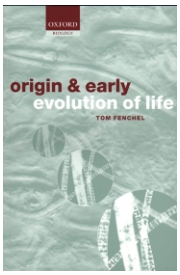

Palaeontology used to be in the doldrums, mainly because fossils were treated as curiously shaped stones. When I entered the field in about 1980, the main employment for palaeontologists was with oil companies and geological surveys, and the justification for the subject was utilitarian: fossils are used to date rocks, so we learn their shapes and names, and we identify them for money. In 1980, most professional palaeontologists, in Europe at least, were employed in geology departments and, with the rise of new analytical approaches in the earth and biological sciences, palaeontology was squeezed out.

This is no longer the case. The few lone palaeobiologists of the 1970s and 1980s have become a clamorous breed. Scarcely an issue of *Science* or *Nature* passes without a palaeobiological contribution: the origin of life, the Cambrian explosion, astonishing new basal metazoans, basal deuterostome phylogeny, the move of life on to land, dinosaur behaviour and habits, the origin of birds, new human fossils, mass extinctions, diversifications, disputes over the shape and timing of the tree of life. Palaeobiologists are everywhere.

Two new books from Oxford University Press exemplify this renaissance of palaeobiology. Both are written by distinguished biologists who are looking at current palaeobiological evidence as outsiders: Richard Southwood has worked professionally on insect ecology, and Tom Fenchel on marine ecology and geomicrobiology. Both books are based on series of undergraduate lectures, and both are therefore slim volumes, brief, clear and well illustrated.

The difficulty in presenting *The Story of Life* as a readable book is that the text could descend into little more than a list of dates and a narrative of what happened next. This could then lack anticipation and the fun of working through an analytical question. There would then be no problems, puzzles, or insights, just a relentless passage of ever-more peculiar plants and animals. And, as has often been noted, telling 'the story of life' can give the reader the mistaken impression that it is all laid out along a preordained path, where everything leads inexorably from the slime, through single-celled organisms, to the first vertebrates, the first amphibians on land, the first warm-blooded mammals, and then humans at the peak. The story could equally focus on the continually changing panoply of prokaryotes through the past 3.6 billion years.

Richard Southwood avoids these problems to a large extent. He makes sure the reader understands the broader implications by introducing topics such as cell structure,

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