BOOKS & ARTS

The interior designer

Can the physiological agents of homeostasis create the appearance of design in nature?

The Tinkerer's Accomplice: How Design Emerges From Life Itself
by J. Scott Turner
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Sharing a broadly accepted idea or philosophical concept comes with a danger: after a period of indulgence in mutual affirmation, it is easy to forget how to effectively defend the concept against a smart and captious critic. Established politicians sometimes stumble and get lost in clumsy arguments when forced to defend the basic concepts of their politics against a cleverly presented and maybe radically different opinion. And evolutionary biologists can struggle to find their best arguments when challenged by a well-prepared enthusiast of 'intelligent design'. Non-physiologists, for example, might overlook the agents of homeostasis that lead, largely by themselves, to the marvellous harmony of structure and function we observe in nature.

In his book *The Tinkerer's Accomplice*, Scott Turner provocatively calls this harmony of structure and function 'designedness', probably because, as he writes, there is "no better way to open minds than to irritate them a bit". And he does an excellent job here, not just with the irritation part but also with what follows.

Most chapters start with a pictorial description of a rather randomly picked phenomenon to build up to a question that may not have been obvious to the average reader before but becomes really burning now. Turner then leads us competently and in great detail through a likely physiological explanation. The argument is well organized, with a high density of information, but the accessible and often humorous language carries us along. When he explains, for example, the thoughts and observations that led to his understanding of how termite chimneys not only capture wind to power ventilation but also regulate its capture, and how this makes the chimney an organ of homeostasis, his narrative skills make you feel as if you were sitting with him at a fireplace in the African bush. When he explains the self-organization of blood vessels, or the way the digestive tract develops and continuously adapts its functionality, you might feel as if you are in the office of a senior professor who is carried away by his enthusiasm for the subject. And you might start pondering how it would feel to grow an antler after reading that its developing shape interacts with the nervous system in such a way that experimentally induced modifications of the antler's shape are memorized in the brain and influence the growth of next year's antlers, even after the modified antler is cast.

Can homeostasis explain the design of termite chimneys?

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Turner challenges Theodosius Dobzhansky's notion that "nothing in biology makes sense except in the light of evolution" with a claim that could be summarized as: "no attribute of life, including its evolution, really makes sense unless we view it through a physiological lens". He reintroduces various dynamic and self-organizing systems and explains the concept of 'Bernard machines', named after Darwin's contemporary Claude Bernard, who emphasized the role of homeostasis in physiology. Bernard machines create environments and regulate them, just like those termite chimneys. For example, fibroblasts remodel collagen meshes to conform to imposed loads, and embryonic cells form into sheets that fold and create new physiological environments.

This leads to the tantalizing question of whether darwinian evolution can dismiss intentionality. Obviously, creative brains can cope better with an unpredictable world and may have a selective advantage, so creativity and intentionality can evolve and in turn influence evolution. But does it really need a brain like ours to bring intentionality into play? Turner views this question through a physiological lens and develops a picture of a modular brain that could be understood as a kind of 'climax' ecosystem with competing and coevolving cells, and with homeostasis as the organizing principle of cognition. He argues that we intentionally design the world when our neural ecosystems generate ideas that then guide our bodies to reshape it. The point is that the brain may be just one example of what Turner calls 'persistors' — persistent environments that are created by systems of Bernard machines and that have a process-based form of heritable memory. 'Darwin machines' — replicators that have to prove themselves under natural selection — shape evolution in the absence of intentionality. But the author argues that life and evolution happen when Darwin machines act in concert with Bernard machines, which are the agents of homeostasis and can be seen, in their own particular way, as goal-seeking and purposeful. These are the 'tinkerer's accomplices' of the title.

It is fun to read Turner's prose, to learn from him about self-organizing systems and their enormous significance in evolution, and to think through his arguments, with all their accompanying intellectual challenges. This important book is for those who search for an understanding of the various forms that life can take and of how life works. It is also a wonderful book for physiology students, especially for those who could use a motivational kick to help them continue their studies. ■

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