that he called "complex coacervates" — what today might be called colloidal assemblies. He suggested that these protocells were a key step in the origin of life. However, given the uncertainty at that time about the nature of biological macromolecules, it was unclear exactly how these colloids might form.

This hypothesis of colloidal assembly has largely been displaced by other concepts of life's origins. For example, some hold that membranes must have come first, arguing that the prebiotic soup contained molecules with water-attracting and water-repelling ends capable of self-assembling into cell-like structures (liposomes). Interestingly, later in life, Oparin himself expressed regret at having focused on colloids instead of liposomes.

However, current cell and molecular biology provides a new perspective on the feasibility of life beginning from liquid-like macromolecular assemblies, suggesting that Oparin might have been more correct than he thought. Many macromolecules have weak multivalent interactions with other macromolecules, which means they have several sites at which interaction can occur. RNA itself is a flexible, extended, dynamic molecular chain; the interactions between it and other molecules are typically numerous and weak. These properties are sufficient for macromolecules to self-assemble into liquid-phase droplets, like Oparin's coacervates. Recent work on RNA compartmentalization and catalysis in liquid droplets provides additional support for Oparin's concept of primitive protocells in a primordial 'RNA world'.

Oparin belongs in the pantheon of the twentieth century's greatest scientists for providing a foundation for understanding early molecular evolution. He believed that natural selection had "completely wiped off the face of the Earth all the intermediate forms of organization of primary colloidal systems and of the simplest living things". Three-quarters of a century before Oparin, Charles Darwin noted that such primitive life forms would be a poor match for contemporary, highly evolved ones. But Darwin also wrote that relatively less-evolved species — "anomalous forms … living fossils" — often come down through the ages, against all the odds.

Like the ancient mitochondrial organisms found in each of our cells, intracellular RNA droplets could reflect a still more ancient lineage in the assembly of complex cellular structure. Oparin's coacervates may still be alive and well, safe within our cells, like flies in life's evolving amber. ■

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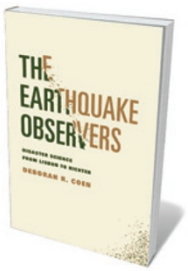
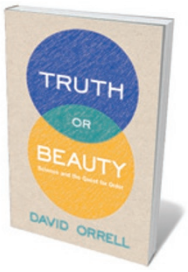
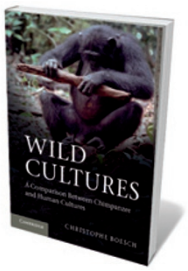
Books in brief



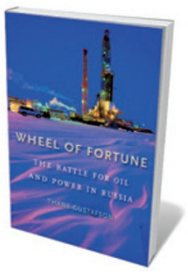
The Earthquake Observers: Disaster Science from Lisbon to Richter
Deborah R. Coen UNIV. CHICAGO PRESS *360 pp. $35 (2012)*
Crowd-sourced science has rarely been so thrilling. As Deborah R. Coen reveals, the rumbustious history of seismology began with roving scientists gathering locals' accounts of shocks, shudders and thumps. Luminaries from Charles Darwin to Alexander von Humboldt reported, too; Charles Dickens likened a quake to a great beast "shaking itself and trying to rise". Coen argues for a hybridized 'disaster science', factoring in such responses from "human seismographs" with geology and instrumental data.



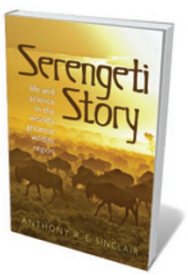
Truth or Beauty: Science and the Quest for Order
David Orrell YALE UNIV. PRESS *356 pp. $30 (2012)*
The philosopher Bertrand Russell averred that mathematics has a beauty "sublimely pure, and capable of a stern perfection". But is science inextricably allied to aesthetic beauty? In applied mathematician David Orrell's exploration of the Pythagorean quest to realise the cosmos mathematically, the cracks in that paradigm show. Orrell swings from the ancient preoccupation with musical harmony and numerical ratios to Renaissance nature studies, the mechanistic approach and the physical sciences of today. Imperfect as it is, 'messy' science, he argues, has a novel beauty of its own.



Wild Cultures: A Comparison between Chimpanzee and Human Cultures
Christophe Boesch CAMBRIDGE UNIV. PRESS *288 pp. £60 (2012)*
For a third of a century, primatologist Christophe Boesch has hiked in the wilds of Côte d'Ivoire and Gabon in Africa to probe the 'culture question' in chimpanzees. Boesch presents systematic evidence for material, social and symbolic culture in wild chimpanzees, drawing too on studies of humans and captive chimps. Comparing the species, he focuses on the teaching and acquisition of cultural traits, and the link between cognition and culture. What makes us human? This book could force a rethink.



Wheel of Fortune: The Battle for Oil and Power in Russia
Thane Gustafson HARVARD UNIV. PRESS *672 pp. $39.95 (2012)*
Russian oil has had a bumpy ride. The world leader in the 1980s, the industry went into steep decline with the Soviet Union's dismantling in 1991. When the Iron Curtain rose, the state's oilmen — mostly geologists and engineers — were shocked by a global industry rife with lawyers and traders. Now oil and roubles shunt through the pipelines of new Russia, but the relationship between state and industry is often explosive. Energy-policy analyst Thane Gustafson reveals Vladimir Putin's pivotal role, the effects of the 2008 crash, and the complex currents and uncertain future of regional oil.



Serengeti Story: Life and Science in the World's Greatest Wildlife Region
Anthony R. E. Sinclair OXFORD UNIV. PRESS *288 pp. £18.99 (2012)*
Like some stupendous open-air stage, East Africa's Serengeti ecosystem hosts some of the world's great faunal dramas. Zoologist Anthony Sinclair has been observing them for nearly 50 years. This is a rich interweaving of natural and human history, covering everything from the rinderpest pandemic and ivory exploitation to today's looming threats. Glinting throughout are stories from the field, such as his wife's inadvertent sleep-in with a leopard.