The natural economy

Jeff Harvey

Towards the end of *On the Origin of Species*, Darwin pictures nature's riotous profusion of biological diversity occurring not as species in isolation, but with an interconnectedness he describes as an "entangled bank". Darwin was essentially describing an ecosystem, which science now defines as 'an integrated system involving the biological, chemical and physical components of a habitat or region'.

QUESTIONS THAT ECOLOGISTS MUST ADDRESS

- How do the cumulative biological and physical activities of individual organisms contribute to larger-scale ecosystem processes such as productivity, resilience and other measures of stability?
- How much can a given ecosystem be reduced in size, through loss of species, populations and guilds (see text), and still function effectively?
- For a given ecosystem, what are the most important functional components, and how much redundancy is there?
- How do direct and indirect interactions across ecosystem gradients (for example, above and below ground) determine the health and stability of the system?
- What are the short- and long-term ecological consequences of human alteration of the biosphere?

VICKY ASKEW

Healthy ecosystems are characterized by sustainable turnovers of energy, nutrients, organic matter and water, which remain stable over comparatively long periods of time. This homeostasis emerges from the collective functions of the system's biota, operating within an exceedingly complex, integrated network. Stability is maintained by functional redundancy, whereby multiple species have similar ecological roles, thereby allowing function to be maintained even in the face of change. In their aggregation over the entire biosphere, ecosystem processes are critically important in regulating global cycles of water, oxygen, nitrogen and carbon dioxide.

Humanity, like all of nature's bounty, is a product of evolution, and a dependence on and affinity for nature are undeniable components of the human psyche. Every human being lives within an ecosystem; towns, cities, farms and factories are freely leased to us by one or more ecosystems. We share ecosystems with literally billions of other organisms, most of which are wholly beneficial to us. Without this teeming array of biodiversity, life as we know it would not be possible. Yet many of us have become so insulated by technology within our artificial urban environments that we fail to appreciate the inputs and outputs of nature's economy upon which life itself—including our own—depends.

In the current age of artificial intelligence, human genomics, perceptual robotics, flow visualization, advanced astrophysics and other high-tech whizzery, it is both disturbing and ironic that our understanding of vital ecological processes is rudimentary. One of the greatest intellectual challenges facing the scientific community is to unravel ecological complexity and to understand better how ecosystems evolve, how they assemble themselves and how they function. The importance of this immense task is greater than it has ever been because of the drastic changes in the functioning of ecosystems caused by humans. Through continued, unrestrained economic development, we may push ecosystems beyond a critical threshold, beyond which they are unable to sustain themselves and, ultimately, us.

Over the past decade, ecologists from different specialized disciplines have accrued a wealth of data, which go some way to unravelling ecological complexity. But only partial headway has been made in understanding the relationship between biodiversity and ecosystem functioning. There has been little attempt to link the results of small-scale, mechanistic studies with research at the level of the ecosystem. The gap between macroscopic and microscopic processes must be closed, so that we

Ecosystems

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can better understand how the complex biosphere has emerged from evolutionary pressures operating on small scales.

Moreover, most ecosystem experiments have been carried out using a small subsample of species that occupy one or two trophic levels in closed systems (microcosms), rather than on larger ranges of multitrophic interactions within an entire ecosystem or community. Admittedly, such blanket studies represent a gargantuan undertaking. But as long as species and guilds (groups of species that exploit resources in similar ways) are excluded from experimental programmes, the conclusions of these experiments will be open to doubt.

A better understanding of existing data sets, combined with further research, is needed to identify the present and future impacts of humanity on our global life-support systems, and to establish conservation priorities. But how can we achieve this, given the complexities? One way is to adopt a multidisciplinary approach, pooling and focusing resources and expertise on particular systems of which there is some historical knowledge. The efforts of ecologists who study ecosystems need to be combined with those who study individuals and populations.

Ecological science is crucial for policy-makers attempting to mitigate the changes that humanity has inflicted on the biosphere. Without a better grasp of ecological processes, future generations will cause even more serious damage. The consequences for the planet are not worth contemplating. ■

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FURTHER READING

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