Uncommonly interesting

Paul Colinvaux

Rarity. By K. J. Gaston. *Chapman and Hall: 1994. Pp. 205. £17.95 (pbk).*

'RARE' is a term usually used by collectors to mean "I have got one and you haven't". Rarity is thus desirable, as reflected in one of its definitions in the *Oxford English Dictionary*: "thing valued as being rare". Biologists are not immune to this human foible, rejoicing in a rare bird or an unexpected species in the collecting net.

But for Gaston, in what is apparently the first monograph on biological rarity, 'rarity' merely means of low abundance or of small range, or both. The rare are ubiquitous, an inevitable part of any community. This abundance, as it were, of the rare is what makes rare species interesting. Why are certain species rare? Do ecosystems need them? Are they successful as a species? Is rarity a sign of impending extinction?

Frank Preston made a fundamental observation in his paper "The Commonness and Rarity of Species" (*Ecology* **29**, 254; 1948) by showing that the distribution of relative abundance is log-normal. This implies underlying randomness. Subsequent attempts to find more subtle patterns of relative abundance have left few traces. Robert MacArthur's "broken stick" model, in which resources of a community are allocated as if by the random breaking of a stick into bits of unequal length, yields distributions of relative abundance that are themselves functions of the log-normal. Joel Cohen's variant of the broken stick theme, the "balls and buckets" model, in which population size is allocated by the random, sequential throwing of coloured balls into an army of buckets, yields a similar echo of the log-normal. No other models have fired the imaginations of ecologists as did the broken stick.

Gaston believes that interesting questions remain to be answered. He offers no new model or theory of rarity, nor is the history of the broken stick and its allies mentioned. Instead he begins a quest for properties of the rare that can be measured.

Definition is a major problem, and Gaston devotes his first chapter to it. He concludes that we have no alternative but to assign an arbitrary proportion of species present as rare, essentially the x per cent of species that have lowest abundance or smallest range. Five per cent of total abundance, biomass or range usually provides plenty of species in the 'rare' category.

With the rare so defined, Gaston takes a population biologist's approach to measuring both the rare and the properties that might account for their rarity. Obstacles are formidable. The very rare almost cannot be counted, as when Eric Pianka noted that it takes a hundred person-days to find one specimen of a rare lizard. And to measure the area occupied by species with patchy distributions probably needs the use of fractals.

To investigate the causes of rarity by measurement, as the author wishes, without hypotheses of rarity to test, is more difficult still. Measuring arrays of environmental factors becomes uncomfortably reminiscent of older schools of plant-community analysis, where the aim was to explain plant distributions as consequences of physical parameters of environments alone.

Gaston describes several possible causes of rarity: endemism, individuals at range boundaries, vagrancy, the lows of fluctuating populations, restricted dispersal or establishment, as well as the pseudorarity that results from limits to our powers of detection. He dismisses the concept that some species remain rare because of restricted niche opportunities, because in the few examples where many resources have been measured, he is unable to find any correlation between resource and relative abundance.

As one who once tried to introduce Raymond Lindeman's concept of efficiency of energy transfer between trophic levels with an essay called "Why Big Fierce Animals are Rare", I remain convinced that tigers are rarer than sheep, and that I know why. But this monograph is about the rarity that remains after possible effects of food chains, functional niches, vagrants and sampling error are removed. This remainder is massive. Preston demonstrated the powerful influence of random process in bringing it about. Gaston suggests that experimental measures will find better answers. Perhaps. But it would be more fun to be given a new hypothesis of community-building over which we could argue with the passion ecologists once brought to the broken stick. □

Paul Colinvaux is in the Smithsonian Tropical Research Institute, PO Box 2072, Balboa, Panama.

Correction

A line of text mysteriously disappeared from Michael Jacobs' review of *Environmental Politics* and *Greener Management International* in this year's New Journals supplement (*Nature* **371**, 458; 1994). His full address is the Centre for the Study of Environmental Change, University of Lancaster, Lancaster LA1 4YN, UK.

It has also been brought to our attention that *Glaucus atlanticus*, the sea slug pictured on page 456 of the same issue, does not live on the sea bed, as stated. The organism is in fact an important inhabitant of the ocean surface film.

Natural selections

Ray Percival

Realism Rescued. By Rome Harré, Jerrold Aronson and Eileen Cornell Way. *Open Court/Duckworth: 1994. Pp. 203. $42.95, £30 (hbk); $18.95 (pbk).*

HOW do you put both physicists and biologists on their guard? Answer: propound a philosophical theory that ignores Darwin's demolition of essentialism in species and brands any physicist who denies your theory of natural kinds as an anti-realist.

A traditional division in philosophy is between metaphysics (what sorts of things exist) and epistemology (what and how we know). Some think that the core of realism is the metaphysical assumption that there is a world independent of our minds. But this core assumption is sometimes clothed in other assumptions, such as theories of truth, truth-likeness, meaning and knowledge. Scornful of what they see as an unnecessary retreat from a fully clothed realism to the naked postulate of a mind-independent reality, Harré, Aronson and Way present a realism that also embraces truth and truth-likeness, as well as their own conception of scientific method and the structure of the world.

Informing their whole approach is a challenging view of scientific theories. Theories, they argue, are "essentially" models, or families of models, that constitute their "content". The idea that theories are sets of propositions is rejected. Well-constructed theories consist of a descriptive model, which portrays the phenomena, and an explanatory model, which portrays the unobservable substructure that causes the phenomena. Models are not simply dispensable aids to the construction and understanding of theories, as Duhem would have said. They expand a theory's explanatory power and help us to explain how theories can be continuously revised and extended to new phenomena.

Models represent type-hierarchies and type-hierarchies are pyramidal representations of the ordered hierarchy of natural kinds that make up the world. Borrowed from artificial intelligence, a type-hierarchy analysis, the authors say, is more faithful to our natural use of language, including metaphor and analogy. This is the authors' "naturalistic" approach. But defining realism in this way poses several problems.

In the authors' picture of the structure of the world, natural kinds are ordered in a hierarchy. Thus diamonds are a subtype of crystals, crystals are subtypes of molecular combinations, molecules are subtypes of combinations of atoms, atoms are subtypes of combinations of subatomic particles. In the 1960s, however, some people held an interesting non-atomistic (holistic) view of matter that pictured each proton and neutron as made of one another. This was called a "bootstrap theory" after Baron von Munchhausen, who claimed to have lifted himself up by his own bootstraps. In this view, the hierarchy cannot be continued because the constituents of the hadrons are no more elementary than the given hadrons — they would be subtypes of each other. This theory is now refuted, but some might quibble at the suggestion that entertaining such a theory at the time was "anti-realist". Defining realism in terms of the details of a particular ontology means that the critics of this particular ontology are anti-realists by definition!

Darwin's theory undermines talk of natural kinds. The ancestry of both a modern human and an earthworm can be traced back through intermediate species to a common virus-like ancestor. How could this be if the virus-like ancestor was a natural kind, that is, had an essence? Darwin's answer was that the steps up to and over the "boundary" between one species and another are slight.

The authors cover in a very readable way many problems, including truth, truth-likeness, metaphor and analogy, similarity, contrary-to-fact-conditionals, and primary and secondary qualities. Truth itself is defined in terms of their view of the structure of the world. Instead of defining realism in terms of a propositional notion of truth as correspondence, truth is defined in terms of realism (the ordering of natural kinds). A model is true if the chunk of the type hierarchy it picks out is identical to the section of the ordered relationships between natural kinds in the world. A model is close to the truth if there is a similarity between these two type-hierarchies.

My reservations about the potential of the project are prompted by the authors' acceptance of a group of refuted doctrines, including naturalism, induction, essentialism and antilogicism. Naturalism is the idea that we should assess philosophical doctrines in terms of what psychologists or artificial-intelligence specialists find out about the way we form concepts, reason and so on. A naturalistic approach to the philosophy of science, however, scorns a real distinction between a descriptive analysis of science and a prescriptive (methodological) analysis. There are several dangers with this. Appraisal of method and theory is liable to be subject to mere fashion. If the 'best method' is understood tacitly as what scientists happen to do and this happens to be unadventurous, then the creation and acceptance of theories that challenge the orthodoxy are impeded. Naturalism also has a tendency to confuse the cognitive (psychological) mechanisms that produce a theory with the nature of the theory considered as an objective product with autonomous properties and its appraisal, just as a proud carpenter might overvalue his product because of the many long hours he spent fashioning it.

There is much to disagree with here, but the systematic presentation of the model view of scientific theories will produce useful debate. □

Ray Percival is [redacted] organizer and chairman of the Annual Conference on the Philosophy of Sir Karl Popper and associate editor of the Popper Newsletter and Journal of Social and Evolutionary Systems.

No stones left unturned

James A. Tyburczy

Introduction to the Physics of Rocks. By Yves Guéguen and Victor Palciauskas. *Princeton University Press: 1994. Pp. 294. $49.50, £35.*

A GEOPHYSICIST studies Earth's subsurface by measuring bulk properties such as seismic velocity, electrical conductivity, thermal conductivity or magnetization from the surface or in a borehole. Then, using the tools of rock physics, he or she extracts from these measurements information about the physical state of the rocks beneath the surface, such as rock type, porosity, permeability and fluid saturation. In this way, one can explore for hydrocarbons, minerals and geothermal resources, and study natural and man-made hazards such as earthquake faults, groundwater pollution and nuclear storage schemes.

Crustal rocks are heterogeneous mixtures of minerals, generally porous and/or fractured and commonly partly to fully saturated by fluids such as water and hydrocarbons. So the tools of the rock physicist include not only elasticity theory, continuum mechanics, rock deformation and fracture mechanics (the sum of which is often referred to as 'rock mechanics'), but also theories of heterogeneous and porous media, fluid flow and percolation theory, surface chemistry, electric and dielectric theory, heat transfer and the theory of magnetic materials.

The text fills a unique and previously

Bovey Valley Woodlands, Devon, one of the 140 wildlife sanctuaries featured in *England's National Nature Reserves* by Peter Marren (English Nature/ T&AD Poyser, £20). With line drawings and over 60 colour plates, the book provides a comprehensive look at the background and philosophy of the reserves and the role they play in conservation and research.