Anoles are Smarter than Humans

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in building up and disseminating that knowledge. I was disappointed to see relatively little consideration of genetic factors, but heartened to read of a wealth of effort being made in other directions and, moreover, being made available to conservationists worldwide. It bodes well for future developments in this field, and I commend the book to all who are intent on conserving bryophytes, the mosses and liverworts which are a crucial part of many plant communities, and which have profound effects in modifying geographical and climatic forces.

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Anoles are smarter than humans

Roughgarden, J. (1995) *Anolis Lizards of the Caribbean. Ecology, evolution and plate tectonics. Oxford series in ecology and evolution.* Oxford: Oxford University Press. xi + 200pp., figs, tables, photos, index. Paperback: Price: £21.95. ISBN: 0–19–509605–3.

Anolis Lizards of the Caribbean is an ambitious book covering the topics of foraging theory, community ecology, and biogeography of the anolis lizards. Although the book is mostly focused on Lesser Antillean anoles, the author also compares the 'simple' anole communities of the Lesser Antilles, in which no more than two species are sympatric, with the complex communities of the Greater Antilles, where in some cases twelve species occur sympatrically (e.g. Cuba). Each of the four chapters begins with a short review of the topic that is followed, in most cases, by Roughgarden's data on anoles.

As Roughgarden points out, *Anolis* lizards occupy a special place in the discipline of evolutionary ecology and biogeography. *Anolis* is one of the largest vertebrate genera, with more than 300 described species, nearly half of which occur in the West Indies. *Anolis* is a prime example of independent adaptive radiations on islands of the Greater Antilles (Cuba, Hispaniola, Jamaica. Puerto Rico). These radiations have produced essentially the same set of ecological types categorized as 'ecomorphs'—species with the same structural habitat, similar in morphology and behaviour, but not necessarily close phylogenetically. Each ecomorph type thus represents convergent evolution in morphology and ecology.

Chapter 1, 'The sentient forager', presents a novel and interesting approach to Anolis foraging theory. Roughgarden presents a new mathematical model together with data on *Anolis* foraging behaviour. The model incorporates some aspect of anole biology (running speed, growth rate, energy expenditure, learning ability) together with some ecological aspects (prey abundance, prey size, perch selection, prey escape ability) to address the evolution of adaptive foraging behaviour in *Anolis*. In this model, learning ability is the key factor to achieve an optimal foraging strategy. Surprisingly, the model prediction that anoles should achieve optimal foraging due to their learning ability is not only supported by the data; but optimal foraging can be achieved by the anole in a short period of time.

One topic of extensive debate is the cause of patterns in body size among anoles occupying the Lesser Antilles. On islands that are inhabited by two species, the species differ greatly in body size, whereas solitary species are intermediate in size. Roughgarden discusses some of the data available regarding competition in anole communities and proposes that it is nearly impossible for an anole to colonize an island that is already occupied by an anole of the same body size. Competitive exclusion is one of the main points used by him to explain the regularity in pattern of body size among islands. However, I was surprised to see no references to the cases where anoles have successfully colonized areas where other ecologically similar anoles of the same size were already present. Moreover, introductions like the one cited on page 102, of *Anolis cristatellus* and *Anolis porcatus* to Hispaniola, are not static; recent work has demonstrated that both species are expanding their range, even in the presence of species that share the same habitat 'ecomorph' and are similar in body size. Along the same lines, Roughgarden claims that anoles of the same size and ecomorph are not sympatric in the Greater Antilles, particularly in Puerto Rico. However, contrary to his argument, this observation is not true for Puerto Rico, nor, for Cuba and Hispaniola. In all of these islands, at least two species of similar size and classified as the same ecomorph can be found sympatrically; in the case of Puerto Rico, for example, *Anolis cristatellus* and *Anolis cooki* occur sympatrically as do *Anolis krugi* and *Anolis pulchellus*.

The scope of chapter 3, 'Origin of the Caribbean', is extremely broad. In it, Roughgarden deals not only with anoles, but also with evidence from other groups of vertebrates and invertebrates to propose a novel idea about the biogeography of the Lesser Antilles, which can be summarized in his fig. 3.5. I have one major concern with this new hypothesis: molecular data suggest that anoles have been in the West Indies for no more than 36 million years. This relatively 'young' age of anoles will not support the vicariance origin proposed by Roughgarden for the anoles in the southern part of the Lesser Antilles. An interesting phenomenon is that, if Roughgarden's pattern is correct, the *Anolis* in the Lesser Antilles would have a completely different biogeographic pattern from that of any other group of Lesser Antillean vertebrate that has been studied. In the last chapter Roughgarden discusses the interactions in an anole food web. He builds a food web in which *Anolis* is the centre of the system. Roughgarden presents the food web in what he calls the 'first pass' and 'second pass'; this approach demonstrates how dynamic and irregular the food web can be, even for a 'simple' community as the one in the island of St Martin.

The breadth and scope of this book is, perhaps inevitably, the book's weakness as well as its strength. One of the major

weaknesses of the book are the annoying factual mistakes in the natural history of West Indian reptiles that may invalidate some of the conclusions made by the author. For example, on page 137, *Sphaerodactylus nicholosi* and *Sphaerodactylus townsendi*, both species which are widely distributed in the cays of the Puerto Rican Bank, are not mentioned; this, together with the fact that in some cays the only reptile present is *Sphaerodactylus macrolepis* and not *Anolis cristatellus*, may produce a different nested subset of species than the one presented. Similarly, on page 148 the author gives a summary of the endemic genera of reptiles from the West Indies, but there are five genera not mentioned in the list, four of which are endemic to Hispaniola. There are many other minor factual mistakes in figures and tables.

In terms of the presentation, more maps of the area illustrating the geological patterns and species distribution would have improved the book. Also, a list of the cays or islands that are used in some of the Figures (e.g. Fig. 3.3) would have been of great help. These criticisms aside, I can recommend this book as a resource and it should be a useful addition to the bookshelves of anyone interested in *Anolis* foraging theory, community ecology, and biogeography.

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Time to include a spatial element

Powell, T. M. and Steele, J. H. (eds) (1995) *Ecological time series*. London: Chapman & Hall. xvi + 491pp., figs, tables, photos, index. Hardback: Price: £58.50 ISBN: 0–412–05191–5 Paperback: Price: £22.49 ISBN: 0–412–05201–6.

There was a time when constructing and studying long time series of biological data was viewed with suspicion, to say the least. And from that period, there are still many ecologists not willing to undertake such a major effort requiring much or all of the time of their scientific carrier. The result is that the ecological literature is rather poor in examples of long-term developments in local or regional floras, faunas or individual species. Further, the best-known examples do not stem actually from scientific interest *per se*, but from applied science, such as hunting for fur, fisheries, or meteorology. The argument against putting such a huge effort into data gathering is often that it is purely inductive, i.e. it does not involve putting a specific question to be solved at the outset. Yet, as we are coming to realise that both environmental conditions and the responding biota are changing for the worse, we appreciate the existing series more and more.

It is therefore important that Powell and Steel have incorporated a great number of papers containing many discussions on ecological time series into one volume. In all, there are twenty chapters, divided into three parts, covering Analysis and Methodology, Comparisons of Scales, and Processes and Principles. The various chapters cover both terrestrial and marine biota, a feature adding to the attractions of this book. Trends in ecological phenomena are covered as well as those in atmospheric and oceanic quality and flow patterns. Mathematical models and analyses, together with purely ecological time series, are included. Clearly, the composition of this book is thoughtful, resulting from great insight into the relevant aspects of theoretical and societal needs.

Typically, several papers are critical, if not uncertain, about the results obtained from ecological time series analysis. Solow (Chapter 2), for example, notices a poor fit between population models and empirical ones, occasionally resulting in *ad hoc* model fitting. In the last chapter, McClaran *et al.* give an overview of analysis and interpretations of three well-chosen series, that of the Canadian lynx for the terrestrial realm, the Dungeness crab for the marine one, and global temperature for atmospheric processes. The result is not encouraging because of the great disagreements between students working on those series.

This book, however valuable in its own right, may also serve as a basis for contemplating what might be wrong with ecological approaches followed so far, and for deciding what could be done to improve matters. Two points seem worth mentioning; one is that the starting point of most studies is the number of individuals or population size, and the other one is that these numbers are in principle only followed over time. Interpretations of these numbers in terms of climatic or marine variables are only done from correlations with these variables or from a relationship between numbers at different subsequent times within the series. The biological mechanism underlying these possible relationships is failing, which means that the relative impacts of the variables and responding species cannot be accounted for. Also, proper prediction cannot be done which make hypothesis testing impossible. Testing, in this case, boils down to a mere fitting of an extrapolated series with new observations without insight into what precisely is going on.

The lack of a spatial perspective implies that migration, if it occurs, plays a minor role. Levin (Chapter 14) does describe spatial processes, but only those of spreading from particular epicentres. If, however, conditions change, the species may start moving around, tracking its conditions as McDowell *et al.* show in Chapter 15 on the Quaternary migration of plant taxa. What processes occur there? Do they also occur at finer time scales and what does their exclusion mean for the interpretation of time series done locally?

I think that studying time series can be very important for ecological understanding, particularly now that our world is changing so drastically. But other studies should be undertaken in parallel, which focus on the level of the individual and consider its physiology and behaviour as well as its life history. This should also be accompanied by studies giving a better understanding of local processes in time as reflections of those occurring in space.

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