

Astronomy

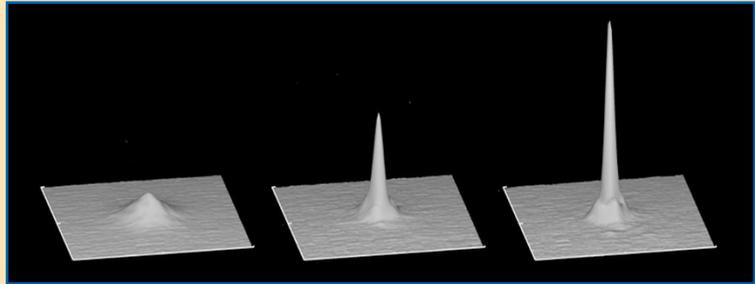
Faking it

Astronomers are celebrating 'first light' at the newly adapted Keck II 10-metre telescope in Hawaii. Keck II now has a laser guide-star system — the first on such a large telescope. By creating an artificial star in the sky, it will greatly improve the telescope's ability to image distant galaxies.

The system is based on adaptive optics (AO), an established technique by which images taken at Earth-bound telescopes can be corrected for the blurring caused by the planet's atmosphere. Using AO produces much sharper images. But the scheme usually relies on there

being a bright guide star in the vicinity of the object under observation, against which the correction is calibrated.

At Keck II, a 15-watt laser beam is fired into the sky, creating a glowing patch in a natural layer of sodium atoms, 90 km above the Earth's surface. Using this glow as an artificial guide star, the images from the telescope become sharper still — as shown in the picture here, of the Strehl ratio



(a measure of image 'perfection') for a star without AO, with AO and with AO plus the laser guide star (left to right).

But it's not just a question of

resolution. The laser system can also be directed at any region of sky: astronomers need no longer rely on good fortune to find a guiding star.

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That is not surprising. What is surprising, biologically, is that neither species-rich nor species-poor families are phylogenetically clustered: that is, if a passerine bird belongs to a single-species family, the most closely related family is no more likely to be species-poor than any other family. If morphological or behavioural innovations were the cause of high speciation or low extinction rates, we should surely expect closely related families, whose species are more similar than those from randomly selected families, to contain similar numbers of species. In contrast, closely related groups of flowering plants do, indeed, have similar numbers of extant species⁵. Furthermore, the passerine families have more than three times as many species, on average, as do the bird families not in Ricklefs' study. The point here is that *within* the passerines there seem to be no strong phylogenetic associations with net speciation rates.

Perhaps the timing over which radiations occur within passerine birds is detectable only among more closely related clades than families (a clade consists of all the species sharing a single common ancestor). The rank of tribe is the next major taxonomic level down, and species belonging to the same passerine tribe last had a common ancestor 10–16 million years ago. But when Ricklefs searched for a phylogenetic pattern of species richness among tribes, he again drew a blank. The families with more species also contained more tribes although, interestingly, those tribes were not unusually speciose. His suggestion, then, is that the events that resulted in speciose families occurred sometime after the origin of families (21–25 million years ago) but before the origin of tribes (10–16 million years ago).

By concentrating on the few families containing six or more tribes (the average

number of tribes per family is about 2.3), Ricklefs proposes that unusual expansion of geographical ranges might explain the unusually species-rich clades. One example is the invasion of South America by North American fringillid finches. Another is the spread of the corvid family — crows and ravens — from Australasia as tectonic plate movement brought Asia close by.

But what about species-poor taxa? Here the explanation is that tribes with few species simply never had a chance to radiate because, for example, they are restricted to remote locations away from the continental land-masses or are dietary specialists. As for the majority of families and tribes with more average numbers of species, a constant-rates speciation–extinction process seems to model their distributions perfectly well with little need to seek key innovations.

But the argument that data fit a model except when they do not fit a model must be viewed with suspicion — especially when, as in one analysis, fewer than half do fit. What is more, there are some weak but significant correlations between species richness and mating system or sexual dimorphism among passerine birds, which need to be explained⁶. Tribes in which mate choice by females is a strong selective force — often leading to the evolution of brightly coloured males — tend to be rich in species. The most straightforward explanation of this effect of sexual selection is that, when female choice is strong, separated populations tend to diverge rapidly in both male plumage and female preference, accelerating speciation.

Ricklefs suggests either that those characters that affect speciation are phylogenetically clustered at taxonomic levels higher than the family, and so cannot be revealed by his analyses, or that 'reversed causation' was involved: high species richness within a clade

somehow promoted sexual selection. A third reason, of course, is 'unreversed causation': sexual selection may, indeed, have promoted speciation (or reduced extinction), but Ricklefs' analyses have not detected this weak effect. Further work should be able to distinguish among these explanations, perhaps by combining Ricklefs' taxon-based approach with trait-based⁶ analyses (testing explicitly whether particular characteristics are repeatedly associated with high diversity) and tree-based methods⁷ (where the structure and shape of the phylogeny are analysed for clues about how it grew).

Whatever the outcome, Ricklefs has provided a fresh perspective from which evolutionary biologists, ecologists and ornithologists can better understand the diversification of the passerines. And, importantly, he has provided a blueprint for similar analyses of other taxa when dated phylogenies that link extant species become available. ■

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