100 YEARS AGO

Referring to Mr. Hardy's experiment described in his letter in Nature, October 8, it is easy to show that whatever the intensity of radio-activity might be at the surface of the sun, by mere surface ratios and assuming no absorption its activity per unit area at the distance of the earth must fall to about one forty-thousandth part… This supposes no absorption from, possibly, some thousands of miles of solar atmosphere. Moreover, we assume in the comparison a sun of solid radium bromide. It would appear, however, that a very small percentage of this body in the materials of the sun would suffice to account for many millions of years of solar heat. … The absence of β and γ radiations at the earth's surface is, therefore, not a weighty argument against the presence of radium in the sun. The arguments in favour of supposing that this element exists in the sun are:— (1) The presence of radium on the earth; (2) the high atomic weight of radium; (3) the presence of helium in the sun; (4) Arrhenius's theory of the Aurora Borealis; (5) the fact that the estimate of the duration of solar heat from the dynamical source appears to run counter to geological data. **J. Joly**

From *Nature* 15 October 1903.

50 YEARS AGO

FORTHCOMING EVENTS

Monday, October 19

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m. — Discussion on "Television".

Tuesday, October 20

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m. — Prof. J. B. S. Haldane, F.R.S. : "The Physiology of Diving".

INSTITUTE OF PHYSICS, EDUCATION GROUP (at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m. — Prof. O. R. Frisch, F.R.S. : "Atomic Energy — How it all Began".

Wednesday, October 21

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m. — Prof. J. Z. Young, F.R.S. : "The Evolution of Vertebrate Organization".

Thursday, October 22

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m. — Dr. Randolph Quirk : "Careless Talk : Some Features of Everyday Speech".

From *Nature* 17 October 1953.

Like YbGaGe, cordierite ($Mg_2Al_4Si_5O_{18}$), β-eucryptite ($LiAlSiO_4$) and NZP ($NaZr_2P_3O_{12}$) all show anisotropic thermal expansion: they have hexagonal structures in which thermal expansion along two axes is compensated by the opposite sign of thermal expansion along the third. These solids are normally based on polycrystalline aggregates, and as the temperature changes the stresses induced by this anisotropic expansion of the unit cell can cause 'microcracks' to develop, which degrade the mechanical properties of the material. The microcracking problem can sometimes be overcome if the crystallites in the solid are sufficiently small. But microcracking will probably be far less of a problem in a metallic material such as YbGaGe.

The oxides that are known to have negative or very low thermal expansion are all electrical insulators. But for many applications, low-thermal-expansion materials that have high electrical or thermal conductivity would be desirable. To date, the only candidate material has been 'Invar', an iron–nickel alloy, whose low thermal expansion is related to its magnetic properties[8]. Now, from Salvador *et al.*[1], we have a metallic material whose very low thermal expansion is based on a distinctly different mechanism. ■

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Evolution

Opportunity versus innovation

Paul H. Harvey and Andy Purvis

Why have some evolutionary lineages produced many more species than others? As far as one large group of birds is concerned, being in the right place at the right time is a plausible answer.

A tradition in biology has been taxonomy, the classification of organisms into hierarchical groupings: the identification of species, the grouping of species into genera, genera into tribes, tribes into families, and so on. Many biologists have long been preoccupied with going further and attempting to construct phylogenies — evolutionary relationships — from that information. But the reverse procedure of building evolutionary trees from molecular data, and then defining taxonomic groupings and levels by dates of common ancestry, has opened up new avenues for studying evolutionary processes.

One such process is the occurrence of species radiations, in which certain evolutionary lineages have diversified and produced far more species than others. What factors lie behind this phenomenon? As he describes in *Proceedings of the Royal Society*, Robert Ricklefs[1] has tackled the question by looking at data for the passerines. This is a group of birds, at the taxonomic level of order (one above families), which includes over 5,000 species and such well-known examples as crows, thrushes and finches. One common assumption in evolutionary biology is that key morphological or behavioural innovations spark off adaptive radiations. For example, plant-feeding in insects has evolved on several occasions and seems generally to have resulted in an increased net rate of speciation[2]. Ricklefs concludes, however, that key innovations are unlikely to have been the major cause of variation in speciation rates among the passerines. Instead, those species that happened to be in the right place at the right time to exploit ecological opportunities were the progenitors of the major radiations.

Ricklefs' starting point was an earlier study by Sibley and Ahlquist[3]. They considered species of birds that last shared a common ancestor between 21 million and 25 million years ago to belong to the same family. Assuming that Sibley and Ahlquist's molecular dating techniques were approximately correct, the number of extant species differs widely among passerine lineages of this age. For example, the most speciose family of passerine birds contains 993 species whereas several others contain just one. If speciation and extinction rates did not differ among lineages, chance alone would ensure considerable variation in the number of species per family; at any point in time the distribution of species among families would follow a geometric probability distribution[4]. But when compared with such a distribution, the variance in number of species in passerine families is far too high: several families have too many species and too many families have very few.

Astronomy

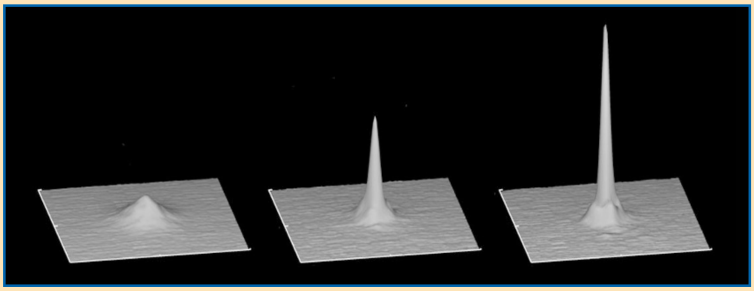
Faking it

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. **Alison Wright**



W. M. KECK OBSERVATORY

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 species[5]. 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 landmasses 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 explained[6]. 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-based[6] analyses (testing explicitly whether particular characteristics are repeatedly associated with high diversity) and tree-based methods[7] (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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