Molecular and palaeontological dates for the radiation of modern mammals appear at odds because molecular studies propose a Cretaceous origin of many eutherian orders, but there are no uncontroversial Cretaceous fossils from modern eutherian orders, a point emphasized by David Archibald in his letter. This conflict might be partly due to differences in the definition of the ‘origin’ of an order—palaeontologists tend to focus on the appearance of members of a defined crown group, whereas molecular dates mark the split between lineages, long before they develop crown-group features. Both definitions are interesting and important, particularly if the timing of lineage divergence and morphological diversification are not tightly linked. We currently cannot distinguish a long Mesozoic radiation of modern mammals from a true Cretaceous radiation. Perhaps, higher phylogenetic resolution or new fossil finds could shed light on this conundrum. To explore the apparent discrepancy between molecular and palaeontological dates, we must ask: if the molecular dates are true, then where are the missing fossils? The most plausible place to hide them is Africa, or perhaps Australia or Antarctica. We do not suggest this is necessarily true, and we certainly don’t expect that 18 eutherian orders arose in Africa. Molecular evidence suggests only some eutherians ‘crossed the K-T boundary’1, which is compatible with the suggestion that a handful of basal eutherian orders form an ‘African clade’2. If the molecular data are true, we have to hide the Cretaceous eutherians somewhere, and Africa seems the best candidate. Conversely, if the palaeontological dates are true, why are the molecular dates too old? Lineage-specific rate variation across mammals3 could cause consistent overestimation of the dates of divergence of mammalian orders. So, we are left with the conclusion that although the discrepancy between molecular and palaeontological dates seems large, at this stage neither can confidently exclude the other.

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References

Reply from L. Bromham,
D. Penny and M.J. Phillips

Molecular dates and the mammalian radiation

In a recent TREE article, W.D. Koenig reviewed the patterns and causes of temporal synchrony in spatially extended populations4. Synchrony can have different causes, one of these is spatial correlation of environmental disturbances, was extensively discussed in a news & comment in the same TREE issue5. This mechanism, which has become known as the Moran effect, occurs when two populations are regulated by the same (linear) density dependence and are exposed to environmental disturbances. If these environmental disturbances are correlated, the fluctuations of population sizes will also be correlated. A further mechanism for synchrony is dispersal of individuals; both papers assumed that dispersal is random, and not density-dependent. The disadvantage of density-dependent dispersal is that it results in the synchronizing effect of correlated disturbances beyond the range of dispersal of the organisms under study. It was concluded that spatial correlations at larger spatial scales are likely to act as synchronizers, and that some of the examples of spatial synchrony in the reviews were predator–prey or host–parasite systems, which have an intrinsic propensity to oscillate. For such systems, synchronicity can be caused by phase locking. Phase locking occurs if the populations are coupled through dispersal and can act at distances exceeding the typical dispersal distance.

This can be demonstrated with a deterministic model for predator–prey systems, which have a fundamental tendency to oscillate. If even one prey or predator does not migrate, phase locking cannot occur. Thus, results can be extended to systems with more patches: some dispersal to neighbouring patches can result in phase-locked population dynamics in large groups of patches9. The dispersal range in this case is small but the correlation can act at distances exceeding the dispersal range of an individual. This effect can withstand the synchronizing effect of correlated disturbances to a certain extent (Fig. 1).

The effect of phase locking will be weaker for populations that are at a larger distance. If uncorrelated noise is superimposed on such a deterministic model, it can result in a correlation that decreases with distance, resulting in a typical