got in the way of the shock wave. The shock wave not only injected the live ^{26}Al, but also forced the cloud core into self-gravitational collapse (P. N. Foster, Carnegie Institution of Washington), leading directly to the formation of the proto-Sun and the solar nebula. Alternatively, the ^{26}Al may have been produced in the presolar molecular cloud core by cosmic-ray irradiation (D. D. Clayton, Clemson Univ.), but observations of γ-rays produced by cosmic ray bombardment in the Orion star-forming cloud indicate a cosmic-ray flux that is too small to produce the required amount of ^{26}Al relative to ^{27}Al (R. Ramaty, B. Kozlovsky and R. E. Lingenfelter, *Astrophys. J.* **438**, L21–L24; 1995).

The collapse of the presolar cloud required about 0.1 Myr. Assuming that the proto-Sun was able to form similarly rapidly, CAIs could then be the first solids surviving from the early hot nebula phase (A. G. W. Cameron, Harvard-Smithsonian Center for Astrophysics). The CAIs formed over a period of less than 0.1 Myr, retaining most of their ^{26}Al. However, searches for excess ^{26}Mg in chondrules have generally yielded only upper bounds, not detections (I. D. Hutcheon, Lawrence Livermore National Laboratory), implying chondrules formed so much later (at least 3 Myr) that nearly all of the ^{26}Al had already decayed. Because chondrules are thought to have formed within the dust-rich environment of the solar nebula, this requires that the nebula lifetime was about 10 Myr.

Now the problems start. The CAIs must have been preserved for ~10 Myr and then accumulated along with newly made chondrules to form the carbonaceous chondrites (see photograph). But the CAIs cannot be stored in the solar nebula for so long, because gas drag forces centimetre-sized pebbles to spiral into the Sun within about 0.1 Myr. This disaster leads to the idea of storing CAIs in much larger (kilometre-sized) bodies, with relatively stable orbits. The large CAI-filled piñatas would then have to be broken apart 10 Myr later, releasing the CAIs for incorporation into chondritic bodies (W. R. Skinner, Oberlin College). Another solution is to assert that the chondrules found in carbonaceous chondrites like Allende and Axtell were formed soon after the CAIs and therefore still contained live ^{26}Al, whereas the chondrules in ordinary chondrites (^{26}Al-free) formed some 3 to 10 Myr later (Cameron). The latter hypothesis has the great advantage of being immediately testable. The first results are not overly encouraging: chondrules from the Manych ordinary chondrite show no excess ^{26}Mg, but neither do chondrules from the Kainsaz carbonaceous chondrite (Hutcheon).

Finding a mechanism for melting the chondrules is a headache (see R. Ash, *Nature* **372**, 219–220; 1994) that may only become worse after waiting for 10 Myr (J. A. Wood, Harvard-Smithsonian Center for Astrophysics); nearly all of the gravitational energy liberated by the formation of the Sun was lost within the first million years. Also, relatively few solar-type stars still have disks at 10 Myr, but the Sun might just be an oddball.

Finally, the absence of excess ^{26}Mg in chondrules might simply be due to heterogeneity in the initial distribution of ^{26}Al; after all, some refractory inclusions show little or no excess ^{26}Mg, and this is attributed to heterogeneous initial ^{26}Al (Wood). Spatial heterogeneity has also been inferred for the short-lived isotope ^{53}Mn, based on differing amounts of the daughter product ^{53}Cr found in chondritic meteorites and the Earth (G. W. Lugmair, Univ. California, San Diego). Initial heterogeneity may, however, be hard to preserve in a turbulent, differentially rotating, protoplanetary disk.

Until these lingering doubts are resolved, we cannot regard the issue of a 10-Myr period of chondrule formation as being settled. There will be no shortage of problems with the CAI-chondrules chronology to address at next year's conference. □

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EVOLUTIONARY BIOLOGY

I'iwis fit the bill

William J. Sutherland

THE i'iwi (*Vestiaria coccinea*) is a Hawaiian honeyeater which, as records from the last century show, used to feed largely by extracting nectar from lobelioid flowers. The i'iwi's long, downcurved bill is well adapted for extracting the nectar from the base of the deep corollas of these flowers, which they pollinate in the process. But lobelioids are no longer abundant, and in a paper in *Conservation Biology*[1] Smith and colleagues describe evidence that the i'iwi's bill is evolving in response to the bird's enforced change in feeding habits.

Lobelioids used to be a prominent component of Hawaiian forests. In the past 100 years, however, a quarter of the species have become extinct and the remainder are rare as a result of habitat changes and grazing by feral ungulates. I'iwi now feed largely upon the flowers of the ohia tree, *Mestrosideros polymorpha*. According to nineteenth-century naturalists, i'iwis were excluded from this tree by the aggressive behaviour of another honeyeater, the 'o'o (*Moho nobilis*). But the 'o'o was extinct by 1900.

Ohia flowers lack corollas and the other honeyeater species that feed upon them have short bills. Smith *et al.* thus predicted that the i'iwi should evolve a shorter bill and they compared measurements of museum specimens collected before 1902 with measurements of live specimens. This analysis showed that i'iwis have undergone statistically significant declines in upper mandible length by about 2–3 per cent, whereas characters such as wing or tarsus length are the same. No such change in mandible length was recorded in a related honeyeater species, the aparine *Himatione sanguinea*, that had not altered its diet.

The classic example of a microevolutionary change in bill morphology is that in one of Darwin's finches, *Geospiza fortis*, on Daphne Major Island in the Galápagos. There the population shows rapid declines in bill depth and width after severe El Niño events, as a result of a short-term fall in the abundance of large seeds and an increase in small ones[2,3]. The especial interest in the case of the i'iwi, however, is that the adaptations in bill length are a response to extinctions and are likely to be long-lived. □

Jack Jeffrey

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Change of diet — i'iwi in an ohia tree.

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