of three, with correspondingly larger energy penalties[2,8]. Each pair of fused pentagons in a neutral fullerene cage carries an energy penalty of 70–90 kJ mol^{-1} with respect to the structure of C_{60} (ref. 8). Two candidate structures (isomers 6,140 and 6,275) have the minimum three fused pentagon pairs; all others in the set have from 6 to 15 pentagon fusions.

We confirmed the qualitative preference for isomers with low numbers of fused pentagons using model calculations that treat the cage as an empty fullerene capable of accepting electrons from a central reservoir. At the density-functional tight binding level of computation[9], with full geometry optimization of a closed-shell electron configuration, the empty cage 6,140 is stabilized by 120 kJ mol^{-1} with respect to its nearest rival, with a 12-line NMR spectrum and the minimal three pentagon adjacencies (isomer 6,275). As between two and six excess electrons are added to the cage, to simulate the range of likely charge transfer from the encapsulated cluster, isomer 6,140 becomes increasingly favoured over all other empty cages in the set. In view of this consistent preference, we propose a structure for $Sc_3N@C_{68}$ (Fig. 2) consisting of the encapsulated Sc_3N cluster in the C_{68} (D_3) three-fold symmetric isomer 6,140 cage. The encapsulated Sc_3N cluster is shown with the Sc atoms on C_2 axes, but from the ^{45}Sc NMR it is also possible that these represent time-averaged orientations.

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Palaeontology

The 'feathers' of *Longisquama*

The elongated dorsal appendages of the reptile *Longisquama insignis*, from the Triassic of Kyrgyzstan[1], have recently been reinterpreted as the first record of feathers in a non-avian tetrapod[2] — long predating the feathers of the oldest known bird, *Archaeopteryx*. Here we present evidence that the dorsal scales of *Longisquama* are not feathers, and that they are in fact strikingly different from avian feathers. We conclude that *Archaeopteryx* remains the oldest known feathered tetrapod.

Longisquama is a small diapsid reptile with an uncertain phylogenetic position. It is known from an incomplete skeleton with integumentary appendages and isolated appendages. Appendage PIN (for Palaeontological Institute of the Russian Academy of Sciences) 2584/7, preserved as part and counterpart, retains an infilling of fine-grained sediment and high-fidelity impressions of the external left and right surfaces of the appendage (Fig. 1). This infilling, preserved either on one side of the specimen or on the counterpart, shows that the tubular configuration described for the proximal portion extends along the entire length of the appendage, although the distal portion is expanded anteroposteriorly and flattened transversely. This indicates that in life the two external surfaces were separated from each other by an intervening space (now sediment-filled).

There are no feather-like features on the distal portion of the appendage. Here, two corrugated membrane-like surfaces touch along their leading and trailing edges to form wide, smooth bands. The two membranes were apparently supported by a median vein-like structure extending the length of the appendage. This has been proposed as the homologue of the rhachis of avian feathers[2]. On either side of this 'vein', the external surfaces of the appendage are corrugated. This corrugation varies along the appendage: proximally, individual rugae are relatively large and widely spaced, but in the distal portion they are smaller and densely packed. The densely arranged distal corrugations have been compared to the pinnae of avian feathers[2], but the fossils indicate that these are formed on a membrane-like structure on either side of the 'vein'.

The fossils were split into part and counterpart during collecting, and most of the appendages are now preserved as impressions of their left and right sides, without the intervening sediment core. The surfaces of both the part and counterpart impressions of individual appendages are concave, an indication that these structures are three-dimensional. In contrast, the parts and counterparts of feather impressions in *Archaeopteryx* are concave and convex, respectively.

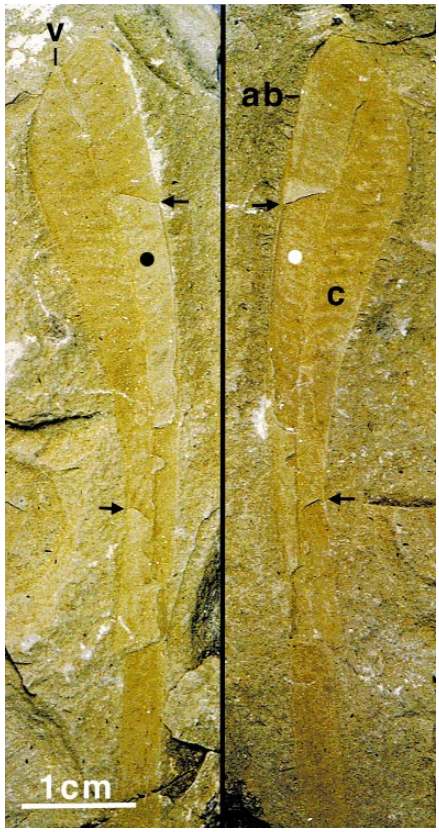

Figure 1 Part and counterpart of an elongated dorsal scale of *Longisquama insignis* (PIN 2584/7). Where the sedimentary infilling (black circles) is not preserved, sharp impressions of the corrugated external surface of the structure are visible (white circles). Arrows point to corresponding patches of sedimentary infilling on part and counterpart. ab, anterior smooth band; c, corrugations; v, median 'vein'.

We believe that the dorsal appendages of *Longisquama* are highly modified scales, as suggested previously[1,3], rather than feathers. Examination of the holotype of *L. insignis* (PIN 2584/4) suggests that they were anchored in the skin or epaxial muscles.

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Correction

Detection of preinvasive cancer cells

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The name of the tenth author of this communication is J. A. McGilligan (not T. McGillican as published).