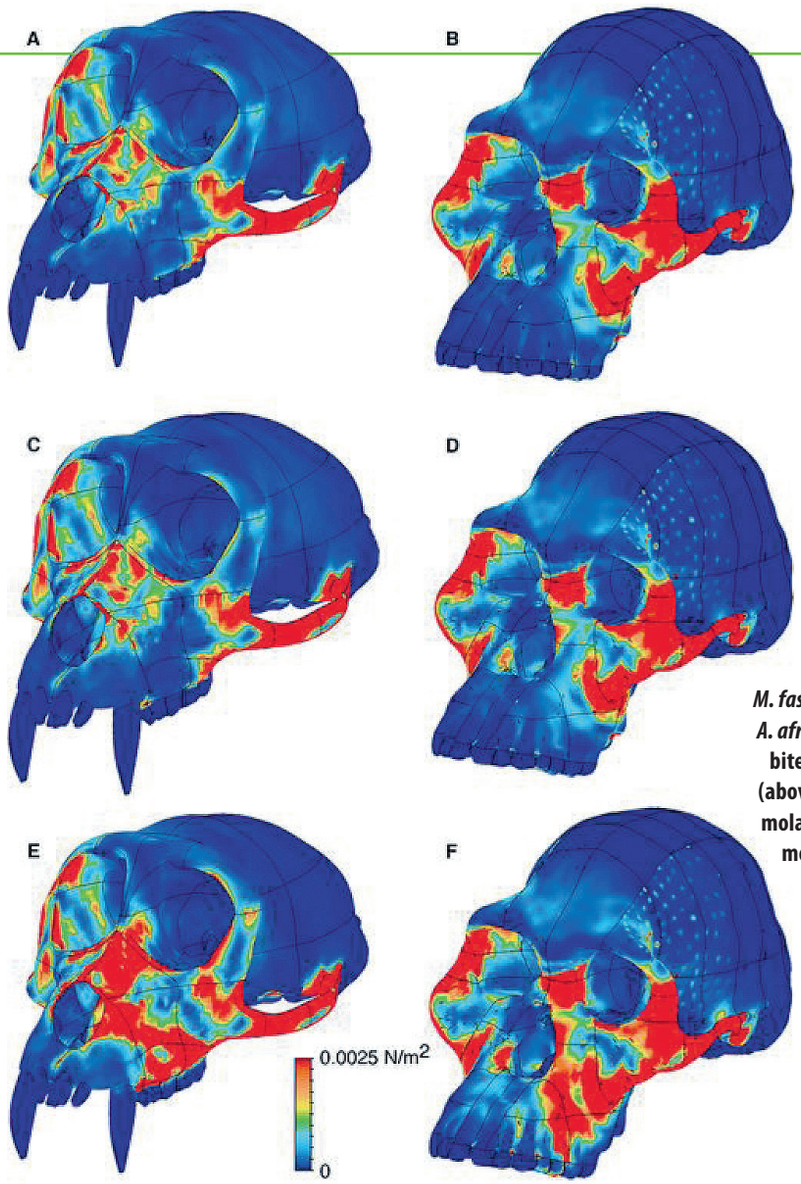
Form Follows Function

Man's ancestors had craniofacial features meant for cracking nuts.



M. fascicularis **(A,C,E) and** ***A. africanus*** **(B, D, F) with bite load on the molars (above), molars and premolars (centre) and premolars alone (below).**

It is quite evident that human beings have a big head and no snout. So it is startling to realise that australopiths, our ancestors who lived two to four billion years ago, possessed a small neurocranium, a snout, very large teeth and, more importantly, faces with buttressed pillar-like growths. Whatever could prehistoric man have needed these for?

Since form and function are closely related, paleoanthropologists believe that the shape of the face was influenced by masticatory forces and loads on the front part of the cranium. Teams led by David Strait (University of Albany) and Gerhard Weber (University of Vienna) used biomechanical models to simulate the distribution of load in skulls of the prehistoric *Australopithecus africanus* and compared it with present-day monkeys, *Macaca fascicularis*.

It was possible to do this using finite element analysis (FEA), a computer technique used in structural load analysis to break up complex geometric figures into small, more easily computable units. The skulls were first reconstructed as precise 3D models and then FEA was applied. The model of *A. africanus* was developed at Vienna, a leading centre for virtual anthropology, and was constituted from two incomplete specimens from South Africa: the finds, Sts 5 ('Mrs Ples', see the Darwin article in this issue) and Sts 52. A US laboratory worked on the cranium of an extant monkey to determine the forces of feeding biomechanics and bone material properties.

Working together, the two teams succeeded in reproducing the forces acting on the skulls of *A. africanus* as well as *M. fascicularis*. A clear functional relationship was established between the bite load on the premolars in the upper jaw and the shape of the front parts of the face. In the case of the macaque, the mechanical load was absorbed by the very long mussel-like snout, while in the case of the Australopithecus, with its much flatter face, the pressure was absorbed by the additional 'anterior pillars' on the either side of the nose.

What kind of food could it have been that so stressed the premolars of the *A. africanus*? "They were probably very large objects," says David Strait, "objects that could not be stuffed into the mouth to reach the molars and which were too hard for the incisors." The conclusion? It appears prehistoric man relied on nuts and hard-shelled seeds with a diameter of one to five cm—at least as survival rations during periods when his preferred food was unavailable.

"Just imagine," says Weber, "if human beings today were to eat steak and ice cream for ten months of the year and then for two months lived on nothing but hard nuts."

In such circumstances, the natural selection process would come into force and, over the centuries, bring about changes in our masticatory morphology. Perhaps human beings would then develop reinforced skulls and a snout! □

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