Why we still love Lucy

SPECIMENS of *Australopithecus afarensis* from 3.4-million-year-old deposits in the Middle Awash at Maka, Ethiopia, described by Tim White and colleagues on page 261 of this issue, should lay an acrimonious debate to rest. Fourteen years ago, Johanson and White surprised (and exasperated) many by basing their new taxon *A. afarensis* not on the Ethiopian skeleton nicknamed 'Lucy', but on more robust and stratigraphically more ancient specimens collected far to the south, at Laetoli in Tanzania, by Mary Leakey and her associates. The implication was that *A. afarensis* was a long-lived species with somewhat variable morphology and high degree of sexual dimorphism.

Critics pointed out that the Ethiopian specimens represented smaller individuals, in general, than those in the Tanzanian collection, begging the question of why males and females should have lived in different places. But the critics went further — the Tanzanian forms lived in fairly open country, and their bipedality is confirmed by the presence of fossil footprints. Lucy's neighbourhood, in contrast, was probably more thickly wooded, with the implication that Lucy might have been a tree-dwelling species.

The cynic will spot a hidden agenda here. The Leakey school stresses the antiquity of

Homo, and for others to have muscled in on the Laetoli fossils and named them *Australopithecus* was a source of contention. In

humerus is also relatively short, which is not what one would expect in a tree-living creature. Henry Gee

Photo by Tim White

photoreduction is coupled to enzymatically catalysed reduction of nitrate to nitrite. The coupling is neatly achieved by covalent bonding of the enzyme nitrate reductase to the polyimine polymer. The latter serves to transport electrons between the TiO_2 particle and the enzyme. Electron flow occurs in cascade fashion: the conduction-band electrons reduce the viologen which in turn reduces the nitrate reductase. Two electrons are pooled by the catalytically active group of the enzyme before they are passed to the nitrate substrate to yield nitrite as a final product.

The concept is not new; electroactive polymers of similar type have been applied previously³ to ensure electronic charge transfer between macroscopic electrodes and enzymes. But the results of Willner and colleagues open the way to extend this type of redox 'wiring' to colloidal assemblies of semiconductors and enzymes.

Apart from the reduction of nitrate, photobiocatalytic semiconductor nanocrystals may be applicable to other multi-electron transfer reactions that require the

intervention of natural enzymes or artificial redox catalysts. An example is the reduction of carbon dioxide. The efficiency of these photocatalytic reactions is often poor, and using redox-wired semiconductor/enzyme assemblies may well lead to improvement of the quantum yields. There are strong hopes of generating fuels such as methanol or fertilizers such as ammonia in this way using sunlight.

Instead of dispersing the colloidal semiconductor particles in solution, one can deposit them as a layer on a conducting glass support. Such nanocrystalline films exhibit some extraordinary properties. For example, colloidal TiO_2 films whose surfaces were treated with a charge-transfer sensitizer are extremely efficient at photovoltaic conversion of solar energy⁴. Another useful feature is that the Fermi level within the particles can be potentiostatically controlled by incorporating the supported film as the working electrode in a conventional three-electrode electrochemical cell. This opens up the prospect of using assemblies of the

type reported by Willner and colleagues as catalytic enzyme electrodes. Multi-electron reduction processes could then be accomplished in the dark, the particle layer being used as a cathode. And indeed, studies in progress at University College Dublin (D. Fitzmaurice, personal communication), using molecular triads (which are composed of three redox-active molecules, with a gradient in redox potential from the first to the third) bound to the surface of nanocrystalline TiO_2 films, confirm that vectorial electron flow occurs and that efficient charge separation can be obtained with such systems. □

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