CHAPTER 7

The Transition to Homo Erectus

PART II. THE EXPLANATIONS

"The reduction in tooth size, the signs of increased energy availability in larger brains and bodies, the indication of smaller guts, and the ability to exploit new kinds of habitat all support the idea that cooking was responsible for the evolution of Homo erectus"
[Wrangham, 2009, p. 98].

"In the transition from Australopithecus to Homo, the greatest transformation in the hominin lineage, natural selection for improved throwing and club-swinging prowess played a major role. Most of the anatomical changes preserved in the fossil record can be explained in this manner"
[Young, 2013].

Introduction. How many different explanations are required to account for the evolution of a relatively small, partly arboreal animal into a large, earthbound creature, striding off bipedally toward a new kind of future with a thoroughly remodeled body? What is the simplest explanation of why natural selection acted to elicit the recorded changes?

What are the changes that need to be explained? As described in the preceding chapter, the last common ape ancestor from which the hominin and chimpanzee lineages diverged was adapted to life in the trees, and in hominins prior to *Homo* significant arboreal adaptations were retained. Early hominins were small animals, their arms long and muscular, their fingers and toes curved, their lower limbs short and relatively weak. Arborealism includes hanging beneath limbs for support or locomotion, arms raised above the head, capable of hauling the entire body upward against gravity. Powerful arms, lightweight legs and a stiff midriff promote these actions, coupled with an upward-facing shoulder joint that facilitates reaching above the head and a funnel-shaped thorax and narrow shoulder breadth that reduces stress on the capsule of the shoulder joint during arm-hanging. The persistence of this body form in *Ar. ramidus, A. afarensis, A. africanus* and *A./H. habilis* indicates that pre-*erectus* hominins continued to make use of their arboreal heritage [Stern and Susman, 1983; Hunt, 1991, 1994; Fleagle, 1999; Ward, 2002; Larson, 2007].

In the transition from *Australopithecus* to *Homo* all of this changed. In *Homo* *erectus* the body was enlarged and the lower limbs were increased in length and strength compared to the upper limbs. Forearm length diminished relative to upper arm length, the hands became relatively smaller, the curved fingers and toes associated with arboreal life were straightened (Chapters 9, 14), the shoulders became broader and more mobile, and the shoulder joint was redirected laterally. In *Homo* a waist appeared and independent rotation of pelvis and thorax became possible (Chapter 6).

Why did hominins retain for millions of years a body structure adapted for life in the trees then lose these arboreal adaptations in *Homo erectus*? Why did body size increase while the chewing apparatus diminished? Why did the thorax change shape in concert with shoulders that become broader and more mobile as the axis of the glenoid fossa become reoriented? Why did *Homo* acquire independent rotation of the thorax and pelvis? Why did the legs become larger and the arms (particularly the forearms) become less massive? *What were the reproductive advantages?*

EXPLANATIONS OFFERED BY PREVIOUS AUTHORS

Early hominins retained a body structure that was adapted for life in the trees. Why did *Homo erectus* lose these features? There is no reason to doubt that the advantages of continuing a behavioral and anatomical adaptation to life in the trees were the same for early hominins as they had been for their ancestors during tens of millions of years. The adaptation was maintained by natural selection because it met their biological needs, such as providing access to food and a place of refuge for sleeping or escape from predators. *Homo erectus* must have abandoned the trees for life on the ground because it provided *increased reproductive advantages*. This concept has had scant prior examination. However, recently Wrangham [2001, 2009] presented and developed the provocative idea that controlling fire and its use in cooking were the key factors in the transition to *Homo*. These are cultural traits, but Wrangham's argument is that they provided benefits that led to natural selection of heritable variations.

In brief, Wrangham's "cooking hypothesis" proposes that controlling fire began with the "habilines". "According to our hypothesis," he wrote, "hominization happened because a late gracile population of australopith apes—such as *A. habilis*—learned to use fire to improve the digestibility and range of its plant foods. It is possible also that cooking of meat was highly significant" [Wrangham, 2001, p. 237]. After they were able to keep fire going at night, some of them occasionally dropped food morsels into it by accident, ate them after they had been heated, observed that they tasted better, and so deliberate cooking began. This released more calories from their existing diet which enhanced their survival and reproduction. Those who cooked reproduced more copies of their genes because they ingested more calories (rather than gaining access to more food or more nutritious food). Since cooking was a cultural behavior, no evolutionary changes were involved. However, cooked diets provided more energy by increasing the digestibility of starch and protein and fewer calories were expended for digestion, detoxification and defense against pathogens [Carmody and Wrangham, 2009a]. As a result, repetition of this habit led to the evolution of *Homo erectus*.

On the face of it, this major transition may seem an unlikely result of caloric enhancement. Here is Wrangham's explication: Hominin bodies were adapted by natural selection to cooked food. Because it was easier to digest, it resulted in smaller digestive tracts. Body size increased and the shoulder, arm and trunk adaptations that enabled habilines to climb well disappeared [Wrangham, 2009]. The "protection fire provided at night enabled them to sleep on the ground and lose their climbing ability" [Wrangham, 2009, p. 194]. "When they no longer needed to climb trees to find food or sleep safely, natural selection rapidly favored the anatomical changes that facilitated long-distance locomotion and led to living completely on the ground" [Wrangham, 2001, p. 102].

The role of cooking in human evolution has been compellingly documented by Wrangham and coworkers. It seems that modern humans have indeed undergone natural selection for eating food that has been cooked. In mice, the positive energetic effects of cooked meat and tubers are higher than if they are eaten raw [Carmody, et al., 2011]. Modern humans also fare poorly on raw diets. Cooking reduces the structural integrity of most foods, leading to a reduction of chewing time and masticatory stress. It denatures proteins, increasing their susceptibility to proteolytic enzymes. It also lowers the costs of food consumption and immune defense and improves the net energy value of plant and animal foods regularly consumed by humans. The adoption of cooking would have helped ancestral humans thrive [Carmody, et al., 2011].

A problem with this explanation, which Wrangham acknowledges, is that evidence of controlled fire first appears in the archaeological record no earlier than 1 Mya, and probably after 0.5 Mya, well after the transition to *Homo*. If one accepts Wrangham's assumption that only the onset of cooking can explain the major anatomical features of this transition, then the control of fire should predate 2 Mya.

The evidence for controlled fire in association with *H. erectus* is scant and inconclusive, according to Berna and coworkers [2012], who report a possible example of burned vegetation dated at~1 Mya in sediments 30 m from the present-day entrance to a South African cave. Pickering [2012] supports the conclusion that hominins may have created these indications of burning, and perhaps also those of similar age he is studying at the Swartkrans Cave in South Africa.

Nevertheless, in Europe early hominins moved into northern latitudes without the habitual use of fire. They lived there for 800,000 years despite temperatures which at times dropped below freezing. One of the earliest signs of controlled fire comes from the Schönigen, Germany, hominin site (famous for its throwing spears) about 400,000 years ago [Carmody and Wrangham, 2009b; Roebroeks and Villa, 2011].

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