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Evolution of Human Bipedalism: A Hypothesis About Where it Happened

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Evolution of human bipedalism: a hypothesis about where it happened†

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A geologically plausible locality for aquatic evolutionary processes leading to bipedalism is postulated.

Introduction

Among attempts to explain the evolution of human bipedalism, the aquatic hypothesis proposed by Hardy (1960) and elaborated by Morgan (1972) and Morris (1977) suggests that, during the late Miocene or early Pliocene epochs, a group of apes was isolated by increasing desiccation of their habitat somewhere along the coast of Africa. To escape predators and to find food they entered the water, an environment for which they were poorly adapted. This radical situation resulted in heavy evolutionary pressure for morphological changes from ape to man within a relatively short span of time. The human features possibly accounted for by the aquatic hypothesis include: superior swimming ability, babies swimming at a few weeks old; relative hairlessness; hair tracts arranged for water streamlining, streamlined body compared to those of other primates; insulating layer of fat beneath the skin plus copious sweat glands; erect posture; and highly sensitive, generalized hands. Along with these, certain behavioural traits were evolved, such as fondness of aquatic activities and sea foods. At the beginning of the Pleistocene, when favourable changes permitted, the upright, hominoid descendants of these apes returned to a terrestrial existence.

So far, the aquatic hypothesis has received little acceptance because no supporting fossil evidence has been adduced (Morris 1967). In particular, no region in Africa containing marine Pliocene deposits associated with ape-like and man-like fossils has ever been found (Howells 1967; Leakey 1976).

Reflection upon the Hardy hypothesis leads to the following conclusions: (*a*) the region was a forested area inhabited by apes during the late Miocene; (*b*) the region was isolated from the rest of Africa during the Pliocene, in which period the evolution of ape-like to man-like creatures occurred; (*c*) the region was reconnected to Africa in the late Pliocene or early Pleistocene, enabling the hominoids to migrate elsewhere. Conclusion (*b*) suggests that bipedalism evolved on an island.

Evidence for the hypothetical locality

Tazieff (1972), Tazieff *et al.* (1972) and Barberi *et al.* (1972) suggest that the northern and central Afar triangle in the past was covered by sea water, with only the Danakil Alps and high volcanoes standing above water as islands. They state that the Danakil Alps are part of a horst: an uplifted crustal block that was broken off and separated from the Nubian plate to the west and the Arabian plate to the east through the action of plate tectonics and sea floor spreading.

† The main points of this paper were communicated to the meeting by Professor Sir Alister Hardy, F.R.S., during the general discussion.

According to Hsü *et al.* (1973), from the beginning of the Messinian (latest Miocene stage) the Mediterranean Sea was repeatedly isolated and then rejoined to the Atlantic Ocean, and was thus caused to dry up and then refill. They suggest that this cycle of drying and refilling was repeated at least eleven and perhaps as many as fourteen times. During the desiccation of the sea, massive thicknesses of salt were deposited on the bottom of the deeper parts.

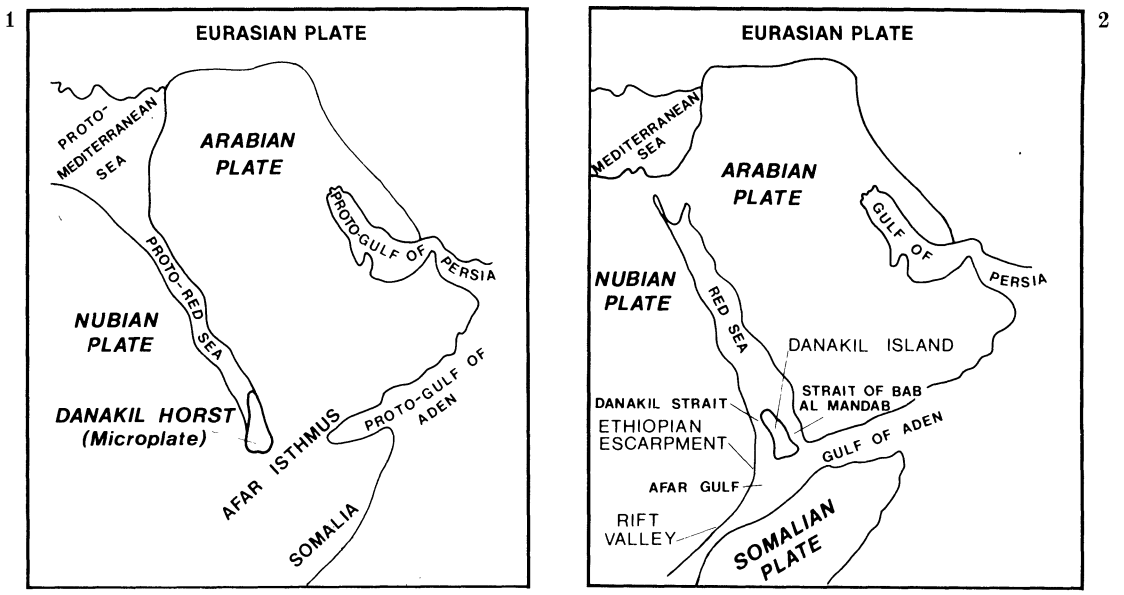

FIGURE 1. The generally supposed relation of the Nubian plate of the African continent to the Arabian plate at the time of the Late Miocene.

FIGURE 2. The configuration of the same region as shown in figure 1, but as it may have been at the beginning of the Pliocene.

Figure 1 displays the configuration of the African continent and Arabian plate as it may have been during the late Miocene. It should be noted that the proto-Red Sea and the proto-Gulf of Aden were separated by an isthmus. This land bridge, here called the Afar Isthmus, apparently existed throughout the late Miocene and was an important link in animal migrations between the continents of Africa and Eurasia (Kurten 1972; Beyth 1978; MacKinnon 1978).

The Afar Isthmus was composed of several crustal blocks. One of these, the Danakil horst, apparently acted as a 'microplate' (Le Pichon & Francheteau 1978). The horst is a mountainous region about 335 miles (540 km) long and up to 45 miles (75 km) wide (Tazieff *et al.* 1972; *Geol. Surv. Ethiopia* 1973). In figure 1, the northern end of the horst marks the southern limit of the proto-Red Sea (Frazier 1970; Barberi *et al.* 1972). It is, therefore, reasonable to suppose that the horst was occupied about 9–14 Ma ago by a group of apes that continued to live there until the forests disappeared at the end of the Miocene (Kurten 1972; MacKinnon 1978).

About the time of the Miocene–Pliocene boundary the African plate moved away from the Arabian plate, and the Danakil microplate was rotated counterclockwise (Tazieff *et al.* 1972; Le Pichon & Francheteau 1978). At the same time the Danakil microplate was tilted so that its Mesozoic sedimentary rock formations slope generally from northeast to southwest (Hutchison & Engels 1970, 1972; Beyth 1978). With the exception of volcanic peaks, the Danakil Alps today rise to a maximum of 1335 m. Finally, the microplate was detached from both the African and Arabian plates, allowing waters from the Red Sea and the Gulf of Aden to flow into the Afar

triangle. Figure 2 displays the configuration of the region as it may have been at the beginning of the Pliocene. Note that the Red Sea was no longer connected to the Mediterranean Sea (Coleman 1974) as in figure 1, but was now linked to the Gulf of Aden and the Indian Ocean through two straits, one to the east of the Danakil horst (Strait of Bab al Mandab) and the other, to the west, which will be called the Danakil Strait. Thus, between 6.7 and 5.4 Ma B.P. in the latest Miocene (Messinian), a group of apes along with other animals could have been trapped on Danakil Island.

According to Barberi *et al.* (1972) and Mohr (1978), the central and southern Afar regions have been repeatedly covered by massive flood basalts during the Pleistocene–Holocene so that the Miocene–Pliocene history of these regions is uncertain. The several volcanoes in the middle of the Danakil horst have been intermittently active from the late Miocene – early Pliocene to the present. About the time of the Miocene–Pliocene boundary the Danakil horst apparently was surrounded by water to the east, the north and the west, while the southern end was covered by extensive flood basalts. The Danakil horst initially may not have been a geographical island, but under the conditions described above, for many land animals, it would have been a biological island.

A scenario for the evolution of genus *Homo*

Forests probably covered most of Danakil Island at the beginning of the Pliocene, but these must have soon died. Those near sea level and the coast would have been the first to disappear, while those at higher, cooler elevations in the mountains would have remained longer. The dwindling forest would have produced exactly the environmental conditions required by the Hardy hypothesis: those apes near the coast, losing their forest, gradually would have been forced into water to find both food and protection from predators. Increasing dryness would probably have destroyed much vegetation, and thus reduced the population of both herbivores and carnivores.

Those apes living along the coast would probably have searched for food by wading in the shallow water, a behaviour often compelling upright bipedal movement. (Their cousins along the Ethiopian escarpment and elsewhere undoubtedly retreated with the dwindling forests.) Thus, the island coastal apes, forced to live under unusual conditions, would have rapidly evolved into the upright, hairless hominids described by Hardy and by Morgan.

Sporadic and episodic volcanism within the Afar triangle has been a feature since the early Miocene (Barberi *et al.* 1972; Gass 1974). Intermittently, the Danakil Strait has been closed and bridged by lava flows as it is today (Frazier 1970; Hutchison & Engels 1972; Lowell & Genik 1971). Eustatic sea level fluctuations combined with erosion probably reopened the strait within a short time. However, during the short time that the island was connected to the mainland, migration of animals must have occurred with the hominids among them. These hominids had evolved in and near the water, and, as they wandered over the lava bridge to the Ethiopian escarpment and then elsewhere, they stayed near water for two reasons: (1) water was their protection against predators; and (2) water provided them with food and drink.

In their meandering search for food, the hominids drifted southward along the western shores of the Afar Gulf. Whenever possible, they explored the rivers and streams that emptied into the embayment from the African Rift Valley.

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The foregoing suggests that the aquatically evolving apes were isolated on Danakil Island for at least 1½ Ma and perhaps as long as 3 Ma before returning to the mainstream of African life.

Suggested locality for exploration

There is much tectonic activity within the Afar triangle (Tazieff 1972). Much of the region is covered by flood or plateau basalts (*Geol. Surv. Ethiopia* 1973), and exposed continental basement is limited. Quaternary and Recent deposits are more extensive and cover both basement and

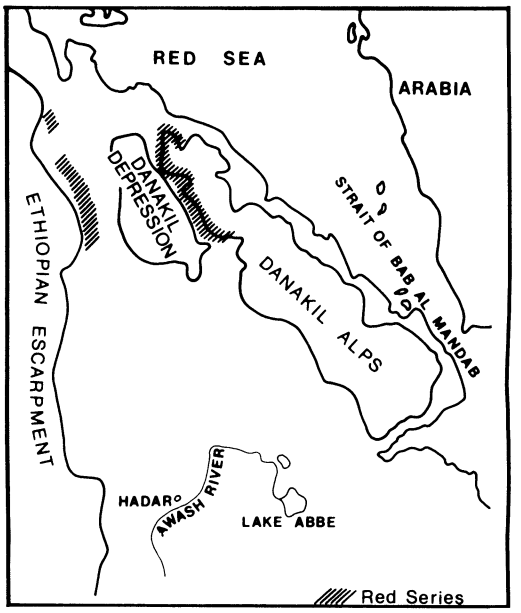

Figure 3. The location of the Tertiary deposits known as the Red Series which should yield fossil hominids if the hypothesis here put forward is correct.

basalts, especially along the Ethiopian and Somalian escarpments and the coast between the Danakil Alps and the Red Sea. The Red Series are Tertiary deposits that contain Miocene fossils (Frazier 1970; Hutchison & Engels 1970; Beyth 1978). The radiometric age of the series ranges from 5.4 to 24.0 Ma B.P. (Barberi *et al.* 1972). Deposits occur along the foothills of the western edge of the northern section of the Danakil Alps and east of the Danakil Depression. They also occur along the foothills of the Ethiopian escarpment west of the depression. The location of the Red Series is indicated in figure 3. If this hypothesis is correct, fossils of our ape-like and man-like ancestors should be found in them and in Quaternary formations.

Conclusions

This hypothesis combined with those of Hardy and Morgan suggests some answers, implicitly as well as explicitly, to many questions posed by students of human evolution. The main points are as follows.

1. A geologically plausible locality where aquatic evolutionary processes could have occurred is postulated.
2. A time zone for these processes is suggested, filling a hiatus in current theory.
3. A geological formation likely to contain hominoid as well as hominid fossils is identified.

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