3 The Evolution of Genus *Homo*: Where It Happened

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SUMMARY
This chapter seeks to establish a possible location for an aquatic phase in hominid evolution. It lists the necessary conditions which such a location would have to fulfil and establishes that the highland area known as the Danakil Alps conforms to all of these. Geological evidence for the former isolation of the site by sea-flooding, combined with data from the fossil record, points to a possible scenario for the early stages of hominoid speciation and a suggested locality for further exploration.*

A major obstacle to acceptance of the hypothesis of an aquatic phase in human evolution is the difficulty of envisaging precisely where and when this episode may have occurred, in what type of habitat, what first motivated the change to an aquatic way of life, and what brought it to an end. This chapter discusses some possible answers.

THE NECESSARY CONDITIONS

Reflection upon the Hardy (1960) hypothesis leads to the following conclusions concerning a possible location:

(1) It must have been a forested area inhabited by apes.
(2) It must have been isolated from the rest of Africa during the period in which the evolution of ape-like to man-like creatures occurred. This suggests an island.
(3) The region must have later become reconnected to Africa, enabling the hominids to migrate to other parts of the continent. In combination, (2) and (3) suggest an area of continuing tectonic disturbance.

The first condition – a forested area inhabited by apes – does very little to narrow the field. The Hominoidea originated in Africa, and prior to about 16 million years before present flourished exclusively on that continent (Campbell and Bernor, 1976). But following the establishment of the Africa–Asia–Europe land bridge, they began to expand throughout the Old World evergreen woodland biome, which at its climax, between 12 and 8 million years ago, extended from the Atlantic to the Pacific and southward into subequatorial Africa on the eastern side (Bernor, 1983).

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Ramapithecus, formerly proposed as a possible ancestor of the genus *Homo* (Howells, 1967; Leakey, 1976; Leakey and Lewin, 1977, 1978; Mackinnon, 1978), ranged widely over this area. Fossils of this ape from Fort Ternan, Kenya, have been dated at 12.5–14 million years before present, and from the Siwalik Hills in India at 9–12 (Leakey, 1976).

Within this biome, the location most subject in the past to recurrent geological changes such as those envisaged in (2) and (3) is the area of north-east Africa at the junction of the African and Arabian tectonic plates.

EVIDENCE FOR THE HYPOTHETICAL LOCATION

The paradigm of continental drift and sea-floor spreading described by Wegener (1966), Wilson (1963), Bullard (1972), and Dietz and Holden (1972), along with others, provides insight and understanding of the geophysical evolution of the Afar triangle. Near the end of the Oligocene or the beginning of the Miocene, the African plate, of which the Arabian plate was then a part, apparently collided with the Eurasian plate. This collision caused three tectonic events that are germane to this chapter, namely:

According to Hsu, Cita and Ryan (1973), starting at the beginning of the

(1) Doming uplifted the region perpendicular to the axis of the present-day Red Sea, causing cracks in the Afro-Asian plate, and was followed by downfaulting and the formation of the proto-Red Sea, which was connected with the proto-Mediterranean Sea (Hutchinson and Engels, 1970, 1972; Coleman, 1974; Pilger and Rosler, 1976).
(2) Rifting began in the Gulf of Aden (Hutchinson and Engels, 1970, 1972; Coleman, 1974; Pilger and Rosler, 1976).
(3) At the junction of these two regions, tectonic activity produced crustal blocks of assorted sizes (Tazieff, 1970; Tazieff *et al.*, 1972).

Messinian (latest Miocene stage) the Mediterranean Sea was repeatedly isolated and then rejoined to the Atlantic Ocean, causing the sea to dry and then refill. They suggest this cycle of drying and refilling was repeated at least seven times, and perhaps as many as fourteen. During the desiccation of the sea, massive layers of salt were deposited on the bottom of the deeper parts.

After combining the results of biostratigraphic, chronostratigraphic and palaeomagnetic investigations, Cita and Ryan (1973) devised an absolute time scale which they believe is reliable and useful. They suggest that the Miocene–Pliocene boundary should be set at about 5.4 million years ago. They also suggest that the Messinian began shortly after 7.5 million years ago. According to Coleman (1974), the Red Sea was a gulf connected to the Mediterranean Sea during the late Miocene. Stoffers and Ross (1974) suggest that when the Mediterranean was subjected to the cycle of drying and refilling, so also was the Red Sea. During this period, massive layers of salt were deposited on the bottom of the deeper parts of the sea.

Figure 3.1 (p. 31) 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 (Kurtén, 1972; Beyth, 1978; Mackinnon, 1978).

THE ISLAND

Many local populations of terrestrial fauna would undoubtedly have been wiped out as a result of tectonic activity in an area as geologically unstable as the Afar region. But there is evidence to suggest that one particular region may have remained habitable. Tazieff (1970), Tazieff *et al.* (1972) and Barberi *et al.* (1972) have suggested 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, that is, 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 Afar Isthmus was composed of several such crustal blocks. The Danakil horst, which apparently acted as a 'microplate' (Le Pichon and Francheteau, 1978), is now a mountainous range about 540 km long and up to 75 km wide (Tazieff *et al.*; *Geological Map of Ethiopia*, 1973). In Figure 3.1 the northern end of the horst marks the southern limit of the proto-Red Sea (Frazier, 1970; Barberi *et al.*, 1972).

In the early Miocene the Danakil horst was separated from the Ethiopian escarpment to form a depression extending southward from the north end of the horst about one third to one half its length (Hutchinson and Engels, 1972; Barberi *et al.*, 1972). Within this Danakil Depression, from its inception to the present time, volcanism and sedimentation of marine, lacustrine, evaporitic and continental facies have occurred contemporaneously. The depression apparently was a lake or embayment that formed the locale for the deposition of a detrital formation known as the Red Series. These deposits – with an age range of 5–24 million years before present (Barberi *et al.*, 1972) – currently exist as narrow bands on each side of the Danakil Depression (*Geological Map of Ethiopia*, 1973). Much of the Red Series is overlain by

Quaternary deposits of lava flow. According to Barberi *et al.* (1972), the age of the upper part of the Red Series is 5.4 million years before present. Starting in the early Miocene, volcanoes in the middle of the horst erupted intermittently, producing extensive lava flows that still cover the entire southern portion. Lava also covers the far northern end. In between lies a region about 150 km long and 75 km wide in which the exposed formations are Mesozoic rocks, mainly Jurassic, covered by a discontinuous veneer of Tertiary and Quaternary deposits (Hutchinson and Engels, 1972).

After a long period of relative quiescence, starting about 9–11 million years ago, volcanism increased in the Red Sea, in the Afar triangle, and in the African Rift Valley, indicating renewed tectonic activity (Pilger and Rosler, 1976). About 6.7 million years ago the Danakil Depression was invaded by marine waters (Barberi *et al.*, 1972). Hutchinson and Engels (1972) state that the deeper part of the depression is covered by thick salt deposits. They infer that the deposition of the lower layers may be correlative with the upper Miocene salt deposits of the Red Sea. The cycle of drying and refilling that apparently occurred in the Mediterranean and in the Red Sea probably also occurred in the Danakil Depression.

About the time of the Miocene–Pliocene boundary the African plate began to move away from the Arabian plate, and the Danakil microplate began to rotate anti-clockwise (Tazieff *et al.*, 1972; Le Pichon and Francheteau, 1978). At the same time it began to tilt so that its Mesozoic sedimentary rock formations slope downwards, generally from north-east to south-west (Hutchinson and Engels, 1970; Beyth, 1978). Excluding volcanic peaks, the Danakil Alps today rise to a maximum of 1,335 m. Finally, the microplate was detached from both African and Arabian plates, allowing waters from the Red Sea and the Gulf of Aden to flow into the Afar triangle. Figure 3.2 (p. 31) displays the configuration of the region as it may have been in the early Pliocene. Note that the Red Sea was no longer connected to the Mediterranean Sea (Coleman, 1974) as in Figure 3.1, but was 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 that will be called the Danakil Strait. Thus, between 6.7 and 5.4 million years ago 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 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 may not have been a geographical island, but for many land animals, under the conditions described above, it would have been a biological island. Examination of the data cited above suggests that the Danakil horst may have become a geographic island sometime before the Pliocene–Pleistocene boundary, and that apes could have existed on it throughout the period of sea-flooding. The southern end of the horst still supports rain-forests, according to Uwe George in an article about the African Rift Valley that appeared in the German edition of *GEO* several years ago.

A SCENARIO FOR THE EVOLUTION OF GENUS *HOMO*

The following is a tentative hypothesis describing what may have happened. Although speculative, it is as well to show that some such course of events may be envisaged.

The Pliocene was a time of increasing desiccation. If the hypothesis of Hsu, Cita and Ryan (1973) is correct, desiccation probably started during the Messinian. Forests probably covered most of Danakil Island at the beginning of the Pliocene, but these must have died in a relatively short period of time. Those near sea level and the coast would be the first to disappear, while those at higher, cooler elevations in the mountains remained longer. The dwindling forest would produce exactly the environmental conditions required by the Hardy hypothesis; those apes near the coast, losing their forest, gradually would be forced into water to find both food and protection from predators. (Their cousins along the Ethiopian escarpments, and elsewhere, undoubtedly retreated with the dwindling forests.)

Witnessing frequent volcanic eruptions and lava flows at both north and south ends of the island, the apes may have made two important discoveries: pebble tools and fire. Hot lavas passing over pebbles scattered along the beaches could have shattered them, to produce keen-edged shards; on meeting water, lavas would be cooled and sundered into sharpened, ready-made tools. Lavas may have cooked plants and animals and so have led the apes to consume and appreciate cooked food. This knowledge would become invaluable to their descendants in the African Rift Valley.

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; Hutchinson and Engels, 1972; Lowell and Genik, 1972). Eustatic sea-level fluctuations combined with erosion probably reopened the strait within a short time. However, during the short time the island was connected to the mainland, migration of animals must have occurred, with the Australopithecines among them. The probability is that the aquatically evolving apes were isolated on Danakil Island for at least one and a half million years, and perhaps as long as three million years, before returning to the mainstream of African life.

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. They did so for two reasons. First, water was their protection against predators. Next, 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. About three million years ago, some of the hominids settled in a place now called Hadar, near the Awash River (Johanson and White, 1979).

The African Rift Valley is a consequence of the collision and subsequent separation of the African and Eurasian plates. Figure 3.3 (p. 32) displays its location. Since its inception, lakes and rivers have been created. Many have been filled, and this has served to cover and preserve fossils. In particular, the Awash River emptied into the Afar Gulf. The river course follows the Rift Valley in a generally south-western direction from the Afar. The hominids followed the river upstream, eventually arriving at the Omo valley, and then proceeded southward, leaving their remains along the way at such present-day sites as the Omo River, Koobi Fora, Lake Turkana, Olduvai Gorge, Laetoli, Makapansgat, Sterkfontein and Taung (Leakey and Lewin, 1978). These sites are located in Figure 3.3. The oldest known hominid fossil from this region is about 3.5 million years old, with those found at Hadar being more primitive than those found farther south.

THE FOSSIL EVIDENCE

Three facts about the fossil evidence are noteworthy:

(1) No fossils of proto-hominids have yet been found for the two million years before the *afarensis* skeletons at Hadar, the 'fossil gap' during which the split between apes and man took place.
(2) The fossils found at Hadar are more primitive than those found farther south, and possibly are older.
(3) A very high percentage of hominid fossil remains have been found in sites which were close to lakes and rivers. This is usually attributed to the fact that the bones are more likely to have been

> preserved in such sites. But it is equally possible that they were in fact the sites where the hominids habitually lived.

Features of Lucy and the other Afar fossils have raised many questions about the kind of life they led. Bipedalism was a surprising feature. Others included the relatively long arms and relatively short legs; the long toes; the stride, relatively as well as absolutely shorter than ours; and the hand grip, better adapted for a precision grip than a power grip (Johanson and Edey, 1981; Charteris, Wall and Nottrodt, 1981; Jungers, 1982). The question arising from these discoveries is how these creatures satisfied the three basic requirements for their survival: namely, (1) fresh water, (2) food, and (3) shelter from predators. Little attention has been paid to the possibility that Lucy may have been a marsh-dweller. This is surprising in view of the fact that the place where the fossils were discovered was, in Lucy's day, the site of a large lake fringed with marshes.

In the film *Lucy in Disguise** Raymonde Bonnefille, the French palynologist, discusses her analysis of pollen obtained at the site where the First Family fossils were recovered. The pollen is mainly from bulrushes, and bulrushes invariably inhabit marshes. Bruce Latimer, after examining the bones of Lucy's foot, concluded that *A. afarensis* was an unusually strong walker and that its long toes would have been invaluable in moving over rough stony ground or in mud, where some slight gripping ability would have been advantageous.

Riverine deltaic marshes are created where a slow-moving river enters a lake or sea. Silts carried by the river water are deposited, forming islets that cause the river to split into several small streams. Thus, marshes often consist of islets interlaced with small streams of depth ranging from a few inches to several feet. In such a habitat the hominid's basic needs would have been met. Such marshes are among the most productive lands in the world. Even the best irrigated agricultural lands yield no more than seven tons of biomass per acre per year; a freshwater marsh may yield up to fifteen tons (Niering, 1985; Teal and Teal, 1969). And much of this – both animal and vegetable – would have been readily available to *A. afarensis*.

Euell Gibbons (1971) describes a variety of marsh-dwelling plants that are, to some extent, edible. For example, the prolific common cat's-tail of the worldwide-distributed family Typhaceae is largely edible, with the exception of the coarse leaves and spike. Moreover, the cat's-tail is easily uprooted from the mud of the shallow waters in which it grows, often in dense stands. The cat's-tail family, along with other marsh plant life, would constitute a dependable year-round source of vegetable food for

* Smeltzer Films, Athens, Ohio, 1981. Produced at Ohio University in co-operation with the Cleveland Museum of Natural History.

the marsh-dwelling apes. In time, either by accident or design and through trial and error, the apes could have learned to catch and consume the various animals that abound in marshes: insects, crustaceans, molluscs, fish, small mammals and birds. Chance discovery of birds' eggs, turtle eggs and crocodile eggs would also have provided a source of food. And the islets would have provided both refuge and places to sleep.

Such an environment would have precipitated and accelerated the adaptation to bipedalism. It offers a possible explanation of Lucy's unusual gait. Any person who has waded barefoot in waist-deep water is acutely aware of the effort required to do so (see Ghesquiere and Bunkens, this volume, chapter 16). He will dig into mud with his toes to acquire a strong forward thrust to move his body through the water, and will take short steps during the process. His wading gait will resemble the 'strolling gait' attributed to the hominids who left their footprints at Laetoli. Many animals which live in, and have become adapted to, an aquatic environment have evolved relatively short powerful legs. (The hippopotamus is an outstanding example.) Both the long arms and the evolution of a precision grip between finger and thumb would have been advantageous in exploring the muddy bottom for edible matter. Even in modern times there are groups of people like those in southern Iraq (see Maxwell, 1957; Schagatay, this volume, chapter 15), who live in marshes and have developed cultures and economies based on them.

Klein (1977) says, 'With respect to site locations, southern African Acheuleans seem to have been quite eclectic. They camped on stream banks or on channel bars, on lake margins, near springs, and in caves . . . The only conclusion that emerges from an analysis of site locations is the trivial one that Acheulean peoples probably never camped far from water'. But the description of this conclusion as 'trivial' is too dismissive. Camping near water was not a behaviour pattern introduced by the Acheuleans. As far back as we can trace our ancestry, the palaeontologic evidence suggests that closeness to water was more essential to hominids than to most animals in the African continent. The physiological reasons which render it essential provide strong evidence that at an earlier stage in our evolution it must have played a crucial part in the emergence of man.

If this analysis is correct, then Danakil Island was the site of the first population bottleneck in the evolutionary line leading to man. It was the crucial one, since it represented the speciating event which originally divided us from the apes and led directly to the bipedalism of *A. afarensis*. A second bottleneck has been identified as taking place probably less than 200,000 years ago in Africa (Cann, Stoneking and Wilson, 1987). The relation between these two great landmarks can be simply stated. Two hundred thousand years ago 'Mitochondrial Eve' marked the beginning of *Homo sapiens*, but she was herself a descendant of the apes marooned on Danakil Island that marked the beginning of *Homo*.

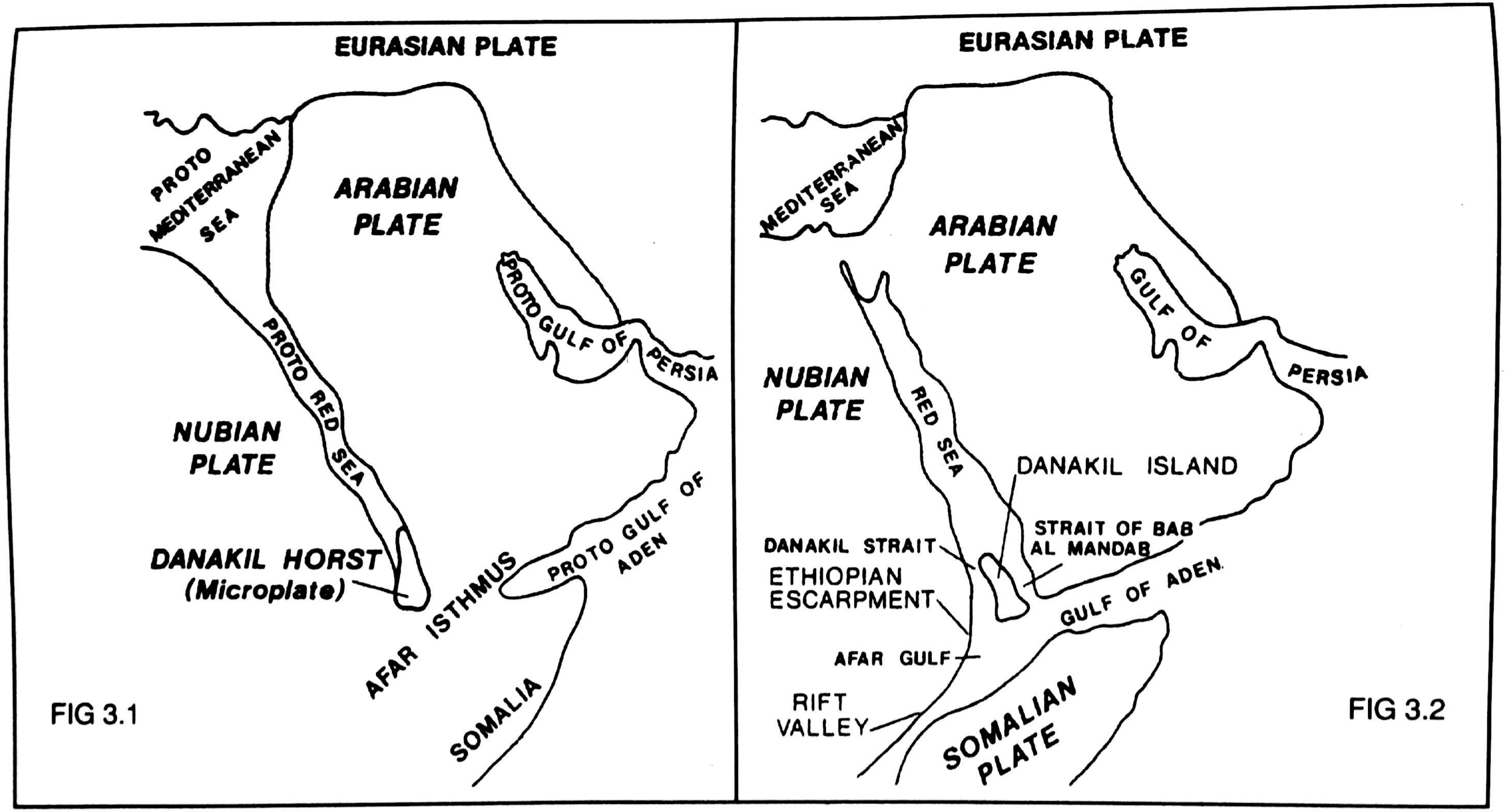
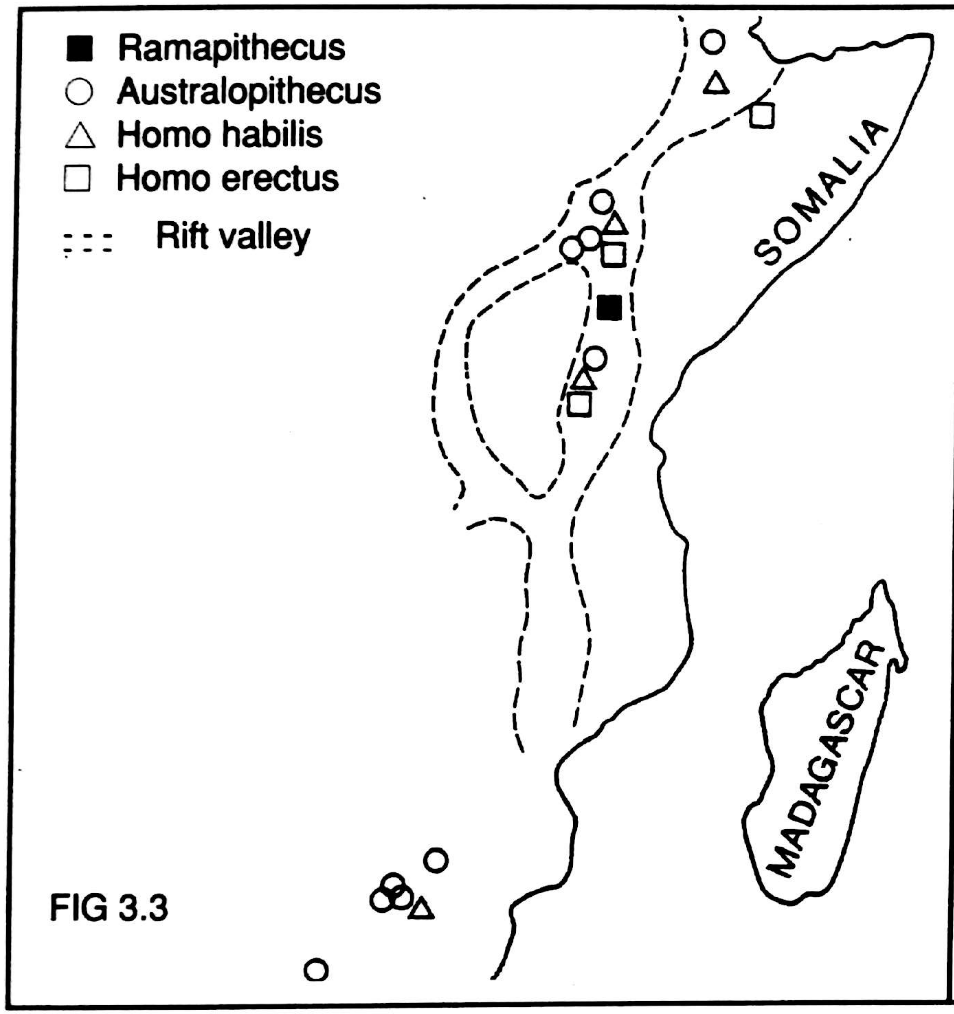


Figure 3.1 The generally supposed relationship of the Nubian plate of the African continent to the Arabian plate during the late Miocene. Figure 3.2 The configureation of the same region as displayed in Figure 3.1, but as it may have been at the beginning of the Pliocene.



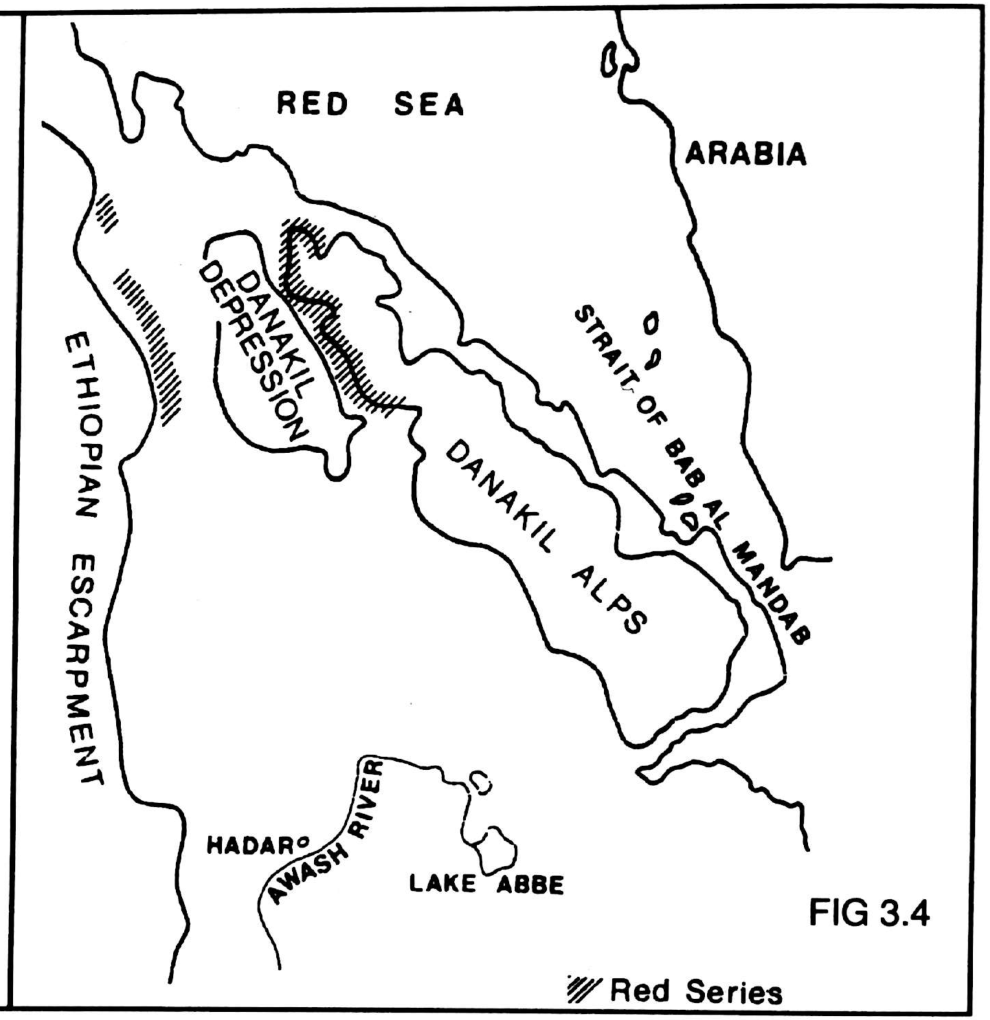


Figure 3.3 The African Valley showing the principal sites where hominid fossils have been discovered.
Figure 3.4 The location of the Tertiary deposits called the Red Series that may yield hominoid fossils if this hypothesis is correct.

SUGGESTED LOCALITY FOR EXPLORATION

Tectonic activity is extremely high within the Afar triangle (Tazieff, 1970). Much of the region is covered by flood or plateau basalts (*Geological Map of Ethiopia*, 1973), and exposed continental basement is limited. Quaternary and recent deposits are more extensive and cover both basement and 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; Beyth, 1978). The radiometric age of the series ranges from 5.4 to 24.0 million years before present (Barberi *et al.*, 1972). Deposits occur along the foothills of the western side 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 3.4. If this hypothesis is correct, fossils of our ape-like ancestors should be found in them, and fossils of our human-like ancestors should be found in nearby Pliocene and Quaternary formations.

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