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# The Caves of Mount Elgon and Their Sandfly Fauna

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## Summary

A survey of the Kenyan side of Mount Elgon revealed numerous caves which were found harbouring phlebotomine sandflies. Among the morphologically identifiable males of two species of the genus *Phlebotomus*, sub-genus *Larroussi* were indistinguishable females, a proportion of which were infected with promastigotes of *Leishmania*. The suspected vector of this parasite, *Phlebotomus pedifer* was found predominant in a relatively low altitude escarpment belt at 1750-1900m, and represented over half of the identified male sandflies detected from the slopes of Mount Elgon. These male sandflies were associated with females infected with *Leishmania* and those which bit man. At intermediate and higher altitudes, the caves harboured mainly *P. elgonensis* and were associated with river valleys and major promontories. The escarpment which is a proven focus of cutaneous leishmaniasis was approximately 257 sq km and 10% of the study area, and took the form of a narrow, elongate cliff along the entire southern slopes of the mountain. Details of the distribution of caves on the slopes of Mount Elgon and their sandfly fauna are presented.

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## Introduction

Cutaneous leishmaniasis (CL) due to *Leishmanai aethiopica* is endemic on the slopes of Mount Elgon, Kenya and in the Ethiopian highlands (Kungu *et al.*, 1972; Ashford *et al.*, 1973; Sang *et al.*, 1993). This species of *Leishmania* can cause an anergic, non-self healing form of the disease known as diffuse cutaneous leishmaniasis (DCL) in a proportion of the cases (Bryceson, 1969; Sang *et al.*, 1993). DCL is characterized by disseminated nodules or plaques that do not ulcerate but cause considerable disfigurement. Treatment with the antimony compound sodium stibogluconate (Pentostam: GlaxoWellcome) only produces a slight and temporary relief. However, in the case of simple lesions of cutaneous leishmaniasis and those presenting with plaques of DCL, they have been treated successfully with ultra-violet light (Sang *et al.*, 1996).

The vectors of *L. aethiopica* are phlebotomine sandflies of the sub-genus *Larroussi*: *P. pedifer* in Kenya, and *P. pedifer* and *P. longipes* in Ethiopia. The females of these species were

morphologically indistinguishable using techniques available at the time. However, the species found on Mount Elgon were virtually exclusively cave dwellers (Sang and Chance, 1993). The animal reservoirs of *L. aethiopica* on Mount Elgon include rock hyraxes, *Procavia johnstoni* and tree hyraxes, *Dendrohyrax arboreus* (Mutinga, 1975a) which occupy the same biotopes as sandflies.



Figure 1: Facial lesions in a case of DLC

According to Sang and Chance (1993) the sandflies found in caves can be placed into three categories, according to the species and altitude of distribution: the low altitude escarpment region (1,750-1,900m) where *P. pedifer* predominated, the intermediate region (1,900-2,300m) where both *P. pedifer* and *P. elgonensis* occurred, and the higher altitudes (2,300-2,600m) where *P. elgonensis* predominated. Sang *et al.* (1993) also showed that cutaneous leishmaniasis (CL) was restricted to the lower southern slopes of Mount Elgon where *P. pedifer* was the predominant sandfly species, and a proven vector of CL. The aim of the current study was to determine the spatial distribution of caves and their sandfly fauna, and their association with the risks in the transmission of this disease.

The mountains of East Africa: Kenya, Tanzania, Uganda, Rwanda and Burundi are associated with the formation of the Great Rift Valley. The highest peaks rise above 5,000m in altitude and are ice capped despite their proximity to the Equator. Mount Elgon lies astride the Kenya/Uganda boundary and is situated at 1° 7'N latitude and 34° 32'E longitude on the Wagagai or Loven's Peak which reaches an altitude of 14,150ft (4,321m). It ranks fourth highest in East Africa after Mount Kilimanjaro (5,895m), Mount Kenya (5,199m) and Mount Ruwenzori (5,109m). Mount Elgon is a volcano of considerable dimension, with a base measuring 60 miles (100km). The spectacular cliffs on the western and southern slopes dominate the surrounding lower plains of Uganda and Kenya which lie at about 3,600ft (1,080m).

There is a game park situated within the forest zone on the eastern slopes. The climate is influenced by the position of the mountain in relation to the prevailing south easterly and north easterly airstreams. Below 10,000ft (3,00m) this is wettest on the southern and south eastern sides, with an annual rainfall of 1,300mm. It is drier on the northern flanks with an annual rainfall of less than 1,000mm. Most of the rainfall occurs between March and November. The inhabited slopes have a temperate climate with diurnal

temperatures averaging 18°C. In addition, on the slopes, rivers have dug large V-shaped valleys of maximum depth of 1,000ft (300m) below intervening ridges particularly on the lower slopes, thus providing an opportunity for cave formation.

Most of the caves on the slopes of Mount Elgon were inhabited by man and livestock until the 1950s. The forested areas teemed with wildlife, both carnivores and herbivores which frequented some of the uninhabited caves. Livestock was looked after and kept inside caves at night. Families kept large herds of cattle and flocks of sheep and goats which are said to have numbered up to 400 or more. These were looked after communally by groups of young male adults and boys aged 15 to 25. Cutaneous leishmaniasis was first detected in the late 1960s mainly in this age group (Kungu *et al.*, 1972). However, significant human infections due to this disease may have occurred in the 1950s as evidenced by characteristic scars dating back to this period.

The growing population and affluence brought about by formal education and the monetary rather than livestock economy resulted in the clearing of land for arable farming and the demarcation of land for permanent settlements. The number of livestock reduced 10 times between 1950s and 1980s. During this period the natural vegetation cover greatly diminished before the introduction of the forest boundary.

Following detection of the initial cases of cutaneous leishmaniasis at Kapsakwony on the south eastern slopes in the later part of 1960s, there was interruption of transmission to man for nearly a decade from mid 1970s to early 1980s (Sang, Unpublished). An apparently renewed transmission occurred in Mount Elgon in the early 1980s as detected in human cases at local health facilities and in a leprosarium. A study was initiated in order to elucidate transmission factors as described by Sang and Chance (1993). Caves were found to be the sole habitats for suspected vectors of cutaneous leishmaniasis, thus confirming the findings from a relatively small number of caves (Mutinga (1975b)). In this study, the caves

have been categorized according to altitude and sandfly fauna and they are mapped to determine their spatial distribution and possible risk of surrounding communities for contracting cutaneous leishmaniasis. This will facilitate possible epidemiologically based on control and prevention of this disease.

## Materials and method

A survey of caves was conducted throughout the slopes of Mount Elgon on the Kenyan side mainly below the forest boundary as described by Sang and Chance (1993). Well known caves inside the forest and within the Mount Elgon Park were also surveyed. Using existing survey maps, all the caves were mapped and correlated with findings from their sandfly fauna. Information on temperature and relative humidity measurements of certain caves were obtained from previous studies. This information included an assessment of the degree of attraction to and landing on humans in each cave. The name and locality of each cave was taken and a code number given according to altitude. Each sandfly found attracted to and biting catchers was captured separately and later dissected for detection of gut promastigotes in the laboratory.

Other sites searched for sandflies included tree hollows, rock crevices and human dwellings. Besides active searches by hand capture using aspirators and space spraying using pyrethrum aerosols, there were searches carried out in human dwellings. Space spray catches were restricted to limited number of homesteads including those with cases of cutaneous leishmaniasis.

## Results

### Caves and sandfly fauna

A survey of the Kenyan side of Mount Elgon revealed a total of 237 caves. Out of 229 (96.6%) caves studied, 202 (88.2%) were harbouring sandflies. 5,220 identifiable males and 3,447 indistinguishable females of the genus *Phlebotomus*, sub-genus *Larrousius* were collected. In 2,315 gravid or fed females

dissected for gut promastigotes, 14 (0.6%) were infected. 164 of the caves (69.2%) harbouring 3,083 (80.8%) males of the suspected vector *P. pedifer* out of 3,814 specimens were found in a relatively low altitude escarpment region at 1,750-1,900m. *P. pedifer* collected from the escarpment region represented 59.1% of the identified male sandflies detected on the slopes of Mount Elgon. All the 14 infected female flies were from the escarpment region and were among 1,125 specimens dissected and examined for gut promastigotes, with an infection rate of 1.24%. Figure 1 shows a case of diffuse cutaneous leishmaniasis from the escarpment region. Figure 2 shows human settlements on an escarpment and Figure 3 shows a cave frequented by people on the escarpment in the southern slopes.

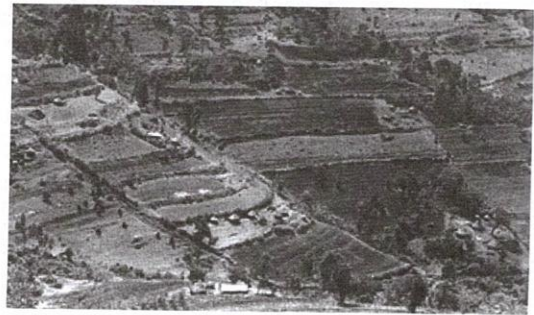


Figure 2: Human settlements on an escarpment in the southern slopes



Figure 3: Cave frequented by people at Chebich on the southern escarpment region

At intermediate and higher altitudes 58 (24.5%) and 14 (5.9%) of the caves, sandflies were found at altitudes of 1,900-2,300 and 2,300-2,600 respectively. At such altitudes which were outside the escarpment region on the southern

slopes, caves with sandflies harboured mainly *P. elgonensis*, and were associated with river valleys and major promontories. In all the caves surveyed, signs of past and current domestic as well as wild mammalian activity and human habitation were evident. Smaller caves of less than 2 or 3 meters long which usually had no evidence of past or current human or domestic animal activity did not contain sandflies of the genus *Phlebotomus*. Only non-vector species of the genus *Sergentomyia* were recovered. These caves were, therefore, not included in the present series.

### Escarpment caves

Nearly all the caves at altitudes of 1,750-1,900 occurred in a conspicuous escarpment spanning

the entire southern slopes of Mount Elgon. This was a dominant feature in the form of a continuous cliff from Saboti in Trans Nzoia district to Chepkube on the Uganda border and beyond. The escarpment was approximately 257 sq km and only 10% of the area of distribution of sandflies was detected on Mount Elgon. Figure 4 shows the escarpment region, focusing on cutaneous leishmaniasis described by Sang *et al.* (1993). It also shows other areas of study on the eastern and northern slopes of Mount Elgon which were mostly above 1,900m. Details of the distribution of caves and cases of cutaneous leishmaniasis for Kapkirongo, Kapkateny and surrounding areas are shown in Figure 5. Figure 6 shows a section of the escarpment at Kapkirongo.

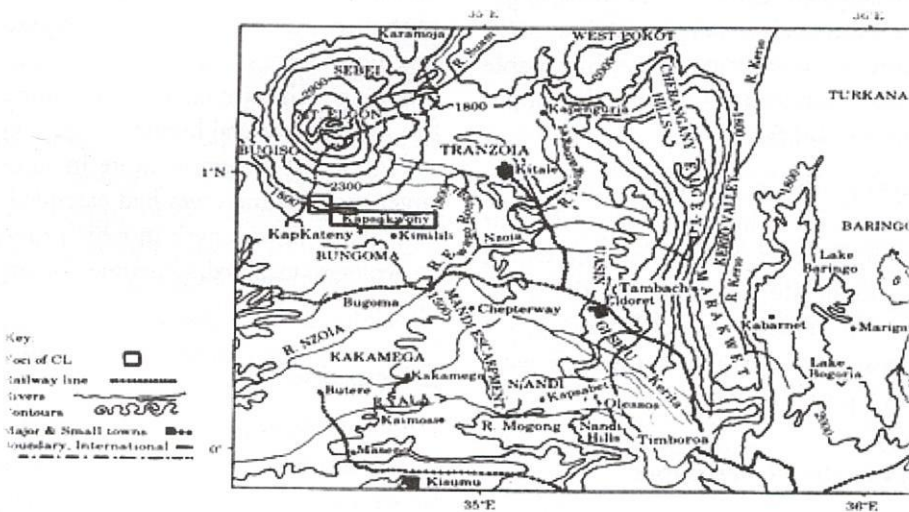


Figure 4: Position of some of the mapped area in Mount Elgon region

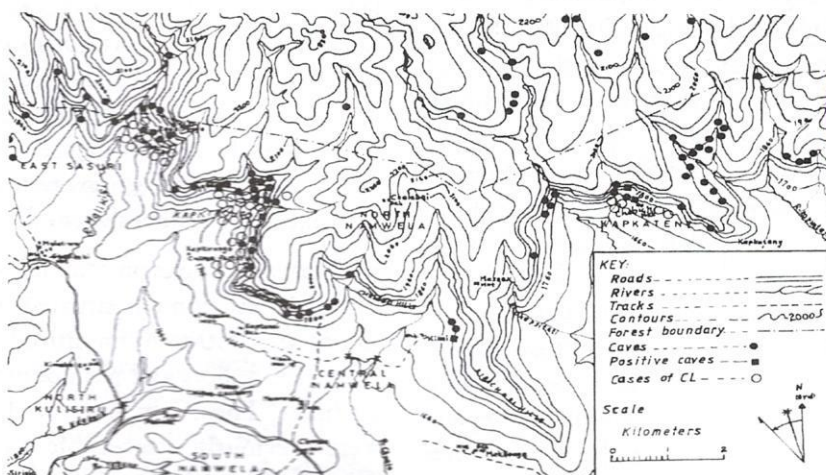


Figure 5: Map of Kapkirongo, Kapkateny and surrounding areas showing distribution caves and cases of CL





**Figure 6:** Section of the escarpment on the southern slopes of Mount Elgon

The cliff face containing caves was more accessible from the lower slopes although sometimes the farmland was closer to the cliffs 100-200m above the caves. On the lower slopes below the escarpment, steeper sections were used mainly as livestock pasture, while arable farming was practiced on the gentler slopes away from the cliff face.

Generally, the population below the escarpment on the southern slopes of Mount Elgon was higher and apparently more settled than the upper slopes. Some of the areas appeared to have become increasingly prone to soil erosion and landslides which were sometimes reported.

### *The caves of the higher slopes*

On the higher slopes, caves were mainly found in river valleys of the intermediate (1,900-2,300) and higher slopes (2,300-2,600m). They occurred in areas of human settlement, forest reserve and the game park. In areas of human settlements, the caves were frequented by people and used for salt lick and rarely as night shelter for livestock. However, one cave situated at Kol on the eastern slopes was still inhabited by an elderly couple and their livestock. They had never left the caves despite owning farmland nearby. In the forest reserve and the game park, the larger caves acted as night time shelter for various wild animals, ranging from hyraxes and several species of antelopes to larger herbivores such as buffaloes and elephants. These sites

were also visited by tourists and other itinerant persons during the day.

### *Conditions in the caves*

202 out of 229 caves (88.2%) harbouring sandflies were dry during the peak of the rains between April and September, except for some pools or wet areas found in portions of some caves. Besides being good tourist attractions particularly in the Mount Elgon game park and in some settled areas, the caves served as convenient resting place and shelter from the weather for people passing by and for those working in nearby field. Characteristic waterfalls cascading down across the entrance of caves was a common feature, particularly during the rainy season. The cliff face and walls of caves contained numerous fossils of vegetation and cave floors were covered with dust and animal droppings. The size of the caves varied from a few meters to several hundred meters long, and as high as 10 meters or more in some of the larger caves. Some caves had extended tunnels of undetermined length in which tourists and archeologists explored, sometimes for several days on end.

### **Discussion**

Hobbley (1919) postulated that cave formation on the escarpment region dominating the lower slopes could have been due to human activities or to wave action of an ancient lake. The waters of Lake Victoria are believed to have once extended as far north as Karamoja northwest of Mount Elgon, and lapped against the slopes of the mountain producing shore line caves. This theory is supported by the fact that sedimentary rocks of a lake bed have been excavated near Kitale adjacent to the eastern slopes of Mount Elgon.

Most of the caves on Mount Elgon occurred along the escarpment situated on the lower slopes at 1,750-1,900m altitude, and along steep river valleys and promontories at higher altitudes. These are some of the areas that were previously inaccessible due to terrain. They have also been within the forest until

recent times from 1960s to 1980s, when agricultural settlements extended to these areas and encroached on the cliffs. As a result, this may have made the cliff containing caves more accessible to the human population. The increased human contact with the cliff face and the caves may be responsible for sparking off sporadic occurrence of cutaneous leishmaniasis, by intrusion into the wild hyrax/sandfly cycle in the caves at lower altitudes.

Caves are the only biotopes detected and found to be inhabited by sandflies on Mount Elgon (Sang and Chance, 1993). It is not known whether *P. pedifer* at altitudes beyond 1,900m and *P. elgonensis* in all the altitudes are susceptible to *Leishmania aethiopica* infection.

Historically the caves of Mount Elgon were inhabited by pastoralists and many still bear family names of some of the inhabitants. One cave situated at higher altitudes at Kol on the eastern slopes was still inhabited. Another cave at Kiptugot in the Kapsetta area was reported to have collapsed in 1948. The early evening incident may have entombed a whole community with livestock. Human habitation of caves may have prevented the wild hyrax/sandfly cycle of transmission of *Leishmania aethiopica* which presumably occurred at lower altitudes below 1,900m from infecting man.

## Conclusion

Cutaneous leishmaniasis was virtually unknown on Mount Elgon until the late 1960s, and there was no local name for this disease. However, presumably since it was not a life threatening disease likely to have been of low prevalence in this area, this could have been ignored or confused with other skin conditions. It is also quite possible that human habitation and domestic fires lit in the caves could have prevented vector sandflies and hyrax reservoirs from establishing themselves inside caves, and therefore minimizing the chances of transmission to man. The present findings will enhance knowledge on the geographical distribution and details of locations of transmission sites in caves.

This is essential for formulation of control and prevention strategies of the disease.

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