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Neurological manifestations of malaria and trypanosomiasis as described by the leaders of the great Central African expeditions

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ABSTRACT

Introduction. This article describes the great Central African expeditions and compares the neurological signs of malaria and African trypanosomiasis with symptoms described by the eminent explorers Stanley, Livingstone, Speke, and Burton.
Methods. We studied explorers' experiences using historical research and their direct accounts.
Results. Some 120 years after the events analysed here took place, malaria is still a major health problem in parts of Central Africa. Although these authors' clinical accounts are very brief, sometimes appearing as mere notes in a diary, they are of great historical interest.

KEYWORDS
Cerebral malaria, African trypanosomiasis, Central African expeditions, history of neurology in the 19th century

Introduction

The search for the source of the Nile, the slave trade, the appropriation of natural resources, colonisation, missionary work, and the spirit of adventure motivated a number of expeditions to Central Africa in the late 19th century. These expeditions were backed by governmental agencies, scientific societies, and trade organisations in countries such as Holland, Germany, France, and England; they were also supported by diverse emirates on the Arabian Peninsula which were interested only in the slave trade.[1]

Endemic diseases such as malaria and African trypanosomiasis, which had high incidence and prevalence rates in Central Africa, decimated indigenous populations, explorers, and colonists alike. However, a malaria vaccine is now being researched and clinical trials are currently underway. In 2012, researchers determined that the latest vaccine was able to protect 50% of immunised subjects.[2] ISGlobal (Barcelona Institute for Global Health) is contributing to the project to perfect the vaccine, and trials are yielding promising results.

The source of the Nile was an unsolved mystery and a challenge for geographers and explorers for many years. The Nile was well-explored as far as just upriver of Khartoum, at the union of its two main tributaries: the Blue Nile, which originates at Lake Tana in the highlands of Ethiopia, and the White Nile which flows from the Sudan. South of Khartoum, the river was unknown; its course split into numerous tributaries forming the wetland known as Sudd, a labyrinth of meanders choked with water plants and weeds making it difficult to navigate and explore. This formidable natural barrier was the reason why expeditions set out from the tropical regions along the coast of the Indian Ocean.[3] The island of Zanzibar and the town of Bagamoyo were enclaves that served as starting points for geographical expeditions setting off for the east or the north. Lakes Tanganyika and Victoria and other African Great Lakes were discovered thanks to such expeditions.[1]

Incidence and prevalence rates for a number of diseases were high among native populations, explorers, and colonists. We will provide a neurological perspective on the first-hand accounts of malaria and African trypanosomiasis written by the explorers who witnessed and experienced their effects.

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Methods

The most direct sources of information are the accounts written by the explorers themselves: Speke,[10] Dr Livingstone,[15,22] Stanley,[18,23] and Burton.[21,24]

1. Malaria

Malaria has an incidence of approximately 500 million cases per year. Mortality ranges from 1 to 3 million per year, with most fatalities occurring among children and pregnant women. The disease causes 9% of all deaths in children worldwide.

The disease is caused by protozoans of the *Plasmodium* genus. There are more than 100 *Plasmodium* species. *Plasmodium falciparum* (PF) is the parasite that causes the most severe cases and neurological symptoms.[4] The disease is transmitted to a human, the intermediate host, through the bite of a female Anopheles mosquito. It is currently considered a tropical disease. PF is the *Plasmodium* species most commonly found in Central Africa, New Guinea, and Haiti. The bacteriological course of malaria is complex, and its discovery was one of the most labour-intensive achievements in the history of microbiology. The discovery of plasmodia parasites and their life cycle in *Anopheles* mosquitoes (by Leveran in 1881), and the explanation of how they are transmitted to humans (by Ross in 1897), represent great milestones in the history of infectious disease research.

The life cycle of the malaria parasite starts with an initial asexual phase which takes place in a human host that has been bitten by a mosquito. This parasite remains within the liver, where it reproduces by schizogenesis; it subsequently invades red blood cells, and the rupture of these parasitised cells causes the clinical manifestations of the disease.

When a mosquito bites a human and ingests its blood, gametes conjugate to form ookinetes. These structures accumulate in mucous membranes within the mosquito's digestive system before travelling to the insect's salivary glands. The life cycle comes full circle when the mosquito bites a human, inoculating that individual with new sporozoites.[5]

Clinical manifestations[4,6] appear after an incubation period ranging from 7 to 14 days. Malaria has a prodromal phase with general discomfort and low-grade fever. Patients present with sudden spikes of high fever with chills and profuse sweating. Fever paroxysms follow classic tertian or quartan patterns. Acute cerebral malaria may present with tremors in lips and tongue, headache, and meningeal syndrome. Seizures are frequent, and examination reveals generalised hyperreflexia and bilateral Babinski sign. The patient then becomes comatose.

The subacute form is characterised by fever, chills, vomiting, and diarrhoea. Seizures and brain injury signs are rare. Patient condition commonly progresses to coma. Half of all cases present splenomegaly; hepatomegaly is less common. The mortality rate for cerebral malaria ranges between 30% and 50% of all cases. The coma abates in 4 days given proper treatment, but neurological sequelae are very common.

Neuropathological study (Fig. 1) reveals cerebral microhaemorrhages and capillary thrombosis. Complications, especially opportunistic infections, arise in more than 50% of all cases of cerebral malaria. Viral infections are frequent due to immune system compromise. Children with malaria frequently present Burkitt lymphoma in association with Epstein-Barr virus.

Figure 1. Neuropathological study of malaria. Abundant punctiform haemorrhages in cerebral white matter. Pedro-Pons A. *Patología y clínica médicas: enfermedades infecciosas, intoxicaciones, enfermedades profesionales y por agentes físicos.* Barcelona: Salvat; 1959. p. 952.

2. Trypanosomiasis or African sleeping sickness

Trypanosomiasis causes 50 000 deaths yearly in Central Africa. Epidemiology studies show that the number of cases has declined significantly in recent decades. It was

calculated that approximately 300 000 individuals had trypanosomiasis in 1996, a number that dropped to 70 000 by 2005. This decrease may have occurred due either to health strategies that have been adopted or to changes in the agent causing the disease.[7,8]

Clinical progression[7] may be divided into three different stages. 1) Skin lesion caused by the mosquito bite. 2) Fever, general discomfort, and large swollen lymph nodes, especially in the posterior occipital region; splenomegaly is normally present. 3) Neurological symptoms: changes in personality and behavioural disorders. It is not rare for infected individuals to develop spiritual interests. Drowsiness is the most obvious symptom and the one that gave the disease its name.

During periods with no drowsiness, patients suffer from headaches and severe back pain. Seizures are frequent, and in advanced stages, patients may display choreoathetoid movements and rigidity. Some patients present with endocrine disorders manifesting as obesity, amenorrhoea, or impotence.

Some patients recover well, but most progress through states of cachexia, lethargy, and coma. Death almost always results from respiratory infections.[7,8] CSF shows mild lymphocytic pleocytosis and high protein levels that generally exceed 2 g. *Trypanosoma* protozoa can also be observed in CSF.

3. The explorers

Many people participated in Central African explorations, but the key figures included John Hanning Speke, David Livingstone, Sir Henry Morton Stanley, Lord and Lady Baker, and Richard Burton.

John Hanning Speke

John Hanning Speke (Figure 2) was born to a family of comfortable means on 3 May 1827 in Bideford, Devon, England.[8] He served in the army in India, and in 1854, after his release from service, he journeyed to Africa with the goal of discovering the sources of the Nile. In Aden, he joined an expedition organised by Burton, but the attempt failed miserably due to an attack by indigenous groups. In December 1856, Burton and Speke organised a new expedition and set out from Zanzibar; their goal was to discover a great lake thought to be the source of the Nile. What they found was Lake Tanganyika. While Burton was recovering from a bout of malaria, Speke travelled north. On 30 July he discovered one of the African Great Lakes, which he named Victoria in honour of the Queen of England.[10,11]

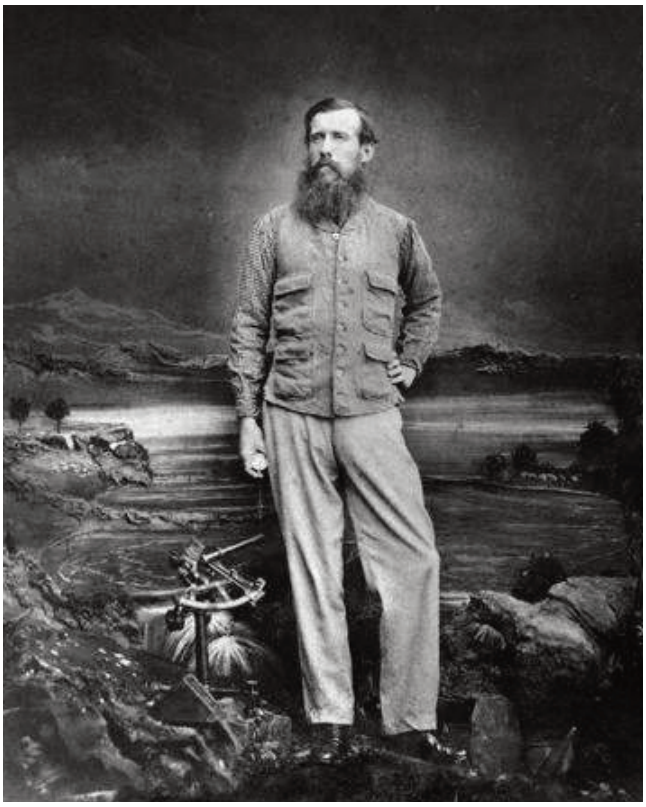

Figure 2. John Hanning Speke.

Speke failed to explore the lake thoroughly, but he remained convinced that it was the source of the Nile. He then left for England, but Burton, still convalescing from malaria, remained in Aden for some time. Before they separated, the two explorers agreed not to reveal the findings of their expedition.

Speke then teamed up with J.A. Grant to organise a new expedition, which was sponsored by the Royal Geographical Society. The two explorers reached Lake Victoria and drew a map of the lake. They found an outlet along its northern edge which they named Ripon Falls after the president of the Royal Geographic Society at the time. Speke and Grant believed that this river was the source of the Nile, and named it the Victoria Nile.[10]

The two explorers then journeyed north and reached the town of Gondokoro in Southern Sudan, where they met Samuel Baker and his wife. Upon his return to England, Burton pointed out the irregularities in Speke's account of the journey. Public opinion was divided between Speke's and Burton's versions of the story. A debate was to be held in Bath to settle the dispute, but Speke died the day before in a hunting accident; some sources claimed that he committed suicide.[8,10]

Sir Samuel White Baker

Sir Samuel Baker was born to a wealthy family on 8 June 1821 in London. He died on 30 December 1893 in Sanford Orleigh (Figure 3).

He turned away from his family's business ventures at a young age to pursue his passions of travelling and hunting.[13] In 1861, he and his second wife, a young Hungarian named Florence von Sass, set off for Africa to explore the Sudan and Abyssinia.

Lord and Lady Baker left Khartoum and headed south for the village of Gondokoro, where they coincided with Speke and Grant. Following the latter's directions, they journeyed onward, and on 14 March 1864, they discovered another of the Great Lakes which they named Lake Albert after the Prince Consort of Queen Victoria.[10] Baker determined that the tributary of the Nile that issued from Lake Victoria, according to Speke, flowed into Lake Albert. Based on this evidence, he believed that Lake Albert could be one of the sources of the Nile.[12]

After many setbacks, the Baker expedition returned to Khartoum. In October 1865, nearly three years after the start of their voyage, they returned to England, where they were met with a hearty welcome.

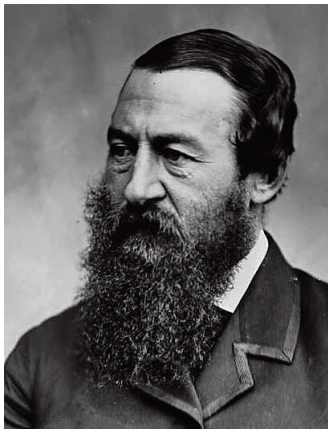

Figure 3. Sir Samuel White Baker.

Figure 4. Dr David Livingstone.

Dr David Livingstone

The most important figure in the history of Central African exploration was David Livingstone (Figure 4). His geographical discoveries, opposition to the slave trade, advocacy for a new approach to colonialism, and respect for indigenous groups made him famous throughout Europe.

Livingstone[14] was born on 19 March 1813 in Blantyre, Scotland to a very humble and profoundly religious family. At the age of ten, he began to work shifts of up to 14 hours a day in a cotton mill, while still finding the time to attend night school. He became a member of the London Missionary Society at the age of 17. He studied medicine, theology, and languages at the University of Glasgow and Anderson's College, and received his medical degree from the University of London in 1840. Livingstone dreamed of travelling to China, but the breakout of the Opium Wars made him change his mind. In 1839 he met Robert Moffat, who had been a missionary in Africa. Moffat influenced Livingstone's decision to travel to that continent to undertake evangelical work. He reached Africa in the spring of 1841. His first mission assignment was in Kuruman, a settlement across the Orange River. The young Scottish missionary spent his days preaching the gospels and caring for the sick. With the help of the indigenous people, he covered a great deal of territory near his mission. In one of these expeditions, he was attacked by a lion, which left him with a severely wounded left shoulder.

In March 1844, Livingstone married Mary Moffat, the daughter of his mentor. The couple continued their missionary work, but faced increasing problems with Boer colonists and indigenous tribes. These tensions and the resulting fear for their safety, plus their daughter's death from malaria, led to the couple's decision to return to England in 1852.

Livingstone travelled to Africa once more in June 1853. He gradually lost interest in missionary work, and instead turned his attention to ending slavery and establishing a trade and colonisation route from inner Africa to its western coast on the Atlantic.[14,15]

Between 1853 and 1856, Livingstone completed the journey that brought him fame and accolades: the crossing of the African continent from the Atlantic to the Indian Ocean. This was the first time an explorer had crossed Africa from coast to coast, a journey measuring 2500 miles.[14] On his journey, during which he completed cartographic studies, he followed the course of the Zambezi river and discovered a waterfall with a vertical drop of 90 metres. He named it Victoria Falls after Queen Victoria.

In March 1858, Livingstone made his third voyage to Africa, this time as the British Consul for the east coast. He was accompanied by his wife and youngest child. Livingstone continued exploring the Zambezi river basin, and he discovered and mapped its tributaries. In 1859, Livingstone's expedition was decimated by malaria; his wife was among the members of the party who died. In the face of territorial and political frictions with authorities in the Portuguese colonies, the British government ordered Livingstone to return to England.

In 1866, Livingstone received a grant from the Royal Geographical Society of London and travelled to Africa once again. This time, his mission was to find and explore the sources of the Congo, Zambezi, and Nile rivers.[14] During the three years which Livingstone spent exploring Central Africa, he reached the southern end of Lake Tanganyika and discovered several smaller lakes. In 1869, he came to the town of Ujiji, which was a hub for ivory and slave trading. Here he established a base from which he set out on several journeys. Suffering the effects of illness and fatigue in 1871, he returned to Ujiji to recover. It was here that he met Henry Stanley, the journalist whose expedition, sponsored by the New York Herald, had been organised to locate the doctor. Livingstone was assumed to be dead, as no one had received word from him in some time. The meeting between the two explorers on 10 November 1871 gave rise to Stanley's famous question, "Dr Livingstone, I presume".[17]

Dr Livingstone was to remain in Africa until his death. On 11 May 1873, when his expedition was based in the town of Chitambo, his faithful porters Chuma and Susi found him dead in his tent. He was kneeling beside his bed as if in prayer. Chuma and Susi embalmed his body by filling it with salt and leaving it to dry in the sun. They removed his heart and buried it at the foot of a tree. Livingstone's loyal servants then brought his preserved body to Bagamoyo on the coast of the Indian Ocean, opposite the island of Zanzibar. The caravan that transported his body travelled more than 1500 kilometres.[14] On 15 April 1874, Livingstone's remains arrived in England and were then laid to rest in Westminster Abbey.

David Livingstone wrote about his African undertakings in *Missionary Travels and Researches in South Africa (1857)*, *Narrative of An Expedition to the Zambesi (1866)*, and *The Last Journals of David Livingstone*. This last was published in 1874, after his death.

Since Livingstone was a doctor, his accounts include information about the diseases he encountered and the patients he cared for during his years in Africa. His descriptions are very brief. This reflects the style of that time, the author's environment, and his superficial knowledge of medicine.

His training was rudimentary. At that time, clinical knowledge was limited and tropical medicine had not been established as a specialty. As malaria was endemic in many European countries, its clinical signs were well-known, but its transmission vector was not understood. However, quinine was known to be an effective treatment for malaria.[14]

Livingstone's anatomical knowledge is believed to have been quite limited. The practice of dissection only became legal four years before he began studying medicine. There was very little knowledge of chemistry, and the science of bacteriology had not yet been developed. We know that Livingstone received *The Lancet* while he was in Africa, although deliveries must have been irregular since he was nearly always deep in the jungle.[14]

We also know that Livingstone suffered from severe bouts of malaria from September to October 1853. In his notes, taken from *The Last Journals of David Livingstone,* begun in 1866, he writes:

> After I had been a few days here I had a fit of insensibility, which shows the power of fever without medicine. I found myself floundering outside my hut and unable to get in; I tried to lift myself from my back by laying hold of two posts at the entrance, but when I got nearly upright I let them go, and fell back heavily on my head on a box...some hours elapsed before I could recognize where I was.[15,22]

A later entry dated 2 August reads: "It is probably malaria which causes that constant singing in the ears ever since my illness at Lake Liemba".[15,22]

In other entries, he mentions disease among the native peoples, writing: "16th October, 1867. A great many of the women of this district and of Lopéré have the swelled thyroid gland called goitre or Derbyshire neck; men, too, appeared with it, and they in addition have hydrocele of large size".[15,22] Hydrocele was probably due to scrotal filariasis.

In general, he provided extensive details about difficulties affecting the expedition, lack of food, and frictions with native populations, but his descriptions of clinical manifestations are very brief. An entry dated 20 October reads as follows: "Very ill; I am always so when I have no work—sore bones—much headache; then lost power over the muscles of the back, as at Liemba; no appetite and much thirst. The fever uninfluenced by medicine".[15,22]

After meeting Stanley, Livingstone documents the journalist's illness:

> 26th November 1871. Sunday. Mr. Stanley has severe fever.
> 23rd December, 1871.—[Stanley] very ill. Rainy and uncomfortable.
> 3rd February, 1872.—Mr. Stanley has severe fever, with great pains in the back and loins: an emetic helped him a little, but resin of jalap would have cured him quickly. Rainy all day.[15,22]

In an entry from November 1872, Livingstone refers to sleeping sickness among the donkeys in his expedition; none of the men suffered from the disease. "The donkey is recovering; it was distinctly the effects of tsetse, for the eyes and all the mouth and nostrils swelled.[15,22] A quote from his notes reads: "22nd February, 1873. I was ill all yesterday, but escape fever by haemorrhage".[15,22]

This comment is hard to interpret, but Livingstone probably attributed to his haemorrhage the benefits that were associated with blood-letting, a common practice in his day.

Henry Morton Stanley

Henry Morton Stanley was born on 28 January 1841 in Denbigh, Wales. He died in London on 10 May 1904. Stanley was an illegitimate child, and he was passed around between orphanages and family members throughout his childhood and adolescence.[16] (Figure 5)

Figure 5. Henry Morton Stanley.

In 1859, at the age of 18, he boarded a ship for the United States. Once there, he was adopted by the Henry Morton Stanley who gave him his new name; he also fought in the American Civil War. He became a journalist and worked as a correspondent for the *New York Herald*, edited and published by James Gordon Bennett. He served as the correspondent for the British punitive expedition, led by General Napier, against Emperor Tewodros II of Abyssinia, who had taken a number of English diplomats and explorers prisoner.

Placing his trust in Stanley's experience in Africa, Bennett then assigned him to find Dr Livingstone, who was believed to be somewhere in Central Africa and from whom there had been no news in nearly three years.[16,17] This quest made the journalist's name famous around the world (Figure 6).

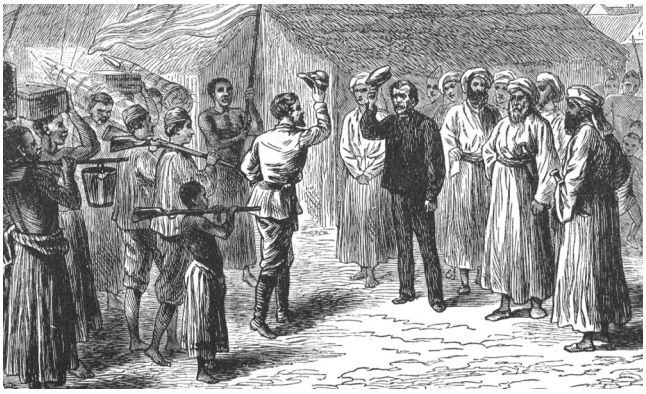

Figure 6. Stanley's encounter with Dr Livingstone.

In 1874, with the support of the *Daily Telegraph* and the *New York Herald*, Stanley undertook a new African expedition to study the Great Lakes and confirm the source of the Nile. During this three-year journey, Stanley mapped Lake Victoria and confirmed it as the source of the White Nile. He explored Lake Tanganyika and the Lualaba River, where he came across a number of obstacles to river travel. One such obstacle was Boyoma Falls, formerly known as Stanley Falls. He followed the Congo River along its entire course, engaging in heated combat with indigenous populations. Stanley effectively removed any stones barring his way along the river by using charges of dynamite. This earned him the nickname 'Bula Matari' — the destroyer of stones— from the natives.[17] In August 1877, the surviving members of the expedition reached Boma and continued on to Cabinda on the Atlantic coast.

Stanley participated in another two expeditions to Central Africa. One was funded by King Leopold II of Belgium, who had proposed colonising the new territories, opening trade routes, and tapping the natural resources of the Congo. The king's idea was to create a Congo Free State, which he himself would manage. Although it was part of the Belgian Crown, the Congo was effectively under the private control of Leopold II.

In 1887, Stanley undertook a fourth expedition to Africa. His mission was to rescue Emin Pasha, the governor of Equatoria, a region in the south of present-day South Sudan that was under Anglo-Egyptian influence. Equatoria was under constant threat from the Mahdi's troops.[17] Emin Pasha was a German subject and a doctor by trade who had been born Eduard Schnitzer. He worked in Albania, which was then part of the Ottoman Empire; he later moved to Egypt, and converted to Islam. He was then named to the government of that country and sent to Khartoum under the orders of General Gordon, its English governor. After Gordon's death and the conquest of Khartoum by the Mahdi, Emin Pasha was sent to Equatoria.

Public opinion in England was that Emin Pasha would share Gordon's fate, and the people called for military action to save Equatoria, but the British Government refused. The rescue expedition was funded by the Imperial British East Africa Company and King Leopold II of Belgium. Under the pretext of coming to Emin Pasha's aid, both parties were really interested in forming a trade route through Central Africa, and the King of Belgium wished to increase his control over territories in the Congo.[17]

This expedition, which could really be considered an army, went up the Congo river; after a few bloody clashes with indigenous groups, it made contact with Emin Pasha. The dislike between Stanley and Emin Pasha made for some tense moments, but in the end, Pasha acquiesced to being escorted by Stanley's expedition in the direction of the eastern coast and Zanzibar. However, the presence of German troops on the continent made Emin Pasha decide to stay on as a member of the German government. Stanley reached Zanzibar without the man he had been sent to rescue.

In this expedition, Stanley described the Rwenzori Mountains, known locally as the 'Mountains of the Moon'. Stanley then travelled to England, where he was named *doctor honoris causa* by the universities of Oxford, Cambridge, and Edinburgh.[17] Stanley published his experiences along his journeys in *In Darkest Africa* (1890) and *Through South Africa* (1898).

In his books about his Central African expeditions, Stanley frequently refers to his health problems, but includes very few details. His book *How I Found Livingstone: travels, adventures and discoveries in Central Africa* includes the following passage:

> The 20th of September had arrived. This was the day I had decided to...commence the march... I was very weak from the fever that had attacked me the day before, and it was a most injudicious act to commence a march under such circumstances...The first evil results experienced from the presence of malaria are confined bowels and an oppressive languor, excessive drowsiness, and a constant disposition to yawn. The tongue assumes a yellowish, sickly hue, coloured almost to blackness; even the teeth become yellow, and are coated with an offensive matter. The eyes of the patient sparkle lustrously, and become suffused with water. These are sure symptoms of the incipient fever which shortly will rage through the system...It is then succeeded by an unusually severe headache, with excessive pains about the loins and spinal column, which presently will spread over the shoulder-blades, and, running up the neck, find a final lodgement in the back and front of the head...the fever is... after languor and torpitude have seized him, with excessive heat and throbbing temples, the loin and spinal column ache, and raging thirst soon possesses him. Before the darkened vision of the suffering man, float...figures of created and uncreated reptiles,

> which are metamorphosed every instant into stranger shapes...growing every moment more confused...Oh! the many many hours, that I have groaned under the terrible incubi...A man in such a state regards himself as the focus of all miseries. When recovered, he feels chastened, becomes urbane and ludicrously amiable, he conjures up fictitious delights from all things which, but yesterday, possessed for him such awful portentous aspects. I speak for myself, as a careful analysation of the attack, in all its...phases.[18,23]

In another paragraph, Stanley recounts a new episode of fever:

> I was attacked...for the third time since arriving in Africa and I suffered a woeful sickness; and it was the forerunner of an attack of remittent fever, which lasted four days. This is the malignant type, which has proved fatal to so many African travellers on the Zambezi, the White Nile, the Congo, and the Niger.[18,23]

Notes on treatment are included in the story; in fact, Stanley mentions Dr Livingstone's prescriptions:

> The Doctor's prescription for fever consists of 3 grains of resin of jalap, and 2 grains of calomel, with tincture of cardamoms put in just enough to prevent irritation of the stomach—made into the form of a pill —which is to be taken as soon as one begins to feel the [first symptoms]. An hour or two later a cup of coffee, unsugared and without milk, ought to be taken, to cause a quicker action. The Doctor also thinks that quinine should be taken with the pill; but my experience—though it weighs nothing against what he has endured—has proved to me that quinine is useless until after the medicine has taken effect.[18,23]

Stanley mentions that quinine and an emetic should be taken for the illness, but observes that repeated use of the same medication leads to a weaker effect. He therefore recommends that travellers carry cathartics of all types, such as Epsom salts and resin of jalap, stating "no quinine should be taken until such medicines shall have prepared the system for its reception."[18,23]

Sir Richard Francis Burton

Richard Burton was born on 19 March 1821 in Torquay, Devon, England. At the age of 19, he matriculated in Trinity College at Oxford, but was expelled shortly thereafter for lack of discipline (Figure 7). He joined the army and served as an officer in India between 1842 and 1850. An adventurous spirit with a considerable talent for languages and disguise, he then entered the military intelligence division. He was an enthusiastic scholar of the customs, religions, and philosophies of the different Indian states. In 1853, with funding from the Royal Geographical Society of London, and disguised as an Arab, Burton visited Mecca and Medina. In his account of the journey, he stated that the Black Stone of Kaaba was probably a meteorite.

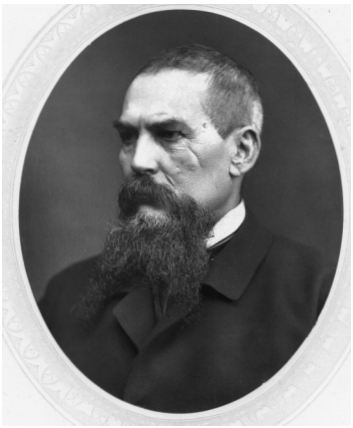

Figure 7. Sir Richard Francis Burton.

Between 1855 and 1858, he undertook several expeditions to Central Africa, one of which was with Speke. He discovered Lake Tanganyika. Burton formed part of the diplomatic service and was posted to several cities before being assigned to Trieste in 1872; he died there in 1890.[19,20]

In addition to being adventurous and acquiring a wealth of experience throughout his journeys, Burton was a prolific and versatile writer who finished more than 40 works describing his journeys to India, Africa, Mecca, and Medina. His knowledge of Eastern languages enabled him to complete English translations of *One Thousand and One Nights* and the *Kama Sutra*, which he accompanied with author's notes that included his personal observations on the subject.[19,20]

Burton's geographical works include *The Lake Regions of Central Africa*.[21,24] This book, structured like a diary, records the details and events during the expeditions. Throughout its numerous chapters, the book describes the diseases suffered by the explorers. Burton mentions fever and several types of discomfort as symptoms, but makes no concrete reference to malaria or African trypanosomiasis.

> At Dut'humi we were detained nearly a week; the malaria had brought on attacks of march fever, which in my case lasted about 20 days; the paroxysms were mild...yet...they thoroughly prostrated me. I had during the fever-fit, and often for hours afterwards, a queer conviction of divided identity, never ceasing to be two persons

> that generally thwarted and opposed each other; the sleepless nights brought with them horrid visions, animals of the grisliest form…My companion suffered even more severely, he had a fainting fit which strongly resembled a sun-stroke, and which seemed permanently to affect his brain.[21,24]

Describing Captain Speke's condition, he wrote:

> My invalid sub. had been seized with a fever-fit that induced a dangerous delirium during two successive nights; he became so violent that it was necessary to remove his weapons... On the 12th September the invalid, who, restored by a cool night, at first proposed to advance...[21,24]

He described indigenous treatments, including the following passage on the use of onions: "...great benefit from the introduction of onions—an antifebral, which flourishes better in Central than in Maritime Africa".[21,24]

In one paragraph he describes symptoms of what might have been leprosy among the natives: "The people of Usagara suffer in the lower regions from severe ulcerations, from cutaneous disorders, and from other ailments of the plain".[21,24]

The pages of Burton's diary recount the exploration of Lake Tanganyika, which he believed to be the source of the Nile based on indigenous people's stories of a great river named Rusuzi north of the lake. Burton was extremely disappointed to find that the river flowed into, not out of, that lake.

In the final pages of his book, Burton mentions Pigaffeta, the navigator and writer who collected information from Portuguese explorers to write a book, published in 1591 in Rome, whose English title is *A Report on the Kingdom of Congo and surrounding countries*. Burton's text refers to Filippo Pigafetta (1533-1604), a military engineer, and not to Antonio Pigafetta (1480-1534), to whom Filippo may have been related. Antonio Pigafetta was an explorer and geographer who chronicled the Magellan and Elcano voyage that circumnavigated the globe. He published *Relazione del primo viaggio intorno al Mundo* in Venice in 1536.

F. Pigaffeta, native to Vicenza, Italy, stated that two large lakes were to be found in northern Angola, some 600 kilometres apart, and that they were located along the same meridian. He was probably referring to Tanganyika and Victoria, which are not on the same meridian, but his lack of precision could easily be explained by the methodology used at the time. Pigafetta's statement contradicted the *Geography* of Ptolemy, which identified two large lakes located at the same latitude, one to the east and the other to the west, as the sources of the Nile. Ptolemy's lakes were probably Lakes Victoria and Albert, although they are not located along the same parallel. As mentioned in an earlier section, these lakes were discovered by Speke and Lord and Lady Baker.

Discussion

Careful reading of the books and notes written by the explorers —Stanley, Burton, Speke, and especially Livingstone— uncovers clinical accounts of malaria and African trypanosomiasis. Although these descriptions are brief, and may be no more than a scattering of notes in an explorer's diary, clinical accounts are of great historical interest.

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