

THE SCOTTISH ENCOUNTER WITH TROPICAL DISEASE



by M.P. Barrett, E.A. Innes & F.E.G. Cox

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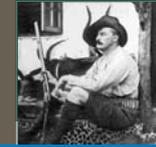
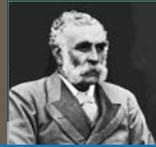
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Many of those diseases specifically associated with the tropics are caused by parasites. Parasites can be single-celled (protozoa) or else multi-cellular (worms, also known as helminths and arthropods including insects and mites) and live within or on other organisms. Parasites exert an appalling toll on human health, causing diseases like malaria, sleeping sickness, elephantiasis and schistosomiasis to name but a few.

The period between 1870 and 1920 has been described as “the golden age of Parasitology”. The causative agents of many important parasitic diseases were described in this time; many by Scottish investigators. This exhibition aims to celebrate these discoveries.

Why were so many discoveries in Parasitology made by Scots? The confirmation, by **Louis Pasteur** (1822-1895) and **Robert Koch** (1843-1910), of the so-called “germ theory of disease” stimulated scientists from around the world to seek microbial agents as causes of disease. British investigators naturally studied those ailments prevalent in countries of the British Empire which, by the 1870s, had spread throughout the tropical world.

Britain itself was, and remains, a conglomerate of different nation states. Scotland tied with England formally after the Acts of Union in 1707 but aspects of Scottish life, above all education, remained distinct.



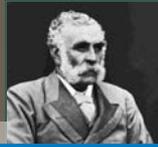
Great Scottish philosophers like **David Hume** (1711-1776) and **Adam Smith** (1723-1790) drove the so-called "Enlightenment". Industrialisation and technological advancement flooded out of Scotland. **Joseph Black** (1728-1799) led a revolution in chemistry and his former Glasgow University pupil **James Watt** (1736-1819) invented the steam engine.

Scottish education was open to anyone whereas strict class and religious rules restricted access to higher education in England. In the early nineteenth century, Scotland, with a population only a fraction that of England, could boast four Universities to England's two.

The educated and enlightened Scots who emerged from this system could not rely on inherited wealth to pay their way. They needed to work. And yet much of the British industrial system was dominated by an elite English establishment. Scots frequently needed to look elsewhere. Two of the most influential early European explorers of Africa were **James Bruce** (1730-1794), who discovered the source of the Blue Nile, and **Mungo Park** (1771-1806) who navigated the river Niger. Both were Scots. These pioneers preceded **Dr David Livingstone** (1813-1873) whose success as an explorer in Africa can be linked to his diligence as a physician so we root our discussions on the Scottish encounter with tropical disease with him (see David Livingstone, pages 6-7).

Patrick Manson (1844-1922) (see Patrick Manson, pages 8-9) was distantly related to Livingstone. Manson's career took off in Formosa, modern day Taiwan, where he established a medical practice having found it difficult to find a lucrative position back home. Many of the individuals described in this exhibition were directly linked to Manson who is often considered to be "the Father of Tropical Medicine".

The tradition established by these forebears in tropical medicine is upheld today. The main Scottish Universities retain active research groups in Parasitology and bring in millions of pounds in research funding every year. The country is rightly considered to be a world leader in research into parasitic disease.



SCOTTISH PARASITOLOGISTS TIMELINE

Timeline of some major discoveries on parasites of humans made by Scottish parasitologists:

- 1768 Lind suggests the use of the herb ipecacuanha to treat amoebiasis
- 1841 Livingstone arrives in Africa
- 1874 McConnell describes the liver fluke *Clonorchis sinensis*.
- 1877 Manson demonstrates that the filarial worm *Wuchereria bancrofti* is transmitted by mosquitoes
- 1881 Manson suggests that the lung fluke *Paragonimus westermani* develops in snails
- 1885 Cunningham identifies leishmania parasites in an oriental sore
- 1893 Davidson publishes his book on 'Hygiene and Diseases of Warm Climates'
- 1895 Argyll-Robertson suggests that the nematode worm *Loa loa* is transmitted by blood-sucking insects
- 1897 Ross identifies malaria parasites in *Anopheles* mosquitoes



1. David Livingstone



2. Patrick Manson



3. Douglas Argyll-Robertson

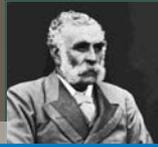


4. Ronald Ross



5. George Carmichael Low

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- 1900 Low demonstrates microfilariiae in mosquito mouthparts and confirms transmission through the bite of a mosquito
- 1903 Leishman describes *Leishmania donovani*.
- 1904 Symmers describes the liver pathology of schistosomiasis
- 1905 Bruce confirms that trypanosomes cause sleeping sickness as well as nagana and are transmitted by tsetse flies
- 1912 Leiper demonstrates transmission of *Loa loa* by flies of the genus *Chrysops*
- 1912 Robertson describes developmental stages of *Trypanosoma gambiense* in tsetse flies
- 1914 Leiper distinguishes between *Schistosoma mansoni* and *S. haematobium* and identifies their snail intermediate hosts
- 1915 Stewart demonstrates the life cycle of *Ascaris*
- 1926 Blacklock elucidates the life cycle of *Onchocerca volvulus* in blackflies
- 1948 Shortt discovers exoerythrocytic stages of *Plasmodium*
- 1969 Hutchison describes the life cycle of *Toxoplasma gondii*



6. William Leishman



7. David Bruce



8. Muriel Robertson



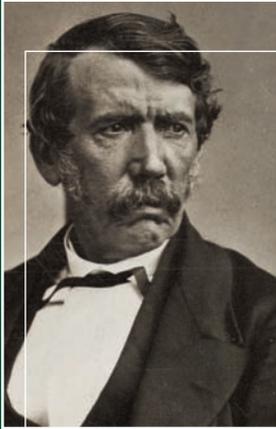
9. Henry Shortt



10. William Hutchison

DAVID LIVINGSTONE

1813-1873



1. David Livingstone

“Dr Livingstone I presume.” With these words **Henry Morton Stanley**, a flamboyant journalist, in 1871, “found” the world’s most famous explorer at Ujiji, a village on the shores of Lake Tanganyika, in modern day Tanzania. **David Livingstone** was born to humble origins in 1813, at Blantyre, a few miles to the South of Glasgow. As a boy, he worked in cotton mills on the banks of the Clyde, but was an avid learner, and eventually enrolled to study medicine at Anderson’s College in Glasgow.

Livingstone went on to join the church and it was as part of the London Missionary Society that he left Britain, in 1841, with the hope of spreading the gospel in Africa. Livingstone’s achievements are awe-inspiring. He travelled 29,000 miles, mainly on foot, through jungle, desert and swamp; discovering peoples, animals, lakes, the Victoria Falls, and vast areas of previously uncharted land. In all he made three separate expeditions to Africa and became one of the greatest figures of the Victorian age. His ultimate aim was to rid the world of slavery. He finally died aged sixty, in 1873, during an extraordinary quest to find the sources of the Nile, the greatest goal of Victorian exploration.

“ *Beware the Bight of Benin, for there’s one that comes out for ten that goes in* ” went an old sea shanty. Parts of Africa had rightly picked up the reputation as “The white man’s grave”. It was Doctor Livingstone’s diligence as a physician that allowed him to succeed where others failed. He suffered from repeated bouts of malaria, but found that quinine (an ancient remedy made from the bark of Peruvian Cinchona trees) could keep the disease at bay. Another Scottish explorer **William Balfour Baikie** (1824-1864) had promoted the use of quinine after navigating the Niger in 1854. Burroughs-Wellcome later marketed a quinine-based medication called Livingstone’s rousers.

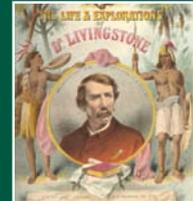
Livingstone suggested the tsetse fly as the agent that transmitted animal trypanosomiasis, and human African trypanosomiasis was described later.

He even introduced the use of arsenic to treat trypanosomiasis, although the microbial cause was not then known. Arsenical drugs are still used in trypanosomiasis therapy today (see African Trypanosomiasis, pages 10-11). He survived multiple different infectious agents, although many of Livingstone's companions, including his wife, Mary, died from malaria.

Under the influence of Livingstone, a generation of young Britons set off with the aim of building what they hoped would be a better world overseas. The hope of economic gains in the lands that Livingstone and other pioneers, like Stanley, had opened up then led to the European colonisation of Africa. The prolific impact of tropical infectious disease on the colonists was a major hurdle in this process.

Sir Henry Wellcome (1853-1936), founder of the Wellcome Trust, who provided funding for this exhibition, was a pallbearer at Stanley's funeral. Wellcome and Stanley had been great friends, with Wellcome providing Stanley with medicines for his travels in Africa.

The priority shown towards tropical medicine by the Wellcome Trust today owes a great deal to Livingstone and Stanley. The building in which Livingstone was born is preserved as a memorial in his honour "The David Livingstone Centre" in Blantyre.



2. Victorian Hero



3. Henry Morton Stanley



4. Sir Henry Wellcome



5. David Livingstone Centre

PATRICK MANSON

1844-1922



1. Patrick Manson

Patrick Manson is widely regarded as the “Father of Tropical Medicine” and is certainly one of the most important figures in the history of Parasitology. He is credited with having established “Tropical Medicine” as a distinctive discipline. Manson was born at Oldmeldrum, Aberdeenshire, and at the age of 14 went to work as an apprentice in an ironworks. However, illness prevented him from pursuing a career in this industry and he enrolled at the University of Aberdeen where he graduated in Medicine.

After routine posts in England, Manson joined the Chinese Imperial Maritime Customs Service and, while working in Amoy (now Xiamen), demonstrated that the filarial worm, *Wuchereria bancrofti* (see The Filariases, pages 18-19) was transmitted by mosquitoes and, in doing so, established the field of vector-borne diseases.

He also recorded the nocturnal periodicity of microfilariae and postulated that infection with adult *W. bancrofti* was the cause of the grotesque disease elephantiasis (see The Filariases, pages 18-19). Later, with **George Carmichael Low**, he elucidated the developmental stages of *W. bancrofti* in mosquitoes.

While in Amoy, he discovered the disease-causing lung fluke, *Paragonimus westermani*, and suggested that it had a snail intermediate host. Additionally, he identified the first cases of human infection with larvae of the tapeworm *Spirometra*.

Moving to Hong Kong, he helped to establish the Hong Kong College of Medicine and became its Dean. On returning to England he made a number of important contributions to our understanding of schistosomes suggesting that there were two species of schistosome, *Schistosoma haematobium* and *S. mansoni*. He began to suspect that schistosomes had been introduced to South America from Africa.

He also reckoned that the geographical distribution of these and other parasites depended on the presence or absence of suitable intermediate hosts.

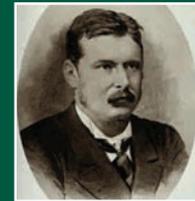
His other discoveries included the recognition of microfilariae of *Loa loa* (see *The Filariases*, pages 18-19) and, with **Douglas Argyll-Thompson**, a description of the morphology of the adult worms. He made a preliminary report on *Onchocerca volvulus* and suggested that it might be transmitted by a blood-sucking insect. He also described the filarial worms *Filaria* (now *Mansonella*) *perstans* and *Filaria* (now *Mansonella*) *ozzardi*. Manson soon confirmed the Russian naturalist **Fedchenko's** discovery that the Guinea worm, *Dracunculus medinensis*, developed in the tiny crustacean known as *Cyclops* and this led to Robert Leiper's discovery that *Cyclops* was indeed the intermediate host of *D. medinensis*.

Apart from his ground-breaking discovery of the mosquito transmission of filarial worms, his most important contribution to Parasitology was persuading **Ronald Ross** to investigate the life-cycle of the malaria parasites and their transmission by mosquitoes, something he scrutinised every step of the way continually encouraging and cajoling the younger scientist. Manson was largely responsible for the foundation of the London School of Tropical Medicine and was instrumental in recruiting the helminthologist **Robert Leiper** to the School.

He was the first President of the Society of Tropical Medicine and Hygiene (now the Royal Society of Tropical Medicine and Hygiene). Many of the other parasitologists shown in this exhibition, and others not shown here, were the protégés of Manson.



2. Manson's filaria drawings



3. Patrick Manson



4. Manson's filaria drawings



5. Plaque From Manson's London home

AFRICAN TRYPANOSOMIASIS



1. Trypanosomes in blood

The African trypanosomiasis afflict both man and animals in Africa (and some can be found on other continents). Trypanosomes are flagellated protozoa of the Order Kinetoplastida. In humans, two subspecies of *Trypanosoma brucei* (*T. b rhodesiense* and *T. b gambiense*) respectively cause acute and chronic forms of the disease human African trypanosomiasis, or sleeping sickness. The parasites, transmitted by tsetse flies, proliferate in the blood and lymphatic systems before invading the brain.

In the brain, trypanosomes cause a progressive breakdown of neurological function and changes in sleep/wake patterns are common (hence sleeping sickness). The disease is always fatal without treatment. The end of the twentieth century witnessed a dramatic resurgence in sleeping sickness with up to half a million people infected by the African trypanosome. Numbers have declined in the last couple of years due to a concerted World Health Organisation-led campaign to deal with the disease.

Treating patients, separating people from the tsetse fly and destroying the fly can all act to help control the disease.

Several drugs are registered to treat human African trypanosomiasis, however none is entirely satisfactory. For example, the most widely used drug once the nervous system is involved is called melarsoprol which is based on arsenic! This drug kills one in twenty taking it (an improvement on the inevitable death from the disease, but clearly not ideal as a drug). The Bill and Melinda Gates Foundation are presently funding development of a new, oral drug for the disease, and fortunately the drug companies Sanofi-Aventis and Bayer currently donate anti-sleeping sickness drugs free of charge to the World Health Organisation to distribute in Africa.

A Geneva-based not-for-profit entity, The Drugs for Neglected Diseases Initiative (DNDi), has development of new drugs for trypanosomiasis as a major goal. Vaccination is not feasible as the parasites are shrouded in a dense glycoprotein coat. They can periodically switch the nature of the coat, meaning that the immune system is in a constant game of catch-up to identify the ever-changing parasites.

Attempts to control the tsetse fly that transmits the disease depend on the use of traps that capture and kill the flies or else targeted spraying with insecticides. The possibility of releasing sterile male tsetse flies that mate with females unproductively has been much debated. The approach was used, alongside tsetse trapping and spraying, to eradicate trypanosomiasis from the island of Zanzibar in the late 1990s. The logistics of pursuing similar campaigns on mainland Africa will be more challenging.

A number of other trypanosome species infect animals and make the import of high-productivity livestock breeds impossible in many areas in Africa (however, some local cattle breeds are tolerant of the parasites). On the one hand trypanosomiasis is thought to deprive local communities of high protein food but, on the other hand, some consider the tsetse to have been a guardian of Africa in keeping domestic livestock at bay allowing indigenous cattle breeds and wild-life to flourish.



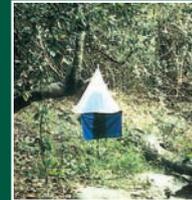
2. Tsetse fly



3. Trypanosomes



4. Sleeping sickness patient



5. Tsetse trap

THE SCOTTISH ENCOUNTER WITH AFRICAN TRYPANOSOMIASIS



1. David Bruce

Sir David Bruce is credited with identifying trypanosomes as the cause of sleeping sickness. **David Livingstone** suspected that tsetse fly bites killed domestic animals in Africa. He saw the tsetse problem as a major impediment to European settlement there. An outbreak of the tsetse-transmitted wasting disease of cattle called nagana, or “fly disease”, alarmed colonial authorities in Southern Africa towards the end of the nineteenth century.

The turn of the century also saw serious human sleeping sickness epidemics break out across Africa. **Sir Winston Churchill**, in 1906, reported that sleeping sickness had reduced the population of Uganda from 6.5 million to 2.5 million.

David Bruce (1855-1931)

David Bruce is credited with identifying trypanosomes as the cause of both nagana in cattle and human sleeping sickness. Bruce was born to Scottish parents in Melbourne, Australia, returning to Scotland (Stirling) aged five. He was educated at the University of Edinburgh, studying Zoology and then Medicine.

An Army Medical Service posting in Malta led to the discovery of a bacterial cause of Malta fever (Brucellosis). In 1894 he was posted to South Africa to investigate a nagana epidemic. He recognised flagellates, similar to trypanosomes (*T. evansi*) earlier found in horses suffering from a disease called Surra in India by **Griffith Evans**. Bruce also incriminated the tsetse fly, *Glossina morsitans*, in transmission of the disease. Between 1901-1912 The Royal Society sent a series of Commissions to investigate sleeping sickness in Uganda. The first included **Aldo Castellani**, an Italian doctor (later a physician to **Benito Mussolini**) who found trypanosomes prior to the arrival of Bruce. However, it is Bruce who is credited with recognising their significance.

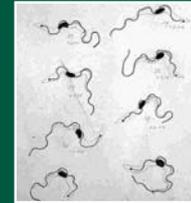
George Carmichael Low (1872-1952)

George Carmichael Low was also part of the first sleeping sickness Commission to Uganda. Low was born at Monifieth (near Dundee) and educated at the University of Edinburgh where he graduated in Medicine before moving to London to work with **Patrick Manson**. He later became superintendent of the London School of Tropical Medicine and played key roles in many discoveries. He showed that avoiding mosquitoes allowed him to stay malaria-free in Italy. In addition, Low conclusively demonstrated the life cycle of the nematode *Wuchereria bancrofti* in mosquitoes. With **Sir James Cantlie**, Low co-founded the Society of Tropical Medicine now the Royal Society of Tropical Medicine and Hygiene.

Muriel Robertson (1883-1973)

Muriel Robertson made key discoveries regarding the trypanosome's life cycle. She was born in Glasgow in 1883. Whilst studying in the Arts at Glasgow University she learned Zoology under **Professor Graham Kerr**. Protozoa in particular fascinated her. She moved to Ceylon (Sri Lanka) in 1907 to study trypanosome infections of reptiles and then in 1911 moved to Uganda.

She played a major role in unravelling the life cycle of *Trypanosoma brucei* in both mammals and in the tsetse fly. She noted the undulating parasitaemia associated with trypanosome infections and found that only the stumpy trypanosomes seen during remission could infect tsetse flies.



2. Bruce's drawings



3. Muriel Robertson

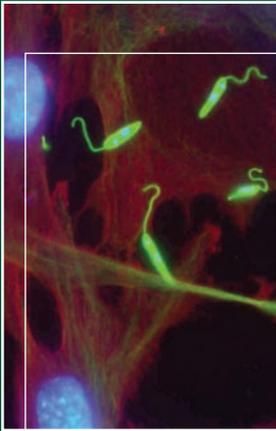


4. David Bruce



5. George Carmichael Low

LEISHMANIASIS



The leishmaniasis are a family of diseases that are prevalent throughout much of the tropics and sub-tropics; some 88 countries harbour the causative *Leishmania* parasites with 350 million people at risk of this disease.

Leishmania are protozoa, closely related to trypanosomes with which they share many features. Diseases caused by these parasites range from a relatively mild skin ailment to a fatal affliction of the visceral organs.

1. *Leishmania* flagellated forms (green)

A particularly unpleasant type of leishmaniasis is the mucocutaneous type which occurs in parts of Latin America. A well known TV documentary about "The Boy David" tells the story of how **Dr Ian Jackson**, a Scottish surgeon, reconstructed the face of David Lopez, a young Peruvian boy afflicted by mucocutaneous leishmaniasis.

Around 1.5 million people contract cutaneous disease each year and half a million or so get the visceral disease. Over 90% of the world's cases are in India, Bangladesh, Nepal, Sudan and Brazil. The disease has also emerged as a considerable problem in southern Europe associated with the HIV/AIDS epidemic.

The parasites are transmitted between mammals by blood sucking sandflies, so called because of their sandy colour. Mammals such as rodents and dogs act as reservoirs of the disease.

Drugs do exist to treat leishmaniasis. Antimony, in various forms, has been a mainstay of treatment, although recent advances have enabled a number of safer drugs to emerge, including some frequently used to treat fungal diseases.

The Drugs for Neglected Diseases Initiative (DNDi) and another not-for-profit entity The Institute of OneWorld Health (iOWH) are seeking new treatments for leishmaniasis.

The World Health Organisation Special Programme for Research and Training for Tropical Diseases (WHO/TDR) has long been involved in research into leishmaniasis and most of the diseases in this exhibition. The Neglected Tropical Diseases Department at WHO is involved in many operational activities against most of the diseases described in this exhibition.

Leishmania parasites thrive within cells usually involved in displaying invading microbes to the immune system. Different *Leishmania* species somehow target different organs in the body.

Although no registered vaccines exist, there is hope that vaccines might be developed since, certainly in the case of the cutaneous disease, exposure appears to lead to lasting immunity.

This fact has led to a process of "leishmanisation" in many parts of the world, where mothers apply sandflies to their infants to induce a localised disease on the buttocks to ensure later exposure would not lead to development of unsightly lesions on the face.

Old World leishmaniasis is an ancient disease and the lesions associated with this condition were well known by a variety of local names including Balkh sore, Baghdad boil, Biskra button, Dehli boil, Sart sore, Pendeh sore and Mal d'Aleppo, throughout the regions where leishmaniasis now occurs.



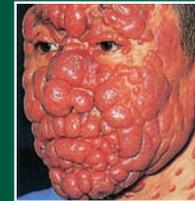
2. *Leishmania* promastigotes



3. Visceral Leishmaniasis



4. Mucocutaneous Leishmaniasis



5. Post-kala azar dermal syndrome

THE SCOTTISH ENCOUNTER WITH LEISHMANIASIS



1. William Leishman

Leishmaniasis is named after the Glaswegian **William Leishman** who is credited with first identifying the parasites that cause this disease. Early in the nineteenth century, military and civilian clinicians in India began to record outbreaks of a febrile disease, known under a variety of local names including black disease, kala azar, Burdwan fever and Dum Dum fever, that did not fit easily into any well-established categories. There was considerable interest in its cause.

Although the organisms causing Old World leishmaniasis had been described by the Russian, **Peter Fokitsch Borovsky**, in 1898, this information was not available to those working in India.

William Boog Leishman (1865-1926)

William Boog Leishman, after whom leishmaniasis was named by **Ronald Ross** in 1903, was born in Glasgow and educated at the University of Glasgow. After graduating in Medicine he joined the Army Medical Corps in which he served for the whole of his career in India and later at the Army Medical School at Netley in Hampshire.

In 1900, using a modification of Romanowsky's stain, now called Leishman's stain, he discovered *Leishmania donovani*, the causative agent of kala azar, in a soldier who had died of "Dum Dum fever". Leishman noted the similarity between these parasites and trypanosomes. Before publishing his findings, however, **Charles Donovan**, serving in the Indian Medical Service, independently found the same parasite. Their two names are commemorated in the common name for the parasites, Leishman-Donovan (LD) bodies.

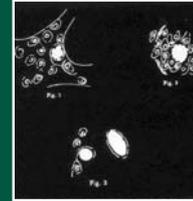
David Douglas Cunningham (1843-1914)

David Douglas Cunningham made the first drawings of *Leishmania* amastigotes isolated from a Dehli boil. Cunningham was born in Prestonpans, East Lothian, and educated at the University of Edinburgh. He became Professor of Medicine and Pathology at the Calcutta Medical College where he made a number of contributions to Parasitology including early accounts of *Entamoeba coli* and *Trichomonas hominis*.

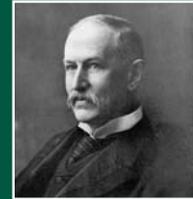
Henry Edward Shortt (1887-1987)

Henry Edward Shortt implicated the sandfly, *Phlebotomus argentipes*, in the transmission of *Leishmania donovani* (bed bugs had been suspected hosts). Shortt was born of Scottish parents in Dhariwal, India. He returned to Inverness as a child and was educated at the University of Aberdeen where he graduated in Medicine and then joined the Indian Medical Service. He made contributions to leishmaniasis, oriental sore, malaria, canine babesiosis and hookworm disease. He was also instrumental in introducing pentavalent forms of antimony as first line treatment for leishmaniasis. On retirement from the IMS he went to London to join **Robert Leiper** at the London School of Hygiene and Tropical Medicine.

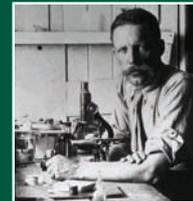
There he began to study the exo-erythrocytic stages of the malaria parasites in birds, monkeys and finally in humans. With **Cyril Garnham**, he discovered the tissue stages of the malaria parasites in the liver, something that had eluded malariologists for half a century.



2. Cunningham's *Leishmania* drawings



3. David Cunningham



4. Henry Shortt



5. William Leishman

THE FILARIASES



Filarial worms are members of the vast helminth family known as the nematodes (or roundworms) that comprises numerous free living forms as well as parasites. The filariases are a group of diseases caused by filarial worms and transmitted by insect vectors. The worms dwell in the blood, lymphatics, skin or other tissues.

1. *Wuchereria bancrofti* microfilaria

Elephantiasis

The filarial worms *Wuchereria bancrofti*, *Brugia malayi* and *Brugia timori* cause lymphatic filariasis. The disease is also known as elephantiasis in severe cases due to the grotesque malformations which are characteristic of patients' bodies. Mosquitoes carry the filaria between people. Over 120 million individuals in 80 countries throughout the tropics and sub-tropics are infected with lymphatic filariasis today. Extraordinary enlargement of the scrotum can mark advanced elephantiasis as can thickening of the skin and massive swelling of legs and feet in particular.

Drugs are available to treat infections with the young worms (microfilariae), but agents that kill adult worms have been difficult to identify. The drug companies Merck and GlaxoSmithKline, respectively donate ivermectin and albendazole for use in global programmes aimed at eliminating the disease. Large scale drug treatment programmes, targeting people living in areas where the disease is endemic, are having an impact on the prevalence of the disease. Spraying of insecticides to restrict the distribution of carrier mosquitoes is also playing a role in combating the disease.

Onchocerciasis

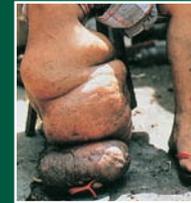
Onchocerciasis, or river blindness, is a terrible disease caused by microfilarial nematodes called *Onchocerca volvulus*. Some 20 million people in Africa and South America are infected. The parasites are seldom fatal but cause much suffering to infected individuals.

Around a million people in the world today have been blinded by the disease. *O. volvulus* is transmitted by blackflies of the genus *Simulium*. These flies breed in well-oxygenated, fast flowing water, hence the association between the disease and rivers. Drugs can treat onchocerciasis but the blindness it causes is irreversible. In an extraordinary development, it was recently shown that the parasites rely upon bacterial symbionts called *Wolbachia*, so much so that the worms lose vitality and fertility when their bacterial partners are killed. Antibacterial agents are currently being tested as novel treatments for filariasis. An Onchocerciasis Control Programme in West Africa, targeting the blackfly vector, restricted spread of the disease through the 1970s and 1980s.

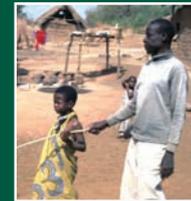
Programmes to eliminate the disease, using drugs as well as vector control, are ongoing in both Africa and Latin America.

Loiasis

Loiasis is caused by filarial worms called *Loa loa*. It is restricted in distribution to West and Central Africa. The worms are transmitted by *Chrysops* flies. Around 20 million people are at risk of the disease. The adult worms migrate around the body and are frequently seen migrating just beneath the skin, or even across the conjunctiva of the eye. More often loiasis is characterised by swellings on the forearm, or elsewhere, called Calabar swellings. Drugs including diethylcarbamazine (DEC) are effective against Loiasis.



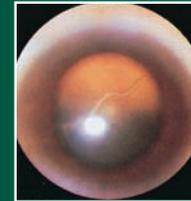
2. Elephantiasis leg



3. River blindness

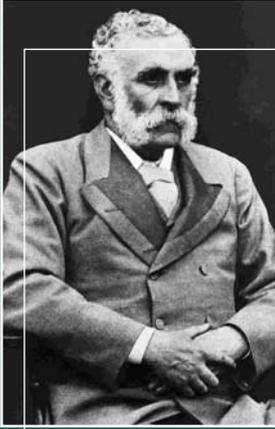


4. *Simulium* blackfly



5. *Loa loa* in eye

THE SCOTTISH ENCOUNTER WITH FILARIASES



1. Douglas Argyll-Robertson

Douglas Argyll-Robertson, a Scottish surgeon, noted the role of *Loa loa* in Calabar swelling. Various other Scots also played key roles in elucidating the nature of the filariases. The discovery of the life cycle of filarial worms by Patrick Manson (see Patrick Manson, pages 8-9) in 1878 is among the most significant discoveries in Parasitology or in Medicine more generally.

Larval stages (microfilariae) of *Wuchereria* were first seen in the blood of humans in 1863 by **Jean-Nicholas Demarquay**. **Timothy Lewis**, who trained in Aberdeen, linked the worms with filariasis in 1872.

Manson's own breakthrough came while working in Amoy. He fed mosquitoes on the blood of his gardener, who was harbouring the parasites. Sure enough larval stages of the worms later appeared in the mosquitoes. The actual mode of transmission, through the mosquito's bite, was only established when suggestions by the Australian parasitologist, **Thomas Bancroft**, were followed up by Manson's colleague **George Carmichael Low**.

Douglas Moray Cooper Lamb Argyll-Robertson (1837-1909)

Douglas Argyll-Robertson made key observations in regard to the filarial disease loiasis. He was born in Edinburgh and educated at the Universities of Edinburgh, St. Andrews and Berlin. After graduating in Medicine (St Andrews, 1857) he trained as an ophthalmic surgeon at the Edinburgh Royal Infirmary before becoming President of the Royal College of Surgeons of Edinburgh.

In 1895 he described male and female adult *Loa loa* and recognised the connection between Calabar swelling and these worms. Argyll-Robertson also pioneered surgical removal of adult worms from the eye.

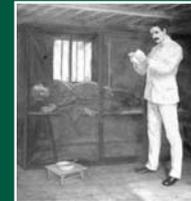
Donald Breadalbane Blacklock (1879-1955)

Donald Blacklock elucidated the life-cycle of *Onchocerca* in its blackfly vector. Blacklock was born in Oban and educated at the University of Edinburgh where he graduated in Medicine. After working in South Africa he trained in public health and took the Diploma in Tropical Medicine at the Liverpool School of Tropical Medicine. In Liverpool he was appointed first as a research assistant to work on trypanosomiasis and then Lecturer and subsequently Professor of Parasitology.

Robert Thompson Leiper (1881-1969)

Leiper was born in Kilmarnock and educated at the Universities of Birmingham and Glasgow where he graduated in Science, Medicine and Surgery. **Manson** invited him to found a Department of Helminthology at the London School of Hygiene and Tropical Medicine and made him promise to spend his whole life on the subject of Helminthology. For over 60 years Leiper was among the most eminent helminthologists in the world.

He made numerous contributions, particularly the incrimination of *Chrysops* in the transmission of *Loa loa*, the development of schistosomes in snails and the mode of infection by cercariae boring through the skin. With Manson, he elucidated the life cycle of the Guinea worm, *Dracunculus medinensis*, in its crustacean host, *Cyclops*. He was instrumental in initiating schemes to control schistosomiasis and Guinea worm and advocated the need for supplies of fresh water to prevent water-borne parasitic infections.



2. Manson with his gardener



3. Donald Blacklock



4. Robert Leiper



5. Cyclops

PARASITIC FLUKES



1. Coupling adult schistosomes

Flukes belong to the flatworm family, a number of which cause important diseases in man and in animals. Their modes of transmission frequently involve water-dwelling intermediate hosts. Schistosomiasis in particular is one of the main scourges of mankind.

Schistosomiasis

Schistosomiasis, or bilharzia, is caused by parasitic trematode worms of the genus *Schistosoma* and transmitted by fresh-water snails including those of the *Bulinus* and *Biomphalaria* groups. Some 200 million people are infected by these worms in 76 tropical and sub-tropical countries with some 85% of cases on the African continent. Larval forms released from the snail burrow through the skin of people in fresh water. In the blood they transform into adult forms.

Different species of schistosome cause different diseases. Much of the pathology associated with the disease is due to the release of microscopic eggs by female worms.

The eggs possess spines and damage tissues in which they lodge. Male and adult female worms, reaching up to 30 mm in length, engage in a life long coupling. The females release several hundred eggs each day and immunological reactions to these can cause serious, life threatening damage to the liver, spleen, bladder, kidneys, lungs and other organs.

Schistosomiasis ranks second only to malaria as a parasitological disease in overall socio-economic and public health impact.

The drug praziquantel is effective against schistosomiasis. It is relatively cheap and widely available. No vaccine is available although research is revealing more about the immune response to the parasite. In addition to large-scale drug administration, control methods have focused on application of molluscicides to water in which the snail hosts are found. Avoiding snail infested water limits the risk of infection.

Liver and Lung flukes

Over 100 species of flukes infect humans either as adults or larvae. Hundreds of millions of people are infected with lung and liver flukes. They are usually acquired when eating infected intermediate hosts such as undercooked fish or shellfish. Sushi eaters beware! The most important human infectious flukes are *Paragonimus westermani*, the lung fluke that causes paragonimiasis, and the liver flukes *Clonorchis* (now *Opisthorchis*) *sinensis* and other *Opisthorchis* spp..

17 million people are infected with liver flukes which cause profound inflammation within the liver. Praziquantel is active against these parasites. Praziquantel is also active against the lung flukes which can be avoided by not eating uncooked shellfish or crustaceans.



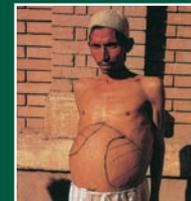
2. Schistosome: cercaria



3. Coupling schistosomes



4. *Biomphalaria* snail



5. Schistosomiasis (splenomegaly)

THE SCOTTISH ENCOUNTER WITH PARASITIC FLUKES



1. Robert Leiper

Robert Leiper (see The Scottish Encounter with Filariases, pages 20-21) made key contributions to research into flatworms (flukes) as well as filarial roundworms. Schistosomiasis has been known since antiquity. The adult worms were described by **Theodor Bilharz** in the mid-nineteenth century, but virtually nothing was known about the pathology or the life cycle of the parasites nor how many separate schistosome species were infectious to man. Scottish parasitologists played major parts in resolving these issues.

Patrick Manson (see Patrick Manson, pages 8-9) made numerous important contributions to fluke research. In 1902 Manson suggested that *S. haematobium* was not the only human infectious schistosome. This was confirmed in 1915 when Robert Leiper named the second species *S. mansoni*.

Manson also suggested that snails may play a role in the transmission of the lung fluke *Paragonimus* (first discovered in the lungs of humans by **Sidney Ringer** in 1879). A number of Japanese investigators, between 1916-1922, described the life cycles of liver and lung flukes including *Clonorchis* passage through snails and also fish, and crustaceans including crayfish.

James Frederick Parry McConnell (1848-1895)

James Frederick Parry McConnell first recognised *Clonorchis sinensis* in 1875. McConnell was born of Scottish parents in Agra, India.

He was educated at the University of Aberdeen where he studied Medicine. After qualifying in Medicine and Surgery, he joined the Indian Medical Service and later became Professor of Pathology at the Calcutta Medical College. It was there that he recognised the first case of infection with the liver fluke *Clonorchis* (now *Opisthorchis*) *sinensis* and realised that it was different from other flukes known from the livers of humans.

He subsequently found the fluke in a number of Chinese patients and, based on the eating habits of these individuals, surmised that the infection might be due to the consumption of uncooked fish but took this no further. He also recorded for the first time *Amphistoma* (now *Gastrodiscoides*) *hominis* and hookworm infections in India but did not consider the latter to be a significant cause of disease.

William St Clair Symmers (1863-1937)

William St Clair Symmers implicated the eggs of schistosomes in the pathology of the disease. Symmers was born of Scottish parents in South Carolina, USA. The American Civil War left the South in disarray. Southerners were excluded from the Northern medical schools. Symmers' Scottish relatives helped secure a place at Aberdeen University where he studied Medicine. During his studies he began to lose his sight. Undeterred he became a bacteriologist and worked with Pasteur in Paris and at the Lister Institute before going to Egypt where he became Professor of Bacteriology and Pathology at the Government Medical School in Cairo.

While there he made a five-year study of liver pathology and it was during this time that he recognised the importance of the eggs in the pathology of schistosomiasis. He went on to become Professor of Pathology at Queens College, Belfast.



2. *S. Haematobium* egg by Manson



3. *Paragonimus* eggs by Manson

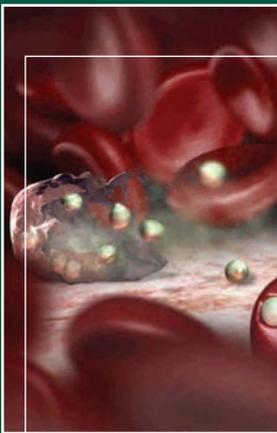


4. William St. Clair Symmers



5. *Opisthorchis*

MALARIA



Malaria is one of the most important infectious diseases on Earth. Over 40% of the world's population dwell in malarious regions and are at risk of infection by parasitic protozoa of the genus *Plasmodium*. Around 500 million people carry the parasites today and 1-3 million individuals, mainly children, die from the disease each year. Four species of *Plasmodium* infect humans, the deadliest being *Plasmodium falciparum*.

1. Malaria parasites burst out of a red blood cell

Malaria parasites are transmitted by female mosquitoes of the genus *Anopheles*. Parasites, injected into the blood, rapidly enter cells in the liver. Here they transform into new forms that invade red blood cells. Every 48, or 72 hours, depending on the species, the parasites complete a cycle of multiplication in red blood cells and then burst out, inducing the profound periodic fevers that characterise the disease. The deadly *falciparum* malaria can, in around 1% of cases, lead to cerebral or other organ damage as parasitised red cells block the blood vessels feeding the brain and other organs.

Malaria was eradicated from Western Europe and the United States through dramatic campaigns, draining swamplands and other standing water, to deprive Anopheline mosquitoes of their breeding grounds. The introduction of DDT as an insecticide promised to facilitate eradication of Anopheline mosquitoes on a wider scale. But those efforts were thwarted by insecticide resistance and concerns that widespread insecticide use may be of detriment to the environment. Since mosquitoes bite principally at night, the use of bednets or curtains, is an important way of preventing contact.

Moreover, insecticide impregnated bednets offer a means of targeting insecticide just to biting insects without adverse effects on the wider insect fauna.

Drugs have been available to use against malaria for many years. Quinine, derived from the bark of the South American Cinchona tree has been used for at least 500 years. Synthetic derivatives like chloroquine were developed in the early twentieth century and used on a large scale during and since the second world war. Unfortunately parasite resistance to chloroquine is now wide-spread. New drugs based on an old Chinese herbal remedy, artemisinin, have recently been introduced.

In spite of our understanding about malaria, the last part of the twentieth Century witnessed more human beings being infected with this disease than ever before. The Roll Back Malaria (RBM) Global Partnership was launched in 1998 by the World Health Organization, UNICEF, UNDP and the World Bank. In 1999 the Medicines for Malaria Venture (MMV), a Geneva based public private partnership, was established attempting to bring new drugs to the market place and the Malaria Vaccine Initiative

(MVI) is also tapping into international expertise in attempts to develop vaccines.

The Bill and Melinda Gates Foundation is providing significant finance towards these efforts. Other agencies, notably Britain's Wellcome Trust, The World Health Organisation and various governments and charities are also contributing. It is estimated that many billions of US dollars will be required to defeat malaria.



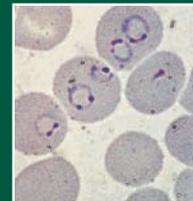
2. *Anopheles* mosquito



3. Malaria splenomegaly



4. Bednet



5. Malaria in red blood cells

THE SCOTTISH ENCOUNTER WITH MALARIA



1. Ronald Ross

Sir Ronald Ross won the Nobel prize for his elucidation of mosquito-transmission of malaria. The earliest accounts of malaria are those of Hippocrates in the fifth century BC and from that time onwards it became apparent that malaria was associated with marshes. Although today we consider malaria to be principally a disease of the tropics it was endemic in the United Kingdom into the twentieth century. **Mussolini** is frequently credited with eradicating malaria from Italy through swamp drainage programmes.

Malaria was even present in medieval Scotland. The eponymous anti-hero of **Shakespeare's** Scottish play was hopeful that his enemies, besieging Dunsinane castle in Perthshire, would succumb to The Ague. Ague was the term used for malarial fevers at this time. It was **John McCulloch**, born on Guernsey to a Scottish father, who first introduced the term malaria into the English language (from the Italian mal-aria meaning "bad air" ; it was long believed that the disease was transmitted by breathing miasmas emanating from stagnant water).

Our scientific understanding of malaria did not begin until the end of the nineteenth century.

The parasites themselves were first seen in 1880 by a French army surgeon, **Alphonse Laveran**. The discovery that the mosquito acted as a vector was due to the intuition of **Patrick Manson** who had already demonstrated that mosquitoes transmitted lymphatic filariasis. Manson persuaded **Ronald Ross**, an army surgeon, to carry out work in India to prove the hypothesis that mosquitoes carried malaria parasites. This Ross did, although Italian malariologists made related discoveries at the same time. In 1947, **Henry Shortt** (see The Scottish Encounter with Leishmaniasis, pages 16-17) showed that, in humans, a phase of division in the liver preceded the development of parasites in the blood.

He also introduced the concept of pre-erythrocytic and exo-erythrocytic forms which had a significant effect on the development of antimalarial drugs and possible vaccines.

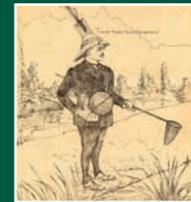
Ronald Ross (1857-1932)

Ronald Ross was born in India in 1857. Ross's family had connections with India stretching back to his great-great grandfather who was a director in the East India Company. The family descended from the Rosses of Balnagowan and Shandwick, Rossshire, Scotland. Ross moved from India to Southern England aged 10. His medical education was at St Bartholomew's Hospital and he joined the Indian Medical Service in 1881. Ross's outstanding achievement was the discovery of the malaria parasite in *Anopheles* mosquitoes. In 1894, Manson encouraged Ross to use his time in India to prove a connection between mosquitoes and malaria transmission. It was on 20 August 1897 that Ross eventually made his discovery. In 1898, he observed the whole of the sporogonic life cycle of an avian malaria parasite, *Plasmodium relictum*, in culicine mosquitoes.

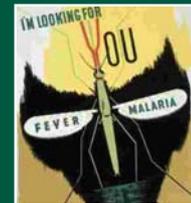
For these discoveries Ross was the first British recipient of a Nobel prize (in 1902) and is the only British parasitologist to have received this honour. In addition to his services to medicine, Ross was also an accomplished mathematician, novelist, playwright and poet. He went on to become an advocate of mosquito control as a means to curbing the transmission of malaria. He was a founding lecturer at the Liverpool School of Tropical Medicine and a true giant in the field of Parasitology. He was not always an easy man to get along with. His feuds with Italian scientists over priority for the discovery of the mosquito-malaria link were but one of many spats with others in the field.



2. Ross's notebook, 1897



3. The mosquito man

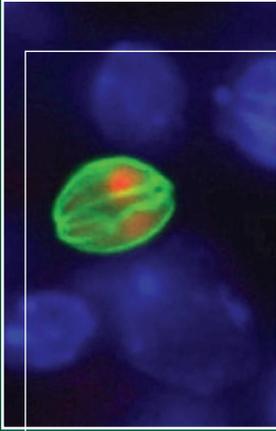


4. Anti-mosquito poster



5. Henry Short

TOXOPLASMOSIS



1. *Toxoplasma tachyzoite*

Around one third of the world's human population is infected with *Toxoplasma gondii*, a protozoan parasite belonging to the same group as malaria-causing parasites. *Toxoplasma* is arguably the most successful parasite world-wide as it is able to infect all warm-blooded animals. *Toxoplasma* is generally a parasite of cats but it enters other animals through the consumption of either under-cooked meat containing parasite cysts, or through food and water contaminated with oocysts shed in cat faeces.

Toxoplasma is capable of living in most animals, causing a wide spectrum of diseases. It can cause abortion in sheep and goats and is a major cause of death in sea otters and Australian marsupials.

In many people the infection is apparently asymptomatic, although it is a major problem in pregnancy as it can cross the placenta and infect the developing foetus. This can lead to death or developmental problems in the unborn child including deafness, visual impairment and neurological disorders.

Generally our immune systems keep the parasites in check. However, *Toxoplasma* can form cysts in various organs and enter a state of dormancy until an opportunity arises for them to proliferate. This is why toxoplasmosis is a major problem in immunocompromised individuals, such as patients on immunosuppressive therapy as often used in treatment of cancer, or in people whose immune systems have been disrupted by HIV/AIDS. Irvine Welsh's character "Tommy" dies from cerebral toxoplasmosis in the iconic novel "Trainspotting" released as a film of the same name in 1996. Tommy caught the disease from a pet kitten after contracting AIDS related to intravenous drug abuse.

Making sure that meat is properly cooked and avoiding close contact with cat faeces both represent good ways of avoiding *Toxoplasma*.

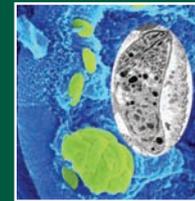
The oocysts of the parasite remain in the environment for a long time. It is important to wash hands after gardening and to clean fruit and vegetables thoroughly before eating; pregnant women in particular are advised to do so. Some drugs are available to treat parasites during their proliferative phase, but these cannot kill the parasites within the tissue cysts and thus cure is not possible. Vaccines suitable for use in animals (e.g. *Toxovax*®) exist to help prevent *Toxoplasma*-induced abortion in sheep and goats. It is hoped that a human vaccine might follow.

Extraordinary research has indicated that *Toxoplasma* might also have remarkable effects on behaviour, possibly making victims less risk averse. For example mice infected with *Toxoplasma* are less concerned about cats than are uninfected mice. The bold mice are then more likely to be eaten by cats and so pass the parasites back to their cat hosts. Other research is suggestive of behavioural changes in humans.

One study suggested that drivers involved in car accidents were more likely than people in general to be infected with *Toxoplasma*. A possible link to schizophrenia has also been proposed. These studies indicate that infection with *Toxoplasma* parasites may represent a more significant public health risk than was previously thought.



2. *Toxoplasma* cyst in brain



3. *Toxoplasma* in cat gut



4. *Toxoplasma* encephalopathy



5. Trainspotting

THE SCOTTISH ENCOUNTER WITH TOXOPLASMA



1. William Hutchison

William McPhee Hutchison (1924-1998)

William Hutchison was born in Glasgow and studied Zoology at Glasgow University. While working at the University of Strathclyde in Glasgow, in the 1960's, he demonstrated that *Toxoplasma gondii* was a parasite of cats which shed oocysts in faeces. Hutchison's work was rewarded with the Robert Koch Medal and Prize in 1970.

T. gondii was initially discovered, largely by accident, in 1908, by **Charles Nicolle**, while searching for a reservoir of *Leishmania* in a north African rodent. At about the same time, **Alfonso Splendore**, working in Sao Paulo, discovered the same parasite in rabbits. Subsequently there were numerous reports from mammals and birds, both in the wild and captivity, and it gradually became clear that *T. gondii* was also a very common parasite in humans and domesticated animals in all parts of the world.

Hutchison first showed that *T. gondii* was passed in cat faeces in 1965.

Initially he thought that the parasite was transmitted with the nematode worm *Toxocara cati*, as happens with the flagellate *Histomonas meleagridis* and the nematode *Heterakis gallinarum*, but subsequently, in 1969, he identified the protozoan oocysts in the faeces as belonging to the group of parasites known as the *coccidia*.

At around the same time that Hutchison made his observations, **Jack Frenkel**, **J. P. Dubey** and **Harley Sheffield** in the United States, **Gerhard Piekarski** in Germany and other workers also identified the role of the cat as the definitive host of the parasite.

Prior to this discovery it had been assumed that the intestinal parasites of the coccidian group had only one host. The discovery of the *T. gondii* life-cycle initiated a search for similar stages in the life cycles of the other coccidian parasites.

It became clear that many organisms found in a variety of animals that had eluded identification were, in fact, different life cycle stages of coccidial parasites. In most cases the parasite's transmission depended on a predator-prey relationship.

Cryptosporidium parasites:

There's something in the water!

Cryptosporidium is another coccidian parasite. It is very common, occurring in Scotland and other countries worldwide. It causes diarrhoea in people and young farm livestock. It can cause a persistent and potentially fatal disease in immunocompromised individuals.

Cryptosporidium oocysts are resistant to chlorination, the principal means of water treatment world-wide.

Several outbreaks have occurred recently in Scotland associated with contamination of public water supplies, swimming pools, hospitals, childcare centres and recreational farm visits. Infection can be spread through contaminated water and through contact with farm animals. *Cryptosporidium* spreads easily among people therefore handwashing is very important after using the toilet or having contact with farm animals and before handling food.

There is no effective treatment for cryptosporidiosis. The infection usually clears up by itself in healthy people, but in very young and elderly people and in immunocompromised individuals, it causes severe disease. Public health authorities and water companies are working together to try and prevent contamination of water supplies.

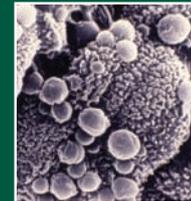
A recent contamination of water in Glasgow resulted in 160,000 households being told to boil their water prior to consumption to protect them against the *Cryptosporidium* parasite.



2. *Toxoplasma* inside cells



3. Sheep



4. *Cryptosporidium parvum*



5. *Cryptosporidium* in the news

A DOSE OF WORMS: THE LATEST HEALTH TONIC?



Could worms provide new hope in the fight against allergic disease?

Diseases such as asthma have risen to epidemic proportions in many countries in the developed world, whereas these allergic disorders are still comparatively rare in people living in the developing world. The reasons for this are unclear, but research indicates that infection with worms dampens down the parts of the immune system that cause allergy.

1. *Heligmosomoides polygyrus*; a worm that alleviates allergy in rodents

In one study, children living in Africa and infected with intestinal worms showed no signs of asthma. Following drug treatment to remove the worms, the children became twice as likely to develop allergic responses leading to scientists proposing that it may be the worms themselves that were somehow protecting people against the development of allergies. The dramatic rise in inflammatory bowel disease (Crohn's disease) in many countries world wide has also been linked to the absence of intestinal worm infestations.

Why parasitic worms?

People and parasitic worms have evolved alongside each other to limit host tissue damage and enable the parasite to maintain its habitat and complete its life cycle. Basically the worms need us to survive as we are, in effect, their homes. As a result of this selective pressure the worms have evolved to be able to regulate and manipulate our immune defences. Indeed many people infected with worms do not show any clinical symptoms.

The worms achieve this by inducing more “regulatory” immune cells that dampen down the inflammatory responses and thus prevent the “overactive” immune reactions responsible for the common symptoms of asthma such as airway inflammation and wheezing or other allergic symptoms.

Can worms control our immune defences?

As worms have been in such close contact with our immune defences throughout evolution they know a lot more about how to manipulate our immune systems than we do. Therefore scientists are interested to find out how the worms are able to fool our body’s defences and try and use this knowledge to develop new treatments for a range of different diseases thought to be caused by an over-active immune system such as asthma, diabetes and inflammatory bowel disease. The search is currently on to identify the molecules used by the worms to regulate our immune systems.

New therapies for the future?

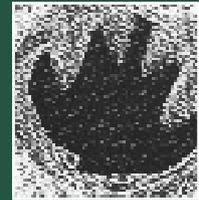
Testing of parasitic worms as therapeutic agents is underway in several different laboratories worldwide in clinical trials for different conditions.

For example, hookworm larvae are being tested for their ability to relieve the symptoms of asthma and Crohn’s disease in the UK and worm eggs (*Trichuris suis*) are being fed to patients to help relieve the symptoms of inflammatory bowel disease in the USA.

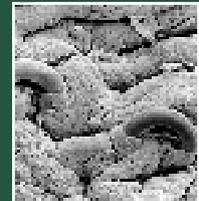
Perhaps we may be able to learn from the parasites how best to treat the many allergic diseases that seem to plague us today.



2. Asthma: a major problem



3. Hookworm



4. Gut burrowing worm



5. *Trichuris* egg

WELLCOME CENTRE FOR MOLECULAR PARASITOLOGY



1. WCOMP

The tradition in Parasitology established by those pioneering Scottish explorers, doctors and scientists described in this booklet, lives on in Scotland today. Although the world has moved on in many ways from the time of Dr Livingstone, the menace of infectious diseases is by no means diminished. Scotland's fight against these diseases continues at the University of Glasgow in the Wellcome Centre for Molecular Parasitology, a leading institute studying parasites and aiming to control the diseases they cause.

Global travel and man's colonisation of ever new regions, means that novel and exotic infectious agents are emerging all the time. In addition you do not have to travel very far from home to play host to a vast array of diverse parasitic animals such as intestinal worms living in your gut, headlice or *Toxoplasma* parasites living happily inside your brain.

Parasitology research in Scotland is stronger than ever with leading internationally recognized research groups studying parasites of importance in human and veterinary medicine, food production and agriculture.

Scientists are applying the latest technological advances to try and devise new and effective control strategies against parasitic disease and also to understand what parasites can teach us about our own immune defences which may lead to novel therapies against allergic disease.

In addition to world class research, teaching in Parasitology remains important and a degree course in this subject is taught at the University of Glasgow and options in Parasitology are available at most other Scottish Universities. Higher degrees, at masters level, or at doctoral level, are also available at Scottish Universities.

Sir Henry Wellcome, whose will founded the Wellcome Trust, was himself pall bearer at the funeral of Sir Henry Morton Stanley and his lifelong fascination with tropical disease was stimulated by his reading of Livingstone's explorations (see page 6-7). Wellcome's legacy has enabled the funding of high quality biomedical research throughout the twentieth and on into the twenty first centuries. The Wellcome Centre for Molecular Parasitology (WCMP) is one of nine biomedical centres created by the Wellcome Trust, as centres of excellence conducting work of major international significance within designated fields of study. The WCMP was founded as a Wellcome Trust Unit in 1987, with a remit to study basic features of parasites, using genetic and molecular technology allied with study of parasites as whole organisms.

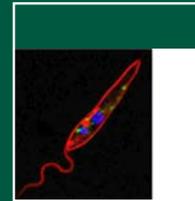
Since then, the WCMP has expanded through recruitment of internationally renowned research leaders and since 2006 the centre has been housed in the multidisciplinary Glasgow Biomedical Research Centre, where strong interactions with Microbiologists, Immunologists and Structural Biologists ensure interdisciplinary research of a type essential for major scientific breakthroughs today.

The activities of WCMP are divided into basic research of parasite biology, and associated translational activities, such as disease intervention and molecular epidemiology. Research focuses on various parasites, including those causing trypanosomiasis, leishmaniasis, malaria, toxoplasmosis and trichomoniasis. Although the parasites differ greatly from each other, there is focus on core processes, many of which show common mechanisms in the different parasites.

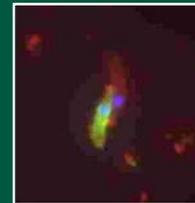
The centre has a strong infrastructure that encourages high-quality science, through multidisciplinary investigation and cross fertilisation in ideas and approaches. Research is conducted across different biological scales, starting with the smallest molecules from which parasites are built to an understanding of the broader ecological context in which the parasites find themselves. The ultimate aim is to use the knowledge gained from the study of parasites to understand their strategies for success and to develop new interventions against the diseases they cause.



2. WCMP Director: Dave Barry



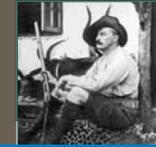
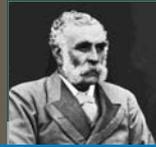
3. Leishmania



4. Plasmodium



5. Trypanosome



ACKNOWLEDGEMENTS



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A number of individuals and organisations kindly provided pictures: including The Wellcome Trust Medical Photographic Library, WHO-TDR, Mosby International Publishers (from *Tropical Medicine and Parasitology* 5th Edition, 2002, Wallace Peters and Geoffrey Pasvol, Eds.), Dr David Ferguson (University of Oxford), Dr Laurence Teitley (University of Glasgow), Maggie Reilly (Archivist, Hunterian Museum, Glasgow), Mrs Carol Parry (College Archivist, Royal College of Physicians and Surgeons of Glasgow), Victoria Killick, Archivist at the London School of Hygiene and Tropical Medicine, Karen Carruthers (Director of the David Livingstone Centre), Mhairi Stewart (University of Glasgow), Gerald Späth and Stephen Beverley (Washington University, St. Louis, USA), The Wellcome Trust (F.E.G. Cox, *The Illustrated History of Tropical Diseases* – 1996),

Lisa Bluett and Professor David Molyneux (Liverpool School of Tropical Medicine), G P Matthews, (<http://www.gpmatthews.nildram.co.uk>), Korean Society of Parasitology, Ms Erica Peake (Archivist of the South Carolina Medical Association), Drew Berry, The Walter and Eliza Hall Institute of Medical Research, Amy Clarke (University of Glasgow), Stylorouge, London, Steve Wright (Moredun Research Institute), Constance Finney (University of Edinburgh), Frank Jackson, (Moredun Research Institute).

A number of people provided information on various diseases, including Professor Stephen Phillips, Professor Paul Hagan, Professor John Kusel, Professor Keith Vickerman and Dr Lisa Ranford-Cartwright (University of Glasgow), Professor David Molyneux (Liverpool School of Tropical Medicine), and Dr Lee Innes (Moredun Research Institute) all of whom also provided excellent editorial assistance and invaluable advice. The Aberdeen Leopard Magazine found some archived material on Manson. Rachel Kidd and especially Amy Clarke also made key contributions to editing and assembly of posters. The poster and booklet design was by the FBLS Graphic Support Unit at the University of Glasgow.

Professor Michael P. Barrett:

Mike Barrett is Professor in Parasitology at the University of Glasgow. His main research interests focus on the development of new drugs for protozoan diseases including malaria and above all human African trypanosomiasis. He is a member of the Human African Trypanosomiasis Network of the World Health Organisation and is involved in numerous collaborative ventures aimed at understanding how drugs work against parasites. He teaches on the University of Glasgow's Parasitology degree and has a long standing interest in the History of Parasitology, particularly from a Scottish perspective. The journeys of David Livingstone through Africa in particular served as an inspiration for this exhibition and accompanying booklet. (m.barrett@bio.gla.ac.uk)

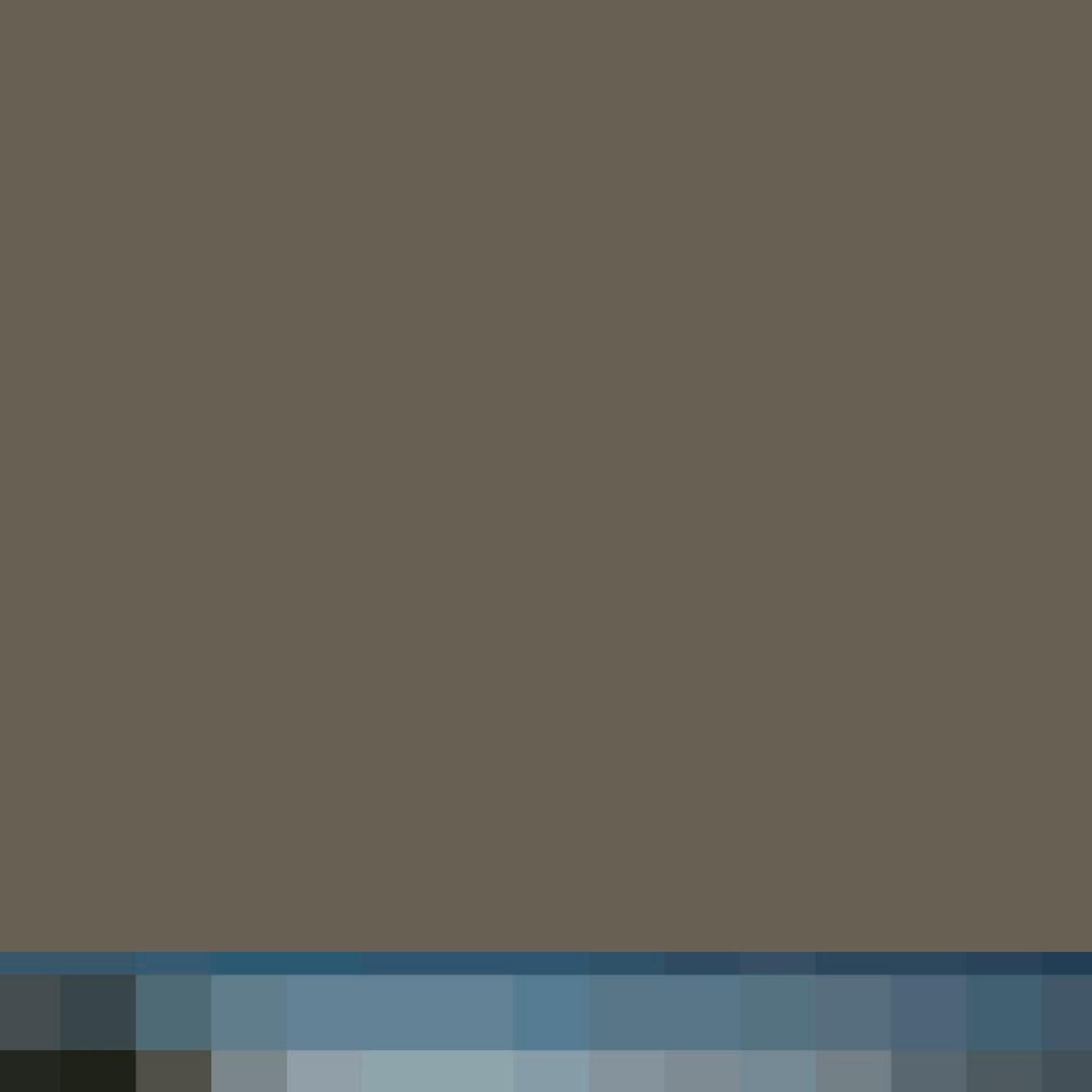
Dr Lee Innes:

Lee Innes obtained a PhD in Tropical Veterinary Medicine from the University of Edinburgh and spent several years working in Africa before returning to Edinburgh where she currently works as Principal Scientist at the Moredun Research Institute. Her main research interests involve protozoan parasites and vaccine development. More recently she has become involved in communication of science and is Director of The Creative Science Company in Scotland. (lee.innes@moredun.ac.uk)

Professor Frank Cox:

Frank Cox is a Senior Visiting Research Fellow at the London School of Hygiene and Tropical Medicine where his interests are in the History of Parasitology and Tropical Medicine. He has written a number of reviews in this area and edited the Wellcome Illustrated History of Tropical Diseases. He was formerly Professor of Parasite Immunology at King's College London where he worked on immunity to malaria and leishmaniasis particularly non-specific killing. Frank has also been Editor of Parasitology and the Transactions of the Royal Society of Tropical Medicine and Hygiene and has written several books including Modern Parasitology. (Frank.Cox@lshtm.ac.uk)







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