



Professor John E Cooper

## ‘Doctor! The monkeys are dying...’

**M**onkey Business is something we are all familiar with. Whether it is the musical versions (Michael Jackson, the Black Eyed Peas) or the cinematic versions (your Ed’s favourite is the Marx Brothers 1931 classic) or just larking around. The business of monkey disease is another thing altogether and who better to introduce a rather alarming aspect of this but John Cooper.

In early February the telephone rang from the east coast of Trinidad and the caller said: “Doctor, the monkeys are dying!” Which monkeys? “Red monkey” (as opposed to the ‘white monkey’). On the whole, plurals in Trinidad depend upon whether you are speaking standard or local English, and the latter is rather attractive in context.

Such news does not need further elucidation to cause consternation in Trinidad. It is well known that the indigenous red howler monkeys (*Alouatta seniculus insularis*) are susceptible to yellow fever and that there are outbreaks of this dangerous disease from time to time. Indeed, the veterinary staff attached to the Ministry of Health monitors certain populations on an ongoing basis.

The attractive, long-limbed, russet-haired howler monkeys that were the subject of the ‘phone call had been found dead or moribund on the forest floor in one of the monkeys’ best-known habitats – Bush Bush Wildlife Sanctuary, a forest reserve forming part of the Nariva Swamp Ramsar Site.

The ‘phone calls multiplied, not simply bearing reports of dead monkeys but also enquiries from interested parties, biologists, tour guides and distressed locals fearful of catching yellow fever. What was happening and what was being done? The University of the West Indies (UWI) School of Veterinary Medicine (SVM) Pathology Department, the State Veterinary Service and the Ministry of Health were all involved. Although the first necropsies were carried out by veterinary pathologists at UWI, where the postmortem room is shared with the State Veterinary Service, little could be said or done until an official diagnosis was announced by the Minister of Health.

### Background

Yellow fever was one of the most dreaded human diseases in the period from the 15th to the 19th centuries. In those times it was prevalent in Africa, parts of Europe and large areas of the Americas. The disease greatly affected the expansion of colonialism and the development of towns and waterways.

Yellow fever was first recorded in Trinidad in 1793. In the Lapeyrouse Cemetery, in the centre of the capital, Port of Spain, stands a simple but moving plaque in memory of nine Dominican nuns, all of whom died in September 1869 during an epidemic of yellow fever (Figure 1).

More recently, scientific interest in yellow fever in Trinidad was prompted by the outbreaks that occurred between 1954 and 1990. These prompted interdisciplinary research on the disease. The monograph *Studies on the Natural History of Yellow Fever in Trinidad*, edited by Dr Elisha Tikasingh and published in 1991 by CAREC (Caribbean Epidemiology Centre) and PAHO (Pan American Health Organization) provides a fascinating insight into those investigations. The researchers studied not only the virus, monkeys and mosquitoes (the vectors of yellow fever are *Aedes* and *Haemagogus*), but also numerous wild-life species.

Figure 1: Memorial to human victims of yellow fever in the Lapeyrouse Cemetery, Port of Spain



### Was it yellow fever this time?

As the precursor to last year's epidemic of sylvatic (or jungle) yellow fever, the first carcasses received by the SVM were of four monkeys, recognizable as howlers only by the presence of characteristic reddish-brown hair. Most of the carcasses consisted of skeletal material, together with some dried soft tissues (Figure 2). At that preliminary stage of our investigations yellow fever was suspected, not confirmed, and therefore was only one possibility on a long list of differential diagnoses. These remains were therefore subjected to a full, forensic-style, postmortem and laboratory investigation, in

Figure 2: One of the first specimens received – bones and red hair of a dead howler monkey



which veterinary students participated. Protocols for the necropsy examination of monkeys had to be drawn up, with particular attention paid to health and safety risk assessment. The SVM has no safety cabinets for this sort of work and therefore not only was protective clothing mandatory but extra precautions had to be taken.

Two more monkeys arrived which were freshly dead. Full necropsy revealed a number of lesions, mainly involving the liver (Figures 3 and 4). Following our postmortem and histological examinations, material submitted to CAREC proved positive for yellow fever using polymerase chain reaction (PCR) and virus isolation.

Figure 3: Gross examination reveals ascites and a discoloured, necrotic liver (near upper finger)



### The response

More exhaustive surveillance of the howler monkey population was then initiated. Game wardens, hunters, field naturalists and others were encouraged to report sightings of dead or sick monkeys. Yellow fever vaccination was provided to all field staff of the Forestry Division, the Ministry of Agriculture, the Police, Fire Services, Coast Guard and the Army. Mobile units visited communities, including schools in high-risk areas, publicity material was prominently displayed and yellow fever vaccination boosters were provided.

Trinidad may only be, at most, 60-km wide and 80-km long but it can be an unaccountable time before 'we reach', as they say locally. One suspect monkey managed to take the best part of a day to arrive for postmortem examination and a much-wanted porcupine carcass failed to appear at all. Communication and access in Trinidad often present problems and circumstances conspire against the best of intentions. A report left on our answerphone (needless to say, on a Friday) of one dead monkey by the roadside and another in the forest, probably the indication of the spread of yellow fever to a new area, was sent by a conservation group in a distant village but they left no return 'phone number. Their message was passed to the Ministry of Health but no official investigator could be sent to the area because the way was blocked by demonstrations against the lack of repairs to the road. (Could this have been related to the fact that the Cabinet was in retreat at a resort along the same route?)

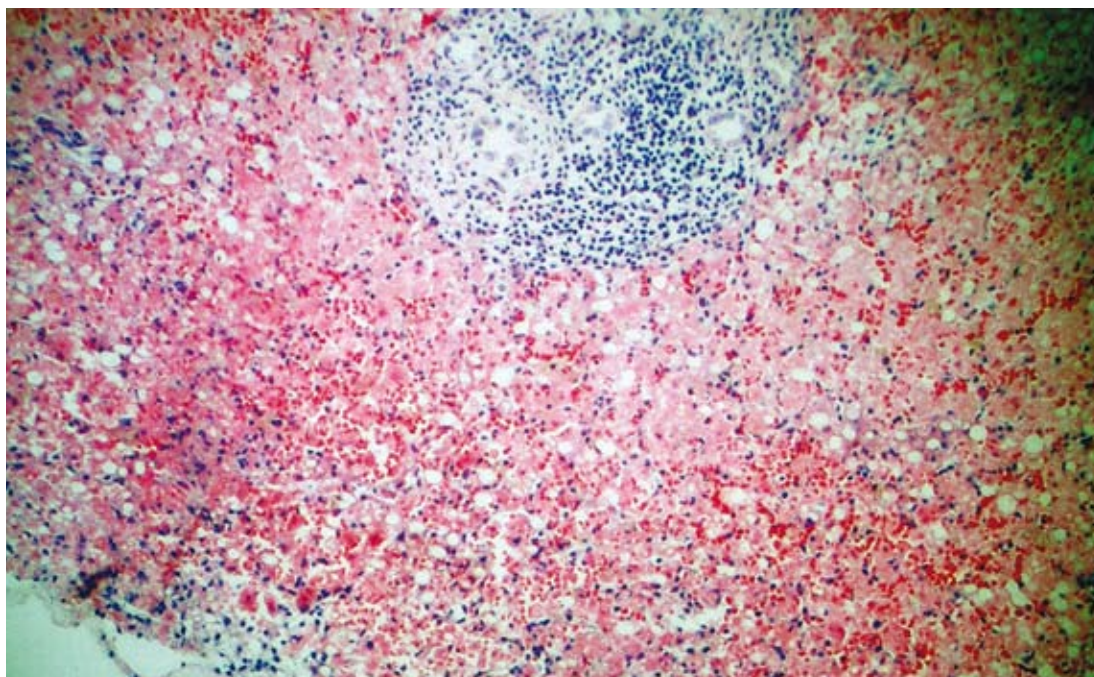
Studies on Trinidad's monkey populations, carried out by ecologists and knowledgeable amateur biologists, will be invaluable when the time comes to assess the impact of the 2009 outbreak of yellow fever in the wild population. However, collaboration in fieldwork, community involvement and interdisciplinary exchange has its own functional problems. Fortunately, 'jumbies' (spirits from traditional folklore) can still readily be blamed for such glitches in the system as these.

In order to improve contact and encourage collaboration between interested parties, at an early stage, a meeting was hosted and arranged by the SVM (Figure 5). This was intentionally integrated into the School's pathology 'rounds' and thus, enabled veterinary students to learn more about the outbreak, as well as educating representatives from governmental and non-governmental bodies. The latter included conservation organizations and naturalists, all very important players in studies on sylvatic yellow fever.

### The unanswered questions

The red howler monkey has been known for some years to be susceptible to yellow fever. As such, it serves as an important sentinel for the disease. When howlers start to die, yellow fever is high on the list of possible diagnoses and appropriate inves-

Figure 4: Histological appearance of the liver in Figure 3, showing extensive hepatic necrosis, with inflammatory cell infiltration. At higher power, characteristic Councilman bodies were detected



tigations begin. For this reason, although yellow fever vaccine is used to protect captive howler monkeys (in the zoo and when kept in private hands) in Trinidad, it is not made available for free-living animals. This approach raises a number of questions in the veterinary mind, not least the welfare and conservation implications of such a policy.

There is also the unanswered question about how yellow fever is maintained on Trinidad in inter-epizootic years. Conventional wisdom dictates that the virus, which can be passed trans-ovarially in appropriate mosquitoes, survives in eggs of the latter. However, could other species of wild vertebrates serve as reservoirs? Porcupines were reported to be dying in our outbreak and also in the earlier studies in the 1960s–1980s. Was this just coincidence? People tend to notice dead wild animals when they are aware of an infectious disease that is killing one species and it has to be borne in mind that porcupines are sometimes shot and not retrieved by hunters. Or could porcupines, which in the New World are arboreal and often live in the high canopy, possibly together with other wild mammals, serve as part of a reservoir population for the virus?

Figure 5: Consultative meeting held at the Veterinary School. Those in the picture include Dr Elisha Tikasingh (seated, fourth from the left), pioneer of yellow fever research on Trinidad



Trinidad is recognised internationally as the location for historic interdisciplinary studies on two important infectious diseases that are transmitted, directly or indirectly, from animals to humans. The first of these was rabies. The pioneering studies in the 1920s and 1930s by Drs A Pawan and J A Waterman (medical) and Capt A Metivier (veterinary) elucidated the role of the vampire bat (*Desmodus* sp) in the spread of rabies to humans, cattle, horses and pigs. The second example is the subject of this article – yellow fever. Interested pathologists should refer to the seminal work on the disease that was carried out in Trinidad by scientists in the 1960s–1980s and which was described so graphically by Tikasingh and his colleagues in the monograph cited earlier.

The veterinary and medical professions work together in the detection and control of rabies and yellow fever in Trinidad. These two viral diseases present a significant threat to humans and to animals on the island. It is heartening that the recent outbreak of yellow fever provides fresh opportunities for members of both disciplines, in collaboration with virologists, epidemiologists and students, to perform crucial investigative and diagnostic work.

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