Sir David Bruce's elucidation of the aetiology of nagana—exactly one hundred years ago

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Surgeon-Captain David Bruce (1855–1931) (Anonymous, 1931a, 1931b, 1932; Hamerton, 1932; J. R. B., 1932) was posted to Pietermaritzburg, Natal, South Africa, for military field service in 1894. At the time, cattle (and also horses) were dying in hundreds from a disease the origin(s) of which was obscure; the Zulus gave it the name nagana (Macarthur, 1955). As a result, the country was faced with ruin, and grave economic stress affected the indigenous stock-raisers and white settlers (Tulloch, 1955). On the initiative of the Governor of Natal and High-Commissioner of Zululand, Sir Walter Hely-Hutchinson (who had lately served as Lieutenant-Governor of Malta whilst Bruce was solving the Malta (undulant) fever problem), Bruce was ordered to proceed on secondment from Natal to Zululand in an attempt to discover the aetiology of this mysterious disease nagana and (tsetse) fly disease of travellers and hunters were, at that time, considered separate entities (Bruce, 1915; Anonymous, 1932, J. R. B., 1932).

The inhabitants of this region of Africa had been seriously bothered by the disease for at least a century (Syme & Underwood, 1962), and perhaps since 1742 (Anonymous, 1931a). David Livingstone (1813–1873) was familiar with it on the banks of the Zambesi in 1847 (Livingstone, 1858; Cook, 1994); he described the disease in 1857 (Livingstone, 1857) and produced an accurate diagram of Glossina morsitans. Many local residents (some of them of European origin) were of the opinion that it was caused by the bite of the tsetse fly (which elaborated a poison within itself) (Bruce, 1915; Anonymous, 1931a; Macarthur, 1955), death of the animal following some 10 d after this event. An alternative theory (apparently held by most Zulus) was that game animals harboured the disease, and that it was transmitted to cattle by food and water contaminated by them—perhaps fascinatedly (Macarthur, 1955). (We now know that both theories possessed an element of truth (Robertson, 1955).) Livingstone was fully convinced that the disease did not affect man; he and his party lived 6 months had, however, been wasted. Bruce was by this time, considered separate entities (Bruce, 1915; Anonymous, 1932, J. R. B., 1932).

At this exciting point in the saga, Bruce was recalled, on 26 January 1895, to Natal (Bruce, 1915; Macarthur, 1955); however, on reaching Pietermaritzburg he discovered that there had been no compelling reason for this order. Following communications between the Governor and the War Office (who were seemingly pretty uncooperative), the Brutes were able to return to Ubombo on 8 September 1895; when they arrived, 7 months had, however, been wasted. Bruce was by this time fully convinced that ‘Haematozoa’ were causatively related to nagana, but this had to be confirmed scientifically. Therefore, he infected healthy animals by inoculating blood of diseased ones. A minor set back came when a dog fed on coagulated, infected blood developed na...
gana—a surprise observation which seemed to support the 'Zulu theory' (see above); in retrospect the only reasonable explanation must be that trypanosomes entered via an oral abrasion(s) (MACARTHUR, 1955). When he proceeded to demonstrate the living 'Haematozoa' in the proboscis of tsetse flies fed on infected animals (MAC ARTHUR, 1955), he decided that these were independent of the proboscis of tsetse flies fed on infected animals (MAC ARTHUR, 1955); Fig. 2 shows the mouth parts of a tsetse fly in a drawing in the first of Bruce's published Croonian lectures. One hour after feeding, they were present in the stomach in clumps of a dozen or so, and remained very active; after 4 h, activity was undiminished. Bruce's notes recorded that the longest survival period of the organism(s) in the tsetse fly gut was 118 h. From these experiments Bruce concluded that the fly can transmit the organisms for up to 48 h after feeding on an infected animal, and that after 72 h infection must be unlikely. In order to establish whether or not a later developmental cycle existed within the fly, he carefully dissected the gut of infected specimens; although he recorded 'disc-like bodies, spirilla, and so forth' (MAC ARTHUR, 1955), he was unable to keep the flies for a full 3 weeks in order to establish the developmental cycle within the tsetse fly gut. He proceeded to demonstrate, by inoculation experiments, that game animals can be infected, but remain asymptomatic (ANONYMOUS, 1931a).

At an entomological level, Bruce also carried out tsetse fly breeding experiments (ROBERTSON, 1955), and noted that larvae were retained in the abdomen of the parent fly. He proceeded to demonstrate that trypanosomes were transmitted in the proboscis of infected tsetse flies (MAC ARTHUR, 1955); he noted, in bush (scrub), with game animals nearby, and the latter in open country. The role of game animals in relation to nagana remained uncertain until Bruce succeeded in 'infecting' a dog by inoculating the blood of an antelope; he repeated this experiment many times, but results were inconsistent. He later concluded that about one-quarter of the local herbivorous game animals (tolerant to infection) harboured 'Haematozoa' in their blood, and that after 72 h infection must be unlikely. In order to establish whether or not a later developmental cycle existed within the fly, he carefully dissected the gut of infected specimens; although he recorded 'disc-like bodies, spirilla, and so forth' (MAC ARTHUR, 1955), he decided that these were independent of the proboscis of tsetse flies (MAC ARTHUR, 1955). At this point, the South African war intervened (Bruce was present at the siege of Ladysmith) and he was unable to keep the flies for a full 3 weeks in order to establish the developmental cycle within the insects' saliva glands—ultimately unravelled by F. K. Kleine (1861-1950) more than a decade later, in 1908.

Bruce thus established beyond doubt, by a series of elegant experiments exactly one hundred years ago, that nagana is caused by a 'Haematozoa,' later named Trypanosoma brucei (brucei) by H. G. Plimmer (1856-1918) and J. R. Bradford (1863-1935) (PLIMMER & BRADFORD, 1899). This is conveyed by an infected (tsetse) fly, which is itself infected by feeding on game animals which form the major reservoir of infection. Bruce was therefore the first investigator to demonstrate transmission of a protozoan parasite by an insect bite (ANONYMOUS, 1932; VELLA, 1973; COOK, 1994); he was also the first to demonstrate the developmental cycle within the tsetse fly. He satisfied himself, furthermore, that dosing with arsenic—first established to be efficacious by David Livingstone in a mare afflicted by nagana (LIVINGSTONE, 1858; COOK, 1994)—had an inhibitory effect on trypanosomes in the blood of animals, but did not prevent a subsequent infection (MACARTHUR, 1955). During the next few years, several important centenaries relating to landmarks in Tropical Medicine will be celebrated; none is more likely to be more important than Major-General Sir David Bruce's elucidation of the aetiology of nagana—regarded by most historians as his most distinguished achievement (HAMERTON, 1932; TULLOCH, 1955).

References


Fig. 2. Mouth part of the tsetse fly (reproduced from Bruce's Croonian lectures to the Royal College of Physicians in June-July 1915; Bruce, 1915: Lanceot, i, 1257.)