Epidemiology, past, present and possible future of Yellow Fever in East Africa

Dr. P. M. TUKEI

East African Virus Research Institute, Entebbe, Uganda

A Yellow Fever Research Institute was established in 1936 by the International Health Division of the Rockefeller Foundation, New York. This later developed to what is now the East African Virus Research Institute. The purpose of the Yellow Fever project was to ascertain whether this virus was present in East Africa and, if so, the geographical distribution and local epidemiology. Of equal urgency was the assessment of possible danger of YF virus spreading to Asia from the eastern coast of Africa. Just prior to the project as described, however, Sawyer & Whitman (1936) had reported, from the results of a general protection-test survey, that protective antibodies to YF were present over a wide area of East Africa.

The Yellow Fever Research Institute soon discovered that there was a high incidence of immunity in Bwamba County, Western Uganda. Bwamba County lies in the Semliki Forest which is the continuation of the great Ituri forest of the Congo basin. A field station established in Bwamba formed the centre of most of the subsequent intensive epidemiological work in Uganda. Armed with the knowledge that the South American jungle YF frequently attacked wood cutters, close attention was paid to road gangs that were constructing a road through the Semliki Forest. This work initially resulted in the isolation of Semliki Forest virus but no YF. The viscerotomy service set up also proved negative.

Serological surveys in the area, however, led to the conclusion that there was endemic YF in Bwamba but was not causing such spectacular outbreaks as to attract attention of medical workers. The re-bleeding of some of the non-immunes living at the forest edges established that conversions were occuring during the investigation period of up to 29 % without the occurrence of serious disease. Up to 70 % of the forest monkeys were found immune, the ages suggesting a continuous enzootic. Work on other forests in Uganda also revealed high immunity rates in monkeys with however very low immunity rates in humans (HADDOW, 1968).

HUMAN CASES OF YELLOW FEVER.

In 1941 in Bwamba, a virus was isolated from a sick woman who was not, in fact, desesperatly ill. It was also isolated twice from *A.* (*S.*) *simpsoni* thus establishing definitely that YF virus was in East Africa, MAHAFFY *et al.* (1942). This then led to the mass vaccination of the people in Bwamba and the adjoining country of Tora District resulting in a 93 % immunity 3 years later.

A soldier is thought to have become infected in Langata forest near Nairobi. No virological confirmation was made, but serological evidence was obtained in the Langata forest fringe (MAHAFFY et al., 1946).

In 1952 a fatal case occurred in a European in Toro, Western Uganda, but this, also, was not confirmed virologically. Clinically and histologically it was compatible with YF. The man, though vaccinated 4 years previously, was thought to have acquired the infection locally and the vaccine was thought to have been inferior to the Rockefeller vaccine. A survey of wild monkeys in the area showed 3 immune monkeys out of 8. Entomological investigation showed the presence of *A. africanus* (Ross et al., 1953).

The most recent case of 1964 in an African in Central Uganda is the only fatal native Ugandan fully documented. Virus was isolated and reisolated from both serum and CSF. The liver histology was unequivocal. Three strains of YF virus were isolated from *A. africanus* taken from ground level and from the forest canopy near the house of the fatal case.

These results further confirmed the already known cycle of YF in East African forests. It was further

observed that, had *A. simpsoni* been anthropophilic, conditions were ripe for a human epidemic. Of the six monkeys captured in this forest, 5 were immune with one showing evidence of recent infection ; HADDOW (1965), TULLOCH and PATEL (1965), WILLIAMS *et al.* (1965) and SIMPSON *et al.* (1965).

RECENT WORK.

Subsequent to the disastrous 1960-62 YF epidemic in Ethiopia, collaborative work was carried out by the E.A. Virus Research Institute, with the Medical Research Laboratories and the Netherlands Medical Research Centre, both in Nairobi. This work was mostly concentrated on the Northern Frontier of Kenya and on north eastern Uganda. Other areas in Kenya where past serological evidence had indicated the possible presence of YF virus were also included. The results of these surveys have been published by HENDERSON *et al.* (1968), (1970) and METSELAAR *et al.* (1970).

Briefly, in Kenya the high immunity rates in humans (7-15 %) found in Lokitaung, Moyale and Lodwar were seriously thought to have been the extension of the Ethiopian epidemic. The 14-22 % immunity rate at Marsabit, however, is thought ho have been acquired locally. This is in fact the second highest immunity rate recorded in East Africa, the highest being Bwamba, Uganda.

Yellow fever virus was not isolated from the mosquitoes. The few vervet monkeys (*Cercopithecus* spp.), baboons (*Papio* spp.) and bush babies (*Galago senegalensis* spp.) were non immune.

No YF virus was isolated from mosquitoes at the coast nor in the Ngong and Langata forests. The 12 bush babies from the coast were negative. In Kenya therefore in recent times, though the investigations are incomplete, it would appear that the classical East African spill-over infection may have occurred only in Marsabit in the absence of *A. simpsoni.*

The results for Uganda put the immunity rate at 1,3 %, all being in adults (HENDERSON *et al.* 1966 a). The absence of immunity in children in Bwamba samples was of particular interest as opposed to previous surveys where the immunity was 2 % in children and 19 % in adults. (HUGHES *et al.* 1941). Immunity to Banzi (H 336), Wesselsbron and West Nile was, however, widely distributed throughout Uganda. A survey of the monkeys showed a surprisingly low rate or 3 % immunes, whereas 71 % were immune to Zika virus. (HENDERSON *et al.* 1968). It was postulated that the Zika immunity may be a factor that has reduced the incidence of YF immunity.

THE POSSIBLE FUTURE OF YELLOW FEVER IN EAST AFRICA.

It is established that YF is in East African forests. In some places it is dangerously adjacent to non-immune human populations. It would probably need only a slight swing in the balance of non biting *A. simpsoni* to a man biting one and the situation would explode.

The coastal areas of Kenya pose a potentially hazardous situation, because here, man biting *A. simpsoni* and endophilic *A. aegypti* overlap. Immunity in Galagos has been detected in the past together with very low immunity rates in monkeys and man. The reasons for the absence of human YF cases in these areas need to be defined.

HENDERSON *et al.* (1970 a) demonstrated with rhesus and vervet monkeys that previous Wesselsbron immune monkeys had no demonstrable viraemia on subsequent challenge with YF. Those immune to Zika demonstrated a reduced viraemia. The full epidemiological significance of the Group B arbovirus cross-protection needs further definition.

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BIBLIOGRAPHIE

HADDOW (A. J.), 1965. — Yellow Fever in Central Uganda, 1964. Part I. Historical introduction. *Trans. R. Soc. trop Med. Hyg.*, **59,** 436-440.

HADDOW (A. J.), 1968. — The natural history of yellow fever in Africa. *Proc. R. Soc. Edinburgh,* **70** (Pt 111), No. 10, 191-227.

HENDERSON (B. E.), METSELAAR (D.), CAHILL (K.), TIMMS (G. L.), TUKEL (P. M.) and WILLIAMS (M. C.), 1968. — Yellow Fever immunity surveys in Northern Uganda and Kenya and Eastern Somalia 1966-67. *Bull. Wld. Hlth. Org.*, **38,** 229-237.

HENDERSON (B. E.), KIRYA (G. B.), HEWITT (L. E.), SEKYALÔ (E.) and MUKUYE (A.), 1968 a. — Serological surveys in East Africa and Somalia. *E.A.V.R.I. Rep.* No. **18,** 35-37 and 48.

HENDERSON (B. E.), METSELAAR (D.), KIRYA (G. B.) and TIMMS (G. L.), 1970. — Investigations into yellow fever virus and other arboviruses in the Northern regions of Kenya. *Ibid.*, **42,** 787-795.

HENDERSON (B. E.), CHESHIRE (P. P.), KIRYA (G. B.) and LULE (M.), 1970 a. — Immunological studies with yellow fever and selected African Group B arboviruses in rhesus and vervet monkeys. *Am. J. trop. Med. Hyg.*, **19,** 1, 110-118.

HUGUES (T. P.), JACOBS (H. R.) and BURKE (A. W.) 1941. — A survey of yellow fever immunity in Uganda. *Trans. R. Soc. trop. Med. Hyg.*, **35**, 131-142.

MAHAFFY (A. F.), SMITHBURN (K. C.), JACOBS (H. R.) and GILLETTE (J. D.), 1942. — Yellow fever in Western Uganda. *Trans. R. Soc. trop Med. Hyg.*, **36**, 9-20.

MAHAFFY (A. F.), SMITHBURN (K. C.) and HUGHES (T. P.), 1946. — The distribution of immunity to yellow fever in Central and East Africa. *Ibid.*, **15**, 57-82.

METSELAAR (D.), HENDERSON (B. E.), KIRYA (G. B.) and TIMMS (G. L.), 1970. — Recent research on yellow fever in Kenya. *E.A. fr. Med. Jour.*, **47**, 3, 1-8.

ROSS (R. W.), HADDOW (A. J.), RAPER (A. B.) and TROWELL (H. C.), 1953. — A fatal case of yellow fever in a European in Uganda. *E.A. fr. Med. Jour.*, **30**, 1-11.

SAWYER (W. A.) and WHITMAN (L.), 1936. — The yellow fever immunity survey of North, East and South Africa. *Trans. R. Soc. trop. Med. Hyg.*, **29**, 397-412.

SIMPSON (D. I. H.), HADDOW (A. J.), WILLIAMS (M. C.) and WOODALL (J. P.), 1965. — Yellow Fever in Central Uganda, 1964. Part IV. Investigation on blood-sucking Diptera and monkeys. *Ibid.*, **59**, 449-458.

TULLOCH (J. A.) and PATEL (K. M.), 1965. — Yellow Fever in Central Uganda, 1964, Part II. Report of a fatal case. *Ibid.*, **59**, 441-443.

WILLIAMS (M. C.), WOODALL (J. P.) ans SIMPSON (D. I. H.), 1965. — Yellow Fever in Central Uganda, 1964. Part III. Virus isolation from man and laboratory studies. *Ibid.*, **59**, 444-448.