156 YELLOW FEVER IN NIGERIA, 1986-1993: CONSIDERATIONS ON EPIDEMIC PREPAREDNESS AND CONTROL. Tomori O*, Nasidi A, and Spiegel R. Department of Virology, University College Hospital, Ibadan, Nigeria; Federal Ministry of Health, Epidemiology Division, Lagos, Nigeria; and CCCD-USAID, Lagos, Nigeria.

A devastating outbreak of yellow fever (YF) occurred in Nigeria between 1986 and 1993. Field investigations, including community and hospital based surveys, as well as laboratory and entomological studies were carried out in response to the reports of the epidemic. The epidemic started in the south eastern zone of the country and was reported in 28 of the 30 states in the country, with many states experiencing annual outbreaks during the period 1986-1993. The officially notified number of cases and deaths were 20,000 and 4,000 respectively. However, epidemiological investigations indicated that morbidity and mortality figures were between X10 and X100 higher than the official figures. In many of the states, majority of the cases and deaths occurred among children below the age of 15 years. A significant entomological finding was the discovery for the first time in continental Africa of breeding populations of *Aedes albopictus*, (the Asian tiger) mosquitoes.

157 EPIDEMIOLOGIC ASPECTS OF A YELLOW FEVER OUTBREAK IN NORTHWEST KENYA, 1992-93. Marfin AA*, Tukei PM, Agata NN, Sanders EG, den Boer JW, Reiter IP, McLean RG, Cropp CB, Moore PS, and Gubler DJ. Division of Vector-Borne Infectious Diseases, Centers for Disease Control, Fort Collins, Colorado; Virus Research Center, Kenya Medical Research Institute, Nairobi, Kenya; and Kenya Ministry of Health, Nairobi, Kenya; World Health Organization, Nairobi, Kenya.

Outbreaks of yellow fever (YF), a mosquito-borne viral hemorrhagic disease with case-fatality of 30-50%, have never been reported from Kenya. In September 1992, the Kenyan Ministry of Health identified a cluster of hemorrhagic fever cases in the Kerio River Valley and, with CDC, serologically confirmed two cases of YF. Cases of hemorrhagic fever were identified by medical record review and hospital-based disease surveillance using clinical case definition. 53 persons with hemorrhagic fever were identified from 2 districts of Rift Valley Province (AR: 8.4 per 100,000). Serologic evidence of YF infection was found in 21 of 53 persons; 3 cases were confirmed by YF virus isolation. Earliest onset of illness was September 10, 1992, and the latest was February 18, 1993. Of 53 persons, 28 (53%) were 10 to 29 years old and 36 (68%) were males. All confirmed hemorrhagic YF cases lived in remote areas within dense forest and brushlands. *Aedes africanus* was the predominant mosquito species captured near homes of these cases; no *Aedes aegypti* were found. A review of hospital records from 1990-91 suggested that YF may have occurred but was not recognized. This is the first documented YF outbreak in Kenya and resulted from transmission by sylvatic mosquitoes. Mass vaccination was initiated to control this outbreak because efforts to reduce mosquito larval habitats and peridomestic pesticide application would have little effect. Although there is no evidence of urban transmission, surveillance should be strengthened to detect the early emergence of an urban epidemic.

158 YELLOW FEVER IN THE KERIO VALLEY, RIFT VALLEY PROVINCE, KENYA, 1992-93: ENTOMOLOGICAL INVESTIGATIONS. Reiter P*, Cordellier R, Ouma J, Tukei PM, Okelo GB, Agata N, Cherogony SC, Marfin AA, Cropp CB, Savage HM, McLean RG, and Gubler DJ. CDC Dengue Laboratories, Division of Vector-borne Infectious Diseases, San Juan, Puerto Rico; Institut Français de Recherche Scientifique pour le Développement en Coopération; Ministry of Health, Division of Vector-borne Diseases, Nairobi, Kenya; Kenya Medical Research Institute, Nairobi, Kenya; Headquarters, Ministry of Health, Nairobi, Kenya; Provincial Medical Headquarters, Kabarnet, Kenya; CDC, and Division of Vector-borne Infectious Diseases, Fort Collins, CO.

An outbreak of Yellow Fever (YF) in south Kerio Valley, Kenya, the first recorded in that country, was reported in September 1992, peaked in January 1993 and ended in February. The ecology of the valley

is complex, from semi-arid thorn scrub and acacia savannah below 1200m to pine forest at 2400 m. Monkeys of several species occur throughout. Most confirmed cases lived in wooded areas between 1500 m and 1920 m. We made human bait collections (March 1993) in (i) non-thorny bush/woodland, associated with the majority of confirmed cases; (ii) gallery woodland on the semi-arid floor of the valley, associated with early cases; (iii) banana orchard/thornbush thicket. In the non-thorny bush/woodland *Aedes africanus* was often abundant, and by far the most commonly collected species, although some sites yielded significant numbers of *Ae. ingrami* and *Ae. keniensis*. In the discontinuous gallery woodland *Ae. luteocephalus, Ae. metallicus* and *Ae. vittatus*, all implicated as YF vectors in semi-arid or arid regions of the continent, were present. *Ae. bromeliae*, an important peri-domestic YF vector, was collected in the thornbush thicket but not in banana orchards. To date, we have isolated yellow fever virus from *Ae. africanus* (1 pool) and *Ae. keniensis* (2 pools). Water storage is not practiced in the area; domestic vectors were rare and there was no indication of domestic transmission. We conclude that this was a sylvatic outbreak in which human cases were directly linked to an epizootic and were independent of each other. The epidemiologic data fully corroborate this interpretation. There is an urgent need to identify potential sylvatic corridors that could conduct the enzootic from the Kerio Valley to adjacent areas where water storage practices support domestic vectors and the human population has not been vaccinated.

159 NATURAL VERTEBRATE HOSTS IN THE TICK-BORNE ENCEPHALITIS VIRUS TRANSMISSION CYCLE: AMPLIFICATION OF INFECTION PREVALENCE BY NONVIREMIC TRANSMISSION. Labuda M*, Kozuch O, Eleckova E, Zuffova E, and Nuttall PA. Institute of Virology, Slovak Academy of Sciences, Bratislava, Slovakia; and NERC Institute of Virology and Environmental Microbiology, Oxford, U.K.

Tick-borne encephalitis (TBE) is the most important human arboviral disease in Europe with TBE virus activity permanently high in some countries (e.g. Austria), and apparently on the decline in others (e.g. Slovakia). From blood and target organs of more than 6,000 small terrestrial mammals live-trapped in selected territories of Central Europe during 1964 to 1991, 48 TBE virus isolates were recovered; 20 isolates were obtained from *Apodemus flavicollis* and 22 from *Clethrionomys glareolus* species. About 15% of these abundant rodent species had neutralizing antibodies to TBE virus. The field collected data raise the guestion: how do these rodent species support the spread of infection into newly feeding ticks? Laboratory experiments were designed to mimick natural conditions of virus transmission by allowing infected and uninfected *Ixodes ricinus* ticks to feed together on uninfected hosts. The greatest numbers of infected ticks were obtained from *Apodemus* field mice, even though they had undetectable or very low levels of viremia. In contrast, bank voles (*C. glareolus*) and pine voles (*Pitymys subterraneus*) developed substantial levels of viremia but gave rise to 4- to 5-times fewer infected ticks compared with field mice. The results suggest that *Apodemus* mice are the most important amplifying hosts of TBE virus and "nonviremic" transmission is an important mechanism for the survival of TBE virus in nature.

160 HOST-PARASITE BIODIVERSITY: THE INTERFACE OF FIELD PARASITOLOGY, SYSTEMATICS, AND MAMMALOGY. Gardner SL*. Department of Nematology, University of California, Davis, CA.

From 1984-1993, approximately 10,000 mammals and their parasites have been collected from throughout Bolivia. Techniques of field parasitology-mammalogy developed during the period of this study have been applied to other disciplines such as botany, herpetology, and ornithology. During our field studies and subsequent laboratory analyses, the highest priority continues to be the acquisition and tracking of accurate data. These data can be used for studies from the level of molecular phylogenetics through ecosystem ecology. Accurate logging of habitat types through the use of field notes, photographs, and now video tape, and digital photography is extremely important for documentation and archival storage of data. In the field, specimens are collected, habitat noted,

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