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Report for IWG on Communication, Bat Conservation and Public health

Bats and Viruses

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Bats harbour a greater proportion of viruses than several other groups of mammals, and the fact that these viruses don't seem to harm the bats points to a long history of co-evolution. Several are zoonotic - they cause disease in humans. Such 'spillovers' either occur directly, through contact with infected bats or indirectly through intermediate hosts such as domestic animals or wildlife that have been contaminated by blood, saliva, urine or faeces of bats. Outbreaks of such zoonotic diseases have increased in recent decades often as a result of bushmeat consumption as well as human encroachment into natural habitats involving deforestation and agricultural intensification. Our ability to identify the causes of such disease has also increased.

Filoviruses

Ebola is the most serious of these recently emerged zoonotic viruses, in terms of human mortality. Sporadic outbreaks of this haemorrhagic disease have been known for 40 years in isolated forest villages across central Africa. They spread in waves, accounting for up to a few hundred deaths before abruptly dying out, often before public health authorities could respond. In the recent outbreak, the virus had mutated to become more infectious and improved transport links in West Africa meant that it soon entered towns and cities. Nearly 30,000 people were infected of whom over 11,000 died. Strong circumstantial evidence points to several species of bats from west and central Africa as the source of the virus although the most recent outbreak may have originated from an insectivorous bat. The first victim (the 'index case') was a two year old boy who had played in a hollow tree used by *Mops condylurus* as a roost. Initial infections result from contact with carcasses of bats and other wildlife carrying the virus, such as chimpanzees, apes and forest duikers that have become infected by eating fruit contaminated by bats - so that hunters and those preparing bushmeat for cooking are most at risk. The high infectivity of Ebola means that it may be contracted by the slightest contact with an infected person. There is no direct cure although good nursing care may reduce mortality and a vaccine has now been developed.

Marburg is the only filovirus that has been isolated from a bat (*Rousettus aegyptiacus*), which is considered to be the natural reservoir. Spillovers to humans occur occasionally and have involved mainly mine workers in Uganda and occasionally tourists who have visited caves. The largest outbreak occurred in Angola a decade ago with 252 cases, 90% of which were fatal.

Coronaviruses

Severe Acute Respiratory Syndrome (SARS-CoV) first occurred in 2002 in China from where it spread throughout the world (thus becoming a pandemic) with over 8000 confirmed cases of which nearly 800 were fatal. Soon after the outbreak, the virus was found in masked

palm civets and raccoon dogs in a market in Guangdong Province and it took some time before horseshoe bats were identified as the natural hosts, from which the virus had spilled over to the carnivores.

Middle East Respiratory Syndrome (MERS- CoV) was first reported on the Arabian peninsula in 2012, is spread mainly by human to human contact and has infected around 1650 people worldwide, about 600 of whom have died. Because a small fragment of viral RNA from an Egyptian tomb bat *Taphozous perforatus* was found to be identical with that from the first MERS patient, it was suspected that bats were the natural reservoirs, but that has not been substantiated, and no other bat has been found to carry MERS. Instead most human infections have been traced to close contact with dromedary camels.

SARS has resulted in a global search for coronaviruses in bats and many have been found, in Africa, Europe and Mexico but none has so far become zoonotic.

Paramyxoviruses

Henipavirus: Hendra was first detected in Australia during an outbreak of infectious respiratory disease in horses and humans in 1994. There have been several subsequent spillovers resulting in seven human cases and four deaths. Pteropodid bats have been confirmed as reservoirs of the disease. Horses became infected when they grazed on pastures infected with bat urine and passed on the disease to those caring for them. However with appropriate horse husbandry, the disease has been contained.

Nipah virus was first isolated in 1998 in pigs and pig workers suffering from encephalitis in Malaysia, where 265 cases resulted in 105 deaths. Cessation of pig movements and culling over a million pigs brought the disease under control. The experience with Hendra soon led to fruit bats being identified as the source of infection, with pigs eating fallen fruit contaminated by bats. Since 2001 however human cases have occurred almost annually in Bangladesh and occasionally nearby in India, with higher fatality rates than in Malaysia and with a different route of infection. This occurs mainly by drinking palm sap infected with the virus by *Pteropus giganteus*. Preventing access by bats to the pots which collect the sap has reduced the infection rate.

Rhabdoviruses

Lyssavirus causes rabies and the genus is rapidly growing, with 15 species currently recognised, all but two of which have been isolated from bats. The best known is classical rabies virus (RABV) which remains one of the most significant human zoonoses, killing tens of thousands of people each year in Africa and Asia following dog bites, according to the World Health Organisation. Vampire bat rabies, caused by the same virus species, is a major public health threat in Latin America. An excellent vaccine is available although its efficacy against some of the newly discovered rabies viruses has yet to be established.

Effects of zoonotic viruses on bat populations

Although some bat mortality in Carlsbad caverns, New Mexico, and in South Africa has been associated with rabies in the past, and mass die-offs of *Pteropus mariannus* in Micronesia in the 1930s occurred when measles affected the human population, zoonotic viruses in general seem to have little effect on bats. Mass die-offs of *Miniopterus schreibersii* reported in caves across southern France extending into Spain and Portugal in 2002 reduced the population by 60-65% although the cause was never established at the time and other bat species in the caves were unaffected. More recently a new virus, named Lloviu and closely related to Ebola and Marburg, has been identified in a cave in Spain in populations of *M.schreibersii* that succumbed to the 2002 die-off.