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NEWSLETTER

Out of Africa: Pathogens and Pandemics[©]

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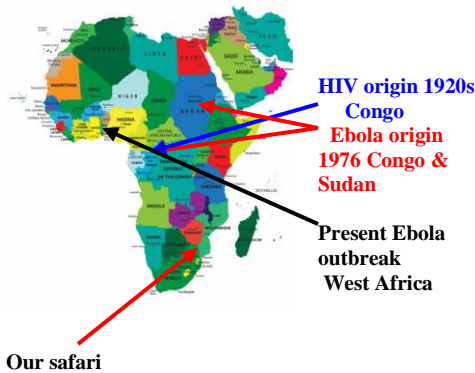
In This Issue:

Again we have just returned from a wonderful African safari, this time to South Africa and Botswana, and the Fall 2014 issue of the NVL Newsletter will discuss *Bartonella*, FIV, FeLV and the current African Ebola epidemic. Southern Africa is one of the most diverse areas of the world with unmatched plant kingdoms and rare and threatened animals.



Introduction:

Once again Evelyn Zuckerman and I (Dr. Hardy) were seated on our transatlantic flight home, after an exciting African safari to South Africa and Botswana, when I began to think of a subject for our Fall 2014 Newsletter. This year we saw, and photographed, descendants of the lions, leopards and cheetahs that we tested, almost 20 years ago, for the feline retroviruses, FeLV and FIV, and for *Bartonella*.^{1,2} We visited East Africa last year and were now traveling during the major Ebola epidemic occurring in West Africa.



The African continent gave birth to mankind but in recent years has been the site of major threats to the human race with the origin of HIV and the Ebola virus from African animals. Both viruses originated around Kinshasa in the Democratic Republic of the Congo.^{3,4} Evolution has been the mechanism for animal divergence and variety but it has also fostered the co-evolution of microorganisms along with their evolving animal hosts or reservoirs. Some of the animal reservoirs have become vectors enabling the more rapid evolution of pathogens to adapt to new animal host species. A good example of this phenomenon was the origin of FeLV, probably somewhere near Egypt, by the trans-species transmission of an endogenous retrovirus of an ancestor of the rat, millions of years ago.⁵

Likewise, there is evidence for the evolution of *Bartonella* species with their animal hosts. Certain *Bartonella* species are only found in one animal species (*B. bacilliformis* in humans) while others, such as *B. henselae*, have adapted to several species (cats, dogs, humans).

With the advent of modern transportation, the spread of microorganisms among and between species has become extremely efficient and rapid. Last year on our flight home from Kenya and Tanzania I read David Quammen's book "Spillover," about the origins, in animals, of most of our new zoonotic diseases. Approximately 80% of human pathogens have originated from animals as zoonotic infections. As he forecasted, a new re-emergence of the current Ebola virus epidemic occurred in West Africa this year.



The Pathogens:

African animals and their pathogens evolved together. Endogenous retroviruses were transmitted across species and then evolved in their new species. FIV-like viruses evolved in many African, and other wild cats worldwide, and became non-pathogenic in most cats.⁶ Unlike feline lentiviruses, the human HIV lentivirus, derived zoonotically recently from chimps, has caused a worldwide epidemic killing millions of people.^{7,8} *Bartonella* is also found in several species of African wildcats, many rodent species, bats and other animals and seems to have evolved separately in each species.^{9,10} Although not a feline pathogen, the canine distemper virus killed many lions in the Serengeti in the 1990s and bovine TB continues to take its toll on African lions.^{11,12} Following is a list of pathogens, common in domestic small animals, that are also found in free-ranging African carnivores.¹³⁻¹⁷

All animal pictures © by Dr. Hardy



Bartonella, FIV & FeLV in African Lions

Animal	<i>Bartonella</i>	FIV	FeLV
Lions	Yes	Yes	No*

* FeLV has been found in 2 captive lions that were exposed to domestic cats.



Bartonella, FIV & FeLV in African Leopards

Animal	<i>Bartonella</i>	FIV	FeLV
Leopards	Yes	Yes	No



Bartonella, FIV & FeLV in African Cheetahs

Animal	<i>Bartonella</i>	FIV	FeLV
Cheetahs	Yes	Yes	No



Bartonella, FIV & FeLV in African Hyenas

Animal	<i>Bartonella</i>	FIV	FeLV
Hyenas	ND	Yes	No



Bartonella, FIV & FeLV in African Wild Dogs

Animal	<i>Bartonella</i>	FIV	FeLV
Wild Dogs	Yes	ND	ND

FeLV: To date, no FeLV has been found in any free-ranging African wildcats although there have been several infected with FeLV while living in captivity.¹³⁻¹⁷ The endogenous FeLV sequences are present only in the members of the genus *Felis* and are not found in African wildcats.⁵ Similar sequences are found in rats whose ancestors must have infected an ancestor of domestic cats after they diverged from the rest of the cat family. Domestic cat DNA also harbors RD-114

endogenous sequences obtained from baboon ancestors in ancient Africa.

FIV: The FIV-like virus found in African cats (FIV-ple) is similar to the one we found in cougars in North America and quite different from the pet cat FIV.¹⁸ FIV-ple is endemic in 9 *Felidae* and one *Hyaenidae* species.¹³⁻¹⁸ The prevalence varies depending on the geographic location and appears to have evolved along with each cat species. The virus is non-pathogenic in these African cats, much like we observed in the pumas in British Columbia, Canada.¹⁸ In collaboration with Drs Steve Osofsky and Karen Hirsch we found 8/31 (26%) lions, 3/18 (17%) leopards, and 1/4 (25%) cheetahs infected in Botswana in 1996.¹ In 2003, with Moritz Van Vuuren, we found FIV infection common in free-ranging lions in Kruger National Park, SA 18/22 (82%), Botswana 20/22 (91%), Zimbabwe 7/22 (32%) but in none of the 18 lions from Hluhluwe-Umfolozi, SA.¹⁴

Bartonella:

Bartonella have evolved with their animal hosts (co-evolution) for millions of years. In Africa, bats and many small rodents are infected reservoirs for numerous *Bartonella* species. *Bartonella* have been found in African ticks and fleas in all countries sampled. Interestingly, fleas are not often found on large carnivores and herbivores in Africa but are common on rodents. Of course ticks parasitize numerous large African animals and they often are infected with various *Bartonella* species. Studies have been done on the prevalence of *Bartonella* in free-ranging African big cats. One study found serologic evidence of exposure in 19/113 (17%) African lions and 23/74 (31%) cheetahs- the country of origin was not specified. 5% of 58 lions and 6% of 17 cheetahs were considered bacteremic by TaqMan PCR.⁹ The other study of 62 lions on a game ranch in South Africa found 18 (29%) were antibody positive by IFA.¹⁰

Origin of Zoonotic Pathogens:

Africa was and is a hot bed of human, animal, and microbe evolution and it is no wonder that many of our new zoonotic diseases are still arising from animals on the African continent. HIV and Ebola virus are but two that have arisen from Africa and more will inevitably follow.

Ebola

Ebola virus, a filovirus, causes the disease Ebola which is characterized by fever, vomiting, diarrhea, and sometimes bleeding. The first outbreaks occurred almost simultaneously in 1976 in the former Zaire, now the Democratic Republic of the Congo and neighboring Sudan.^{3,4} One of our early FeLV collaborators, Dr. Don Francis, a physician from the CDC who worked in Dr. Max Essex's lab at Harvard, was sent to investigate this first outbreak. Since then there have been about 27 different Ebola outbreaks that have been quickly controlled until this current severe and long term outbreak in West Africa. Presently there is no vaccine and 25-90% of infected people die. The virus is transmitted by direct contact with infected blood, body fluids, and tissues. Fruit bats are a natural reservoir of the Ebola virus and they are an important source

of protein in areas where wild animals are in short supply.¹⁹ They are often shot and then sold covered in blood. Chimpanzees and gorillas are



Fruit bats, the reservoir for the Ebola virus, roosting in the dining area in our lodge in Botswana.

also known Ebola virus vectors who will die from their infections. However bats do not die from Ebola virus infection, thus they maintain the virus in tropical forests. Local people will often eat dead primates found on the forest floor and thus may become infected. Contact with these infected animals transmits the virus to people and the zoonosis begins. There is serologic evidence that the Ebola virus infects dogs in areas where epidemics have occurred but, unlike humans, there has been no disease occurrence observed in infected dogs and they have not transmitted the disease to people.²⁰

One Health: Ebola & Veterinarians

The One Health effort is of great importance in combating the Ebola epidemic in West Africa.

Dr. Steve Osofsky, Executive Director for Wildlife Health and Health Policy at the Wildlife Conservation Society. Our friend and previous collaborator, Dr. Steve Osofsky, gave an insightful interview on CNN recently and we will paraphrase his recommendations. Simply put, Dr. Osofsky says we can be infected by viruses from wild animals when we kill and eat or trade their body parts, when we capture and trade live wildlife and mix species together in markets, and when we move into wilderness areas. Bats are reservoirs for many viruses including SARS, Ebola, Nipah and rabies. Thus, we must work to prevent the capture, killing and consumption of bats, the disruption of their roosting trees, and the establishment of farms where they defecate and urinate. The same can be said for primates, our closest relatives, who can be vectors for Ebola virus. Food security is a basic human right and many people need to hunt "bush meat" to feed their families. We need to identify species that should be avoided if at all possible and provide alternative safe food species for these people.

Dr. Oyewale Tomori, President of the Nigerian Academy of Science, a veterinarian, was the WHO regional virologist for the African region in 1995 during the Ebola outbreak in Kikwit in the Democratic Republic of the Congo (DRC). After Dr. Tomori finished his talk on Ebola at the recent International Meeting on Emerging Diseases and Surveillance, there was stunned silence. Tomori, used his plenary lecture to deliver a scathing critique of how African countries have handled the threat of Ebola and how corruption is hampering efforts to improve health. Aid money often simply disappears, Tomori charged, "and we are left underdeveloped, totally and completely unprepared to tackle emerging pathogens." **Reference- ProMed Digest Vol. 29, 11-8-2014.**

Conclusion: One Health- Africans and the world must develop disease surveillance systems, medical and veterinary infrastructure and personnel to respond to the inevitable future new and re-emerging zoonotic diseases. Safe and available food alternatives to "bush meat" must also be developed.

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