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# 16

## Evaluating Camel Health in Kenya—An Example of Conservation Medicine in Action

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### Introduction

The ability to adequately feed the 7.6 billion people that currently inhabit the planet has become increasingly challenging due to climate change and other environmental stressors that are occurring on a global scale and at an ever-accelerating rate.<sup>1</sup> Additionally, as the human demand for animal-based protein continues to escalate, with estimates of a 50% increase during the first 20 years of the 2000s, the need to find ways to feed our species without jeopardizing the survival of wildlife should be a top goal for the conservation medicine initiative<sup>2,3</sup> (see also Chapter 19). We must find solutions to these combined challenges by taking into account the need for proper human nutrition and health, wildlife conservation, and environmental resilience. An example of a holistic conservation medicine program is well demonstrated by our work focused on camel health in the shifting landscape of Northern Kenya. In fact, the changing demographics of people and their livestock in this region may have immediate and long-standing negative implications for sympatric wildlife species. These changes demand a conservation medicine approach.

The semi-arid region of Northern Kenya has experienced great transformations in recent decades caused by changing climate, as semi-arid lands become more arid, and with displaced persons coming into the region from areas of conflict outside of Kenya.<sup>4,5</sup> It is here that the largest refugee camp in the world, Dadaab, which houses an estimated 500,000 people, is found along the border with Somalia.<sup>5</sup> These people are mostly displaced from conflict in their home countries and are, unfortunately, as Muslims and refugees, a marginalized part of Kenyan society.<sup>5</sup> It is these more recent arrivals to Kenya, residing in Dadaab camp, across Northern Kenya, and more widely dispersed throughout Kenya including the capital of Nairobi, that have traditionally used camels as a source of milk and meat. This change

in human demographics, combined with climate change, is a driver of demand for camels throughout the region.

Along with this increase in people, the recent increase in drought conditions in the region has compounded negative impacts on human livelihoods. This has led to a switch from a cattle-based economy to one based on camels. Camels provide a strategy for climate change adaptation due to their ability to survive under harsh environmental conditions and as such are a means to improve human livelihoods and climate resilience.<sup>4</sup> The camel is claiming a strong position in the face of East Africa's changing climate.

In Kenya, the growth in the dromedary camel population over the past couple of decades is evident with estimates of 717,500 camels in 2000 increasing to 2.9 million in 2013.<sup>6</sup> During a similar period, cattle numbers in the country decreased by 25.2% because cattle survival has become increasingly difficult in a landscape modified by climate change.<sup>7</sup> Today, Kenya has Africa's third largest dromedary camel population, estimated at 3,091,200 animals; the camel meat and milk industry in Kenya is worth approximately US \$11,000,000 annually.<sup>8</sup> This rise in camel production in Kenya is largely due to the increase in droughts, the ability of camels to survive days without water or food, as well as the ability of camels to eat 100% natural forage, all leading to this switch from cattle to camels.<sup>4,6</sup> For example, a study found that 71.5% of the households interviewed in Isiolo County, Northern Kenya, preferred camels over other livestock and cited their endurance to climate factors as the main benefit they gain.<sup>9</sup> Overall land and water footprints for milk production have increased for camels, whereas it has decreased by half for cattle.<sup>10</sup>

This increase in camels has provided protein for the people of Kenya with estimates over a 13-year period (2000–2013) of camel milk production increasing from 335,000 tons to 937,000 tons, and meat production from 15,000 tons to 651,000 tons.<sup>8</sup> These numbers are encouraging for human health because the ability for cattle to survive

in the changing environment has declined; however, this may also indicate three points of concern when viewed in a conservation medicine framework. First, with just one camel milk pasteurization plant in the country, Kenyans have little access to pasteurized milk. It has been estimated that 10% of Kenya's 40 million people drink unpasteurized camel milk.<sup>11</sup> Because raw camel milk is a possible transmission route for many microorganisms, the consumption of unpasteurized camel milk in Kenya may pose a high public health cost in the country.<sup>11–15</sup> Secondly, camels are browsers and have great ability to cover large areas across the landscape, which may lead to competition for food with sympatric wildlife.<sup>16</sup> Lastly, there remains a shortage of veterinary education for camel health and a lack of veterinary support for camel production in the country. As a relatively new large-scale production livestock species in Kenya, and as a species often viewed as most closely linked with marginalized people, veterinary care and biosecurity for camels in Kenya significantly lags behind that for more traditional livestock (e.g., cattle, sheep, goats). This lack of care has potentially devastating implications for productivity losses related to disease-associated morbidity and mortality, as well as an increase in disease transmission between camels, other livestock, wildlife, and humans. All these factors and challenges demand a conservation medicine approach.

## What Is a Conservation Medicine Approach and How Do Zoos Fit Within It?

Although a number of definitions have been provided for conservation medicine, one unifying theme may be that it is a strategy that strives to expand transdisciplinary collaborations and communications to improve the health of humans, animals, and the environment.<sup>17</sup> Today, with the push for AZA-accredited zoos to dedicate 3% of their revenue to conservation, the time is right for zoos to be leaders in this initiative. This should be an easy fit as a core objective of zoo conservation is often to ensure healthy wildlife populations and ecosystems, without compromising the health of humans. Thus, the conservation mission of accredited zoos fits perfectly within a conservation medicine framework.

Zoological institutions have an opportunity to play many roles within conservation medicine programs and we may be the advocates that help to ensure species' conservation is considered within these programs for improving human, animal (e.g., domestic and wild), and environmental health.<sup>17–19</sup> Briefly, these roles may include (1) providing healthcare for zoological species, thus ensuring sustainability of biodiversity; (2) conducting studies on diseases of conservation concern; (3) understanding diseases in zoo wildlife as sentinels for emerging diseases of humans and animals in surrounding areas; (4) performing surveillance of diseases in wild animals at the interface of wildlife, domestic animals, and humans; (5) making contributions to the fields

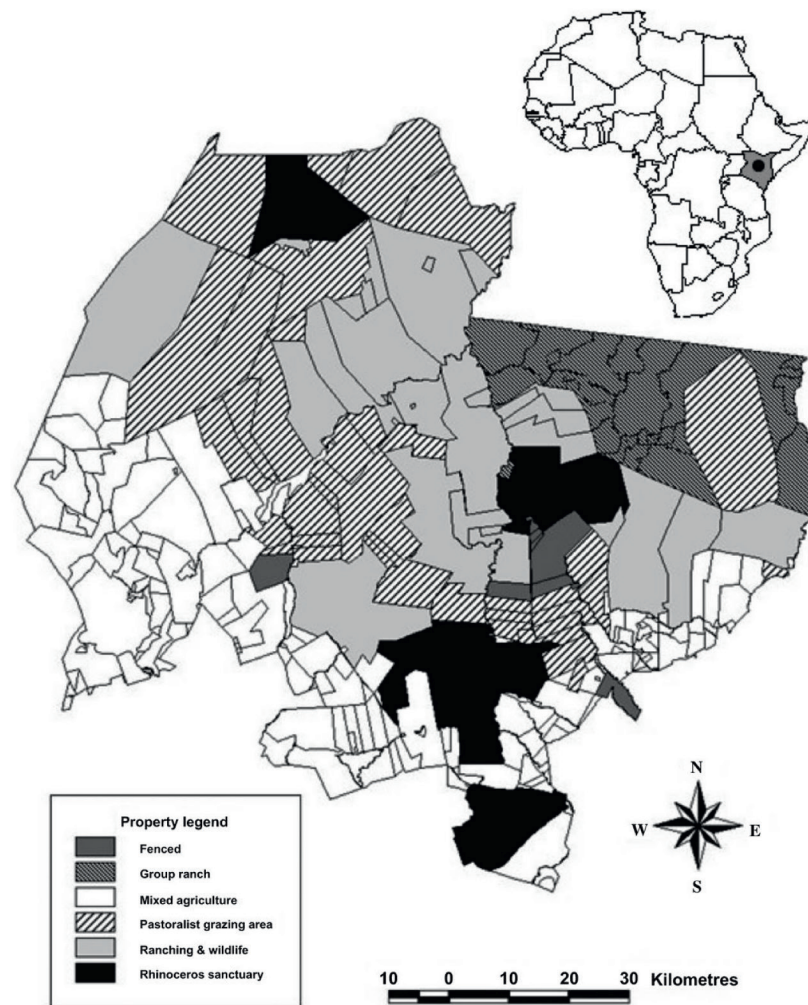
of comparative medicine and discoveries in all life forms; and (6) demonstrating the importance of nature for human health.<sup>17–20</sup> This chapter presents a conservation medicine program focusing on camel health in Kenya, which demonstrates roles that zoological veterinarians play to ensure healthy animals and healthy people.

## Project Design

In 2012, the Saint Louis Zoo Institute for Conservation Medicine (ICM) was invited to spearhead camel health studies at the Mpala Research Centre (MRC) in Laikipia County, Kenya (Fig. 16.1). The invitation was from colleagues working at MRC and Novus International, an animal nutrition company with headquarters near St. Louis, MO. After researchers embarked on camel nutrition studies, they soon realized that little data existed on the health status of, and disease risks for, camels in Kenya. (This was just before Middle East Respiratory Syndrome [MERS-CoV] was on the international stage with the first detection of MERS-CoV in a 25-year-old student in Jordan.<sup>21</sup> See also chapter in this volume: An Overview of Middle East Respiratory Syndrome in the Middle East.) We at the Saint Louis Zoo immediately accepted this opportunity because the ICM had just launched as a new Zoo department, and one of the Zoo's WildCare Institute conservation centers had been focusing efforts on wildlife conservation in the Horn of Africa for many years prior to this time.

With minimal research, it quickly became evident that a camel conservation medicine program was important because (1) camels had become the “new cow” in Kenya; (2) many diseases of camels may be transmitted to humans, livestock, and wildlife; and (3) the region of Kenya where MRC is located has experienced the largest increase in camel numbers while still holding the highest densities of wildlife in the country, although these numbers are falling significantly as humans and livestock move across the landscape.<sup>9,22</sup>

To get the program underway, we took a multistep approach that included (1) conducting research to better understand the species and region; (2) reaching out to international camel experts and livestock/wildlife and conservation researchers in Kenya; and (3) securing funds and people to make the program a success (Box 16.1). First was the task of gathering literature on dromedary camel health and diseases, and to consider these in a conservation medicine framework. We focused on the diseases that were of most concern for camel productivity and human health, as well as diseases transmissible across the camel-livestock-human-wildlife interface. Dromedary camels may harbor agents with zoonotic potential (e.g., *Coxiella burnetii*, *Brucella* spp., *Toxoplasma gondii*, Rift Valley fever, anthrax) and/or those that may be transmitted only among camels, other livestock and wildlife (e.g., blue tongue, bovine diarrhoea virus, *Trypanosoma evansi*).<sup>23–29</sup> It was also clear that some of these diseases (e.g., *Brucella* spp.) are difficult to diagnose in camels.



• **Figure 16.1** Map of Laikipia County, Kenya. (From Browne AS, Fèvre EM, Kinnaird M, et al: Sero-survey of *Coxiella burnetii* (Q fever) in Dromedary Camels (*Camelus dromedarius*) in Laikipia County, Kenya. *Zoonoses Public Health* 2017. doi:10.1111/zph.12337. <http://onlinelibrary.wiley.com/doi/10.1111/zph.12337/full#zph12337-fig-0001>.)

### • BOX 16.1 How to Start a Conservation Medicine Program at the Livestock-Wildlife-Human Interface

1. Do your homework and research *all* aspects of the study; including human, animal, and environmental truths.
2. Reach out to others across disciplines to develop collaborations and partnerships.
3. Find funding streams that will allow you to execute the program.
4. Get the people-power to staff the various parts of the program.
5. Use the program to educate the next generation of conservation medicine practitioners globally.
6. Share the data in the scientific and policy arenas so your science is not just a hobby.
7. Use the program to help others capitalize on your work and/or expand into other directions.
8. Be flexible to modify the program as necessary based on political and biological realities.

It was immediately evident that losses due to infectious diseases in camels impact the economies of local camel herders in Kenya.<sup>30</sup> As seen in similar regions with camel production, we hypothesized that mastitis, with a prevalence estimated at 23%–76% for camels in the region, was also of top concern in Laikipia.<sup>31</sup> Therefore possibly with simple preventive measures we could minimize this camel and human health concern.

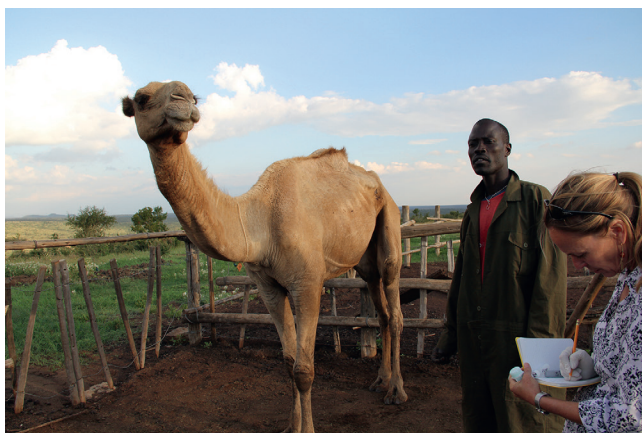
The literature review into the study site and how camel production in the region may impact human health, wildlife conservation, and environmental resilience in Laikipia produced a great deal of information on the area with Laikipia County known to have high levels of biodiversity and diverse land-use practices, ranging from pastoralists to commercial ranching, agriculture, habitat conservation, ecotourism, and wildlife research.<sup>22</sup> Furthermore, it was known that the large increase in camels in the region was likely to influence both conservation efforts and land-use dynamics.<sup>22</sup>

After gaining an appreciation for the issues at hand, we needed to determine how to fund the program and what partnerships with other conservation medicine practitioners we could develop. Seed money from Novus International helped get the project started. Subsequently, we were able to secure funds from internal grants at the Saint Louis Zoo, foundations, private donors, and governmental agencies. Collaborations quickly grew in the first year and we continue to have new organizations working with us on camel health issues. These collaborations became increasingly easy to develop following the discovery of MERS-CoV, and the role that camels have in the epidemiology of the disease.<sup>21</sup>

## Program Outcomes to Date and Future Plans

Now entering the fifth year of this camel program in Northern Kenya, we have produced a number of scientific and layperson-friendly products to help with camel production, while minimizing human and wildlife health concerns. Early in the study we developed a camel herd health protocol that was shared with local camel herders in the region.<sup>32</sup> Also, after the first field season and with the documentation that mastitis was indeed causing high production losses, we conducted a study to better understand the risk factors associated with mastitis prevalence.<sup>33</sup> Reports were also shared with local camel herders to provide information on the health status of their animals based on complete blood counts, chemistry profiles, and exposure to a number of infectious and parasitic disease-causing agents.

One example of an immediate improvement in camel welfare and productivity was the diagnosis, using simple blood film evaluations, of *T. evansi* in a camel herd that was experiencing high calf mortality and severe morbidity in adults (Fig. 16.2). The herd owner had not been using trypanocide for prevention because trypanosomiasis was thought to not occur in the region. However, in this increasingly interconnected world, with animal movements (e.g., camels from northern Africa and the Middle East into



• **Figure 16.2** Adult camel with clinical signs of, and blood film confirmation for, *Trypanosoma evansi*. (Photo credit: Sharon L. Deem.)

Laikipia County), herders started to appreciate that with the movement of animals comes the movement of all their micro- and macrobiota.

We also focused much of our work on *C. burnetii*, because the original literature review indicated that Q fever was an emerging infectious disease (EID) in Kenya, and that during recent years it had been causing significant disease in Kenyans.<sup>34</sup> However, with little known on the epidemiology of the disease in Kenya, we elected to explore the possible role of camels. Our studies have demonstrated a high seroprevalence to Q fever in camels, and the potential role they may serve as reservoirs of the bacteria, with implications for cross-species transmission between livestock, sympatric wildlife, and humans.<sup>35,36</sup>

Rather serendipitously and shortly after we had started working with camels, the emergence of MERS-CoV in the Middle East, with spread to other regions of the world, was a catalyst for the development of this conservation medicine program. The use of samples we had collected and bio-banked in the initial years and just prior to MERS-CoV being on the world stage provided an important source of data for understanding this significant EID in the region.<sup>37</sup>

Lastly, a large part of our camel program in Kenya has been the training of next generation conservation medicine practitioners through involvement in a real-life public health and wildlife conservation program.<sup>19</sup> This has included students from Kenya, the United Kingdom, and the United States. Through this program, we have trained DVM, MSc, and public health students and provided them experiences in which they gain an appreciation for the disease risks associated with changing environmental conditions, protein sources for humans, and the inevitable increase in interactions at the domestic animal/wildlife/human interface.

## Future Work

This program is ongoing and we continue to focus on all four core components. These include: (1) improvements in camel husbandry, health, and production including plans for a camel veterinary course at the University of Nairobi College of Veterinary Medicine; (2) Q fever and MERS-CoV epidemiologic studies with emphasis on the role of vectors and use of slaughterhouses for surveillance, respectively; (3) training of conservation medicine practitioners; and (4) continued collaborations across institutions and disciplines.

Developed in 2012 and at a time that few people had camel health on their radar, we now know of the importance of camels in the epidemiology of MERS-CoV and other EIDs (e.g., Q fever) in Kenya.<sup>35–37</sup> Therefore there is an increase in organizations and individuals that are working to improve camel production in Kenya, and we continue to expand partnerships within this program. Only through scientific research, veterinary medical care and public policy for camel production will we be able to mitigate the potential risks to public health, and sympatric wildlife and livestock health, while advancing camel productivity in the region.

We continue as one of the collaborators working to advance camel welfare, health, and productivity; all imperative to help support human health and, as importantly, to be sure that this new form of climate change adaptation and food security does not lead to unchecked negative impacts on the conservation of Kenya's amazing wildlife.

## Concluding Thoughts on Conservation Medicine Programs

This work on camel health in Northern Kenya is one example of a transdisciplinary conservation medicine program initiated by a zoo conservation medicine department. The program has already generated the data necessary for better understanding diseases at the camel, livestock, wildlife, and human interface, in the face of changing environments. Zoo staff and veterinarians are often well-versed in this across-taxa approach. Some may question why a zoological institution and zoological veterinarian took the lead on developing a program for a “domestic livestock” species. However, when viewed at the intersection of camel, livestock, wildlife, and human health and disease concerns, this is the type of program zoos should increasingly embrace. Zoological veterinarians are first and foremost veterinarians; we have an ability to partner with public health colleagues, and zoos are working to increase their “fence to field” reach to work for the conservation of wildlife species, while ensuring human livelihoods and health are not compromised.<sup>17,19</sup> As previously stated,<sup>38</sup> one solution to disease and conservation at the wild-domestic animal interface is the implementation of a proactive approach—addressing potential pathogen transmission before a volatile problem occurs. This program did just that.

Charles Darwin is reported to have said that the species that survive are not necessarily the strongest or the most intelligent; rather they are the ones that are the most adaptable to change.<sup>39</sup> This grassroots conservation medicine program, which began prior to camels being on the world stage due to their role in the emergence of MERS-CoV, best demonstrates how the ability to adapt and attend to concerns of the day are in everyone's best interest. A proactive approach to camel health, at a time that camel numbers are growing across the Kenyan landscape, with potential negative impacts for wildlife conservation, is one example of how zoos may lead in the conservation medicine initiative to help address these 21st century challenges. We took an opportunity that at first glance might not have seemed a “good fit” for a zoo conservation department but was shown very early in our work to be an excellent fit.

While working on this chapter, security issues in northern Kenya again escalated due to worsening drought with dire consequences for pastoralists, herders, and ranchers in the region. Food security, and simple human security, will worsen in the short term, if not also the long term. We will have to be ready for these changes. As we strive for improvements in human livelihoods (e.g., poverty alleviation,

conflict resolution, food security), it is imperative that the conservation of wildlife species be included in the equation if we are to properly address human, animal, and environmental health, resilience, and ultimately survival.

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