One Health Relevance of Agricultural Research: Control & Eradication of Arthropod Pests & Vectors of Emerging & Re-Emerging High-Consequence Animal & Zoonotic Diseases

Adalberto A. Pérez de León
The health of animals, people and the environment is connected. The “One Health” approach is the collaborative effort of the human health, veterinary health and environmental health communities. Through this collaboration, USDA achieves optimal health outcomes for both animals and people.

With its partners such as the U.S. Fish and Wildlife Service, U.S. Food and Drug Administration (FDA), the Centers for Disease Control and Prevention (CDC), the National Institutes of Health (NIH), the Environmental Protection Agency, tribal Nations, USDA seeks to maintain or reduce health risks to animals, humans, the environment and society.

USDA serves the nation through its commitment to producing wholesome and nutritious foods; ensuring the safety of plant and animal commodities entering the country; safeguarding the health and welfare food-producing animals; and preventing entry or controlling plant and animal pathogens. These cumulative actions ensure the health and safety of humans through these One Health partnerships.
In 1893, nine years after the establishment of USDA’s Bureau of Animal Industry (BAI), Dr. Theobald Smith & Dr. Frederick Kilborne, a veterinarian, published their monumental discovery proving the cattle tick (R. annulatus) was the vector of B. bigemina.

In 1891, Dr. Cooper Curtice found evidence of an association between the “cattle tick” or “fever tick” (now R. annulatus) and Texas fever.

Dr. Cooper Curtice
“Father of Tick Eradication”

In 1896 Dr. Curtice began campaign advocating the eradication of the ticks from the U.S.

In late 1906 Congress appropriated $82,500 for the initiation of the Cattle Fever Tick Eradication Program
Emerging and Reemerging infections - 70% vector-borne or zoonotic

Arthropod-borne  Rodent-borne  Other (including bats)

The Mission

2, 4, 6, 8: We perform research that protects 2 and 4-legged creatures from 6 and 8-legged arthropods.
One Health Implications of ARS Efforts Ensuring Continued Health & Welfare of Our Nation’s Livestock Populations

• Identification of “high-consequence” foreign animal diseases and pests facilitates emergency preparedness

• Ready to respond effectively when faced with a foreign animal disease outbreak or pest infestation

• If introduced, they pose a severe threat to U.S. animal health and, in some cases, the economy and human health as well

• Tiered approach according to risk level

High-Consequence Foreign Animal Diseases and Pests

In carrying out our safeguarding mission, the U.S. Department of Agriculture’s (USDA) Animal and Plant Health Inspection Service (APHIS) works to ensure the continued health and welfare of our Nation’s livestock and poultry populations. One important aspect of this work is emergency preparedness—making sure we are ready to respond effectively when faced with a foreign animal disease outbreak or pest infestation. As part of these efforts, APHIS’ animal health officials identify "high-consequence" foreign animal diseases and pests. These are serious diseases and pests that do not currently exist in the United States. If introduced here, they pose a severe threat to U.S. animal health and, in some cases, the economy and human health as well.

The list divides diseases and pests into tiers according to risk level, as described below.

Tier 1
Tier 1 diseases are those of national concern. They pose the most significant threat to animal agriculture in the United States, as they have the highest risks and consequences. This category includes:

- African swine fever*
- classical swine fever*
- foot-and-mouth disease*
- notifiable avian influenza (H5 and H7 strains that need to be reported to the World Organization for Animal Health, or OIE)*
- virulent Newcastle disease*

Tier 2
Tier 2 diseases are transmitted primarily by pests. How quickly those diseases spread and APHIS’ ability to control or eradicate an outbreak depends largely on whether these pests are present in the environment and whether they can transmit the disease between

Tier 3
Tier 3 diseases and pests pose less risk and fewer consequences than those in Tiers 1 and 2, but still rise to the level of inclusion because of their potential negative impact on animal or human health. This category includes:

- African horse sickness
- contagious bovine pleuropneumonia and contagious caprine pleuropneumonia
- glanders and melioidosis
- henipaviruses (hendra and nipah)*
- rinderpest* and pests des petits ruminants*
- tropical bont tick

What the List Means
These high-consequence foreign animal diseases and pests are of primary importance to APHIS’ emergency preparedness officials, guiding many of our program priorities. For example, the list will help inform decisions on how we procure countermeasures to address a disease outbreak and, potentially, funding for research and response activities. The diseases marked with an asterisk are those APHIS has identified as biological threats that need to be considered in program priorities and countermeasure stockpile requirements.

How We Developed the List
APHIS developed this list after carefully considering all foreign animal diseases and pests that could negatively affect livestock or poultry. We also took into account disease agents that are identified in the agricultural select agent program, as well as those that can severely threaten public health and animal health (zoonotic diseases) or the safety of animal products. We did not include diseases and pests that are endemic, or common, in the United States or any disease APHIS already manages through one of our animal health
### High-Consequence Foreign Animal Diseases & Pests

<table>
<thead>
<tr>
<th>Tier 1</th>
<th>Tier 2</th>
<th>Tier 3</th>
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<tbody>
<tr>
<td>African swine fever</td>
<td>Heartwater</td>
<td>African horse sickness</td>
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<td>Classical swine fever</td>
<td>New World screwworm</td>
<td>Contagious bovine and caprine contagious pleuropneumonia</td>
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<tr>
<td>Foot-and-mouth disease</td>
<td>Rift Valley fever</td>
<td>Glanders and melioidiosis</td>
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<td>Avian influenza (any strain that is highly pathogenic or zoonotic)</td>
<td>Venezuelan equine encephalitis</td>
<td>Henipaviruses (Hendra and Nipah)</td>
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<tr>
<td>Virulent Newcastle disease</td>
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<td>Rinderpest and peste des petits ruminants</td>
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Criteria guiding designation of animal disease or pest as of high, negative consequence:
epidemic potential; economic impact; trade impact; morbidity, mortality; species infectivity; speed of detection; vaccine availability; zoonotic potential
Background: Babesia are emerging health threats to humans and animals in the US
One Health approach applied to identify gaps in scientific knowledge regarding babesioses
Driven by increased risk for outbreaks of bovine babesiosis associated with increased cattle fever tick outbreaks

Results: Involvement of wildlife in ecology of cattle fever ticks jeopardizes efforts to keep US bovine babesiosis-free
Emergence of human babesiosis apparently linked to increase in the white-tailed deer population
Research needs for human and bovine babesioses were identified and are presented herein

Conclusions: Translation of this research expected to provide veterinary and public health systems with tools to mitigate impact of bovine and human babesioses
Economic, political, and social commitments are urgently required, including increased national funding for animal and human Babesia research, to prevent the re-establishment of cattle fever ticks and the increasing problem of human babesiosis in the US
One Health Nexus:
Global Change, Arthropod Pests & Vectors, Livestock-Wildlife Interface, & Disease Ecology
Baseline Susceptibility to Pyrethroid and Organophosphate Insecticides in Two Old World Sand Fly Species (Diptera: Psychodidae)

Andrew Y. Li, PhD
Adalberto A. Pérez de León, DVM, PhD, MS
Kenneth J. Linthicum, PhD
Seth C. Britch, PhD
MAJ Joshua D. Bast, MS, USA
Mustapha Debboun, PhD

Research paper
First documentation of ivermectin resistance in *Rhipicephalus sanguineus* sensu lato (Acari: Ixodidae)
R.I. Rodríguez-Vivas, M.M. Ojeda-Chi, I. Trinidad-Martínez, A.A. Pérez de León

Acaricidal efficacies of *Lippia gracilis* essential oil and its phytochemicals against organophosphate-resistant and susceptible strains of *Rhipicephalus (Boophilus) microplus*
Livio M. Costa-Júnior, Robert J. Miller, Péricles B. Alves, Arie F. Blank, Andrew Y. Li, Adalberto A. Pérez de León

Interaction of plant essential oil terpenoids with the southern cattle tick tyramine receptor: A potential biopesticide target
Aaron D. Gross, Kevin B. Temeyer, Tim A. Day, Adalberto A. Pérez de León, Michael J. Kimber, Joel R. Coats
Arthropod genomics research in the United States Department of Agriculture-Agricultural Research Service: Current impacts and future prospects

Brad S. Coates¹,⁎, Monica Poelchau², Christopher Childers², Jay D. Evans³, Alfred Handler⁴, Felix Guerrero⁵, Steve Skoda⁵, Keith Hopper⁶, William M. Wintermantel⁷, Kai-Shu Ling⁸, Wayne B. Hunter⁹, Brenda S. Oppert¹⁰, Adalberto A. Pérez De León⁵, Kevin Hackett¹¹ and DeWayne Shoemaker¹²
A transgenic male-only strain of the New World screwworm for an improved control program using the sterile insect technique

Carolina Concha1,2,3, Azhahianambi Palavesam4,10, Felix D. Guerrero4, Agustin Sagel5, Fang Li1, Jason A. Osborne6, Yillian Hernandez7, Trinidad Pardo8, Gladys Quintero9, Mario Vasquez5, Gwen P. Keller7, Pamela L. Phillips5,8, John B. Welch9, W. Owen McMillan3, Steven R. Skoda5,8 and Maxwell J. Scott1,*
About the Fever Tick Vaccine
Bm86 immunomodulator by Zoetis is a new vaccine that is being used in the Cattle Fever Tick Eradication Program. The vaccine targets and kills both species of cattle fever ticks: *Rhipicephalus* (formerly *Boophilus*) *annulatus* and *R. microplus*.

How the Vaccine Works
After cattle have been vaccinated, their immune system will produce antibodies in the blood that will fight against a protein found in the lining of the tick’s gut. The tick will take in the antibodies when it consumes the blood of vaccinated cattle.

The antibodies bind to the lining of the intestines in the tick, which prevent the tick from absorbing nutrients. The vaccine will kill or weaken ticks as they feed on vaccinated cattle and weak surviving ticks will not be able to reproduce.

Vaccine Use
The vaccine will be used in addition to eradication practices already in place for the Cattle Fever Tick Eradication Program. **It will not replace systematic treatments.** Vaccines will only be administered by USDA/APHIS/Veterinary Services, Texas Animal Health Commission employees or authorized agents.

Cattle That Should be Vaccinated
- **Cattle in Permanent Quarantine:** Beef cattle over two months of age are required to be vaccinated at least once a year.
- **Cattle in Temporary Preventative and Control Quarantine Areas:** Beef cattle over two months of age may be required to be vaccinated if there is an elevated risk determined by USDA/TAHC epidemiologists.
- **Cattle in the Free Area:** Cattle should not be vaccinated at this time.

Vaccination Schedule
Cattle should receive an initial dose, a booster four weeks later, followed by additional boosters every six months. This schedule is important because one dose will not produce enough antibodies to be effective. Vaccination every six months after the initial dose and booster is needed to keep the concentration of antibodies in the blood high enough to be effective.
Simulated interactions of white-tailed deer (*Odocoileus virginianus*), climate variation and habitat heterogeneity on southern cattle tick (*Rhipicephalus (Boophilus) microplus*) eradication methods in south Texas, USA

Hsiao-Hsuan Wang\textsuperscript{a,\,*}, Pete D. Teel\textsuperscript{b}, William E. Grant\textsuperscript{a}, Greta Schuster\textsuperscript{c}, A.A. Pérez de León\textsuperscript{d}

- Help assess CFT outbreak dynamics & spatial attributes in tick-host-landscape systems involving diverse hosts
- Allow testing treatment efficacy & integration of strategies for sustainable eradication
Survival and Fate of *Salmonella enterica* serovar Montevideo in Adult Horn Flies (Diptera: Muscidae)

PIA UNTALAN OLAFOSON,¹ ² KIMBERLY H. LOHMEYER,¹ THOMAS S. EDRINGTON,³
AND GUY H. LONERAGAN⁴


Special Collection: Filth Fly–Microbe Interactions

Dana Nayduch
Why it is important to study soft ticks?

Ticks (Acari: Ixodida) are notorious parasites of animals and vectors for many pathogens including nematodes, bacteria and viruses. While diseases transmitted by hard ticks are well recognized, much less known about soft tick-transmitted diseases and possible threats they may pose to humans and livestock. According to the extensive literature review we have performed, Argasidae can harbor and transmit a wide range of viruses (73 known species and varieties) belonging to three major arboviral families, some of which are known to cause disease in humans, as well as a number of uncharacterized and suspected arboviruses. Considerable part of these viral agents have been isolated from representatives of the subfamily Ornithodorinae (Fig. 1). Notably, certain Ornithodoros spp. are biological vectors and reservoirs of African swine fever – a viral disease that threatens modern pig farming globally. However, there are number of other bacterial and viral agents, which represent potential threat to human welfare that can be transmitted by Ornithodoros ticks. Progress in identifying and understanding these potential threats is often hampered by gaps in our knowledge regarding the distribution and ecology of soft ticks in a specific area. This is particularly true in Eastern European countries where studies on Ornithodoros ticks were almost abandoned in the 1980s.

Out of the 7 soft tick species previously reported from the territory of Ukraine (Filippova 1966), Ornithodoros verrucosus (Fig. 2) seems to be of a greater importance because the species is a confirmed vector of a severe form of relapsing fever (Gromashevsky et al. 1956) and more recently, considered as a suspected vector of African swine fever virus (ASFV) in the Caucasus and Eastern Europe (Sanchez Vicario et al. 2009). Moreover, Geran virus and Aratat virus (Bunyaviridae: Nairovirus) were isolated from the Caucasian populations of O. verrucosus in the past (Lvov et al. 2014; Alkhovskiil et al. 2013). However, no information regarding the species current distribution, ecology and possible epidemiological role in Ukraine existed before the start of our project.

What was done?

This knowledge gap was addressed through the collaborative research project titled “African Swine Fever Threat Reduction through Surveillance in Ukraine” between the National Scientific Center “IECVM” & USDA-ARS. During realization of the project, Ukrainian scientists developed research capacity in soft tick biology, collection methods, rearing and colonization techniques, and vector-host-pathogen interactions at USDA-ARS locations, and collaborating universities in Texas.

We re-evaluated decades old data on distribution of O. verrucosus and conducted field surveys in southern Ukraine. As the result of these efforts, for the first time in the XXI century, the species’ distributional data in Ukraine has been updated (Fig. 3). From specimens collected in the field, a laboratory colony of this suspected ASFV vector has been established at the NSC “IECVM” (Fig. 4).

What we would like to do next?

- To assess taxonomic status of O. verrucosus and its evolutionary relationships with other Ornithodoros spp.
- To conduct ASFV vector competence studies with O. verrucosus.
- To develop specific molecular tools for assessment of the tick-host interactions (such as ELISA test for detection of Ornithodoros-specific anti-tick antibodies, Western Blot antigenic assay, etc.).
- To explore field ecology and possible range of pathogens that can be transmitted by O. verrucosus
- To conduct surveillance for other soft tick species and in the neighboring countries (Southeast Europe, The Caucasus)

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REFERENCES


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Blacklegged tick (Deer tick)

Vector of pathogens that cause Lyme disease

United States Department of Agriculture
Agricultural Research Service

Area-wide Tick Control Project

Contact: (301) 504-5401
Objectives: To facilitate binational cooperation & strengthening of the surveillance & control of vectors in the US-Mexico border, the binational exchange of vector surveillance information, & the development of a pilot project of a participative entomological surveillance tool to be used in both countries

Participants: Representatives of US-Mexico border (Texas, Arizona, Nuevo Mexico & California), state authorities of the Mexican border (Baja California N & S, Coahuila, Chihuahua, Sonora, Nuevo León & Tamaulipas), federal officials from National Center of Preventive Programs & Control of Diseases (CENAPRECE), representatives from the Mexican National Institute of Public Health, CDC, representatives from Hidalgo county, TX, UTRGV, USDA-ARS & other academic institutions & public health agencies from the US border states
Holistic Research Required to Solve Problem with Complex V&VBD Systems Exacerbated by Global Change

Integrated strategy for sustainable cattle fever tick eradication in USA is required to mitigate the impact of global change

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Pathogenic landscape of transboundary zoonotic diseases in the Mexico–US border along the Rio Grande

Maria Dolores Esteve-Gassent 1, Adalberto A. Pérez de León 1, Dora Romero-Salas 3, Teresa P. Feria-Arroyo 4, Ramiro Patino 4, Ivan Castro-Arellano 5, Guadalupe Gordillo-Pérez 6, Allan Auclair 7, John Goolsby 8, Roger Ivan Rodriguez-Vivas 9 and Jose Guillermo Estrada-Franco 10

ADVANCING INTEGRATED TICK MANAGEMENT

ADVANCING INTEGRATED TICK MANAGEMENT TO MITIGATE BURDEN OF TICK-BORNE DISEASES

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