RESILIENCE COFFEE HOUR

March 4, 2022

Insect Vectors and the Growing Impacts on Our Community

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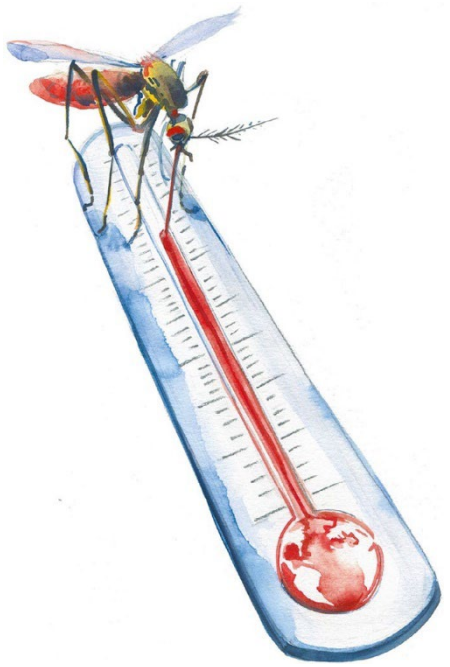
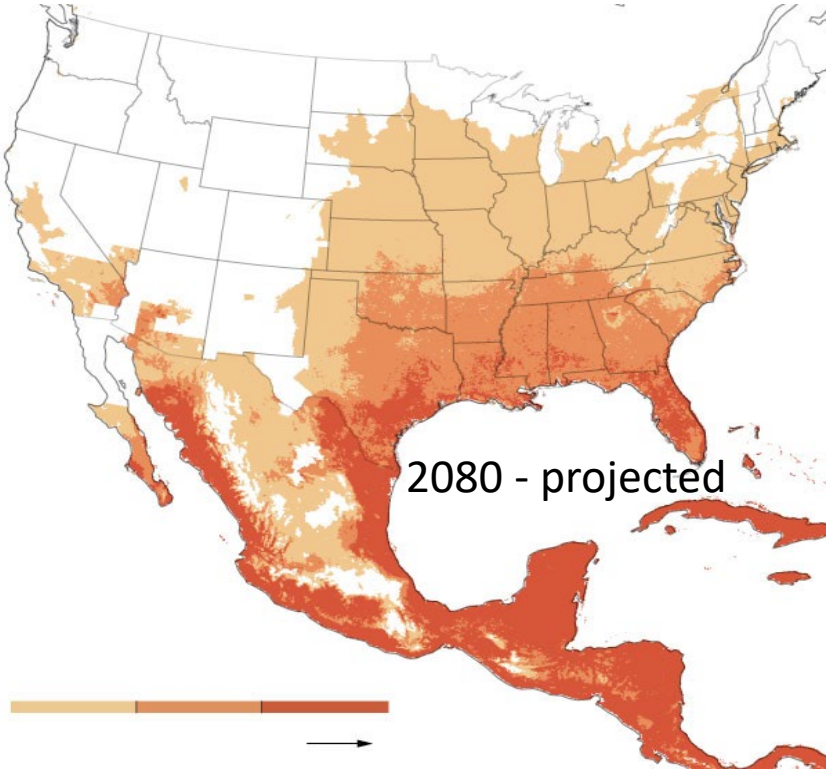
Insect Vectors and the Growing Impacts on Our Community

Coastal Empire Resilience Network / Rosmarie Kelly /4 March 22



Insect Vectors

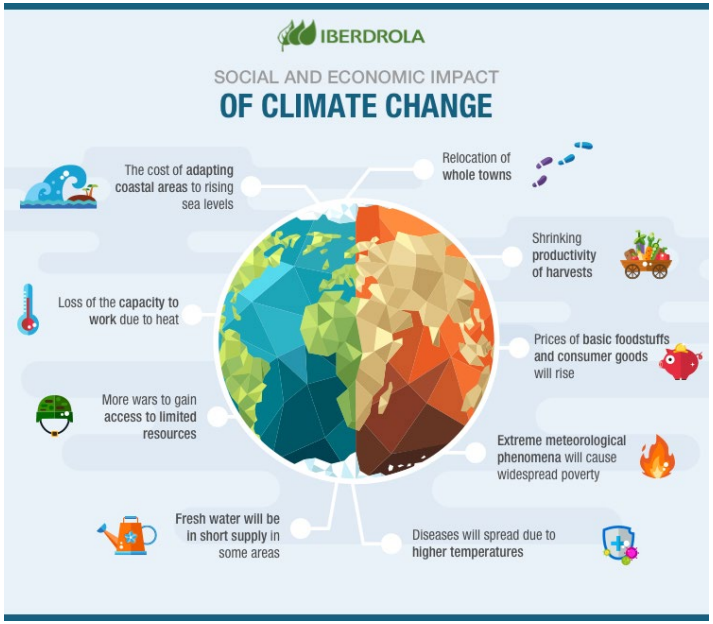
- Climate is one of the factors that influence the distribution of diseases borne by insect vectors
- Infectious disease transmission is sensitive to:
  - Local, small-scale differences in weather
  - Human modification of the landscape
  - The diversity of animal hosts
  - Human behavior that affects vector-human contact
- Although 'warmer is better' for vectors in general, relationships between temperature and vector survival, abundance and feeding behavior are often complex



The potential effect of climate change on dengue transmission.

What is climate change?

- Climate change refers to long-term shifts in temperatures and weather patterns.
- These shifts may be natural, such as through variations in the solar cycle.
- Since the 1800s, human activities have been the main driver of climate change, primarily due to burning fossil fuels like coal, oil and gas.
- The consequences of climate change include:
  - intense droughts
  - water scarcity
  - severe fires
  - rising sea levels
  - flooding
  - melting polar ice
  - catastrophic storms
  - declining biodiversity



GLOBAL WARMING

IMPACTS MOSQUITO BEHAVIOR & DEVELOPMENT

WARMER TEMPERATURES

- Accelerate the development of mosquitoes
- Increase activity of female mosquitoes
- Reduce incubation time for the mosquito to become infectious
- Allow mosquitoes to survive winters in areas that were formerly too cold
- More heat, drought, disrupted rainfall patterns mean more people storing water in containers that can serve as breeding sites
- Longer active seasons for mosquitoes

HIGH HUMIDITY

- Improves mosquitoes' chance of survival

INCREASED PRECIPITATION

- Secures ideal mosquito breeding habitat

EXTREME WEATHER

- Disrupts water and sanitation services, can lead to conditions that facilitate mosquito breeding and proliferation
- Increased flooding can increase breeding sites
- Damages human living areas, exposing them to mosquitoes

Source: Summarized from the 2009 NRDC Fever Pitch report

Break Dengue

What difference does climate change make to ticks?

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Break Dengue

Natural Disasters and Vectorborne Diseases

- Natural disasters, such as floods, severe storms, or hurricanes, are local, small-scale differences in weather, relatively speaking.
- Members of the public often assume that water-related natural disasters produce more pools of standing water, which lead to more mosquitoes and more cases of vector-borne disease.
- In the United States, vector-borne disease outbreaks immediately after natural disasters are uncommon.
- However, since the number and intensity of natural disasters is likely to increase due in part to climate change, it is especially important to understand what, if any, effects these disasters will have on vector-borne diseases.
- Effective surveillance is key to any effective response and integrated pest management (IPM) program, as it allows vector control programs to rapidly assess the scale of the emergency and determine the type and extent of proper response measures.

The effect of natural disasters on mosquitoes

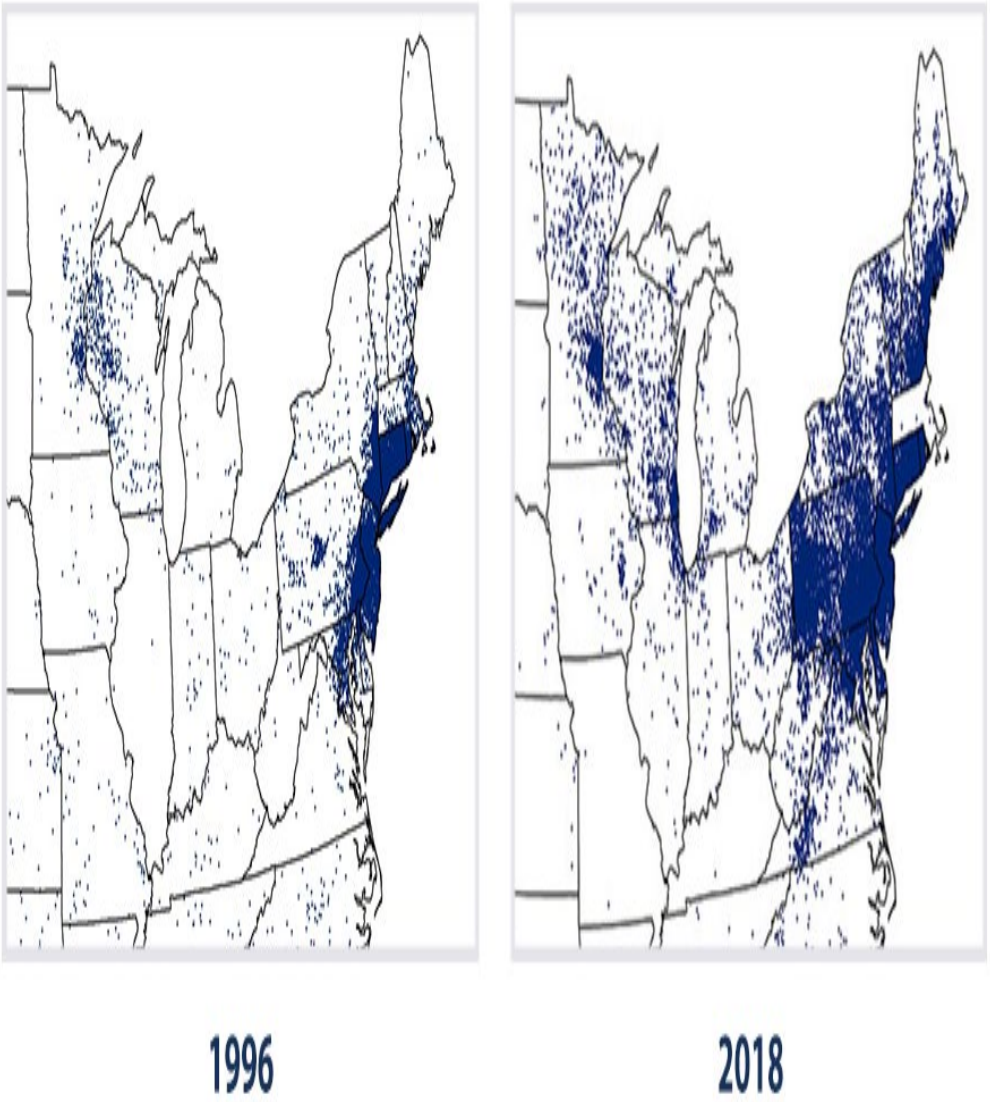
- Natural disasters, such as hurricanes and floods, are frequently followed by a proliferation of certain species of mosquitoes and requests from residents and government agencies for widespread application of insecticides.
- However, nuisance mosquito species, which often require emergency control measures, rarely present a threat to public health due to disease transmission.
- Epidemics of arboviral encephalitis have rarely followed hurricane- or flood-related disasters in the United States.
- If disease transmission has occurred in the area before the natural disaster, transmission may occur again, but not until at least a month after the event.
    - Mosquito populations need time to rebuild.
    - Virus replication needs to occur.
- The risk of outbreaks is greatly increased by complicating factors, such as changes in human behavior (increased exposure to mosquitoes while sleeping outside, a temporary pause in disease control activities, overcrowding), or changes in the habitat that promote mosquito breeding (landslide, deforestation, river damming, and rerouting).

The effect of natural disasters on ticks

- After flood events, tick activity is typically massively reduced.
- Data indicate that residual sediment has a greater impact on tick abundance and activity than the flooding itself.
- Indirect effects include:
  - Changes in habitat
  - Reduction in leaf litter
  - Reduction in host animal populations
- Differences in the leaf litter and vegetation can have an effect on the presence and on the survival of ticks, as well as on the risk of disease transmission.

What other factors drive the distribution of vectorborne diseases?

- Climate can affect the transmission dynamics, geographic spread and re-emergence of vector-borne diseases through multiple pathways, including direct effects on the pathogen, the vector, non-human hosts and humans.
- Non-climate drivers can be categorized into four groups:
  - globalization and environment
  - sociodemographics
  - public health systems
  - vector and pathogen characteristics
- Economic development and public health interventions —and not climate change — appear to have been the primary drivers of the incidence of many vector-borne diseases globally over the past decade.
- However, lack of high-quality global-scale observational data on disease incidence and non-climate drivers makes it difficult to determine the impact of climate change.



- There are many non-climate drivers that determine whether a vector-borne disease is found in a particular geographic area (Table 2).
- For example, malaria was present in the southern United States until the 1950s, when it was eradicated by aggressive vector control measures.
- Changes in sociodemographic factors lead to fewer opportunities for infected mosquitoes to feed on hosts at night in houses.

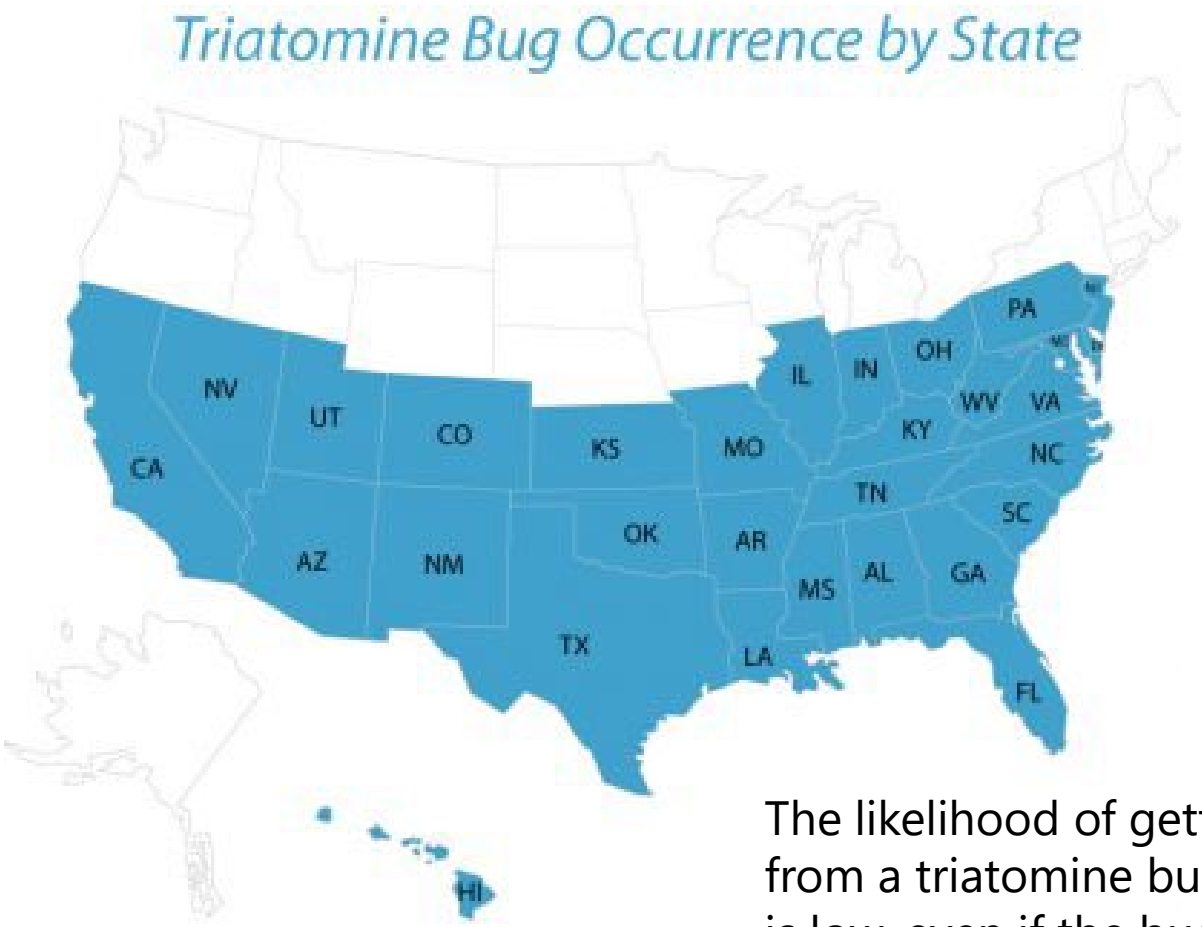
https://www.nature.com/articles/s41590-020-0648-y

Malaria in the United States

Anopheles quadrimaculatus is historically the most important vector of malaria in the eastern United States.

Malaria was a serious plague in the United States for centuries until its final eradication in the 1950s.

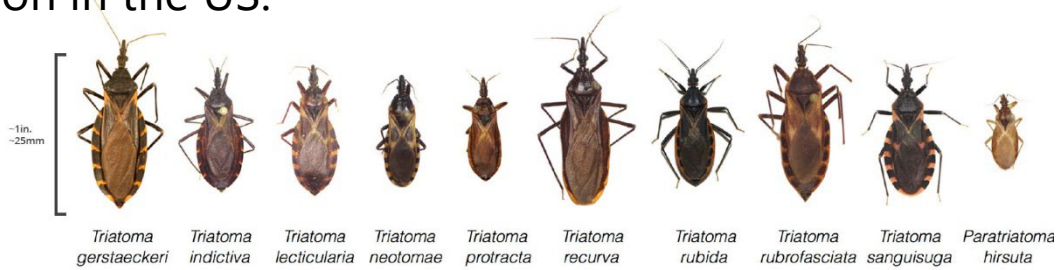
Triatomine Bugs and Chagas Disease



The likelihood of getting *T cruzi* infection from a triatomine bug in the United States is low, even if the bug is infected.

Triatomine Bugs and Chagas Disease

- Triatomine bugs are a type of reduviid bug that can carry *Trypanosoma cruzi*, the parasite that causes Chagas disease.
- Most of the world's kissing bugs are in Central and South America and Mexico.
- They've also been found in the United States, primarily in the lower 28 states.
  - Eleven different kinds of kissing bugs are in the United States.
  - Texas, New Mexico, and Arizona are the states with the most different species and most findings of kissing bugs.
- Sociodemographic factors lead to fewer opportunities for Chagas transmission in the US.



https://www.cdc.gov/parasites/chagas/gen_info/vectors/index.html

Invasive Species

- Invasive species are animals or plants from another region of the world that don't belong in their new environment.
    - Global trade and the movement of people and goods have caused massive shifts in insect populations, introducing insect species to areas where they have no natural predators.
    - Without predators, parasites, and pathogens to keep them in check, invasive insect populations increase unimpeded.
- Insects in various stages of life could be moved by natural means in the passive or active form of transport.
    - Passive transport can be by wind, water currents, or animals.
    - Active transport can be by the insects' own movements, intentional introduction, or human activity via travel or trade.
- Establishment is the process of forming a permanent population in a new geographic location different from the species' place of origin.
- Climate change may facilitate the establishment of introduced invasive species through two mechanisms:
    - Species that are currently unable to survive in a new environment due to climatic limitations may increasingly be able to survive and become established there.
    - Invasive species that can tolerate new climatic conditions may have a higher potential to overcome biotic constraints and establish permanent populations under climate change.

Recent introductions…

Ochlerotatus japonicus

- *Ochlerotatus japonicus* was first described in 1901 from Tokyo, Japan
- *Oc japonicus* was established in the northern US in the 1990s
- The 1st published record of *Oc japonicus japonicus* in Georgia (Rabun County) occurred in 2004.
- This species was collected earlier (2002) in Fulton County.
- Movement is likely through transportation of eggs in tires from the second-hand tire trade.

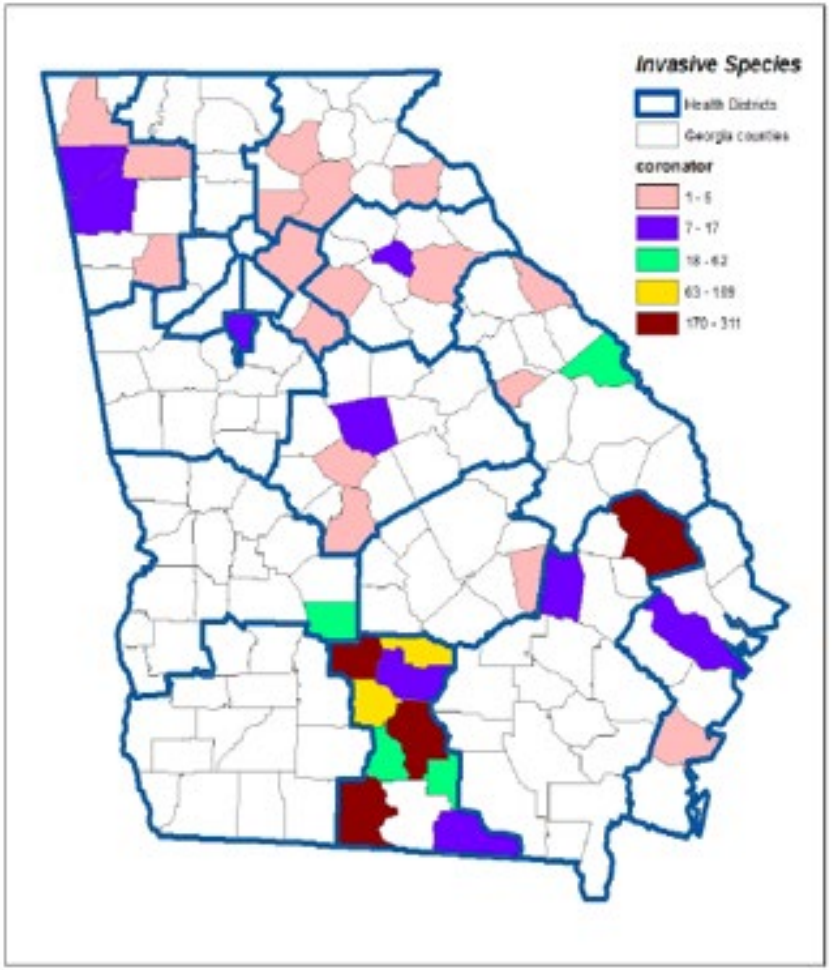
Recent introductions…

Currently, the mechanism for range expansion of *Cx. coronator* is unknown, but hypotheses include an increase in mean annual temperatures (Goddard et al. 2006, McNelly et al. 2007), movement via recent hurricane activity (McNelly et al. 2007), and human aided movement (Goddard et al. 2006); combinations of these and other factors have potentially aided and continue to aid this species' expansion.

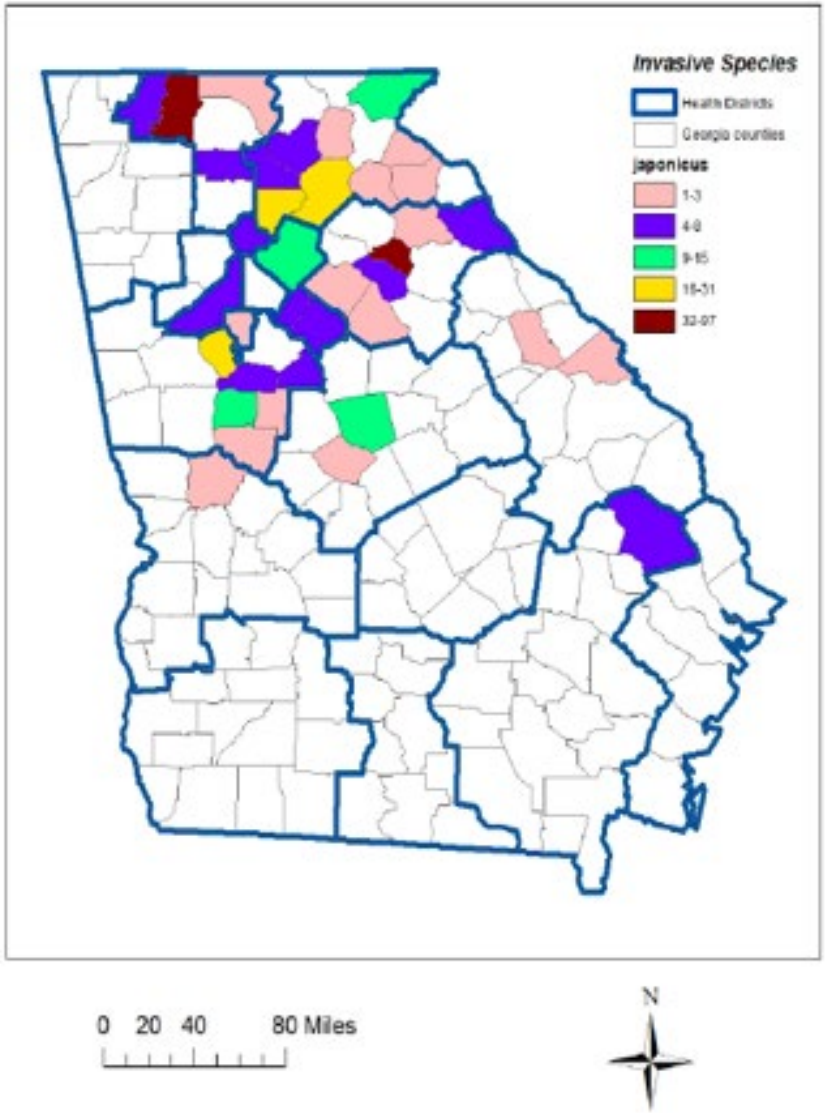
Culex coronator

- *Culex coronator* is a highly invasive Neotropical species that was first observed in Trinidad and Tobago in 1906
- The first collection of *Culex coronator* in the USA was made in Texas in 1920.
- A total of 10 female *Cx coronator* were collected from 6 different sites during routine mosquito-borne virus surveillance in Dougherty County in 2006.
- In 2007, adult *Cx coronator* were collected in Chatham County, Georgia.

Culex coronator, 2019



Ochlerotatus japonicus, 2019



The Effects of Climate Change - Summary

- Rapidly shifting patterns of temperature and precipitation pose novel challenges as they combine with decades of other anthropogenic stressors including the conversion and degradation of land.
- Climate change is not one phenomenon, illustrated by the fact that nighttime temperatures are warming faster than daytime conditions.
- Current warming is not evenly distributed across the globe, with regions at higher latitudes and elevations experiencing the most severe increases, which could be expected to disproportionately impact populations (positively or negatively).
- Climate change is already affecting vector-borne disease transmission and spread, and its impacts are likely to worsen.
- Climate can affect the transmission dynamics, geographic spread and re-emergence of vector-borne diseases through multiple pathways, including direct effects on the pathogen, the vector, non-human hosts and humans.

The Effects of Climate Change - Summary

- In addition to having direct effects on individual species, climate change can alter entire ecosystem habitats (including urban habitats), in which vectors or non-human hosts may thrive or fail.
- It is expected that vector abundance, survival and feeding activity will increase with increasing temperature, as will the rate of development of the pathogen within the vector.
- Relationships between temperature and vector survival, abundance and feeding behavior are often complex.
    - The geographic range of vectors is limited by ambient temperatures.
    - As the Earth warms, the concerns are that the vectors and their pathogens will spread to higher latitudes and altitudes, that incidence will increase, and that the transmission season will lengthen in some endemic areas.
    - There is also the possibility of a decrease in the incidence of vector-borne diseases in endemic areas if the areas become so hot that vector survival or feeding are inhibited.

The Effects of Climate Change - Summary

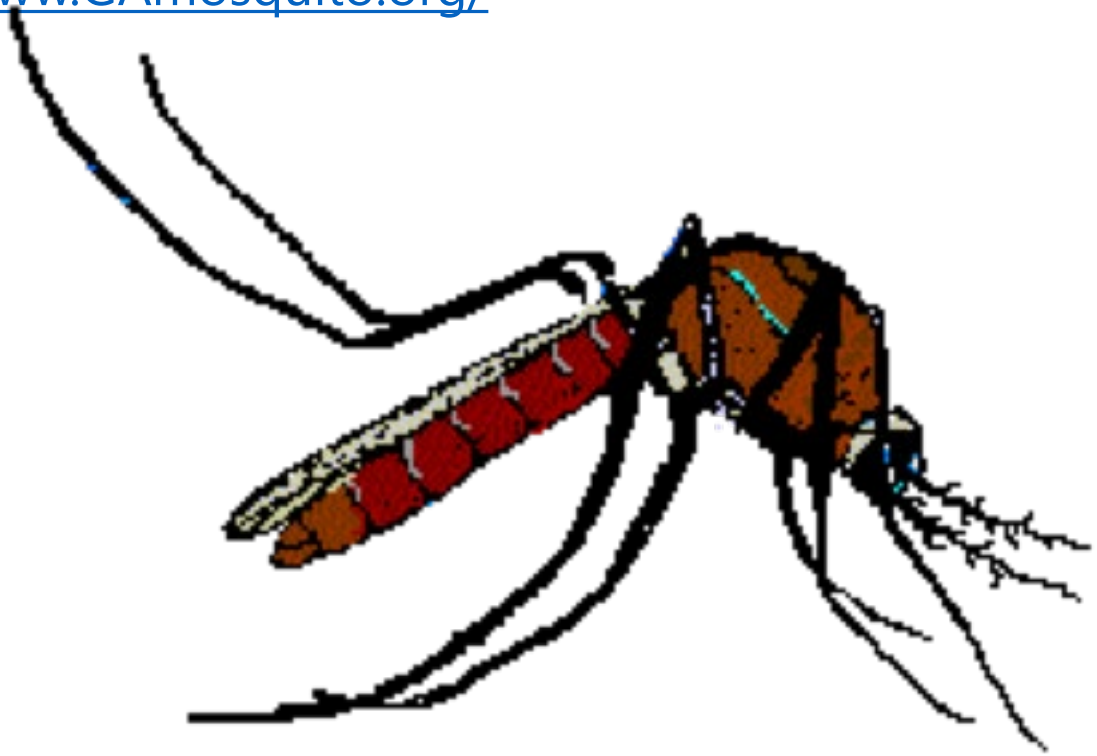
- The relationship between precipitation and vector abundance is complex and context specific.
  - Increased precipitation could provide more vector breeding sites.
  - Drought could also provide more breeding sites due to an increase in the use of containers for rainwater collection and storage.
  - Ecosystem change could degrade or enhance vector habitats and species competition, or it could increase or reduce the abundance of vector predators or vector pathogens.
- Abundance and behaviors of both non-human and human hosts may be influenced by climate.
- A suitable climate is necessary but often not sufficient, as the climate determines the potential geographic distribution of a vector-borne disease, but other factors determine the actual distribution within the boundaries set by climate.

https://www.nature.com/articles/s41590-020-0648-y

Any questions?

https://dph.georgia.gov/zoonoticvector-borneinfestations

http://www.GAmosquito.org/



RESILIENCE COFFEE HOUR

Friday, April 1st
8:30 AM – 9:30 AM
bit.ly/CERN-Coffee_April

Coastal Property Insurance & Climate Change

Jeffrey Brady, ANFI

RESILIENCE COFFEE HOUR

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