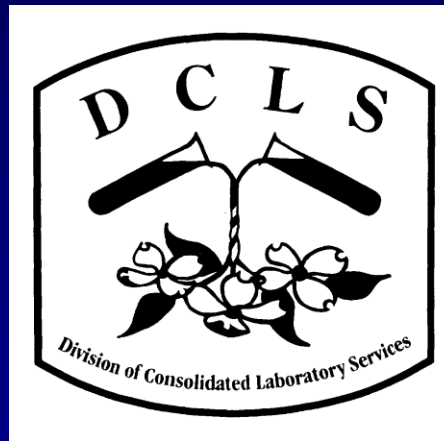


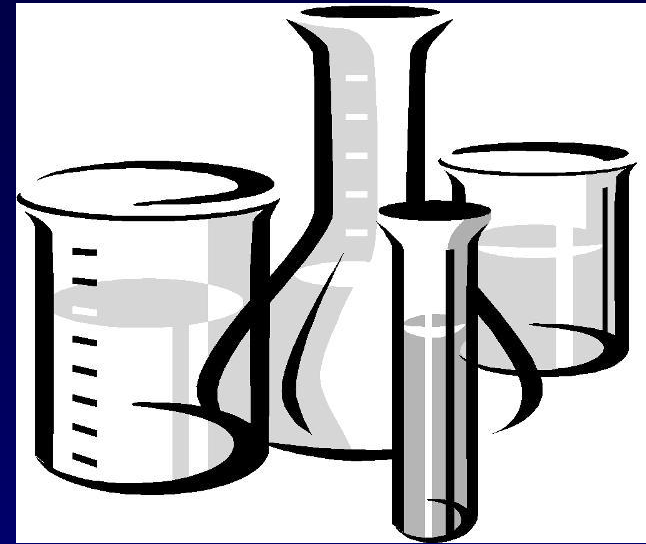
# *Laboratory Testing:* *What does it all mean?*



*Denise M. Toney, Ph.D.*  
*Commonwealth of Virginia*  
*Division of Consolidated Laboratory Services*

*CASA – May 2011*

# Types of Laboratories



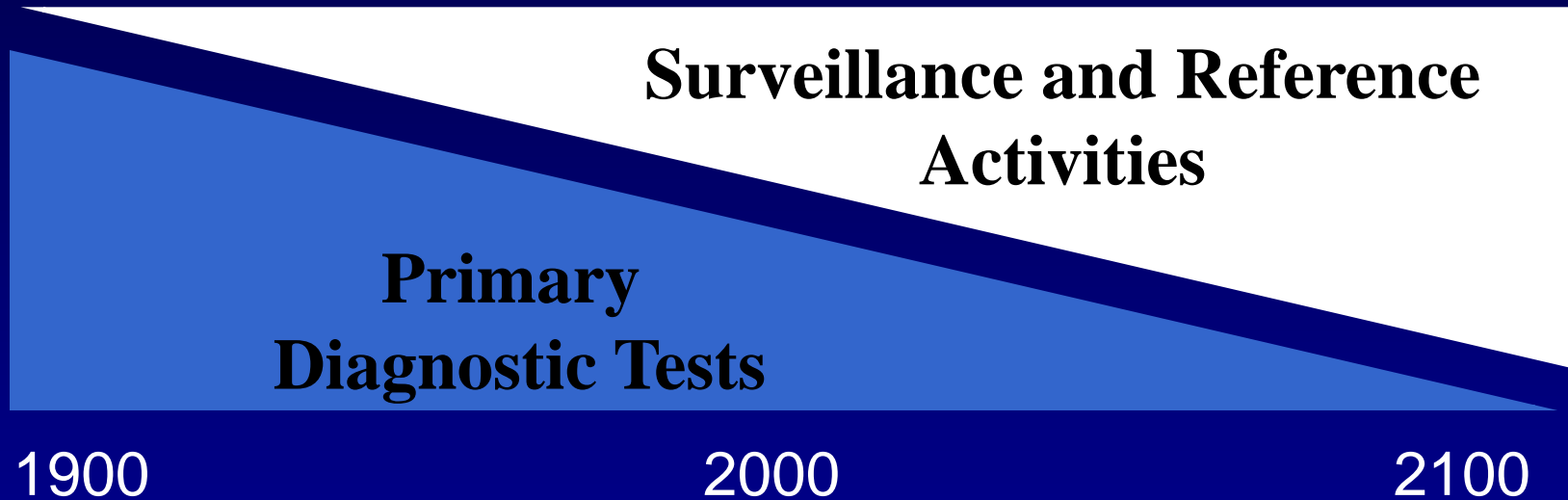
- Clinical or Diagnostic
  - Hospital laboratories
  - Private or commercial laboratories
  - Government (local, state, federal) laboratories
- Environmental or Veterinary
  - Private or commercial laboratories
  - Government (local, state and federal) laboratories
- Research
- Pharmaceutical or Industry



# State Government Laboratories

- All states have laboratories but not all are created equally
- These laboratories serve varied purposes
- State Laboratories may be administratively positioned within different organizations
  - Agriculture Department, Health Department, Environmental Department, Labor and Industry, University, others
- They may be combined
  - Environmental and health most commonly (ie. Microbiology only, Microbiology and Chemistry....etc

# Changing Role of State Laboratories



- Classical sub typing and surveillance
- Classical reference services

- Advanced laboratory subtyping and surveillance
- Improved biological and chemical analysis capabilities
- Rapid response and enhanced throughput

# Laboratory Goal: Timely Testing

Reducing further illness, disease or exposure

**Real-time  
Investigation**

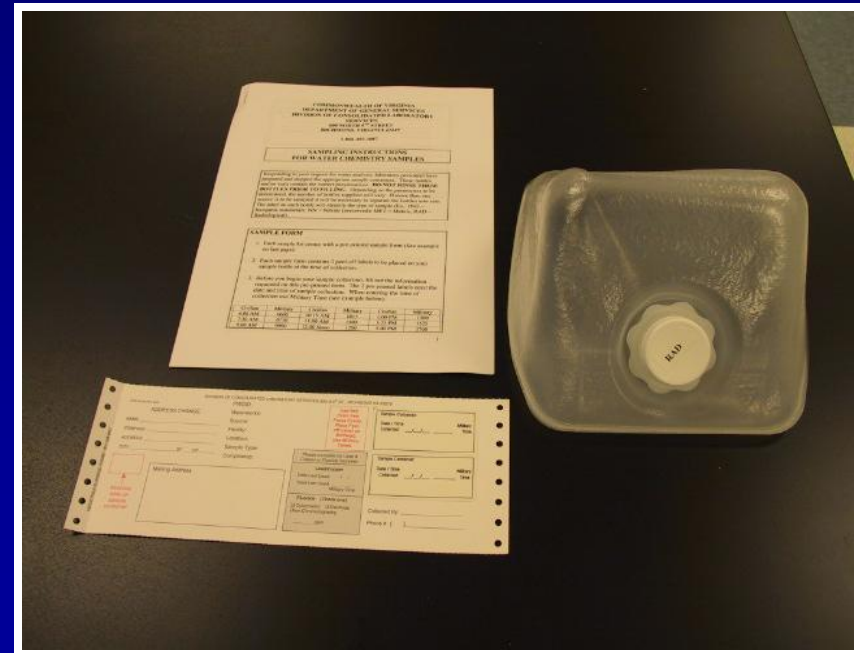
**Effective Surveillance, Outbreak  
or Terrorism Response**

**Real-time  
Laboratory  
Testing**

# General Laboratory Principles

- For ANY laboratory test (ie. Infectious agent, toxin, chemical or radiologic agent) there are a specific set of tests that can be performed to best achieve diagnosis or detection
  - Constantly changing and improving
  - Catalog of services often available
  - When in doubt, call the lab - ask to speak to the scientist, subject matter expert or lab director
- For EACH laboratory test there are specific specimens, collection procedures, and transport conditions required to achieve optimal test performance
  - May differ from lab to lab
  - Review specific specimen collection guidelines (written or on-line), phone call to lab, etc.
  - Remember: GARBAGE IN = GARBAGE OUT  
(No matter how excellent the lab or the lab test is!)

# Customized Sampling and Specimen Collection Kits





# Multi-purpose Sample Collection Kits (Environmental Crimes)

- Collaboratively designed (VDEM, Hazmat Teams, DEQ and VSP)
  - Sealed Cooler with lock (Sample security)!
  - Sealed sampling containers for organic inorganic and biological sample collection
  - Paint can, bottles, gloves, spatulas, camera, whirlpaks and bags
  - Chain of custody, notepads, pens, markers
- Kits out in the field
  - Replenish or trade out kits with sample submission



# Proper Sample Collection

- Samples must be collected in accordance with the collection guidelines
  - Chemistry, Microbiology, Environmental
  - Sampling strategies; subsamples, etc
- Sample must arrive with correct paperwork or electronic data and be labeled according to the submitting agency requirements
  - Regulatory
  - Chain of Custody
- Samples that deviate and do not have corresponding paperwork/electronic data and labels are subject to rejection.
- Samples must be preserved properly for analysis requested.

COMMONWEALTH OF VIRGINIA – DEPARTMENT OF GENERAL SERVICES  
 Division of Consolidated Laboratory Services  
 600 N 5<sup>th</sup> St. Richmond, Va. 23219  
**Clinical Microbiology/Virology Request Form**

**Patient Information (Please Print)**

Name \_\_\_\_\_ DOB \_\_\_\_/\_\_\_\_/\_\_\_\_ Age \_\_\_\_ oM oF  
Last First Middle Initial

Pt Address \_\_\_\_\_ City \_\_\_\_\_ State \_\_\_\_\_ Zip Code \_\_\_\_\_

City/Country of Residence \_\_\_\_\_

Medical Record/Chart/Accession# \_\_\_\_\_ Patient ID \_\_\_\_\_

Marital Status:  single  married  separated  divorced  widowed  unknown  
 Race:  Black  White  Asian  AI/AN  NH PI  Other \_\_\_\_\_ Ethnicity:  Hispanic/Latino  Not-Hispanic/Latino  
*(check all that apply)*

**Submitter Information**

Submitter Code # \_\_\_\_\_ Site code \_\_\_\_\_ FIPS code \_\_\_\_\_  
*Send Report to:*

Submitter \_\_\_\_\_ Submitter Phone # \_\_\_\_\_  
(Name of Health Dept, Hospital &/or private Clinician)

Submitter Address \_\_\_\_\_ City \_\_\_\_\_ State \_\_\_\_\_ Zip code \_\_\_\_\_

Attending Clinician \_\_\_\_\_  
 Attending Clinician Phone # \_\_\_\_\_  
 District or PH Contact \_\_\_\_\_  
 District or PH Contact Phone # \_\_\_\_\_

**Site Use**

STD  ATS  ECU  SFP  GYN  Div Hys  
 Obstetrical care  AHC  Field  IMM  Job Corp  Peds  
 TB  GMC  CHC  DTC  Refugee  SCI  
 Hospital  OCMIS  Student HC  Other \_\_\_\_\_

**Patient Medical History**

Disease suspected/ Diagnosed \_\_\_\_\_

Signs/Symptoms:  Asymptomatic  Fever  Respiratory  Bloody sputum  
 Cough  Productive cough  Rash  Vomiting  
 Diarrhea  Stool + Blood  Stool + Mucous  Abdominal Pain  
 Apnea  SIDS  Sudden Unexplained Death  
 Other \_\_\_\_\_

Date of Onset: \_\_\_\_/\_\_\_\_/\_\_\_\_  
 Deceased Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Vaccine Administered \_\_\_\_\_  
 (Please specify)  
 Vaccine Administration Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Recent Exposure (if applicable)  Birds  Ticks  Mosquitoes  
 Other \_\_\_\_\_

Antibiotics/Anti-Viral Used \_\_\_\_\_  
 (Please specify)  
 Antibiotics/Anti-viral Start Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

**Special Information for Laboratorians:**  
 Outbreak Related  no  yes Outbreak Number: \_\_\_\_\_  
 Role of Patient (ex. food-handler, patron): \_\_\_\_\_  
 Other Information \_\_\_\_\_

\*Complete information on back

# Specimen Collection

## Who's Responsible??





# Clinical or Food Specimen Collection

## Diagnostic testing or routine surveillance/sampling

- Usually a physician, veterinarian, hospital or facility staff function

## Outbreak or complaint related

- Health Department (Epi or EH) or Department of Agriculture function
- Rapid responder or law enforcement function if suspected to be intentional or criminal in nature

\*\* Contact the laboratory prior to specimen collection if you have questions



# Environmental Specimen Collection



- Usually a Health Department (Epi or EH), Department of Agriculture, or DEQ, private company/person
- At least one member of the team should be trained to collect specimens
- Contact the laboratory prior to specimen collection if you have questions



Where does the laboratory start??



# Chemical & Radiologic Targets

- Includes everything from household to environmental sources
- Sample types are varied
  - Human
    - Human Body's response to break down of suspected agent
  - Environmental
  - Food and/or water
- Type of analysis depends on suspected agent and sample to be tested



# Chemical & Radiologic Testing Considerations

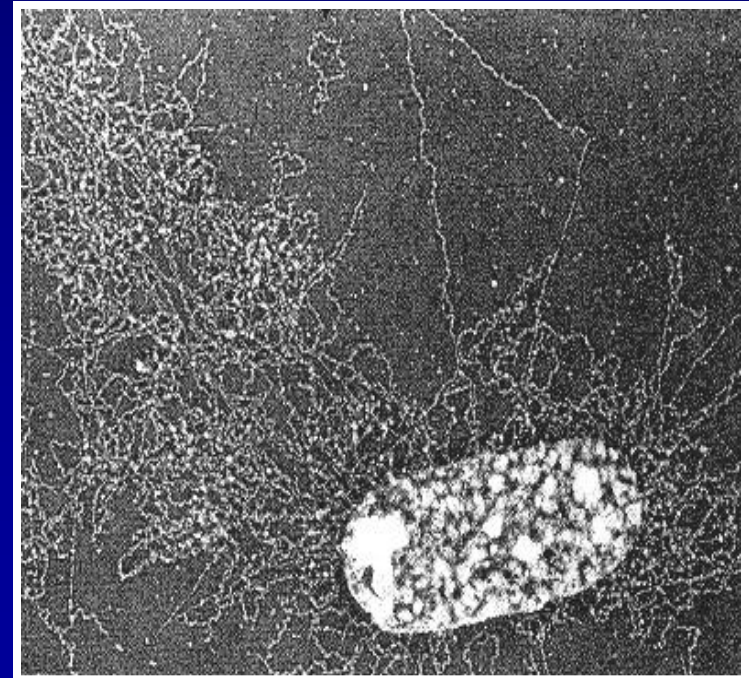
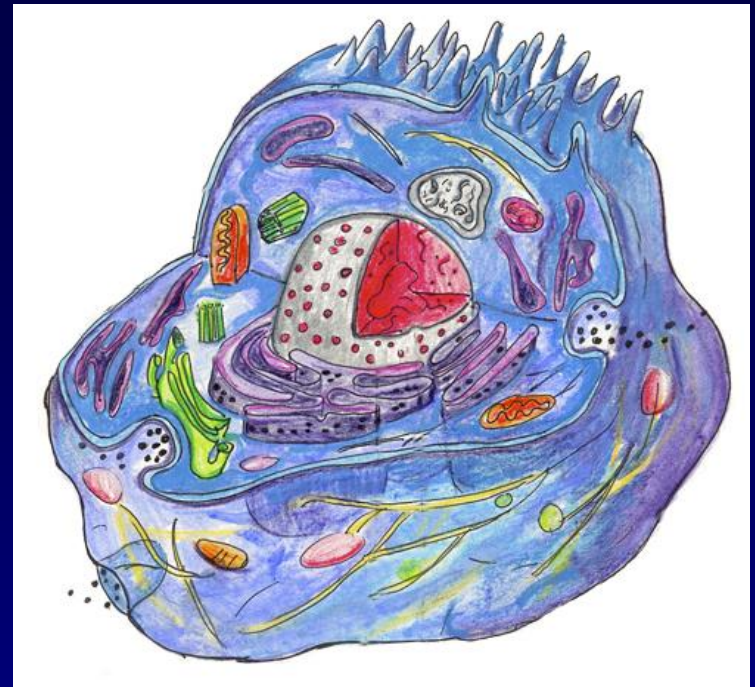
- Field testing is not reliable – decisions should NOT be made on this data alone; often time the sample is completely consumed
- Poor collection information, poor storage instructions or limited sampling volumes prevent full testing capabilities
  - Milk kept at RT for months
- Cross contamination MUST be a consideration
- Lack of a control for comparison, sometimes impossible to tell if compound is just background or contamination
- Food samples often are difficult to extract from because of high fat/protein/sugar contents

# Chemical & Radiologic Testing Considerations

- Important to communicate with lab staff if contaminant is unknown, supply as much background information as possible related to the release
  - possible sources
  - visual and olfactory information
  - If contaminant is known, always helps lab to know if you are sending in a "hot" (high concentration) sample.
- Inform lab if you need just qualitative results (what is it) or quantitative (how much), and how quick you need to know
  - qualitative completed much sooner than quantitative
- If sample has the potential to go to court, follow chain of custody procedures to document that sample(s) were not tampered with

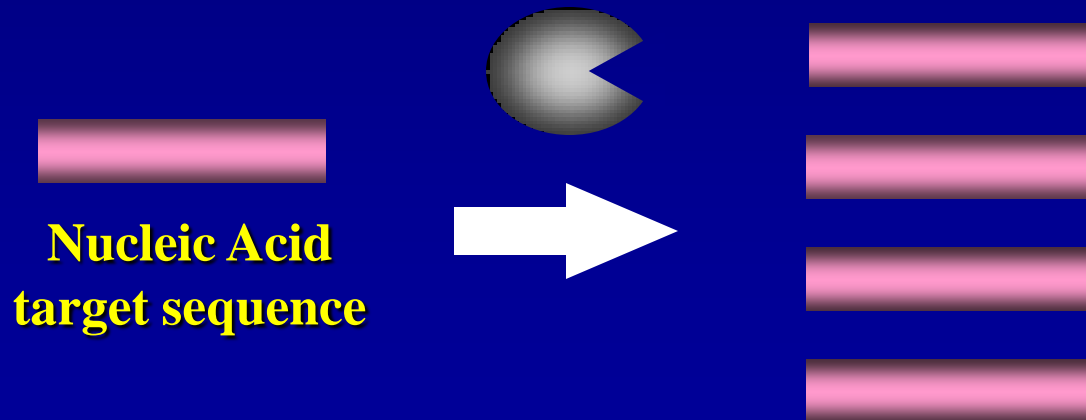
# Biological Targets

- Typically infectious agents but could be toxins
- Phenotypic
  - Biological or biochemical
    - Specific proteins, sugars, enzymes or surface structures
    - Antibiotic susceptibility
    - Toxin presence
  - Human Body's response (ie. antibody) to foreign cells
- Genotypic (DNA or RNA)
  - Nucleic Acid Amplification or Sequencing
  - Probe hybridization



# Nucleic Acid Amplification (PCR)

- Replication of DNA/RNA of biological organisms in a test tube
- Rapid, sensitive, and specific method
  - Sensitivity often comparable to culture
  - For some agents, sensitivity can be significantly greater than culture
- PCR has been extensively adapted to infectious disease testing; expect continued evolution of new tests and test platforms



# Genotypic Methods

## Advantages:

- Rapid, sensitive and specific
- Direct detection possible from clinical, food and/or environmental samples – ideally!!
- Ability to identify multiple pathogens from a single specimen
- Ability to assess relatedness of isolates
- Identification of genetic changes/mutations

## Disadvantages:

- Cannot assess viability or whether agent is infectious
- Can be too sensitive (ie. below infectious dose)
- Designed to be agent or target specific

# Biological Testing Considerations

- Each test has its own sensitivity and specificity
  - When phenotypic AND genotypic testing is performed you could get discrepant results
- Bacterial and viral culture based testing is SLOW!!
- Rapid testing is often not reliable
  - Decisions should NOT be made on this data alone
  - Field tests - worst
- Screening tests may or may not be reliable
  - Confirmation can confirm or confuse
  - False positives are possible
- Improper collection or collection of limited specimen volumes prevent full testing capabilities

# Considerations with NAA Tests

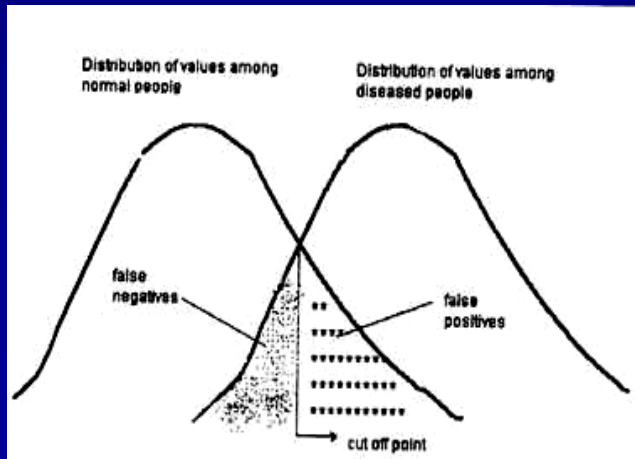
- Sensitivity of assay in real specimens may not be as high as in spiked samples used to develop assay
- Primers/probes used for the target are so specific that they cannot detect variants or subtypes
- Closely related organisms can cross react at the genetic level
- RAPID but false negatives are possible (false positives are less likely but could occur)
  - Inhibitors or poor specimen collection
    - Vomitus or food
  - PCR amplifies dead organisms just as efficiently as viable organisms
  - Failure to release nucleic acid from agent
    - TB, Spores



# Final Considerations



- All lab test results must be interpreted within the context of the patient's clinical signs and symptoms, medical history, risk factors including travel, investigational findings, etc.
- Testing of food and environmental samples should focus on specific targets NOT be performed independently
- No lab test can EVER be 100% diagnostic
- Results are just ONE piece of the puzzle



# Summary

- Laboratory tests provide ONE PIECE of the puzzle in any investigation
- Its important to understand the tests you are ordering and the results you receive
  - If you don't - CALL
- Proper specimen storage, handling and shipping are essential for optimal laboratory testing and results
- Many situations require the collection of multiple specimens, especially for unknowns; often on multiple or consecutive days
- Keep track of information on the specimens collected
- Properly dispose of any infectious or contaminated materials used for collection and take all necessary safety precautions
  - Use the laboratory as a source of information
- ALWAYS be prepared
  - Maintain adequately specimen collection supplies and kits and store all supplies properly until used

## Contact Information:

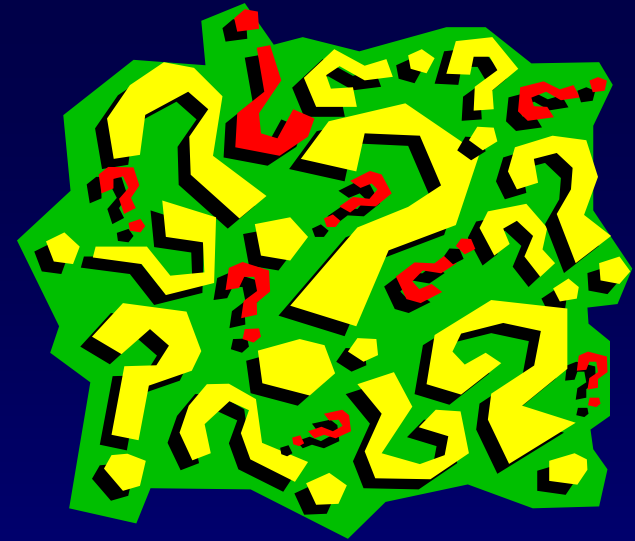
*Denise M. Toney, Ph.D.*

*Lead Scientist*

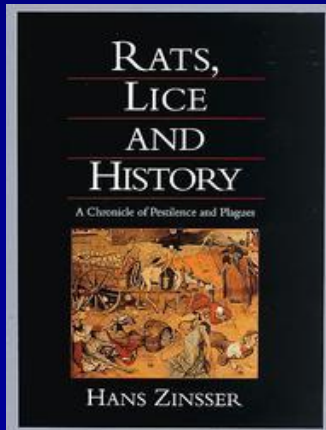
*600 North 5<sup>th</sup> Street*

*Richmond, VA 23219*

*Phone: 804-648-4480 ext 282*



“ Infectious disease is one of the few genuine adventures left in the world. The dragons are all dead and the lance grows rusty in the chimney corner.....About the only sporting proposition that remains is the war against those ferocious little fellow creatures, which lurk in dark corners and stalk us in the bodies of rats, mice, and all kinds of domestic animals; which fly and crawl with insects, and waylay us in our food and drink and even in our love.”



*Hans Zinsser*

*Rats, Lice and History (1935)*