BIO 475 - Parasitology
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Lecture 3

Last Lecture

We left off discussing 4 important questions to ask if you want to be scientific.

Greasy hair
1cm thick glasses
Bow tie
Never brushes teeth
Glow-in-the-dark T-shirt
Pocket protector
Mutant rat
Unidentifiable carcinogen

What Science IS

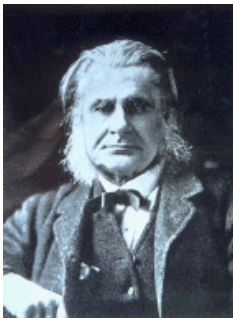A way of finding out how and why the universe works the way it does.

"A way of knowing."
John A. Moore.

Science Accomplishes This By:

1. Discovering facts about the universe
2. Organizing them into conceptual schemes called:

    a. Hypotheses

    b. Theories

    c. Laws

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This Process is Called the Hypothetico-Deductive Method

But as T. H. Huxley said, science is really just *"trained, organized common-sense."*

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This Deductive Approach is Extremely Powerful

1. It generates yes/no answers; therefore *eliminates possibilities*.

2. It reveals what *appears* to be true and *what is not*; therefore it allows us to *order our perceptions*.

3. It permits classification of phenomena; therefore *permits understanding*.

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Science is Powerful: Why?

1. It is RATIONAL not RELATIVISTIC.
2. It REDUCES rather than INCREASES the number of possible explanations.
3. It promotes HONESTY and EVIDENCE, not simply force of CLEVER ARGUMENT.

Science: 4 Questions

1. What evidence exists?

a. Science is hierarchical.

b. As more data accumulates which verifies a phenomenon, more weight is given to that explanation.

What Evidence Exists?

Global Temperature Changes (1880-2000)
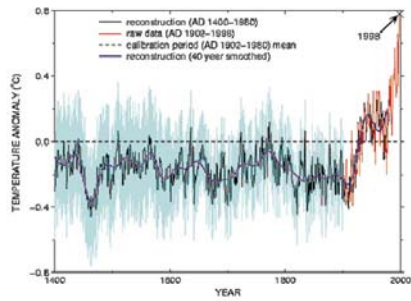
Source: U.S. National Climatic Data Center, 2001
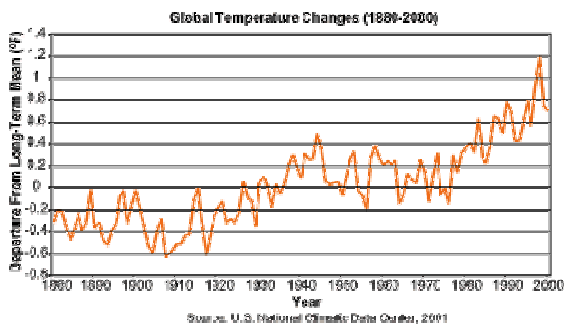
Figure 6. Northern Hemisphere mean temperature reconstruction from A.D. 1400–1980, shown with raw instrumental NH series (red) through 1998. The low-frequency trend (timescales longer than 40 yr emphasized) is shown by the thick curve. The blue-shaded region indicates the two standard error uncertainty limits in the reconstruction (see Mann et al., 1998 for details). Additional data are available online at ftp://ftp.ngdc.noaa.gov/paleo/paleocean/by_contributor/mann1998/mannnhem.dat.

What Evidence Exists?

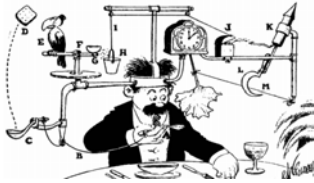1995 Greenhouse Gas Emissions per Capita

MMTCE/million people
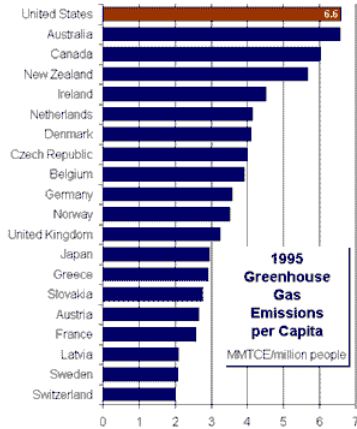
What Evidence Exists?

Science: 4 Questions

2. Is it the simplest explanation?

a. This means that elaborate mechanisms requiring many steps are less likely then simple ones.

The Principle of Parsimony

Occam's Razor: That which can be done in fewer steps is done in vain with more.

Occam's Razor: Is it the simplest explanation?

1. Lots of apparently complex mechanisms exist.

2. We need to be careful to eliminate complicated alternatives.

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The simplest explanation?

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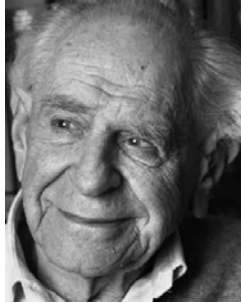**The simplest explanation?**

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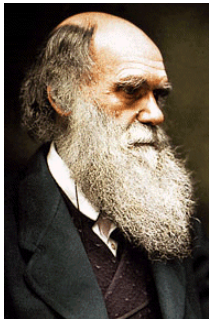
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Science: 4 Questions

3. Is the proposed explanation testable?

a. Can conditions be identified that render the explanation *untrue?*

Karl Popper 1902 - 1994

Darwin and Natural Selection:

"If it can be shown that a single characteristic of one species exists for the sole benefit of another, it would annihilate my hypothesis, for such could not be produced by natural selection."

Is the proposed explanation testable?

b. Establishing host preference

1. H_o: all hosts are equally infected - or not?

Science: 4 Questions

4. Is there a source of bias?

a. Honesty is necessary in science because it:

1. Acknowledges the hard work of science.

2. It prevent blind alleys that occur due to data fabrication.

3. Bias prevents understanding.

# Bias and its Consequences

Hulton Deutsch

How can we prevent bias?

1. by ACCURATE and REPEATABLE measurements.

2. Useful parameters in Parasitology:

   a. Prevalence

   b. Incidence

   c. Relative Density

   d. Mean Crowding

   e. Relative Incidence

Measures of Parasitemia

1. Prevalence: the fraction of hosts infected at a given time.

a. Examine a population of potential hosts, N_{hosts}

b. Identify the number of infected (N_I) and uninfected individuals (N_U)
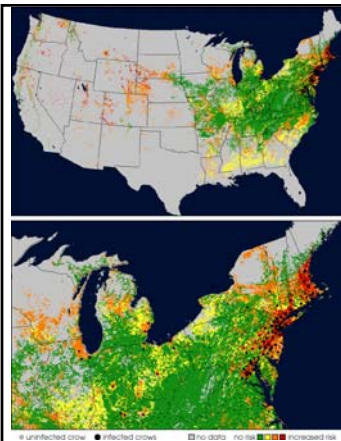
Measures of Parasitemia: Prevalence

Crows infected and uninfected by West Nile Virus

uninfected crow   infected crows   no data   no risk   increased risk

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Prevalence

Thus, $P = N_I / N_{hosts}$

1. Let $N_{hosts} = 1,500$, $N_I = 375$, $P = 375/1500 = 0.25$.

1. This value is a *proportion*; sometimes this is confused with incidence.

Incidence

1. The number of ***newly infected*** individuals per unit time/number of uninfected individuals at time t=0.

a. This is a *rate*.

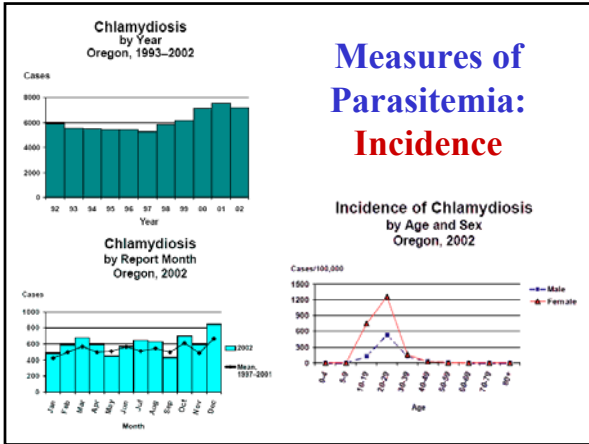a. It asks the question, "how infective is the parasite?"

Incidence

2. Also gives information on the degree to which hosts are susceptible to parasites.

a. That is, the *rate* at which parasites are transmitted.

Incidence: Example

a. Let time interval (t) equal 1 month.

1. Let $N_{U[t=0]}$ = 1,500; i.e., the entire population

2. After one month, 25 individuals are infected, φ_i.

3. $\varphi_{[t=1]}$ = 25/1,500 = .016.

4. Clearly, this can be plotted over time to show how infection rate changes.

Measures of Parasitemia: Incidence

Chlamydiosis
by Year
Oregon, 1993–2002

Chlamydiosis
by Report Month
Oregon, 2002

Incidence of Chlamydiosis
by Age and Sex
Oregon, 2002

"Relative Density"

1. Equals the arithmetic mean of parasites in all hosts.

a. Not strictly correct since relative terms should be standardized against the average.

Relative Density: Example

2. if $N_{parasites}$ = 100 and N_{hosts} = 100

a. D = 100/100 = 1,

b. However, this tells little about where the parasites *are*.

Prevalence and *D*

1. Prevalence (*P*) combined with **D** is somewhat more informative.,

a. If all in 1 host, P = 1/100 = .01

b. If in 5 hosts, P = 5/100 = .05

c. If in all hosts, P = 100/100 = *D*,

But not if *number* of parasites varies *among* hosts.

Mean Crowding

1. Estimates the degree to which parasites are *aggregated* within hosts

2. Or, the average parasite's experience of other parasites within its host.
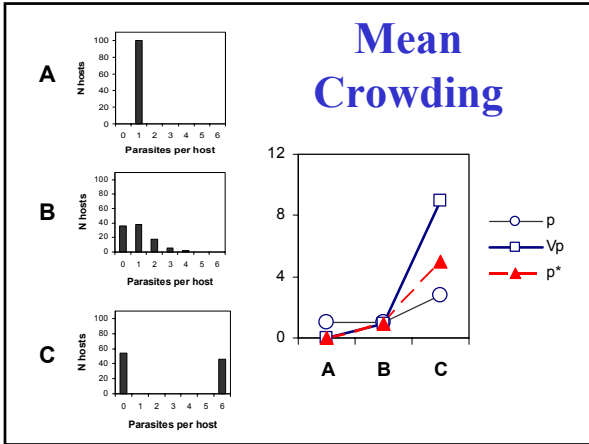
$$p^* = p + V_p/p - 1$$

Mean Crowding

$$p^* = p + V_p/p - 1$$

Where, $p = \sum p_i / N_{hosts} = D,$

p_i = the number of parasites in the i-th host,

N_{hosts} = the total number of hosts, and

$$V_p = \sum p_i^2 / N_{hosts} - p^2$$

Mean Crowding

1. Crowding of parasites within hosts provides an estimate of the degree to which certain hosts may be unusually susceptible.

2. Provides useful information for understanding modes of infection, variation in host resistance.

Relative Incidence

1. A measure for comparing populations:

a. Infection rate within populations/average infection rate between populations.

b. A relative measure of *populational variation* in susceptibility or recovery.

c. $\varphi_i / \varphi_{bar}$

Reproductive Strategies in Parasites

1. Productivity and probability of transmission.
a. High productivity may equal higher probability of transfer.
b. The trade off is how severely the host is affected.

Reproductive Mode

1. How an organism makes copies of its genome (propagules).
2. Asexuality
3. Sexuality
a. Hermaphroditism
b. Gonochorism

Asexuality

1. Producing identical copies.
a. Another way of increasing numbers of propagles, often serves to increase the probability of transfer among hosts.
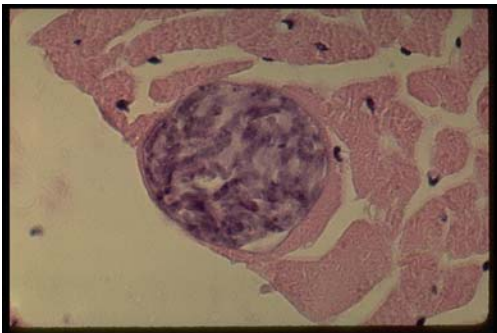
Modes of Asexual Reproduction

1. Binary fission – one individual divides into two.
2. Schizogony – multiple fission.
   a. More common than not in parasites.

Binary Fission

© Ron Neumeyer

Schizogony – Multiple Fission

Modes of Asexual Reproduction

3. Production of numerous life stages in different hosts.

a. utilizes diversity of niches

b. spreads propagules more widely in the environment.

Hermaphroditism

1. A possible method for overcoming problems with low density.

a. If few opportunities for multiple mating exist, emphasize female function.

2. A possible mechanism for increasing access to mates.

3. A possible mechanism for increasing fecundity.