

# HOW SPECIFIC ARGUMENTS DEFEAT GENERAL DOGMAS: LACK OF PARSIMONY IN MOLECULAR BIOLOGY

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How do you scratch your head?



- Maximizing scientific knowledge as a whole.
- Optimal distribution of resources.
- Bigger picture – How do breakthrough results occur?



- *Lex parsimoniae*: other things being equal, we should prefer simpler theories to less simple ones.
- Kant: “Rudiments or principles must not be unnecessarily multiplied” (Critique of Pure Reason).
- Newton: “Nature is pleased with simplicity, and affects not the pomp of superfluous causes” (Principia Mathematica).

Possible definition:

Efficient method for finding the true theory, even if the truth is complex (K. Kelly 2004, 2007).

Connections with induction: only hypothetical outcomes can be justifiably considered in the inductive analysis.



- What is Ockham's Razor in argumentation theory?
- How to optimize scientific argumentation?

- A case study approach;
- Molecular biology (a field-specific approach);
- Significant non-parsimonious results.

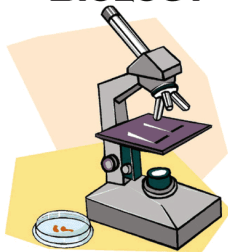
Benefits of a case study approach:

- it is context dependent;
- it has a clear reach;
- and a straightforward application.



- Dynamic argumentative flow in the field of molecular biology (versus e.g. contemporary experimental physics).

## BIOLOGY



# CHOICES: SPECIFIC CASES

- Modern dilemmas;
- Nobel Prize winning research:



Stanley B. Prusiner



Thomas R. Cech

$D_1$ : All infectious diseases are caused by an organism. (Koch's postulate)

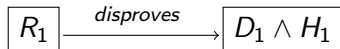
$D_2$ : DNA encodes genetic material,  
RNA transmits it,  
proteins have a catalytic function.

Summary: These are simple and universal explanations of the phenomena.

## Assumptions:

- Experimental results are considered to be truthful (unless they are deliberately faked)  $\rightsquigarrow$  they defeat a hypothesis in the strong sense –they disprove it.
- Only hypotheses can contradict each other, i.e. attack each other.
- We only consider correct inferences.

# ARGUMENTATION EXAMPLE



$R_1$ : Scrapie agent does not need to have intact nucleic acid.

$D_1$ : All infectious diseases are caused by an organism.

$H_1$ : All organisms need to have intact nucleic acid.

Cases in which a disease is caused by an organism e.g. anthrax.

$H$ : Disease is caused by a specific organism, e.g. bacillus.

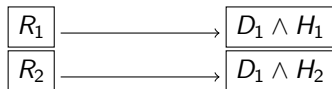
$R_1$ : Organism found!  $\rightsquigarrow$  **correlation**

$R_2 \wedge R_3$ : Organism has to be grown in a pure culture and able to infect subjects.  $\rightsquigarrow$  **causation**

$$\frac{R_2 \wedge R_3}{H}$$

Koch's postulates.

# ARGUMENTATION COMPARISON



$R_2$ : Scrapie agent can be killed by protein destroying treatment X.

$D_1$ : All infectious diseases are caused by an organism.

$H_2$ : Treatment X destroys proteins.



$R_3$ : Scrapie agent is as small as a protein.

$H_3$ : No organism is as small as a protein.



$R_4$ : PrP protein is also in healthy organisms.

$H_4$ : Protein has only one fold (no special features).

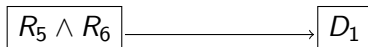
$H_5$ : PrP protein causes the disease.

Simple correlation!

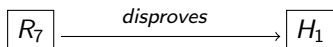
$R_5 \wedge R_6$ : Expressed protein causes the disease.  $\rightsquigarrow$  **causation**  
Convincing argument for the biological community.

$$\frac{R_5 \wedge R_6}{H_5}$$

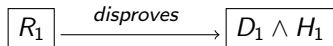
Finally, since  $D_1$  logically contradicts  $H_5$ :







$R_7$ : At least one organism is very resistant against DNA destructive treatment.

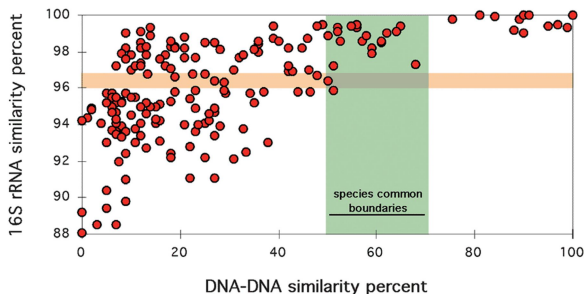


## SECOND ANALYSIS: RNA HAS A CATALYTIC FUNCTION

- Experimental results were showing that there is no protein involved.  $\rightsquigarrow$  **correlation**
- The lack of energy requirement in the reaction.  $\rightsquigarrow$  **correlation**
- Purified RNA had the same behaviour.  $\rightsquigarrow$  **correlation**
- Elimination of different factors in reactions.  $\rightsquigarrow$  **correlation**
- Exact findings.  $\rightsquigarrow$  **causation**

# LEVEL OF INSPECTION AND FREQUENCIES

- Mutation scenarios are typical examples of non-parsimonious behaviour in biology.
- Phylogenetics (subfield of evolutionary theory) uses maximum parsimony as an optimality criterion. Yet, there are exceptions.



(Rosselló-Mora and Amann, 2001)

## Conclusions:

- It is necessary to invest also in non-parsimonious ideas.
- Even if non-parsimonious behaviours are more prominent in molecular biology than in other disciplines, such behaviours are exceptions.
- Argumentation analysis helps us to understand important scenarios in which the principle of Ockham's Razor is violated.

## Questions:

- When is it reasonable to consider non-parsimonious explanations?
- How many argumentative steps is reasonable to require?

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