

How Can the History and Philosophy of Science Contribute to Contemporary U.S. Science Teaching

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Assessing the Impact of a Historically Based Unit on Preservice Teachers' Views of the Nature of Science

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Outline

- I. Introduction
- II. Method
- III. Results
- IV. Conclusions

I. Introduction

1. Nature of Science

1. Explicit and Reflective Approach

1. Role of History

1. Nature of Science

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(c.f. Lederman 2007)

Scientific Knowledge is

- Tentative
- Empirically based
- Subjective
- Involves human inference, imagination, creativity
- Is socially and culturally embedded

Observations vs. Inferences

Relationship between scientific theories and laws

2. Explicit & Reflective Approach

(c.f. Abd-El Khalick 1998)

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Explicit

- Planned instructional activity

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Explicit

- Planned instructional activity

Reflective

- Students discuss, reflect
- Come to own conclusions

3. Role of History

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Contextualized

vs.

Decontextualized

Clough (2006)

Research Questions

1. Were there any changes in NOS views associated with the intervention?
2. If so, how do interviews and our previous experiences inform our interpretation of the results?

II. Method

1. Participants
2. Context
3. Intervention
4. Procedure
5. Data Analysis

1. Participants

- Conducted at large Midwestern university
- Fall 2007 & Spring 2008
- Preservice elementary school teachers
- 130 participants (221 potential)
- 94% white, 85% female, avg. 21 yrs. old

2. Context

- Based on Michigan Science Curriculum Framework, AAAS Project 2061, National Science Education Standards
- BIOS 1700 *Life Science for Elementary Educators I*
 - Taxonomy, Anatomy and Physiology, Ecology, Evolution
- Taught in lecture-lab (24 students) format
- Unit of interest takes place during lab

3. Intervention

3 day unit based on history of research on industrial melanism



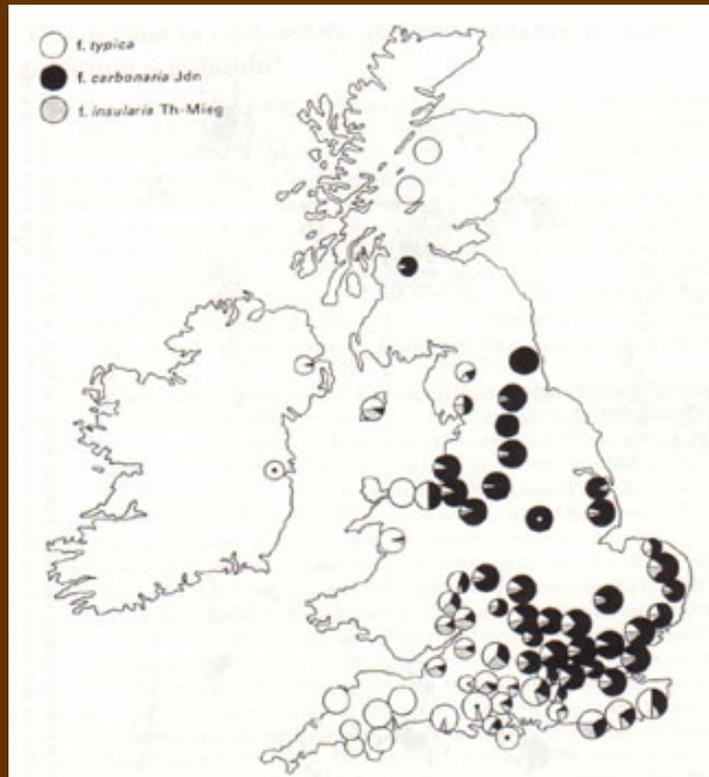
“The Mystery Phenomenon”

DAY ONE



1848 - Manchester, UK

Frequency of dark forms



Centers of air pollution

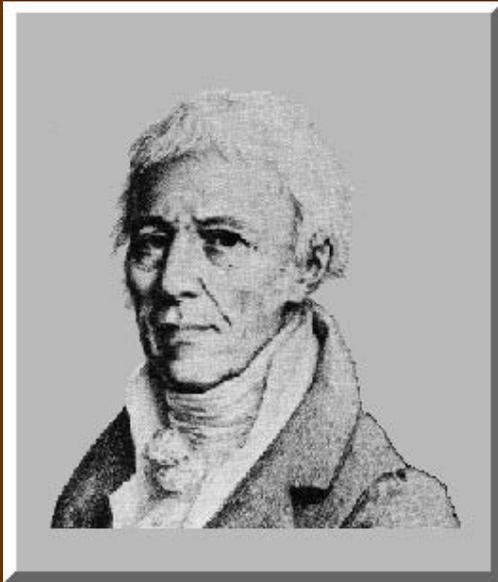


Mystery Phenomenon:

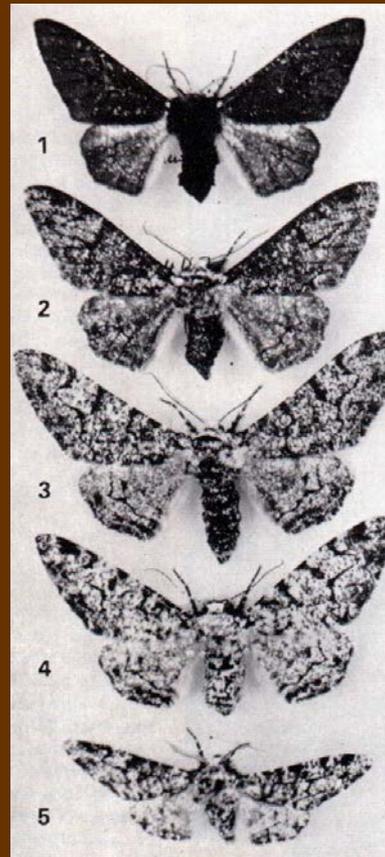
Why is the dark form becoming more common in the vicinity of manufacturing centers?

DAY TWO

Lamarckian Inheritance:

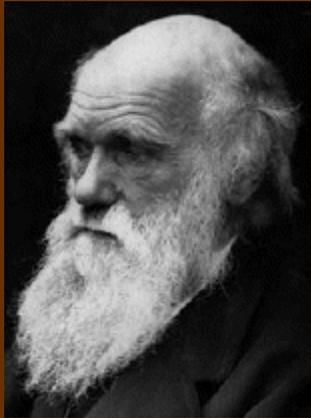


Jean Baptiste Lamarck
(1744-1829)

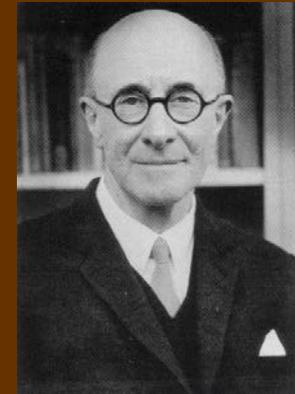


Nicholas Cooke
(1818-1886)

Natural Selection:



Charles Darwin
(1809-1882)

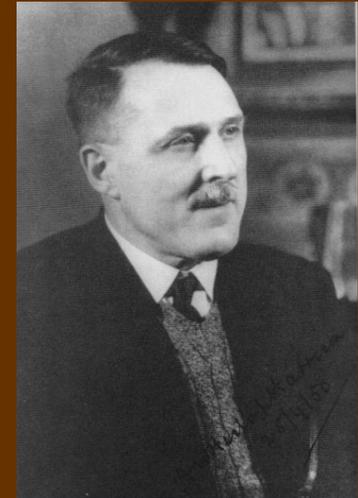
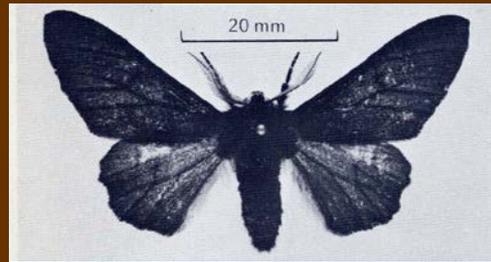


E.B. Ford
(1901-1988)

Mutation Theory:



Hugo De Vries
(1848-1935)



J.W. Heslop
Harrison
(1881-1967)

What is a theory?

DAY THREE

Discuss and interpret results



What are experiments?

MOVIE: Evolution in Progress

Evolution in progress.

*The story of Natural Selection and
'Industrial Metanism' in the
Peppered Moth (*Biston betularia* L.)*

*A film from the
Genetics Laboratories,
Department of Zoology,
University of Oxford.*

Discrepancies in textbook account

- Still regarded as excellent example of natural selection
- Phenomenon is very complex
- *What should science teachers do in light of these complexities?*

4. Procedure

Qualitative (Interpretive) Research

1. Pre/post test = open-ended VNOS-C survey
2. Semi-structured interviews^{††}
 - To establish validity of survey
 - To allow further probing of student responses

^{††}Lederman & O' Malley, 1990

5. Data Analysis

- Characterize pre- and post- responses to questions into emergent themes
 - cross checked consistency with rest of students answers
- To address *whether* change has occurred
 - analyze aggregate for evidence of change
- To address *why* change has occurred
 - analyze responses of interviewed individuals

III. Results

1. Were there any changes in NOS views associated with the intervention?

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Nine of twelve items were coded significantly differently

Example: What is a Theory?

Code	Description	Rank	Pre	Post
1	Explanation	Most	28.5% (n=37)	38.5% (n=50)
2	Claim		33.8% (n=44)	39.2% (n=51)
3	Hypothesis/ Guess		24.6% (n=32)	11.5% (n=15)
4	Nonsensical/ No answer	Least	13.1% (n=17)	10.8% (n=14)

Improvement	No Change	Backsliding
33.8% (n = 44)	43.8% (n = 57)	22.3% (n = 29)

Impact: What is a theory?

χ^2	Degrees of Freedom	<i>p</i> -value	Net effect
12.12	3	0.007	significant, 15

Significance

Stuart Maxwell test for marginal homogeneity
used on matrix of frequency of each coded pair

Net Impact

Total pairs representing improvement - backsliders

Impact of Intervention as a Whole

Assessed by Wilcoxon Signed-rank Test

- For each question rank assigned to pre-intervention response, ranks normalized and summed for all 12 items – allows assigning of test rank
- Done again for post responses
- Post ranks were significantly higher ($p < 0.01^{**}$)

Wilcoxon 1945

III. Results

2. How do interviews and previous experiences inform our interpretation of the results?

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Interviewees mentioned things that occurred during the unit, but were often vague

Example: What is a Theory?

I[interviewer]: Have you ever used a theory before... in your own experiences?

S[tudent]: Yeah.

I: Okay. Can you give me an example?

S: Well, the one I gave was about the one in class where we had, uh, the... the... the *Betularia* [?] or whatever...

I: The (unintelligible)? Mmm-hmm.

S: Yeah and um, we had to come up with three theories on why they were changing col—why the, the, uh, the colors, you know, were changing. And we came up with, you know, three different things and it was kinda... I mean, we created our own theories and then compared them to what scientists came up with.

I: How did you do that? How did you come up with your...

S: Um, we used, like, the idea of natural selection and, uh, a couple – I don't remember what else we did but we, um, used that idea and then explained how – why that would be occurring.

I: Okay. (Student 117 interview, 2->1)

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- Unit as a whole had a positive net impact on distribution of codes assigned to student responses, despite brevity
- Study gave us some insight into how to improve the unit
- Role of history is unclear – use of multiple examples seems to help students appreciate generality

Acknowledgements

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Thanks!