Currie, Chpt 9. Introduction:

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- The essay argues against the view that historical scientists cannot generate their own evidence and are limited to passive observation
- It challenges the idea that historical scientists are "stuck with what nature provides" in terms of evidence
- The author will argue that historical scientists can manufacture "smoking guns" (key pieces of evidence) through controlled manipulations

Background on "smoking guns":

- Carol Cleland's concept of a "smoking gun" is clarified
- A smoking gun is not necessarily a decisive critical test, but rather a piece of evidence that shifts investigations in a particular direction when combined with other evidence
- Cleland sees historical scientists as searching for evidence while experimentalists generate it

Case study: Modeling ancient echinoderm development

- Zachos and Sprinkle created a computer model of echinoderm development to study differences between ancient (stem group) and modern (crown group) echinoderms
- The model suggested stem group echinoderms may have developed similarly to modern ones, just with more insertion points for new plates (relaxed "Ocular Plate Rule")
- This challenges the view that stem and crown group echinoderms had radically different developmental systems

Argument that the model results can count as evidence:

- The author uses the law of likelihood to argue the model results can count as evidence favoring one hypothesis over another
- Key is establishing a probabilistic link between the model results and the hypotheses about ancient echinoderm development
- The model's validity for modern echinoderms, plus phylogenetic relationships, allows it to serve as a proxy for manipulating ancient echinoderms

Addressing objections:

- Models only generate hypotheses, not evidence
- Countered by noting the model produced surprising results and is treated as evidential by the researchers
- Models only mediate between theory and data
- Countered by noting this model doesn't draw out consequences of a mathematical theory, but represents developmental systems directly
- Models rarely provide evidence in practice
- Author acknowledges challenges but argues validation practices and holistic assessment can often establish evidential relevance

Conclusion:

- Historical scientists can generate evidence by constructing and manipulating models/surrogates
- This undermines pessimism about historical sciences' epistemic capabilities
- Next chapter will further explore use of models as "surrogate experiments" in historical science

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- Idealization as a prevalent and puzzling feature in science. Examples:
  - Newton treating the moon and Earth as a two-body system
  - Zachos and Sprinkle treating three-dimensional sea urchins as two-dimensional geometric shapes
  - Population geneticists treating finite populations as infinite
- Three main aims for the chapter:
  - Connect: the discussion of surrogates in historical science to the broader literature on modeling and idealization
  - Argue: the purpose of idealizations in historical science is often to facilitate testing by ensuring information is provided at the right grain
  - Introduce: the concept of investigative scaffolding and its importance in historical science

II. Simulations and Surrogate Experiments

- The author provides Parker's (2009) definition of simulation and discusses its implications.
- A detailed example of Hyde et al.'s study of Snowball Earth is presented:
  - The ice-sheet model is explained, which predicts ice extent
  - The energy balance model (EBM) is described, which outputs global and equatorial temperature
  - The author goes into detail about the equations and variables involved in these models, providing a taste of their complexity
- Hyde et al.'s "experiments" with the simulation are described:
  - They tested the sensitivity of ice-sheet extent to different levels of CO2 atmospheric concentration
  - They investigated the relationship between CO2 and continental freeboard
  - They tested the occurrence of snowballs against different continental arrangements

III. Surrogate "Experiments"

- The author compares procedural and substantive accounts of experiments:
  - Procedural accounts define experiments as interventions on a system
  - Substantive accounts focus on the epistemic power of experimentation
- The concept of "surrogate experiments" is introduced:
  - These are controlled investigations of surrogates, not specimens
  - They differ from true experiments in that the object and target are different kinds of things
- The advantages of surrogate experiments in historical science are discussed, particularly their ability to actively generate new knowledge about the past

IV. The Purpose of Idealization

- Weisberg's framework for understanding idealization's purposes is presented:
  - Tractability: Idealization helps manage complexity and compensate for limited knowledge
  - Explanatory salience: Idealization can isolate the most relevant causal factors
  - Conflicting desiderata: Idealization can help navigate tensions between different scientific goals
- The author introduces a new purpose: facilitating testing at the right grain for evidential relevance
- A case study of Wilkinson et al.'s sauropod methane hypothesis is examined:
  - The inference tool used to estimate sauropod population and methane output is described
  - Van Loon's objections to the tool are discussed, highlighting issues with its level of idealization

V. Investigative Scaffolding

- The author defines and explains investigative scaffolding as a process where coarse-grained hypotheses must be established before finer-grained ones can be teste-
- Examples from Snowball Earth research are provided to illustrate scaffolding:
  - The reevaluation of trace evidence led to more complex hypotheses about atmospheric composition
  - Consideration of the relationship between Snowball Earth and the Cambrian explosion motivated new simulations and hypotheses
- An abstract characterization of scaffolded investigation is presented, emphasizing the relationship between coarse-grained and fine-grained hypotheses
- The role of idealization in scaffolding is explored:
  - Idealization helps in getting the grain right for hypothesis testing
  - De-idealization often occurs when scaffolds are reached and more fine-grained evidence is needed