Promise as an Explanatory Virtue

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Outline

The take-home: Explanations in the life sciences invoke a concept of "promise" that deserves further study.

Explanatory Virtues

> What are the characteristics of a theory which scientists value and which guide them in their choice to adopt one theory or another? In other words, what are the virtues of a scientific theory? (Schindler 2018, 5)

Explanatory virtues are values which explanations (or potential explanations) exemplify, that lead to those explanations being preferred (or sought) by scientists.

All else equal, we will tend to prefer theories that produce explanations bearing these qualities – there is thus a tight link between **theoretical** and **explanatory** virtues.

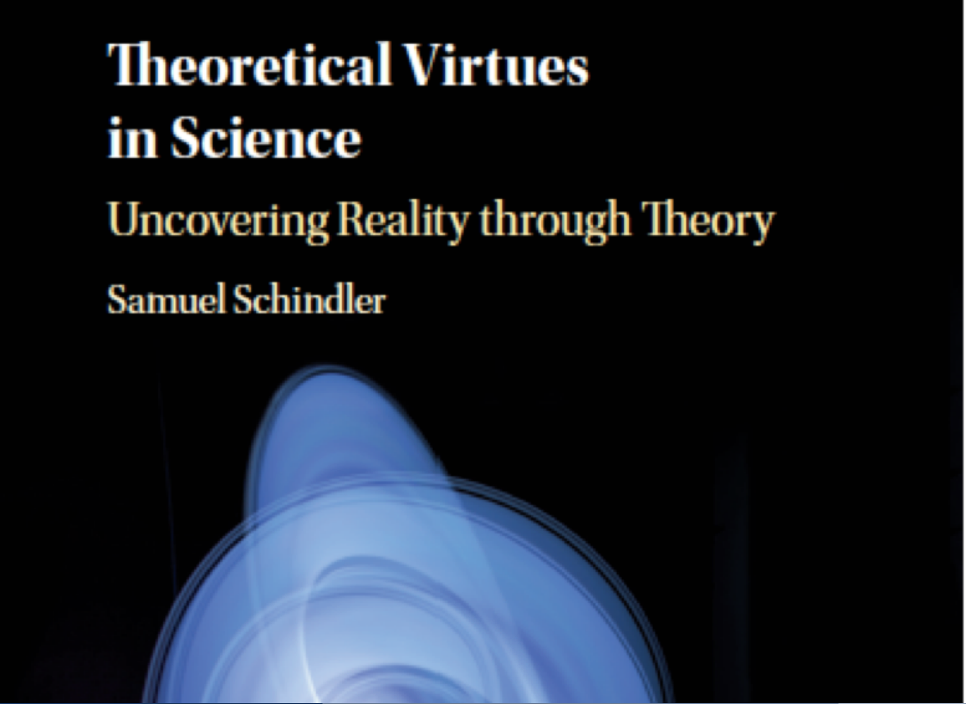
> These five characteristics—accuracy, consistency, scope, simplicity, and fruitfulness—are all standard criteria for evaluating the adequacy of a theory. (Kuhn 1977, p. 322)

A Few Others

- testability
- lack of ad-hoc components
- symmetry
- visualizability
- conservativeness

Scope

> Third, it should have broad scope: in particular, a theory's consequences should extend far beyond the particular observations, laws, or subtheories it was initially designed to explain. (Kuhn 1977, p. 322)


Theoretical Virtues
in Science
Uncovering Reality through Theory
Samuel Schindler

> A theory has unifying power (*or broad scope*) when it unifies phenomena which were previously considered distinct. (Schindler 2018, p. 11, emph. added)

Newton's achievements in dynamics, astronomy, and optics inspired some of his successors to undertake an ambitious program which I call "dynamic corpuscularianism." *Principia* had shown how to obtain the motions of bodies from a knowledge of the forces acting on them, and had also demonstrated the possibility of dealing with gravitational systems in a unified way. The next step would be to isolate a few basic force laws, akin to the law of universal gravitation, so that, applying the basic laws to specifications of the dispositions of the ultimate parts of bodies, **all of the phenomena of nature could be derived.** (Kitcher 1981, pp. 512–3)

> If only we could derive the other phenomena of nature from mechanical principles by the same kind of reasoning! For many things lead me to have a suspicion that all phenomena may depend on certain forces by which the particles of bodies, by causes not yet known, either are impelled toward one another and cohere in regular figures, or are repelled from one another and recede. Since these forces are unknown, philosophers have hitherto made trial of nature in vain. (Newton 1999, pp. 382–3)

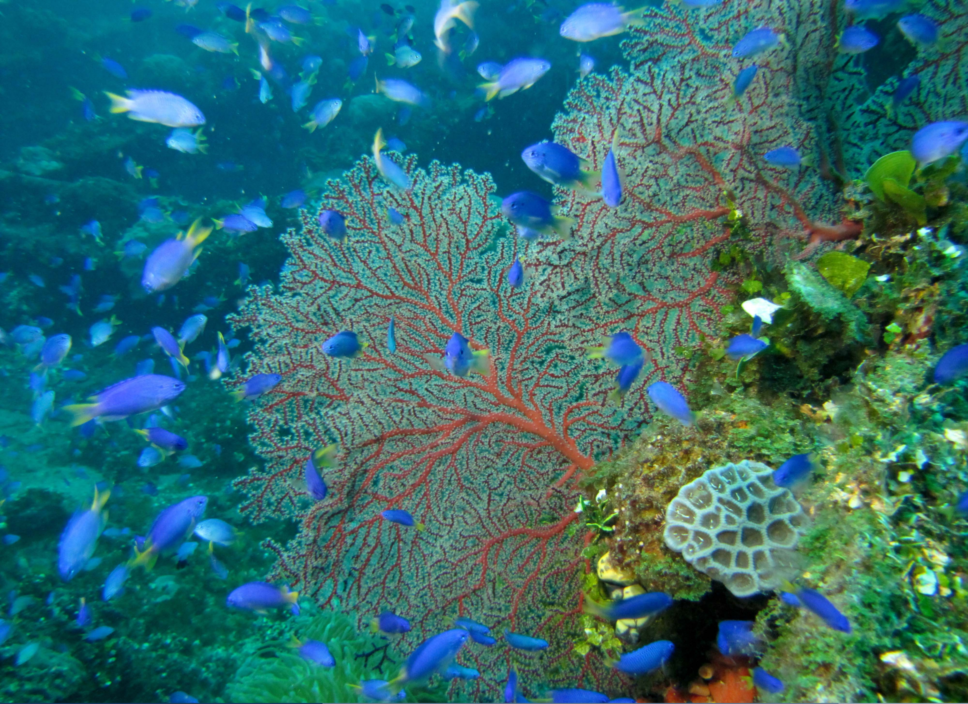
A Living Body is compounded of Canals of diverse kinds, conveying different sorts of Fluids.

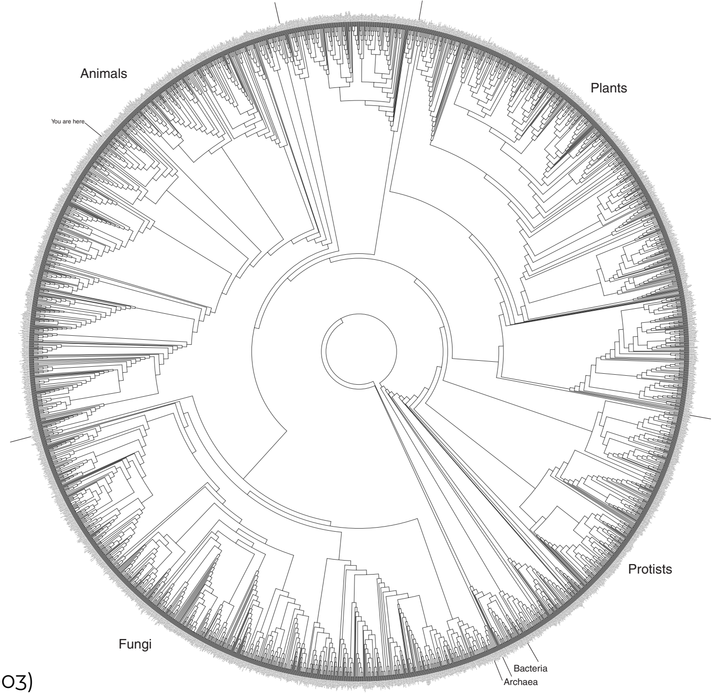
A Disease is the circulatory Motion of the Blood too much increased or diminished.

A fever is the Motion of the Blood encreased. (Pitcairne 1717, quoted in Brown 1987, p. 632)

> …we should note that unifying power should be distinguished from the *empirical* scope of the theory. A theory can conjoin many facts and therefore have broad empirical scope but little unifying power. That would be the case if the theory gave us no clue as to how the conjoined facts are interrelated at a 'deeper' level. (Schindler 2018, p. 12)

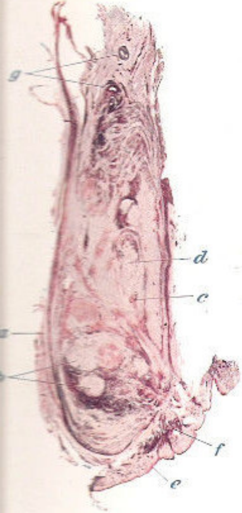
Scope in the Life Sciences?




Animals
You are here
Plants
Protists
Fungi
Bacteria
Archaea

Hillis (2003)

Abb. 131



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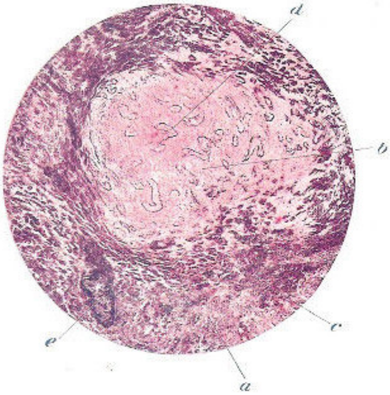
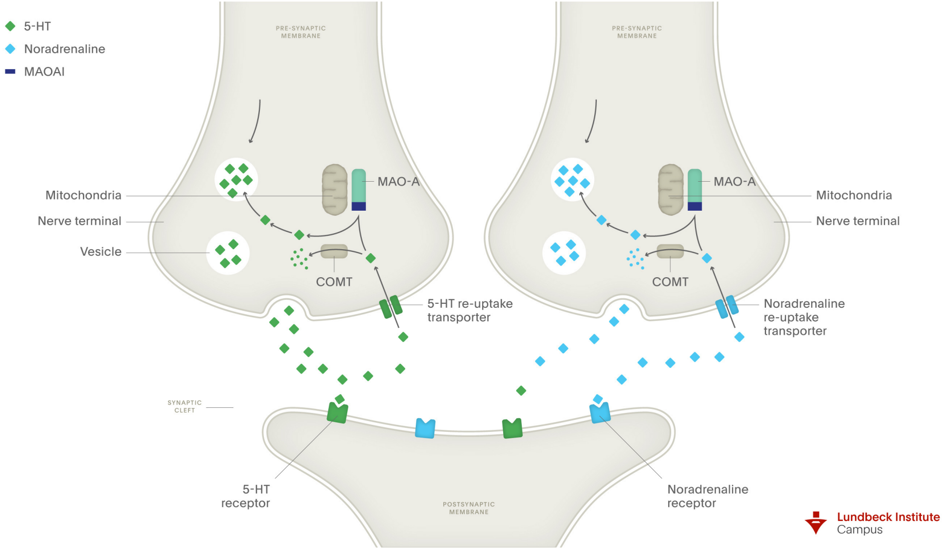


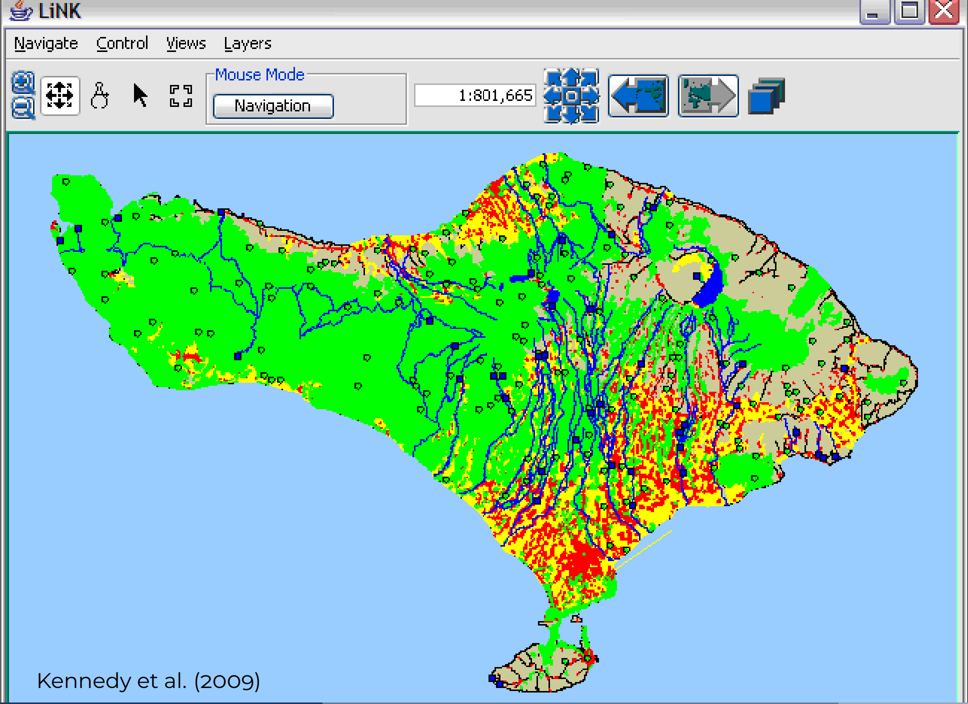
Abb. 133

Christeller (1927)

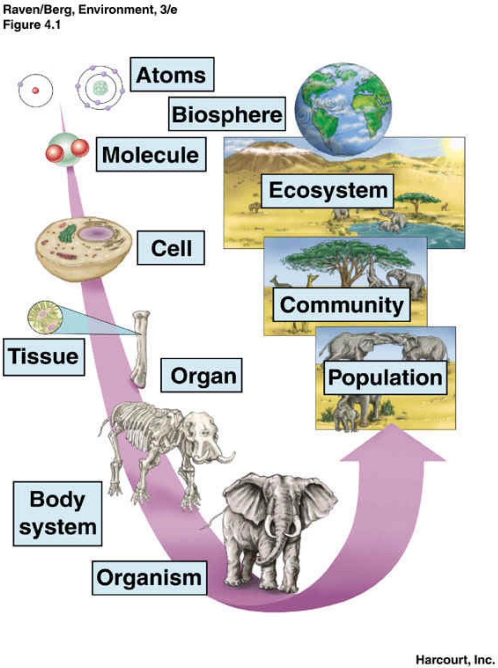
Georg Thieme, Leipzig



Lundbeck Inst. (2016)



Kennedy et al. (2009)


Raven/Berg, Environment, 3/e
Figure 4.1
Atoms
Biosphere
Molecule
Ecosystem
Cell
Community
Tissue
Organ
Population
Body system
Organism
Harcourt, Inc.

Okay, this is just the pursuit of scope, right?

Okay, this is just the pursuit of scope, right?

The Big Claim For Today: No.

1. It's not the pursuit of **empirical scope,** because we find complex reasons and arguments for scientists' choices.
2. And it's not the pursuit of **unifying power,** because the explanations invoked here are often *radically* disunified.

In short: scientific practice doesn't seem to be directed at scope, in either of its guises.

From Scope to Promise

commence handwaving

Some Context

1. Darwin's "natural history" (orchids, insectivorous plants, earthworms)
2. Big data in the life sciences
3. Scientific publication, preprints, and social media

What *Isn't* at Stake

1. **Mechanistic explanation:** mechanism sketches and mechanism schemas can be useful tools here, but not sufficiently elaborated to let us theorize about promise
2. The literature on **explanatory depth** is interesting and useful, but it doesn't seem to have this distinctive life-science character

conclude handwaving

What's Different?

The choices made in these expansions of biological theory – in the search for **promise** – seem to be:

1. selective
2. opportunistic
3. value-laden

Selective

Choices about explanatory promise are almost never made as though the primary goal is scope for its own sake. Researchers might pursue **more difficult** cases or **fewer** cases, none of which seems natural for pursuing scope.

Opportunistic

These choices have a lot to do with what **other work is already going on** – think of the literature on the use of model organisms – or with particular **integrations** between extant bodies of knowledge.

Eco-Evo-Devo: The Time Has Come

6

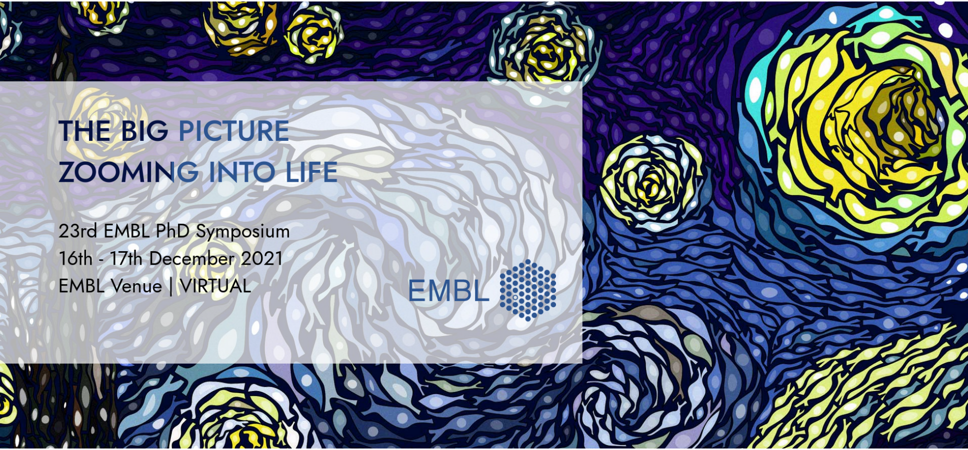
Ehab Abouheif, Marie-Julie Favé, Ana Sofia Ibarrarán-Viniegra, Maryna P. Lesoway, Ab Matteen Rafiqi, and Rajendhran Rajakumar

Abstract

The major goal of ecological evolutionary developmental biology, also known as "eco-evo-devo," is to uncover the rules that underlie the interactions between an organism's environment, genes, and development and to incorporate these rules into evolutionary theory. In this chapter, we discuss some key and emerging concepts within eco-evo-devo. These concepts show that the environment is a source and inducer of genotypic and phenotypic variation at multiple levels of biological organization, while development acts as a regulator that can mask, release, or create new combinations of variation. Natural selection can subsequently fix this variation, giving rise to novel phenotypes. Combining the approaches of

Value-Laden

Perhaps most importantly, these choices seem to reflect **non-epistemic value commitments** – understanding those values can be key for realizing why scientists make the promise-based choices that they do.


THE BIG PICTURE
ZOOMING INTO LIFE
23rd EMBL PhD Symposium
16th - 17th December 2021
EMBL Venue | VIRTUAL
EMBL

> Each year, the life sciences are becoming more and more interdisciplinary in nature. No better example can be given than the current pandemic, where researchers in different fields have collaborated to bring about a rapid research-driven response against the novel coronavirus. We are dedicated to creating a symposium that brings together researchers who study life sciences at different scales and explore the interdisciplinary approaches utilized to link the different scales of life. (EMBL PhD Symposium: About)

This isn't the pursuit of scope, but rather the pursuit of **promise.**

Some Objections

Is promise just a way of talking about fruitfulness?

Is promise just a way of talking about generalization or idealization?

Is promise just a pragmatically useful tool for responding to a certain class of critics?

Case Study: Natural History

What Is Natural History?

> For our purposes, *natural history* is the observation and description of the natural world, with the study of organisms and their linkages to the environment being central. (Tewksbury et al. 2014, p. 300)

What Is Natural History?

> At its most stereotyped, natural history has been, and is, strictly phenomenological. This is unexciting but not totally evil. (Bartholomew 1986, p. 326)

What Happened?

> Suddenly, [naturalists] found themselves being told that what they had all along been accustomed to think of as useful and even in some cases valuable scientific work was no longer of very much moment and, worse, ought for preference to be abandoned and a quite different approach adopted in its stead. (Allen 1998, p. 361)

What Happened?

> In contemporary biology, much of the glamour and most of the funding go to research on the lower levels of integration. At these levels active researchers generally agree on the key questions. This consensus is so complete that we see large numbers of highly intelligent investigators with a trasure trove of instrumentation and techniques all concentrating on a few questions. (Bartholomew 1986, p. 328)

Why is this Bad?

> Knowing natural history allows an investigator to phrase questions with precision. It facilitates synthesis from lower to higher levels of integration and can help orient those biological sectors that focus on physiological mechanisms and issues far removed from the organisms they make up. (Bartholomew 1986, p. 328)

Why is this Bad?

> Organisms themselves embody genetics, development, morphology, physiology and behavior, and they are the fundamental components of populations, communities and ecosystems. An understanding of organisms in nature is thus integral to studies at both lower and higher levels in the hierarchy of biological complexity… (Greene 2005, p. 24)

Do We Really Disagree?

> The crux of the natural history tradition is the search for order in nature. The goal of the tradition is, and always has been, to formulate concepts that allow us to perceive order in nature. It is the pursuit of the goal, rather than the tools of employment, that defines the tradition and hence the naturalist. The tools of the naturalist are equations and sequencers, as well as binoculars and notebook. (Arnold 2003, p. 1067)

Do We Really Disagree?

> The dispute among us thus looks to be a red herring, an emotional but largely inconsequential misunderstanding that has perhaps been fueled in part by fuzzy, interchangeable use of the words 'theory,' 'models' and 'concept building' on the one hand and 'natural history,' 'organism-focused' and 'empiricism' on the other. (Greene 2005, p. 25)

What's Left?

> Second, Arnold expressed no concerns for the empirical and educational aspects of natural history *[sensu] stricto*… Futuyma, Dayton and I are particularly concerned that we lack sufficient empirical reference points to move reliably among scales of time, space and biological organization, and that science therefore cannot adequately address environmental dilemmas. (Greene 2005, p. 25)

What's Left?

> The importance of systematics and natural history thus lies in defining the boundaries and contours of organismic diversity.
>
> […]
>
> It is because of phylogenetic systematics that we can place special value on the coelacanth, the tuatara, and other "living fossils," and that we hypothesize that chimpanzees, not gorillas, are our closest relatives. (Greene and Losos 1988, pp. 458–459)

What’s Left

The defense of natural history by Tewksbury et al. (2014) is structured into the following sections:

1. Human health
2. Food security
3. Conservation and management
4. Recreation

And it’s summed up in a section titled “Natural history in academia: Connecting science and society.”

What's Left?

A **debate about promise.**

What's Left?

A **debate about promise.**

Pitting certain kinds of **non-epistemic values,** on the one hand, against certain kinds of **opportunistic use of tools** (like sequencing and molecular-biology approaches) on the other.

Questions?

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