Breadth in Scientific Explanation

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Outline

1. Scope and Newtonian Mechanics
2. Life Science and Scope
3. From Scope to Breadth
4. A Few Objections

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

Explanatory Scope

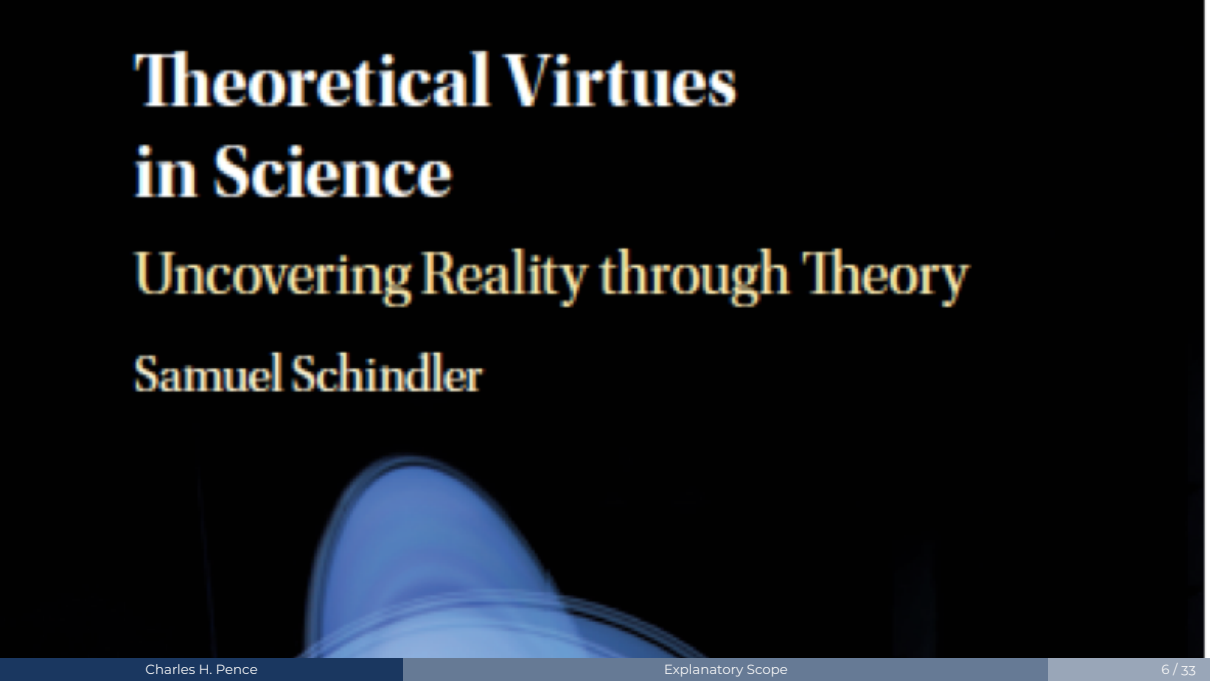
> Third, it should have broad scope: in particular, a theory's consequences should extend far beyond the particular observations, laws, or subtheories it was initially designed to explain. (Kuhn 1977, p. 322)

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

Theoretical Virtues in Science

Uncovering Reality through Theory

Samuel Schindler

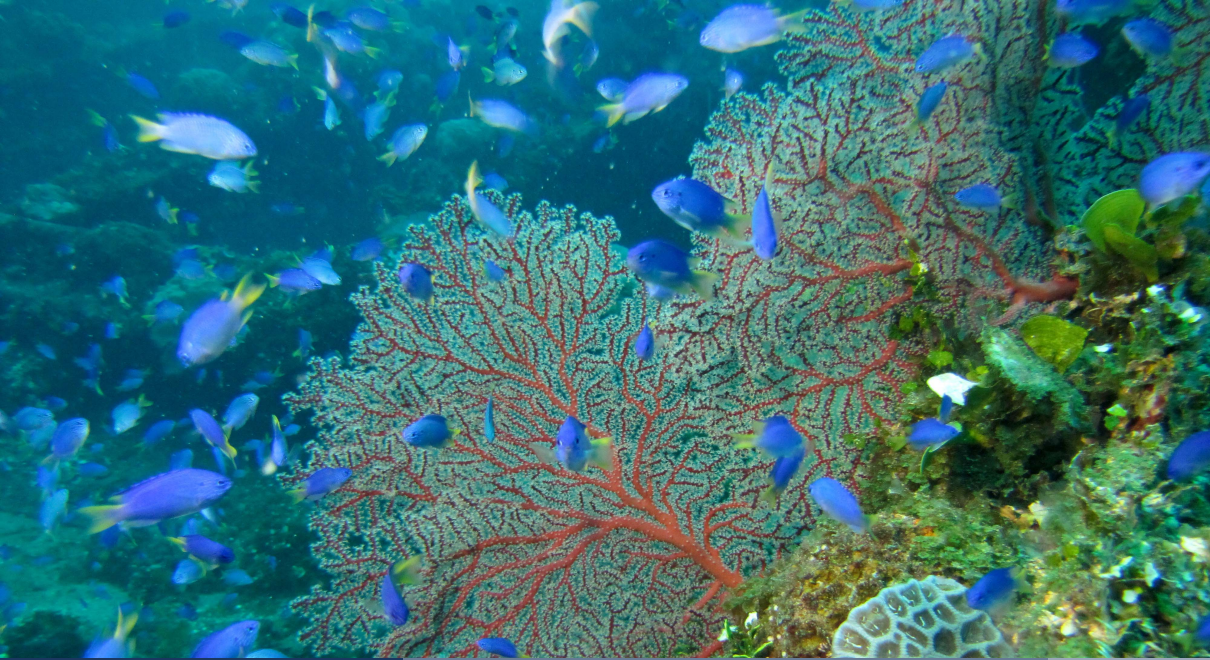


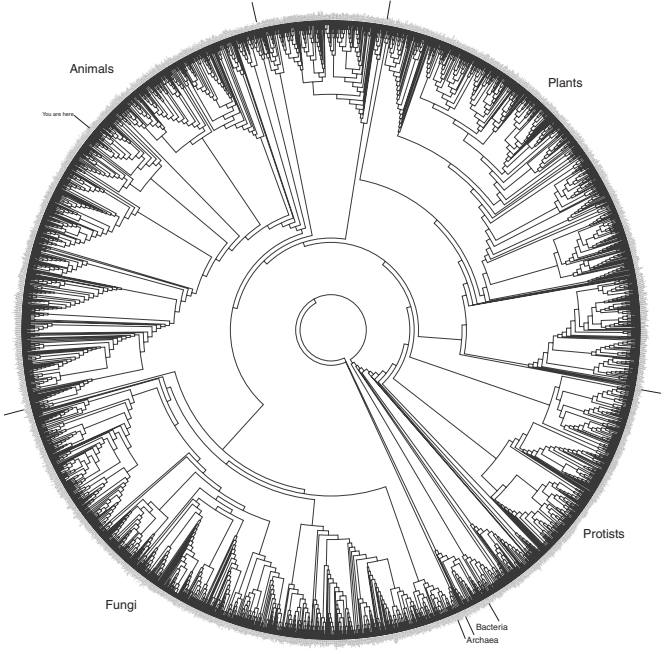
Newton's achievements in dynamics, astronomy, and optics inspired some of his successors to undertake an ambitious program which I call "dynamic corpuscularianism." *Principia* had shown how to obtain the motions of bodies from a knowledge of the forces acting on them, and had also demonstrated the possibility 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)

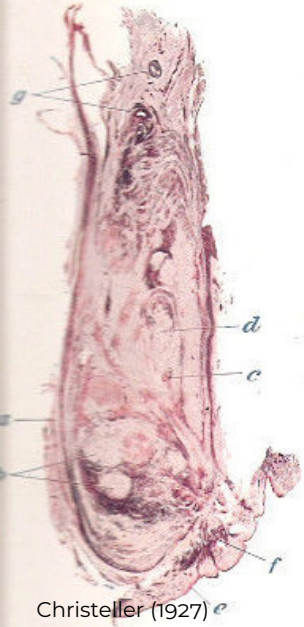
A Living Body is compounded of Canals of diverse kinds, conveying different sorts of Fluids.
A Disease is the circulatory Motion of the Blood too much increased or diminished.
A fever is the Motion of the Blood encreased. (Pitcairne 1717, quoted in Brown 1987, p. 632)

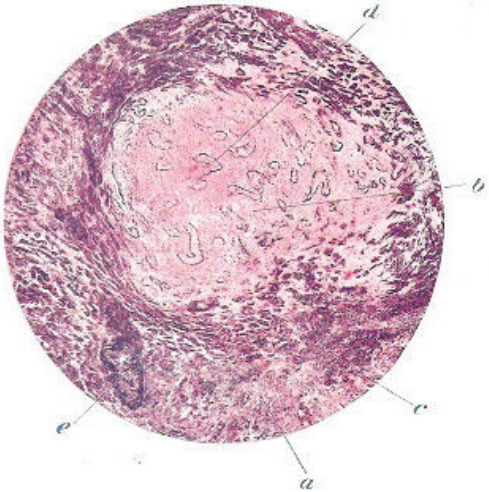
Scope in the Life Sciences



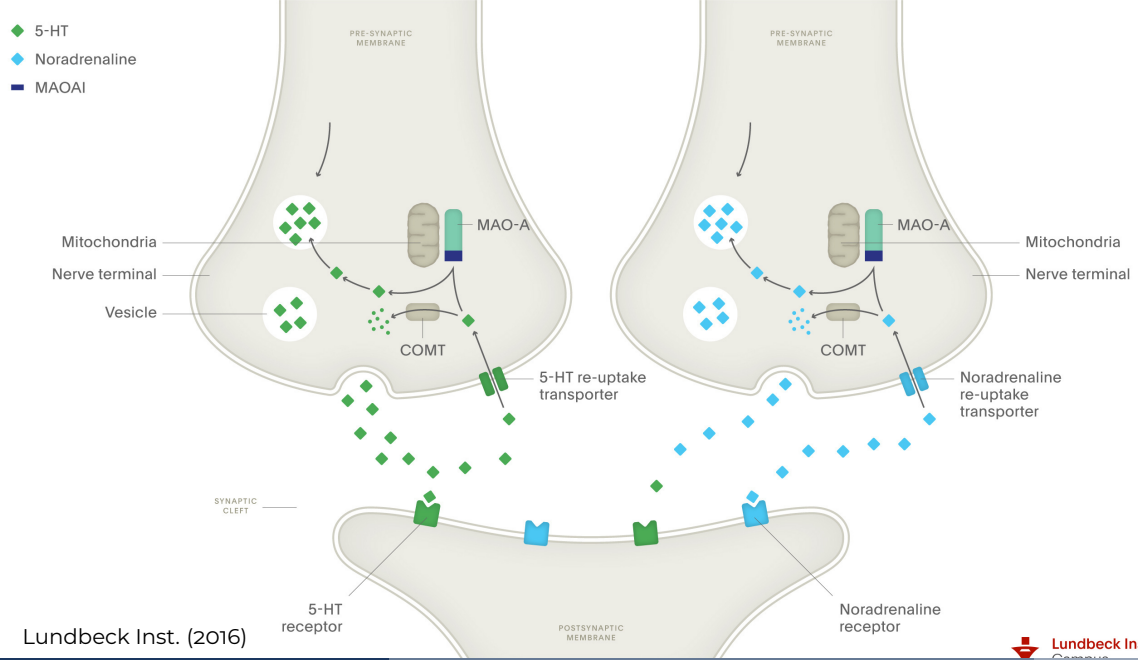

Animals
You are here
Plants
Protists
Fungi
Bacteria
Archaea

Hillis (2003)

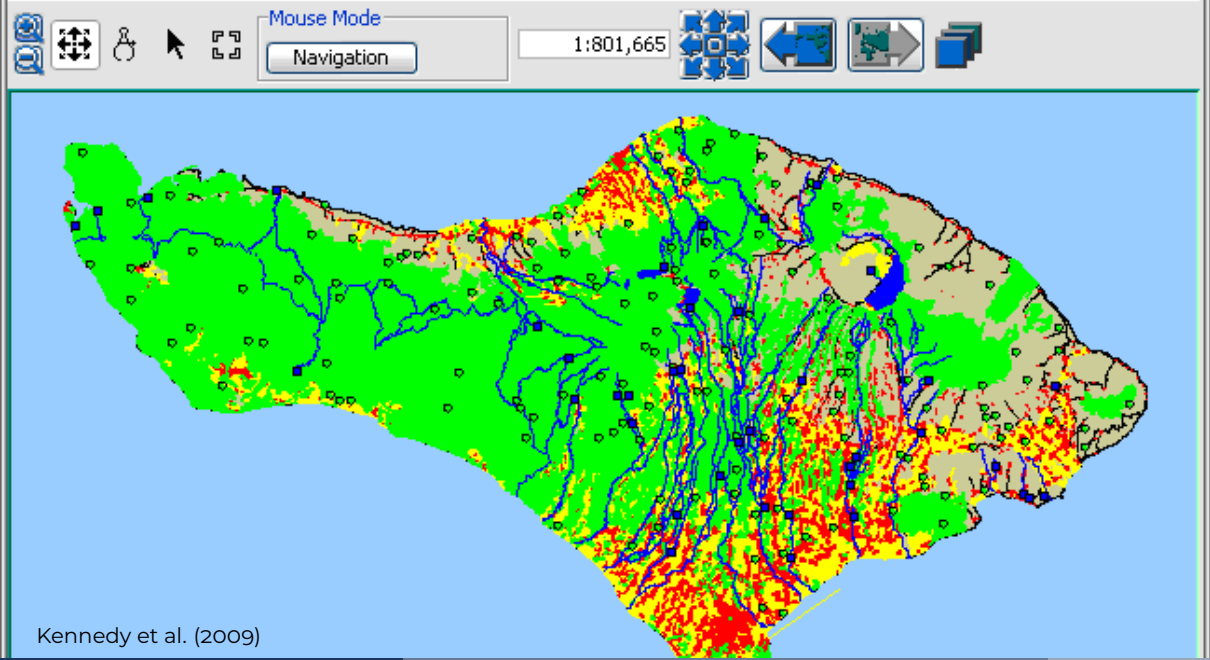




Christeller (1927)

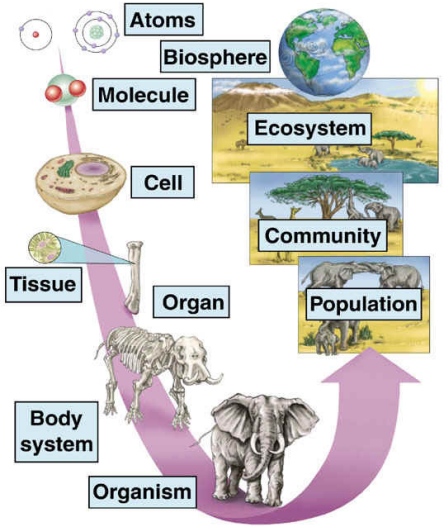


Lundbeck Inst. (2016)



Kennedy et al. (2009)

Raven/Berg, Environment, 3/e
Figure 4.1



Harcourt, Inc.

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

Claim: No, not quite. These examples feel different – they're not just the pursuit of universal application, they're chosen for different and more complex reasons. In short: scientific practice doesn't look like it's directed at scope.

From Scope to Breadth

What's Different?

The choices made in these expansions of biological theory – in expansions of **breadth** – seem to be:

1. selective
2. opportunistic
3. value-laden

Selective

Choices about theoretical breadth 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 theoretical knowledge.

Eco-Evo-Devo: The Time Has Come

6

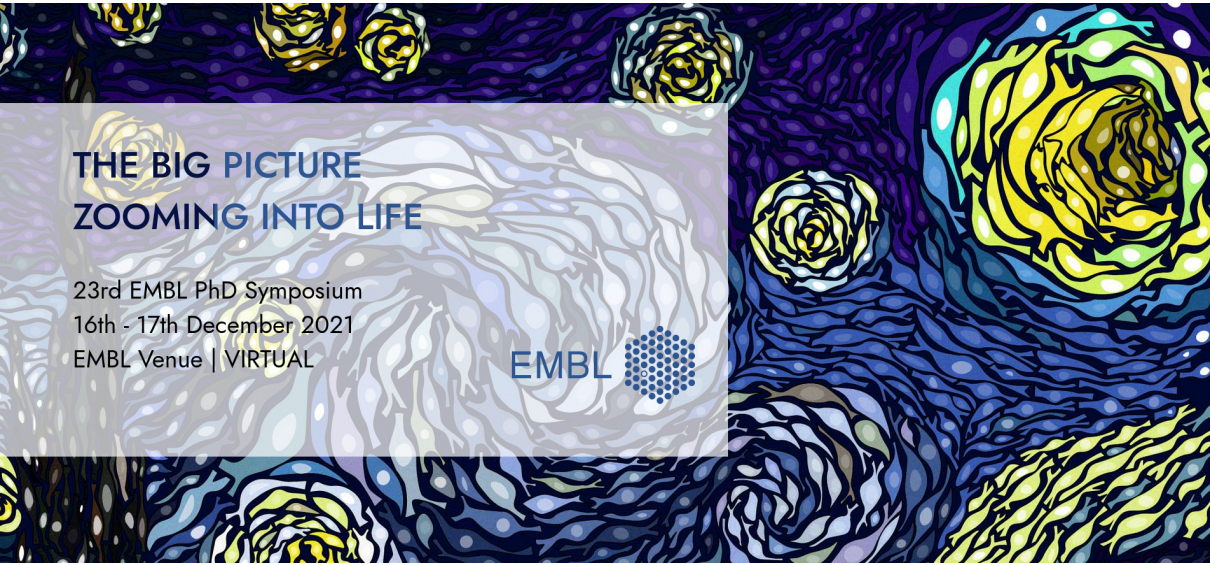
Ehab Abouheif, Marie-Julie Favé, Ana Sofia Ibarrarán-Viniegra, Maryna P. Lesoway, Ab Matteen Rafiqi, and Rajendhran Rajakumar

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,

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 breadth-based choices that they do.


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

Some Objections

Is breadth just a way of talking about fruitfulness?

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

Questions?

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