#### THE ECONOMY OF NATURE AND STRUCTURE IN EVOLUTION

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## What is preserved across historical instances of scientific theory change?

### STRUCTURAL REALISM

There was an important element of continuity in the shift from Fresnel to Maxwell - and this was much more than a simple question of carrying over the successful *empirical* content into the new theory. At the same time it was rather less than a carrying over of the full theoretical content or full theoretical mechanisms (even in "approximate") form. (Worrall 1989, 117)

There was continuity or accumulation in the shift, but the continuity is one of *form* or *structure*, not of content. [...] Roughly speaking, it seems right to say that Fresnel completely misidentified the *nature* of light, but nonetheless it is no miracle that his theory enjoyed the empirical predictive success that it did; it is no miracle because Fresnel's theory, as science later saw it, attributed to light the right structure.

(Worrall 1989, 117)



#### BIOLOGICAL STRUCTURALISM

- McMullin (1984): gene as structural concept
- French (2011, 2012, 2014): biological models as structural, grounded in natural selection

Claim: Economy of nature as an underappreciated structural element in the history of biology



#### Economic and theological contexts

The animal is formed by circumstances: this explains the inner perfection and its expediency with regard to external conditions. (Goethe)

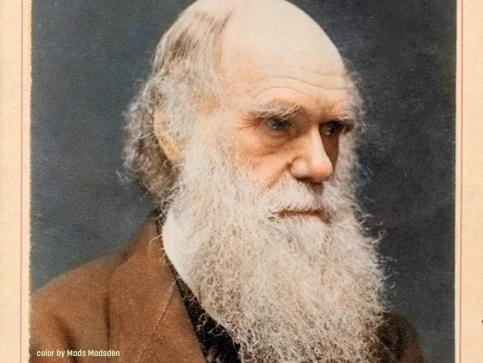
There is a law universal in Nature, tending to render every reproductive being the best possibly suited to its condition that its kind, or organized matter, is susceptible of, which appears intended to model the physical and mental or instinctive powers, to their highest perfection, and to continue them so. (Patrick Matthew)

Thus we see Nature resemble a well regulated state in which every individual has his proper employment and subsistence, and a proper gradation of offices and officers is appointed to correct and restrain every detrimental excess. (Linnaeus, *Police of Nature*)

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By the Oeconomy of Nature, we understand the all-wise disposition of the Creator in relation to natural things.... Whoever duly turns his attention to the things on this our terraqueous globe, must necessarily confess, that they are so connected, so chained together, that they all aim at the same end, and to this end a vast number of intermediate ends are subservient. (Oeconomy of Nature)

## A structure of *places* against which we should understand the distribution of life on earth



If proof were wanted let any singular change of climate [occur] here ... the pressure is always ready ... a thousand wedges are being forced into the œconomy of nature. (Sketch, 7-8)

I need hardly observe that the slow and gradual appearance of new forms follows from our theory, for to form a new species, an old one must not only be plastic in its organization, becoming so probably from changes in the conditions of its existence, but a place in the natural economy of the district must [be made,] come to exist, for the selection of some new modification of its structure, better fitted to the surrounding conditions than are the other individuals of the same or other species. (Sketch, 145)

### An empty *place* in the economy of nature as prerequisite for evolutionary change

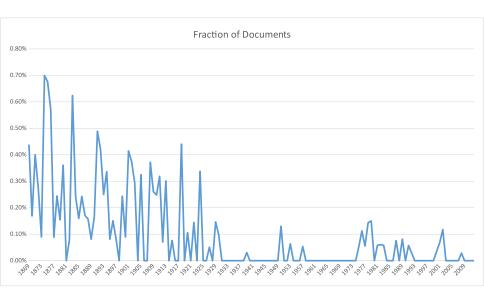
The face of Nature may be compared to a yielding surface, with ten thousand sharp wedges packed close together and driven inwards by incessant blows, sometimes one wedge being struck, and then another with greater force. (*Origin*, 67)

#### Where'd the metaphor go?

The truth of the principle, that the greatest amount of life can be supported by great diversification of structure, is seen under many natural circumstances. In an extremely small area, especially if freely open to immigration, and where the contest between individual and individual must be severe, we always find great diversity in its inhabitants. (Origin, 114)

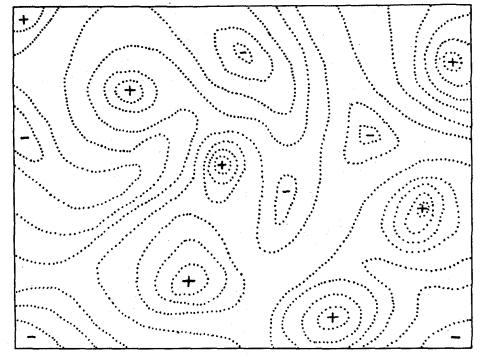
Principle of divergence still divulges information about the underlying structure present in nature

# AFTER DARWIN



Hypothesis: Structural role formerly occupied by the economy of nature taken up by genetics

The true role of the environment in evolution could not be understood until the nature of small mutations and of selection were fully comprehended (Mayr 1966, 3)



# WHAT'S NEXT?

[From an eco-evo-devo perspective, biology must] uncover the relationships within and among different levels of biological organization ... [from the molecular-organismic divide to] levels of organization external to the individual organism [which] extend to higher levels, such as groups, populations, and communities. (Abouheif et al. 2014,

**Take-home: Economy of nature** is a significant structural element throughout the history of evolutionary theory

#### **QUESTIONS?**

Thanks to my collaborator, Daniel G. Swaim, at the University of Pennsylvania!

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