EVOLUTION AND CHANCE

Darwin Day, SFASU, 2/10/2017

Charles H. Pence

**Department of Philosophy
and Religious Studies**

LSU
LOUISIANA STATE UNIVERSITY

Creationists still gleefully pounce on a quote from the Cambridge University astrophysicist Fred Hoyle, who late in his career compared the likelihood of a living cell arising through evolution to "a tornado sweeping through a junkyard" and assembling a Boeing 747. (NY Times)
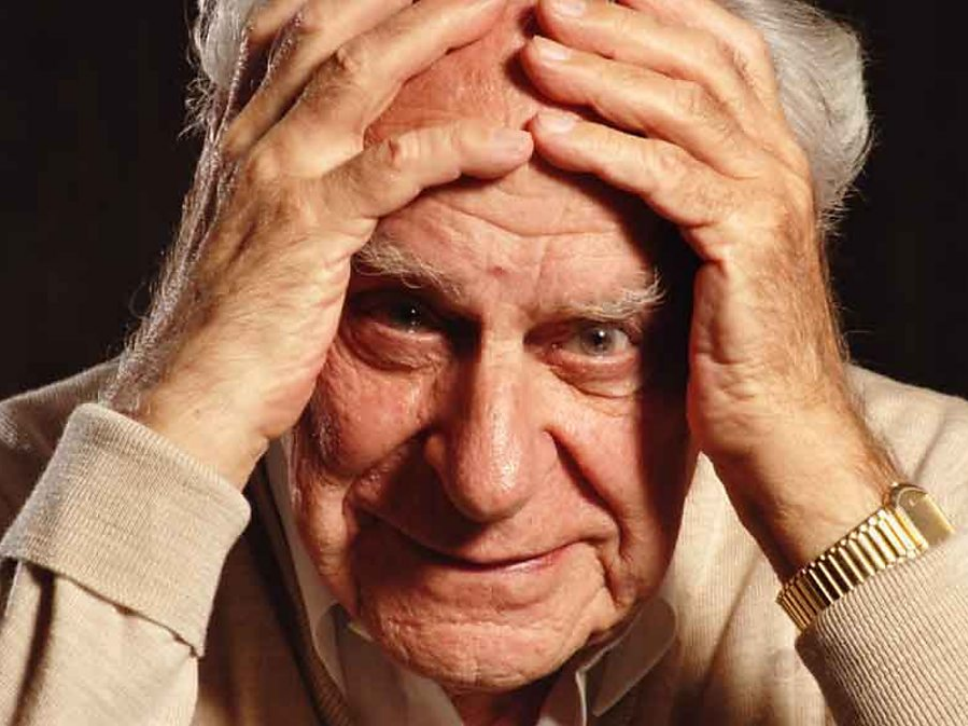
I have come to the conclusion that Darwinism is not a testable scientific theory, but a *metaphysical research programme*.... Let there be a world in which there are entities of limited variability. Then some of the entities produced by variation will "survive," while others will be eliminated.
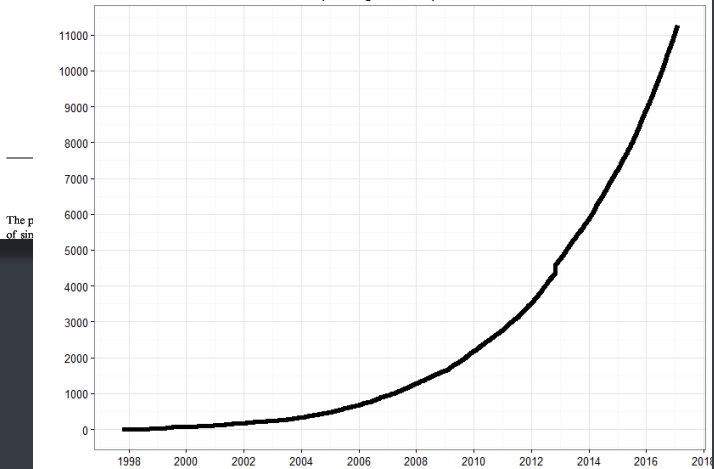
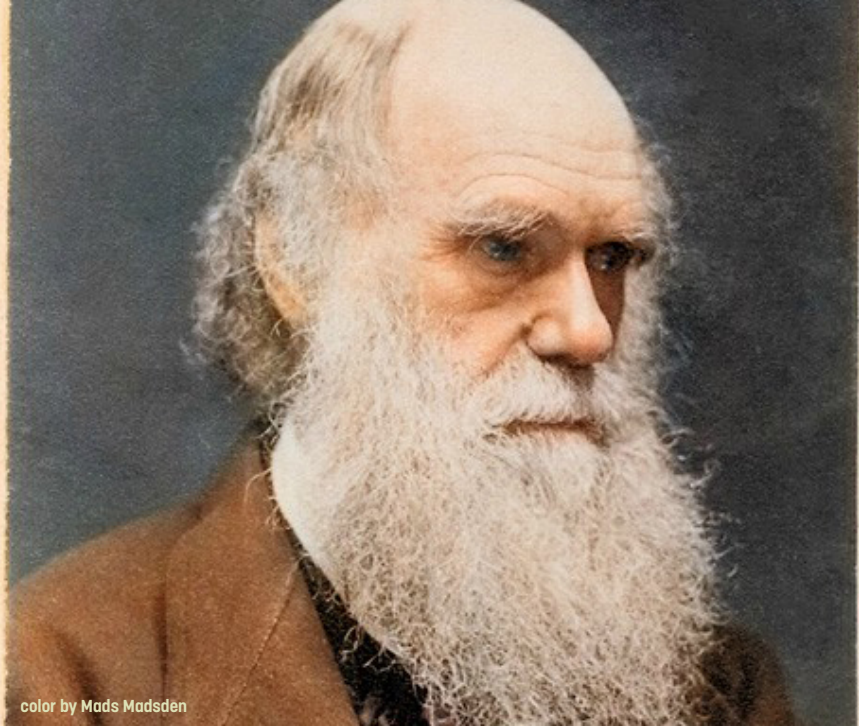# A New Foundation for the Propensity Interpretation of Fitness

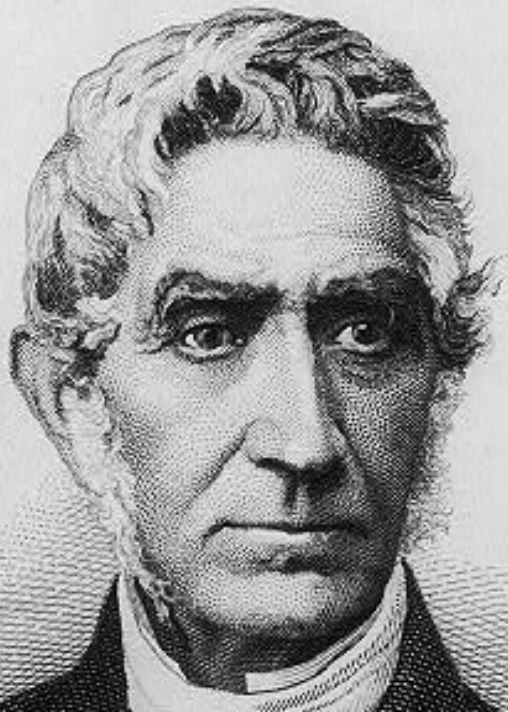### Charles H. Pence and Grant Ramsey

ABSTRACT

The propensity interpretation of fitness (PIF) is commonly taken to be subject to a set
of simple counterexamples. We argue that three of the most important of these are

Number of R packages ever published on CRAN

The p
of sin

SUR L'HOMME

ET LE

DÉVELOPPEMENT DE SES FACULTÉS,

OU

ESSAI DE PHYSIQUE SOCIALE;

PAR A. QUETELET,

Secrétaire perpétuel de l'Académie royale de Bruxelles, Correspondant de l'Institut de France, de la Société royale astronomique de Londres, des Académies royales de Berlin, de Turin, etc.

Quetelet (1835)

I fear you must take it as a fact that Darwin had no liking for statistics. (Galton to Pearson)

BIG
QUESTIONS

What does this say about evolutionary theory itself?

Did Darwin miss something essential to evolution, or have we added a useful tool that's not conceptually necessary?

What did Darwin say about cases where we now see chance as essential?

What did the biologists who first introduced statistical methods into biology think about what they were doing?

DARWIN ON CHANCE

Chance in Variation

Mere chance, as we may call it, might cause one variety to differ in some character from its parents, and the offspring of this variety again to differ...
(*Origin,* p. 111)

Chance in Selection

[A]ny variation, ...if it be in any degree profitable to an individual of any species, ...will tend to the preservation of that individual... (*Origin,* p. 61)

I have hitherto sometimes spoken as if the variations - so common and multiform in organic beings under domestication, and in a lesser degree in those in a state of nature - had been due to chance. This, of course, is a wholly incorrect expression, but it serves to acknowledge plainly our ignorance of the cause of each particular variation. (*Origin,* p. 131)

...but this is not strictly correct; for the shape of each depends on a long sequence of events, all obeying natural laws; on the nature of the rock, on the lines of deposition or cleavage, on the form of the mountain, which depends on its upheaval and subsequent denudation, and lastly on the storm or earthquake which throws down the fragments. (*Variation,* p. 2:427)

- **Chance as subjective ignorance or unpredictability**
- **Chance as accident or the lack of design**
- **Objective chance, or the lack of causation**

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INTRODUCING STATISTICS

If in any country or district all animals of one species be allowed freely to cross, any small tendency in them to vary will be constantly counteracted. (*Sketch,* p. 3)
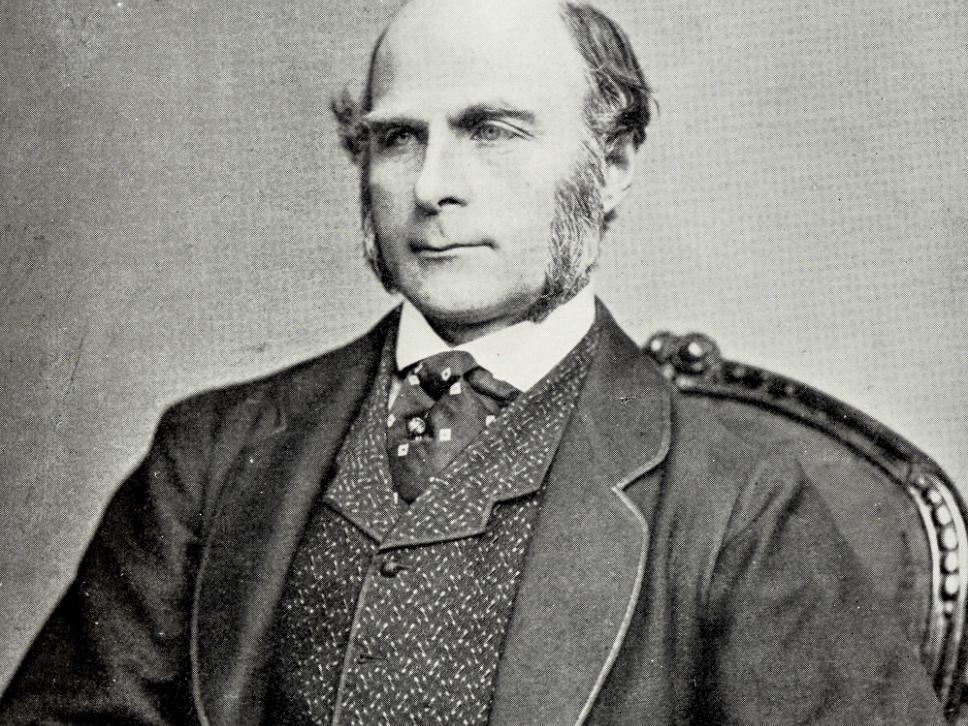
[Consider] an urn containing a great number of balls, marked in various ways, and a handful to be drawn out of them at random as a sample: this sample would represent the person [i.e., the developed characters] of a parent. (Galton 1872, p. 400)

[T]he influence, pure and simple, of the Mid-Parent [the average of the mother and father] may be taken as 1/2 and that of the Mid-Grand-Parent [the average of all four grandparents] as 1/4, and so on. Consequently the influence of the individual Parent would be 1/4, and of the individual Grand-Parent 1/16, and so on. (Galton 1889, p. 136)

- Statistics only present in the theory of heredity
- Statistical laws "may never be exactly correct in any one case, but at the same time they will always be approximately true and always serviceable for explanation" (Galton 1877, p. 532)

II. "The Variations occurring in certain Decapod Crustacea.—
I. *Crangon vulgaris*." By W. F. R. WELDON, M.A., Fellow
of St. John's College, Cambridge, and Lecturer on Inverte-
brate Morphology in the University. Communicated by
Professor M. FOSTER, Sec. R.S. Received March 20, 1890.

It is well known that two sets of animals, belonging to the same
species, but living in different places, exhibit differences from one
another by which they can, in many cases, be easily distinguished.
But it is at the same time equally certain that the forces determin-
ing the differences between local races of the same species do not so
act as to produce the same effect upon all individuals of the same
race: for I am aware of no case in which the individuals composing
any race of animals—however small and isolated the area in which
they live, however uniform the conditions which obtain throughout
that area—have been shown to resemble one another *exactly* in any
character.

Since the adjustment of a local race to the average proper to it is

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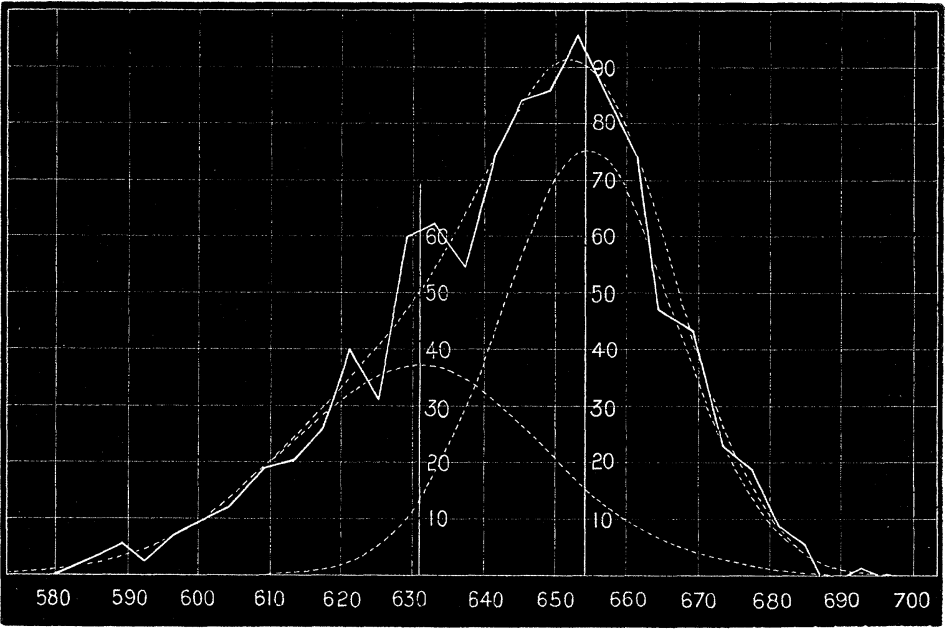Professor M. FOSTER, Sec. R.S. Received March 20, 1890.

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character.

Since the adjustment of a⟨...⟩

It cannot be too strongly urged that the problem of animal evolution is essentially a statistical problem...and when we know the numerical answers to [statistical distributions of characters] for a number of species, we shall know the direction and the rate of change in these species at the present day – a knowledge which is the only legitimate basis for speculations as to their past history and future fate. (Weldon 1893, p. 189)

These are all the data which are necessary, in order to determine the direction and rate of evolution; and they may be obtained without introducing any theory of the physiological function of the organs investigated. The advantage of eliminating from the problem of evolution ideas which must often, from the nature of the case, rest chiefly upon guess-work, need hardly be insisted upon. (Weldon 1895a, p. 379)

The questions raised by the Darwinian hypothesis are purely statistical, and the statistical method is the only one at present obvious by which that hypothesis can be experimentally checked. (Weldon 1895b, p. 381)

In the last chapter we freely used the words 'evolution' and 'selection' as if they had current common values. Now this is very far from being the case, and it is accordingly desirable to give to these terms and other subsidiary terms definite and consistent meanings. It is only within the last few years, however, with the growth of a quantitative theory of evolution, that precise definition of fundamental biological concepts has become possible. (Pearson 1900, p. 372)

BUT WHY?

Pearson

[L]aw in the scientific sense only describes in mental shorthand the sequences of our perceptions. It does not explain *why* those perceptions have a certain order, nor *why* that order repeats itself; the law discovered by science introduces no element of necessity into the sequence of our sense-impressions; it merely gives a concise statement of *how* changes are taking place. (Pearson 1892, p. 136)

Pearson

An emphasis on descriptive, mathematical laws, with causation described purely as a mathematical summary of observed data.

Weldon

If we want to make a statement about the stature of Englishmen, ...we must find some simple way of describing our whole experience.... We must give up the attempt to replace our experiences by a single value and try to describe the whole series of results our observation has yielded. (Weldon 1906, p. 94)

Weldon

An emphasis on retaining the complexity of the biological world, avoiding the oversimplification that comes with mathematical rigor.

THE
MORAL

Why did Pearson and Weldon turn to statistics?

Why did Pearson and Weldon turn to statistics?

Two dramatically different reasons.

- **Statistics as positivist, descriptive, mathematical laws (physics-envy?)**
- **Statistics as preservation of the wide scope of biological variation**

No single, clear motivation for why statistics *had* to enter into evolutionary biology when it did.
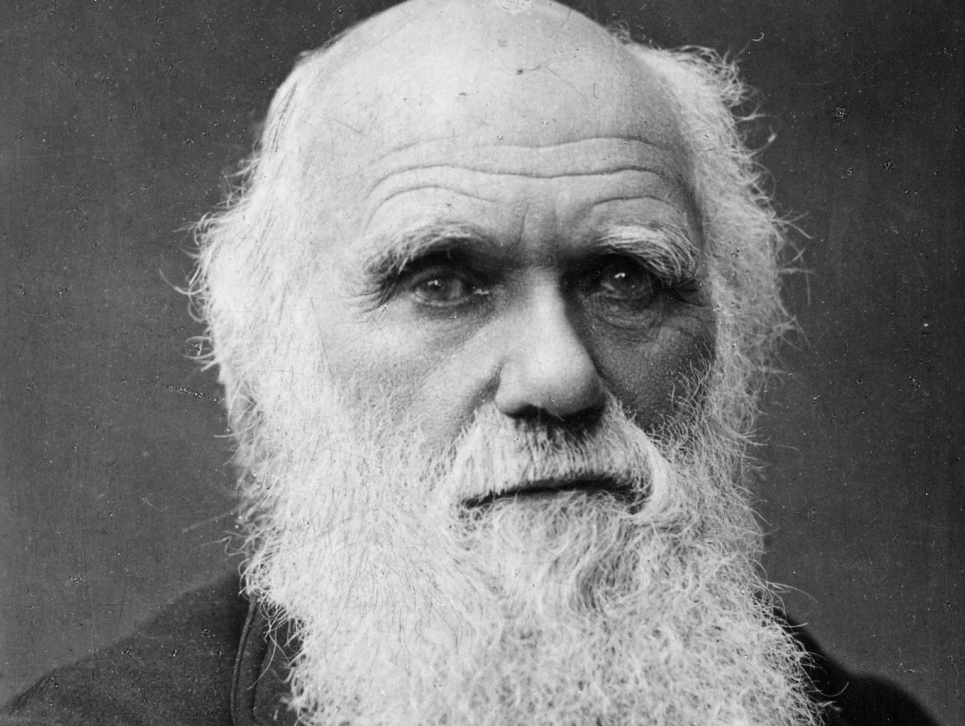
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Did Darwin miss something vital to evolution?

That, too, depends.

Does evolutionary theory *need* general, descriptive laws like those in physics?

According to most biologists and philosophers, nope.

Does evolutionary theory *need* statistics to capture the range of variation in natural populations?

That's a harder question. Maybe!

Natural selection as algorithm, with variation as a brute fact: probably doesn't need statistics

Contemporary evolution, focused not just on adaptation, but on generation of variation, genetics, G$\rightarrow$P map, etc.: hard to imagine

NewScientist

Darwin was wrong

ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

or the

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE
FOR LIFE.

QUESTIONS?

charles@charlespence.net
http://charlespence.net
@pencechp