Chance, Statistics, and Experiment

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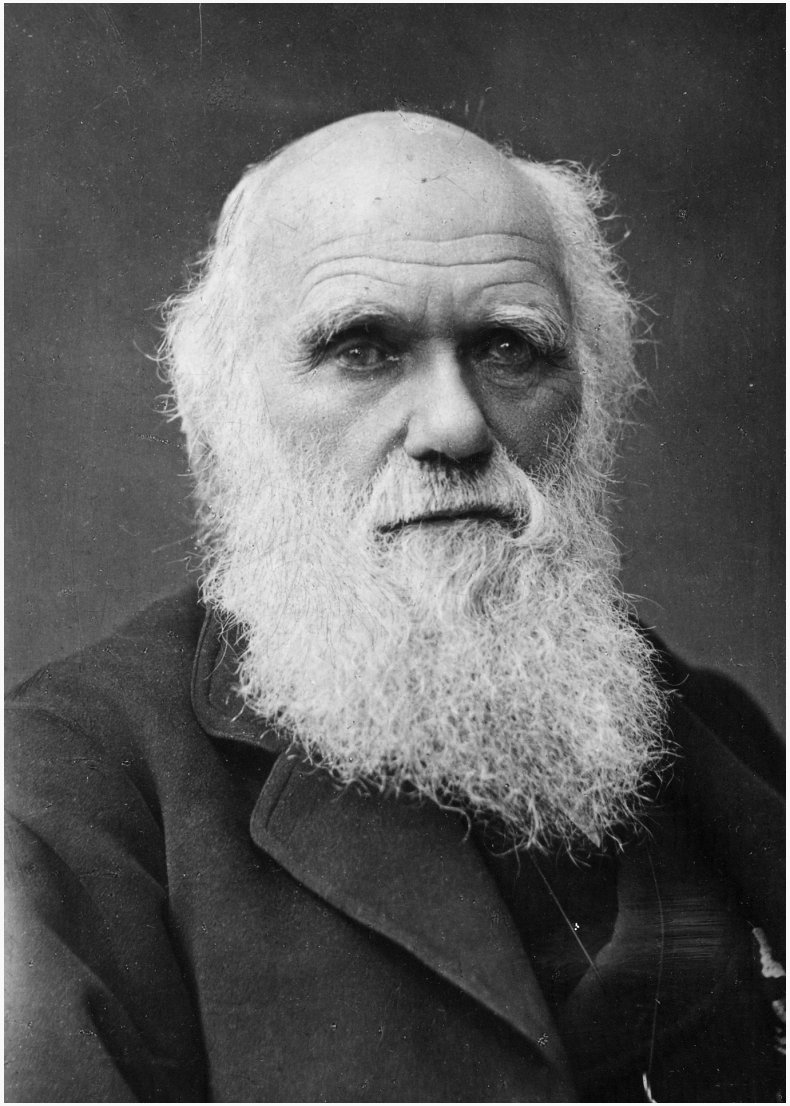
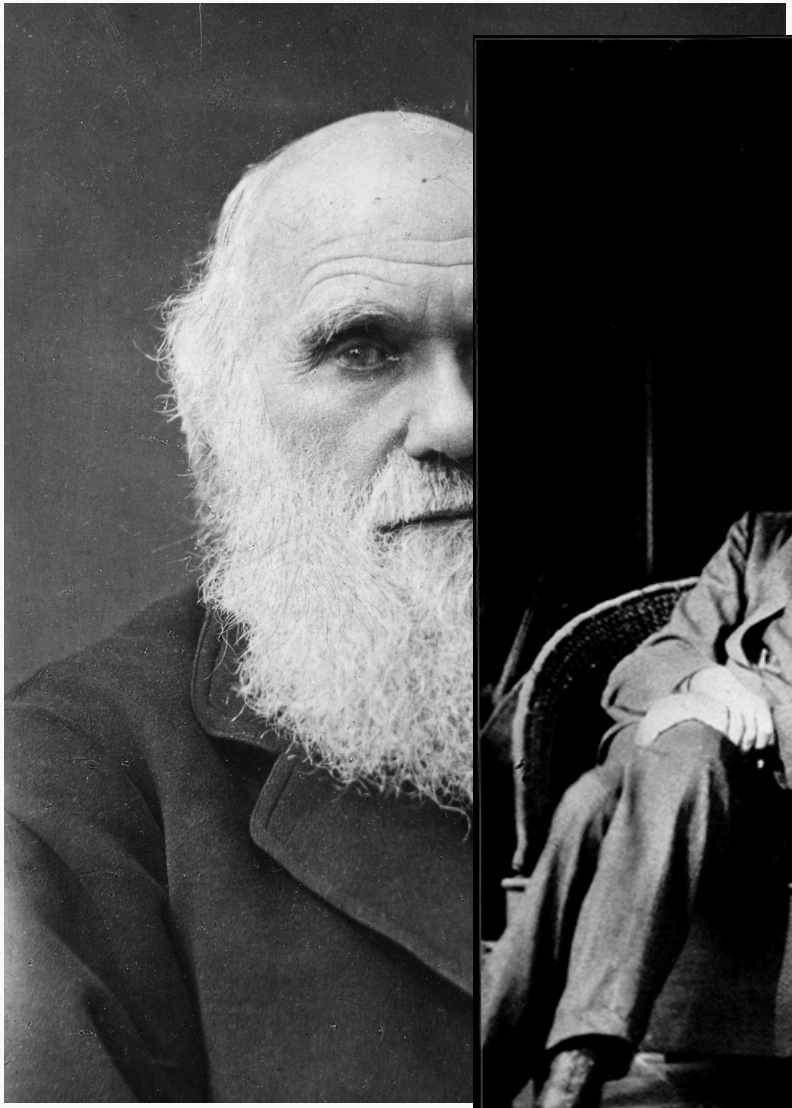
Outline

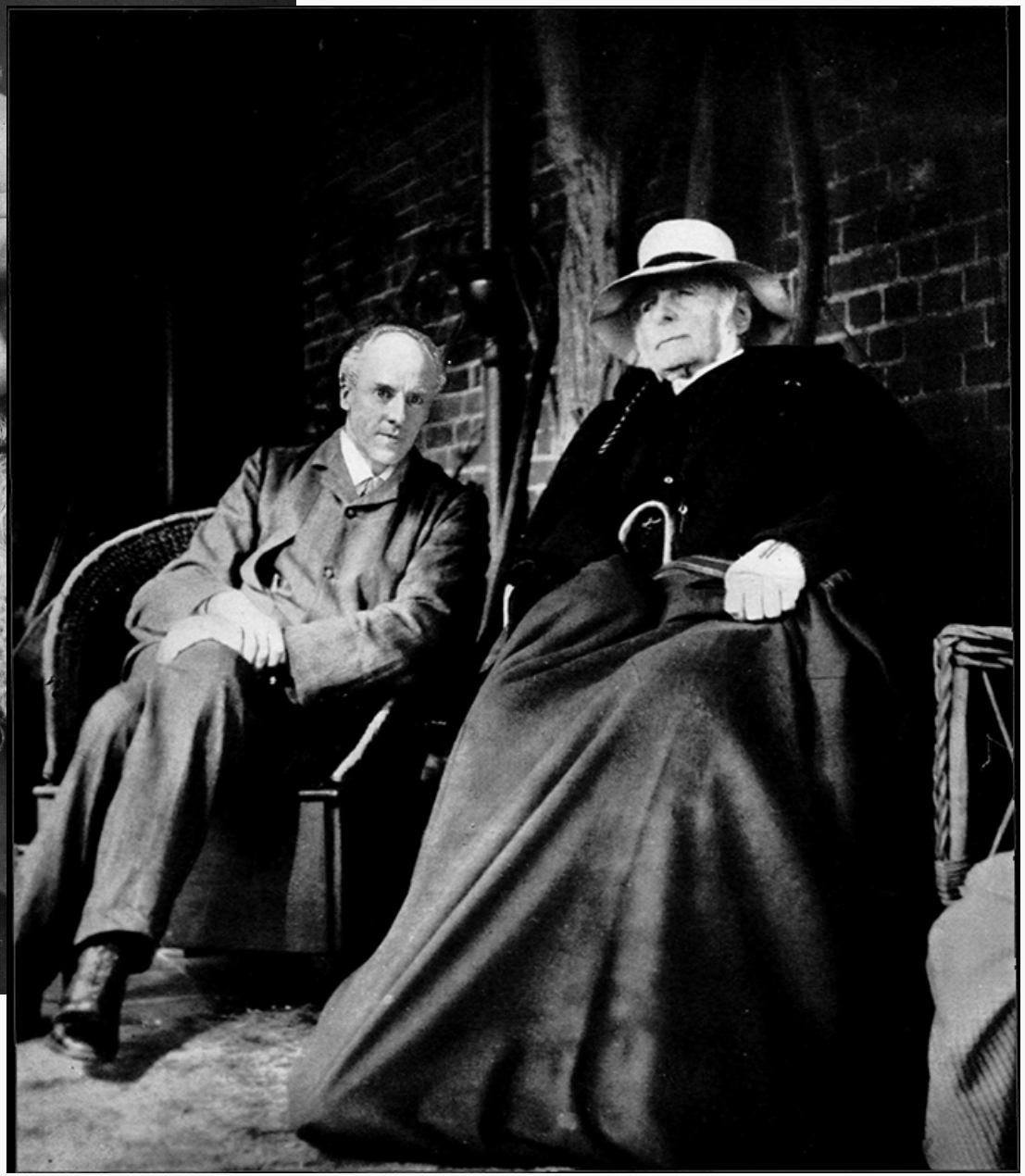
1. Evolutionary biology in the early 1900s
2. W.F.R. Weldon's philosophy of science
   - 2.1 Statistical methods
   - 2.2 Experimental methods
   - 2.3 How to do both?
3. A few lessons for contemporary philosophy of science?

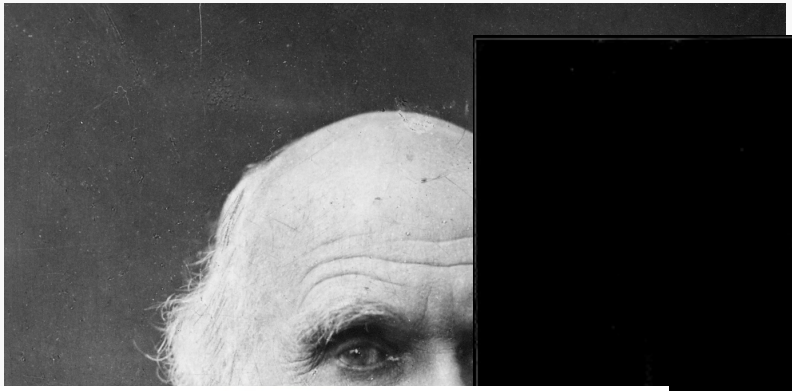
The take-home: The biologists who were introducing statistical methods into evolutionary theory were also building sophisticated philosophies of science to match!

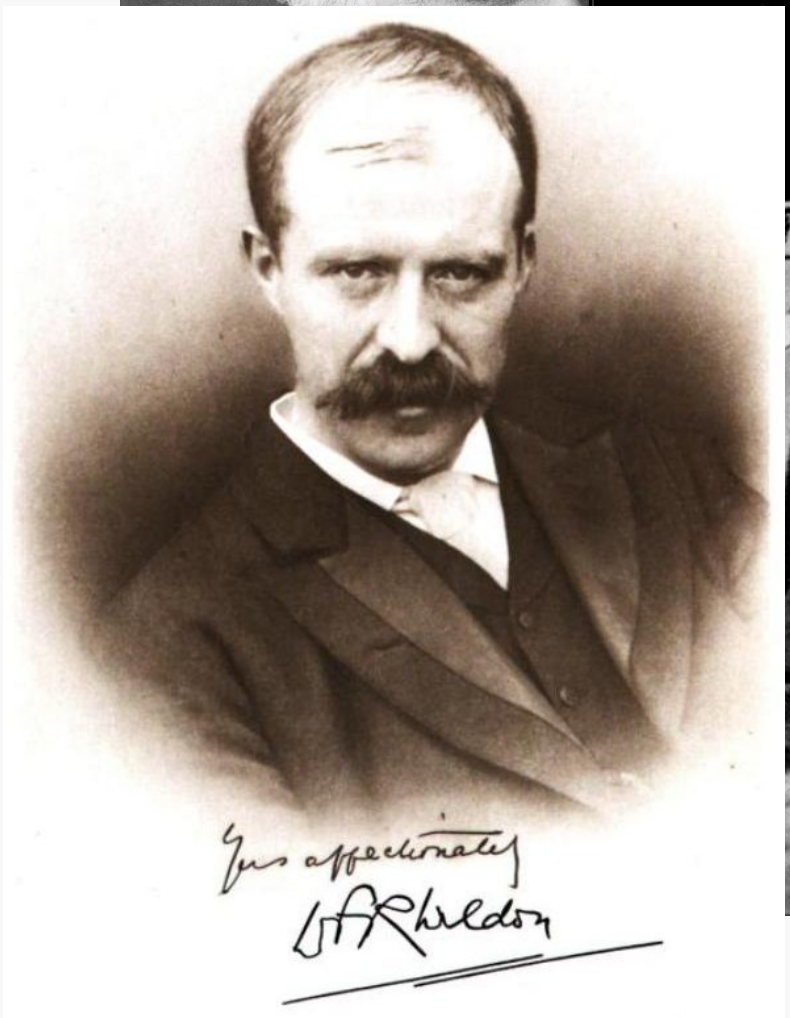
Evolutionary Biology in 1900

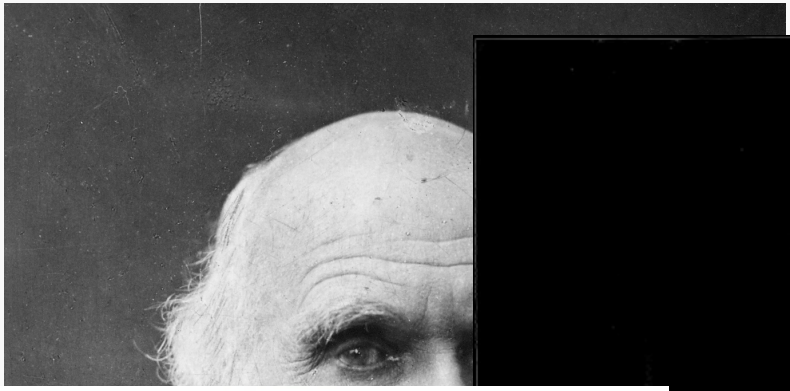


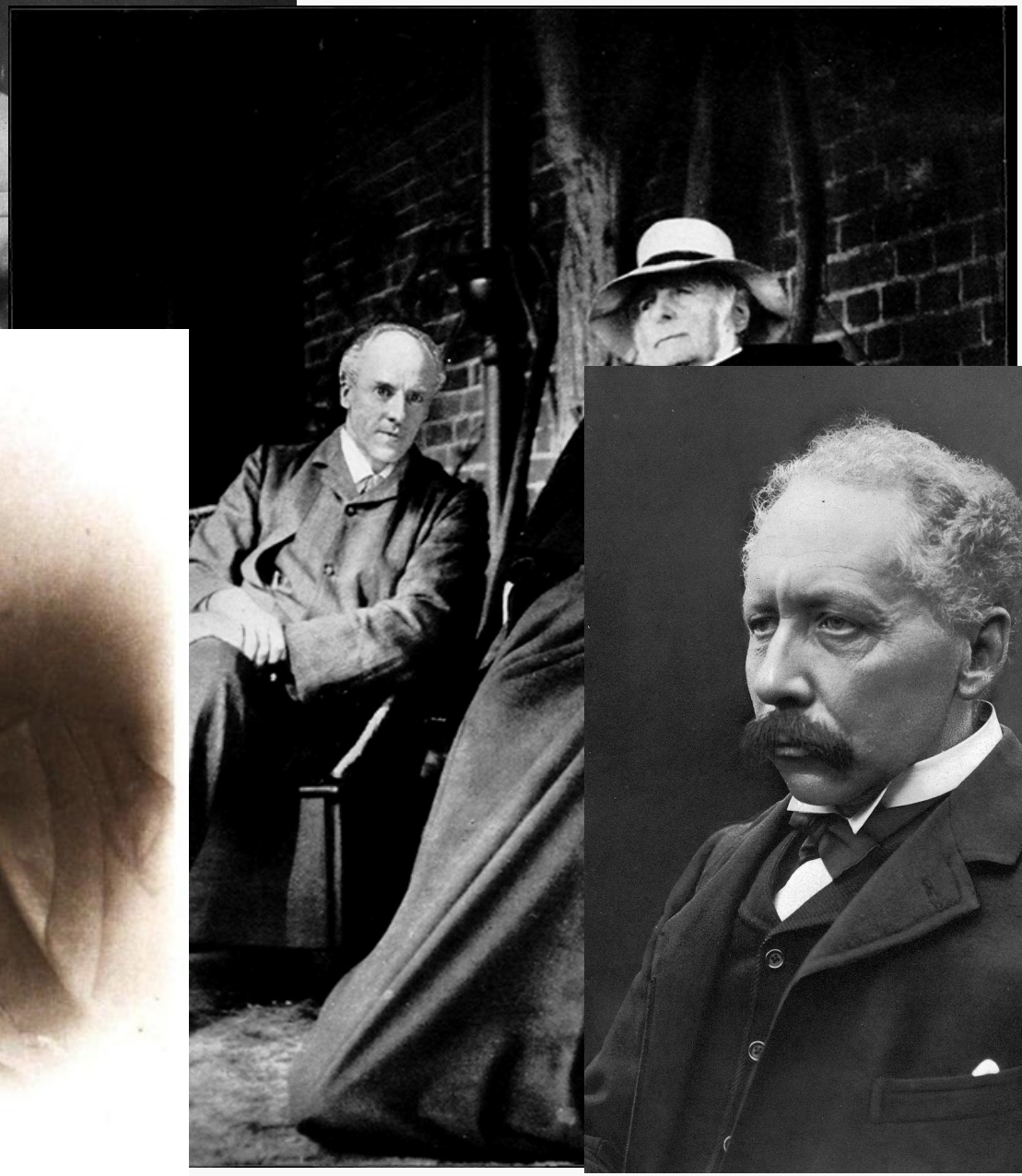


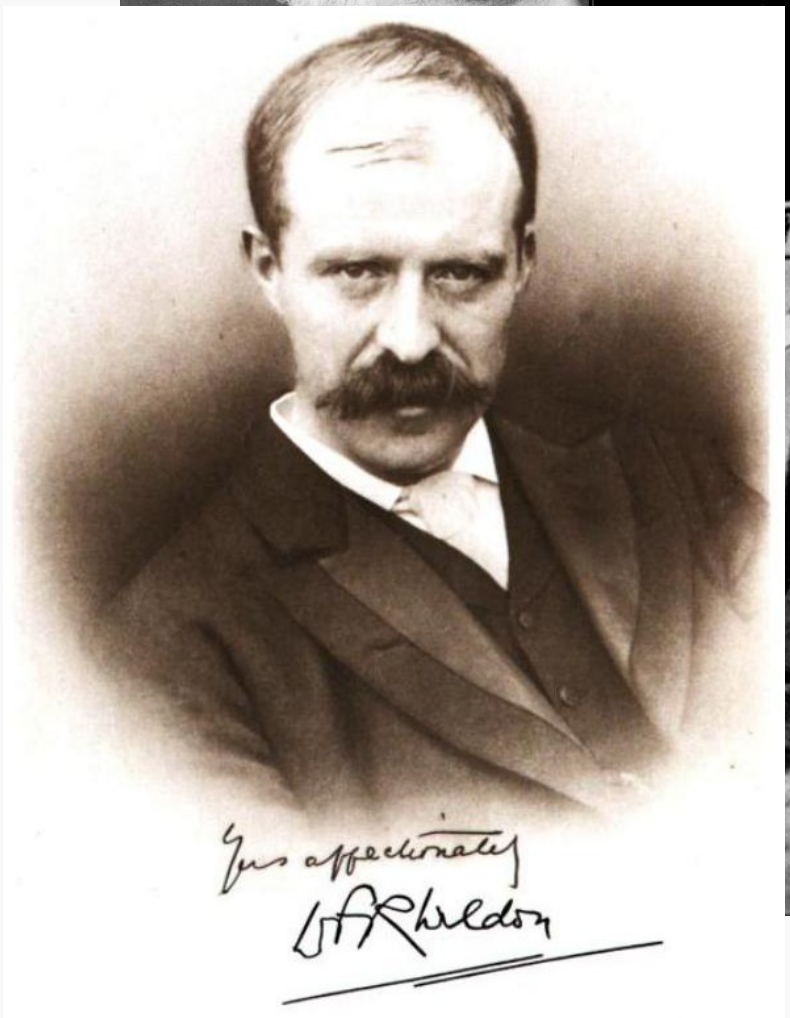


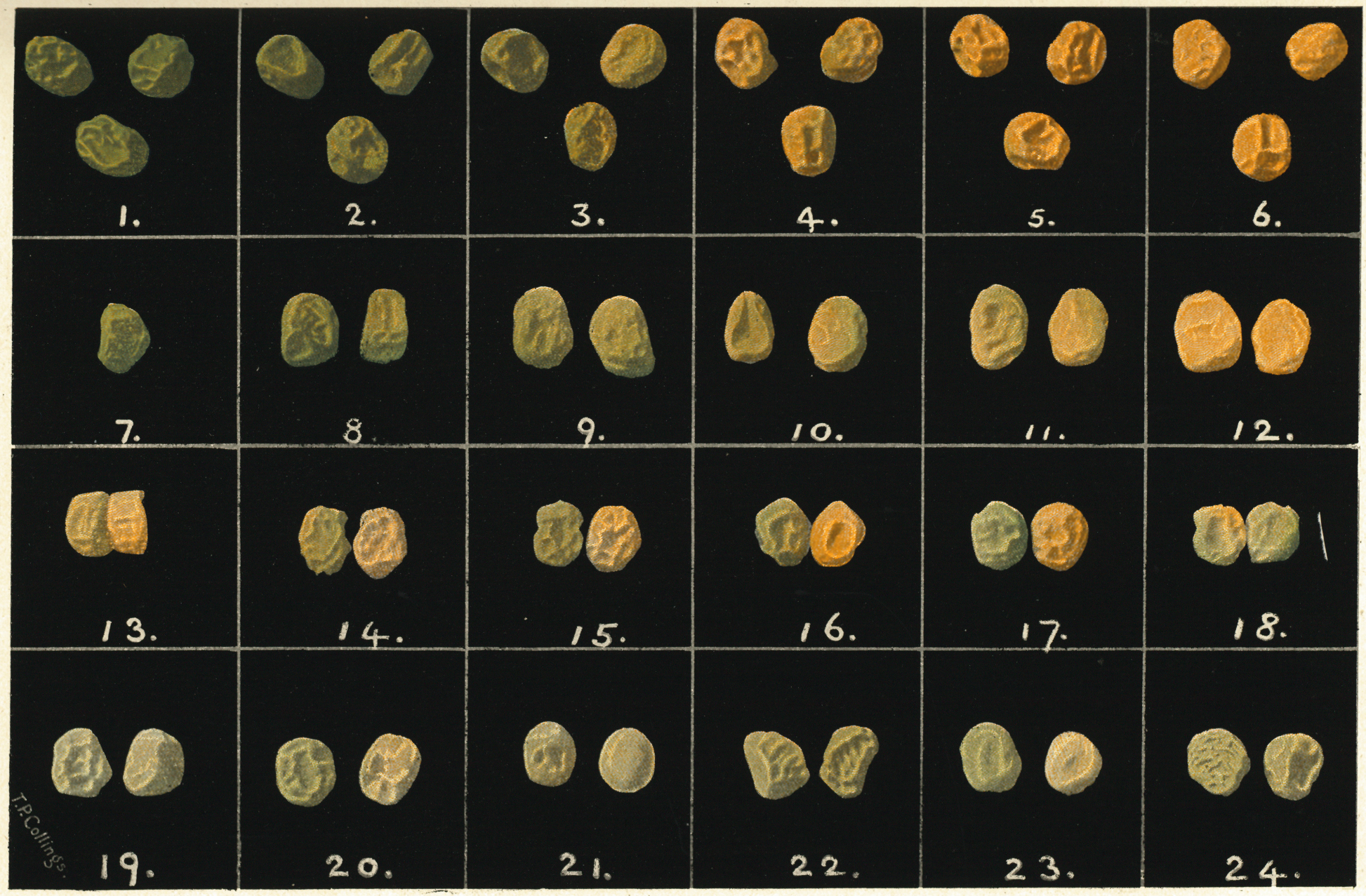



Yours affectionately
J. A. Sheldon






Yours affectionately
L. A. Sheldon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What's at stake?

- Is Mendelian ("alternative") inheritance a general theory of heredity?
- Does our theory of heredity permit the inheritance of acquired characters? Should it?
- How should we understand reversions to long-dormant ancestral types?
- How should we understand plasticity and regeneration?
- What is the material basis of hereditary determinants? How do they work?

What is the appropriate way to study problems of inheritance?

Weldon on Statistics

It cannot be too strongly urged that the problem of animal evolution is essentially a statistical problem: that before we can properly estimate the changes at present going on in a race or species we must know accurately [a number of statistical distributions]. These are all questions of arithmetic; and when we know the numerical answers to these questions 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. 329)

[B]iologists have not yet advanced so far as [physicists and chemists]: the margin of uncertainty in their experience is still so large that they are obliged to take account of it in every statement they make.

[…]

We must give up the attempt to replace all our experiences by a single average value, and try to describe the whole series of results our observation has yielded. (Weldon 1906, pp. 93–4)

The student of heredity has two main objects: the first is to discover what degree of stability is actually exhibited by the various races of animals or of plants, and to determine the extent to which deviation from the average character of parents or other ancestors is associated with deviation in their descendants…

[i.e.,] to make a purely descriptive statement of the actual relation between the visible bodily characters of living things and those of their ancestors or their descendants… (Weldon [1905] MS PEARSON/5/2/10/4, ch. 1, p. 2)

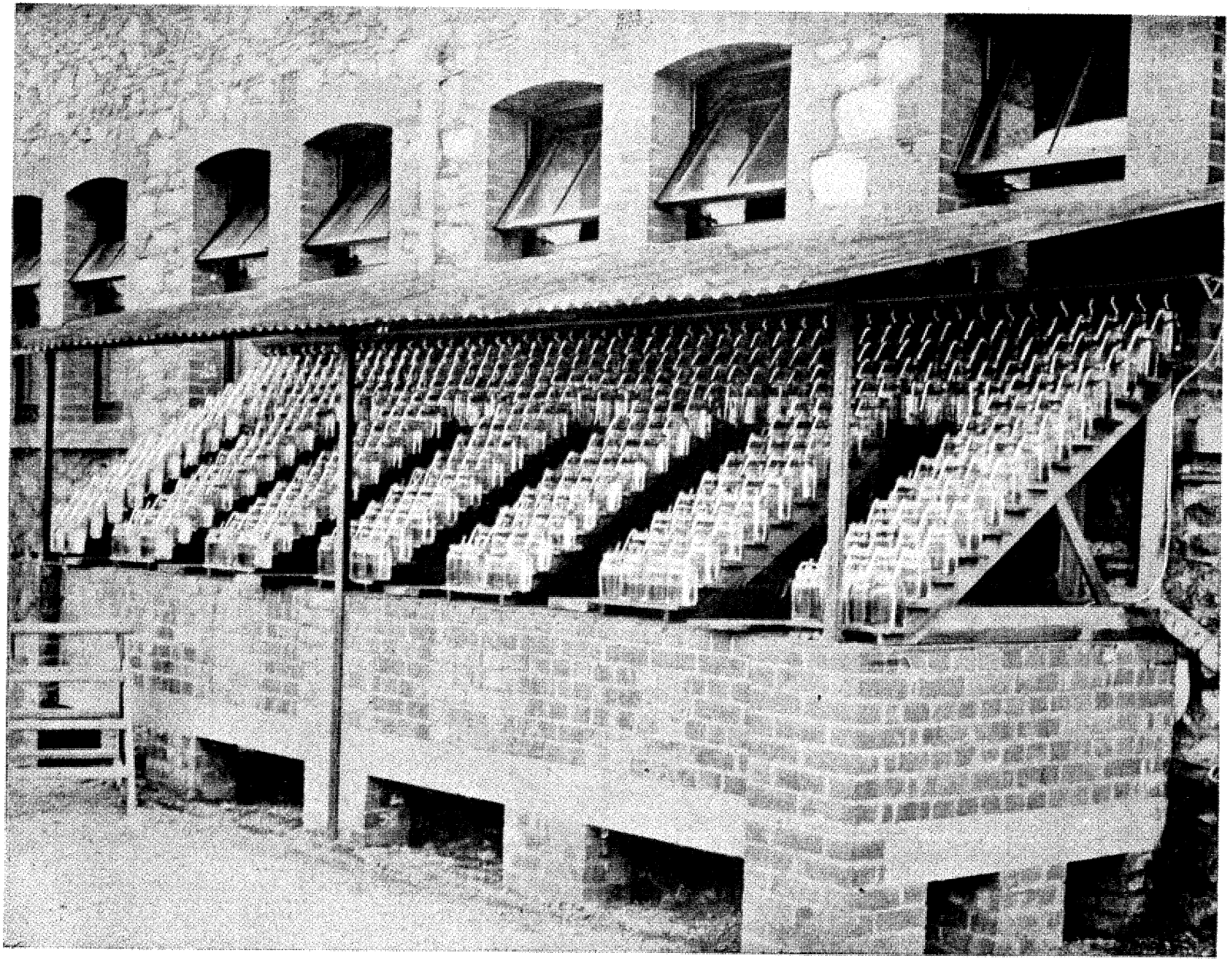
A descriptive statement of the relation between the visible somatic characters of parents and those of children involves no biological hypothesis whatever, and requires no peculiarly biological methods for its compilation.

[...]

It does not matter in the least whether the objects measured are men or telegraph cables; while we are comparing their lengths we are concerned with the number of units of length in each of them, and with nothing else. (Weldon [1905] MS PEARSON/5/2/10/4, ch. 1, p. 3)

Weldon on Experiment

[T]he second object is to acquire such knowledge of the changes which occur during the growth and maturation of the germ-cells, their fusion and subsequent development, as may serve to indicate the process by which the observed relation between parental and filial characters is brought about. (Weldon [1905] MS PEARSON/5/2/10/4, ch. 1, p. 2)



A "Crabbery" at Plymouth.

The method which was for some time popular with so many professional biologists – the attempt to infer the facts of inheritance from a study of the germ-cells – has led to no useful result, and seems unlikely to do so in the future. (Weldon [1905] MS PEARSON/5/2/10/4, ch. 1, p. 2)

Putting Them Together

These two objects are pursued by different methods, and as it happens they are generally pursued by different men, so that few attempts have been made to consider the bearing of what we actually know concerning the relation between the visible characters of parents and those of their offspring upon the possible interpretation of structural changes revealed by minute study of the germ-cells and of embryonic processes in general. (Weldon [1905] MS PEARSON/5/2/10/4, ch. 1, p. 2)

It is the purpose of this essay first of all to describe the two principal theories of inheritance which have been based upon direct comparison between the characters of living things and those of their ancestors or their descendants, and afterwards to see how far the facts of development and regeneration as well as the facts of inheritance support one theory or the other… (Weldon [1905] MS PEARSON/5/2/10/4, ch. 1, p. 3)

Some Morals

While it is very important to him early on, by 1905, the use of statistics itself is not philosophically notable!

Weldon's view of the challenge in 1893

Evolution is essentially and necessarily a statistical problem.

We have not been able to move forward in biology thanks to a lack of statistical distribution data for natural populations.

Weldon's view of the challenge in 1905

Construct a theory that takes account of *all* of our data:

- Statistical relationships between parents and offspring
- Developmental biology
- Regeneration of parts from tissues of different types
- Reversion to distant ancestral characters
- Mendelian data on alternative inheritance

Changing focus

A move from a reductive, statistical picture to a holistic focus on the relationship between statistical theories and the biological world

Why?

- A degenerating research programme
- Inconsistency
- A sophisticated response to the repeatability of Mendelian results

Why?

Driven by the apparent extent of “alternative inheritance” to reconsider the ways in which we might connect statistical data to biological processes

Questions?

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