Reversion and Deep Ancestry in Early Genetics

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Outline

1. Background: From Darwin to the young Galton
2. Galton frames the debate
3. From the biometrical school to Mendel
4. Why reversion?

The take-home: The reason that reversion and ancestry were so important in early statistical biology is deeply unclear, and seems drastically different from the biology of the Synthesis and onward.

Some Background

If it could be shown that our domestic varieties manifested a strong tendency to reversion,—that is, to lose their acquired characters, whilst kept under unchanged conditions, and whilst kept in a considerable body, so that free intercrossing might check, by blending together, any slight deviations of structure, in such case, I grant that we could deduce nothing from domestic varieties in regard to species. But there is not a shadow of evidence in favor of this view… (Darwin 1859, 15)

Moreover, when two birds belonging to two distinct breeds are crossed … the mongrel offspring are very apt suddenly to acquire these characters; for instance, I crossed some uniformly white fantails with some uniformly black barbs, and they produced mottled brown and black birds; these I again crossed together and one grandchild of the pure white fantail and pure black barb was of as beautiful a blue colour, with the white rump, double black wing-bar, and barred and white-edged tail feathers, as any wild rock-pigeon! (Darwin 25)

First major problem: If we are focused on heredity as **the phenomenon of offspring (nearly) resembling parents,** then how can theories of heredity make sense of **reversions to long-disappeared characters?**
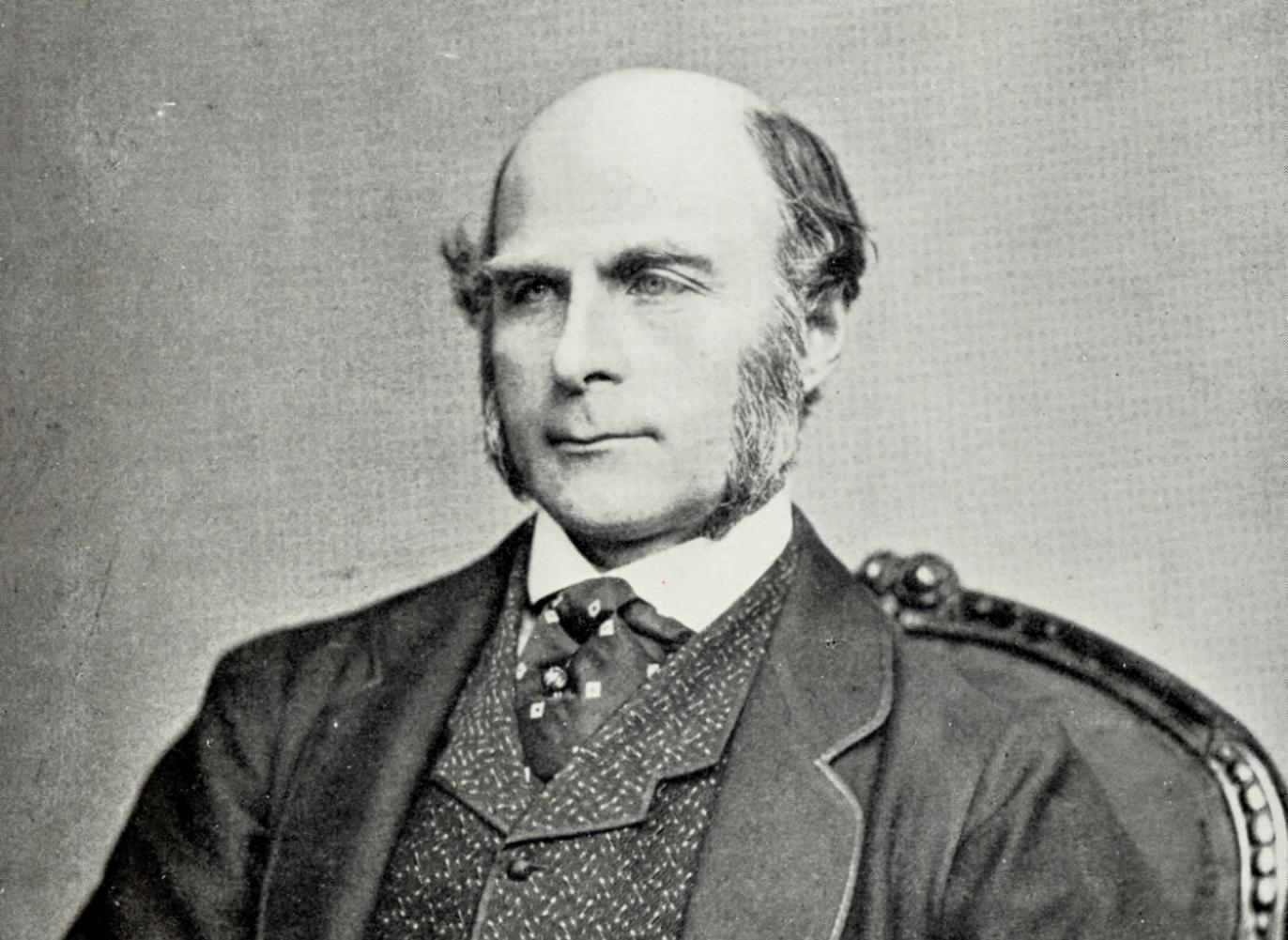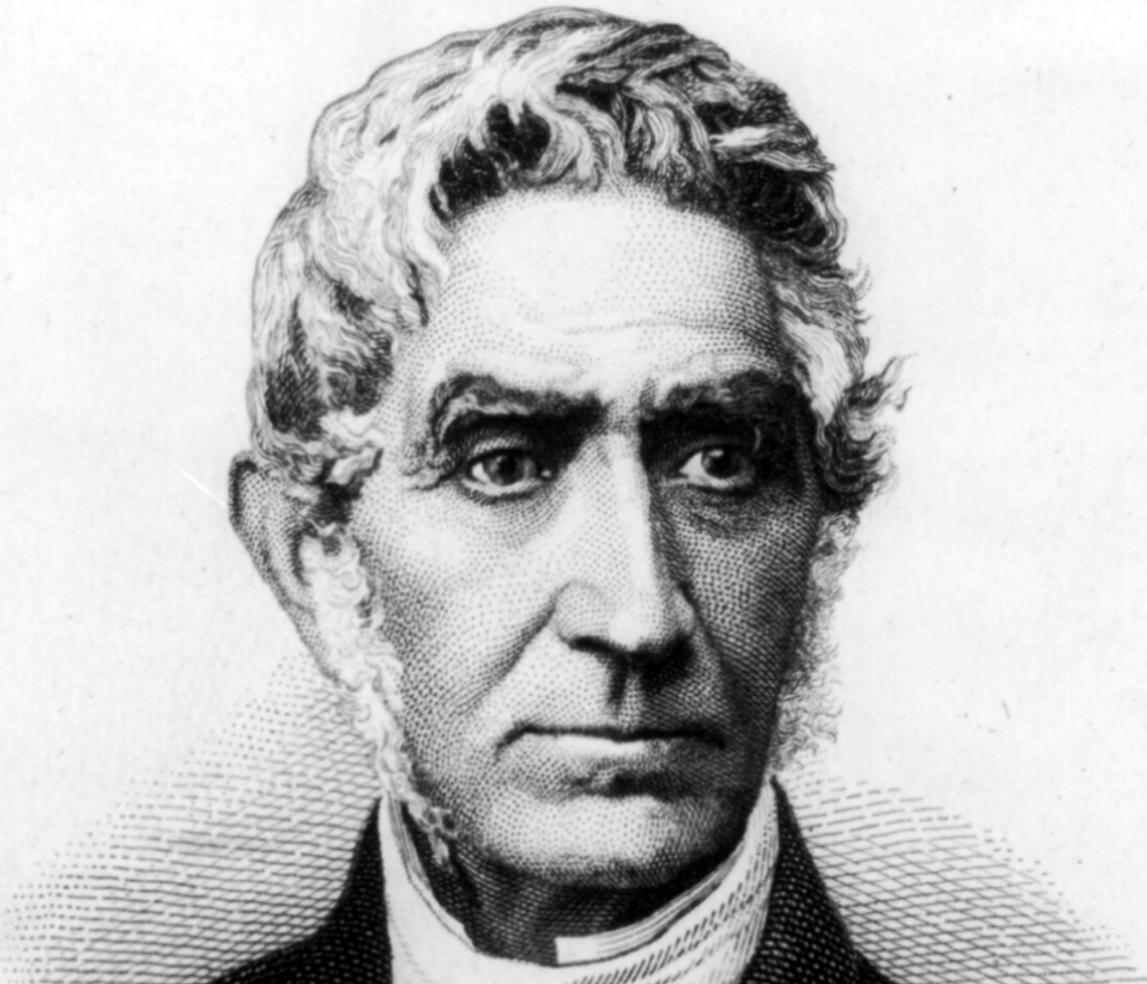
L'homme que je considère ici est, dans la société, l'analogue du centre de gravité dans les corps ; il est la moyenne autour de laquelle oscillent les élémens sociaux : ce sera, si l'on veut, un être fictif pour qui toutes les choses se passeront conformément aux résultats moyens obtenus pour la société. Si l'on cherche à établir, en quelque sorte, les bases d'une *physique sociale*, c'est lui qu'on doit considérer, sans s'arrêter aux cas particuliers ni aux anomalies, et sans rechercher si tel individu peut prendre un développement plus ou moins grand dans l'une de ses facultés.
(Quetelet 1835, 1:21)

Triste condition de l'espèce humaine ! Nous pouvons énumérer d'avance combien d'individus souilleront leur mains du sang de leurs semblables, combien seront faussaires, combien empoisonneurs, à peu près comme on peut énumérer d'avance les naissances et les décès qui doivent avoir lieu. (Quetelet 1835, 1:10)

Second major problem: If statistics is about **static distributions of population characters,** then how can statistical biology **help us understand change** (like reversions)?

Early Statistical Biology
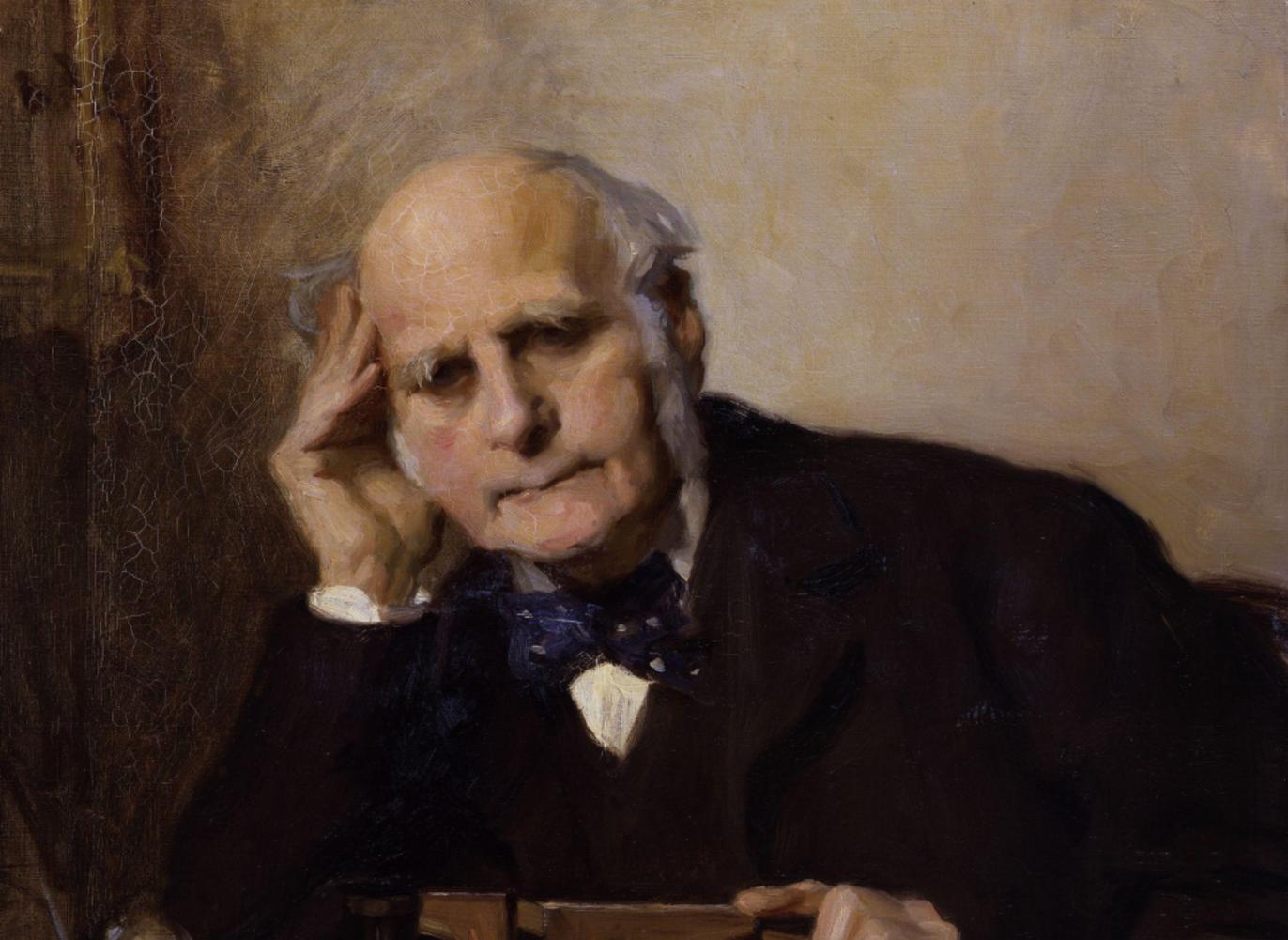
I know of scarcely anything so apt to impress the imagination as **the wonderful form of cosmic order** expressed by the "law of error." A savage, if he could understand it, would worship it as a god. It reigns with serenity in complete self-effacement amidst the wildest confusion. The huger the mob and the greater the anarchy the more perfect its sway. (Galton 1886, 494–5)
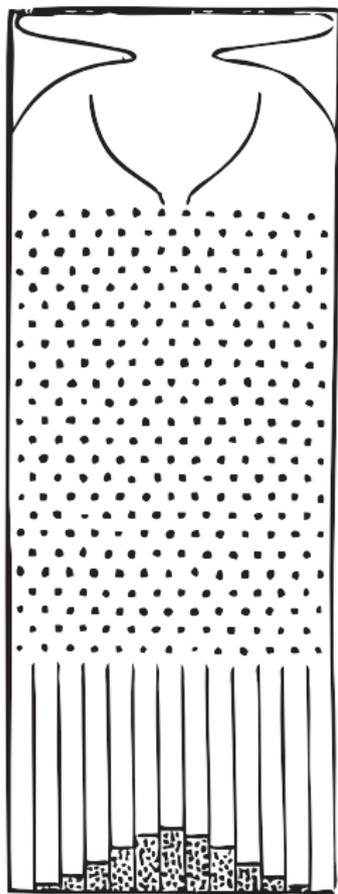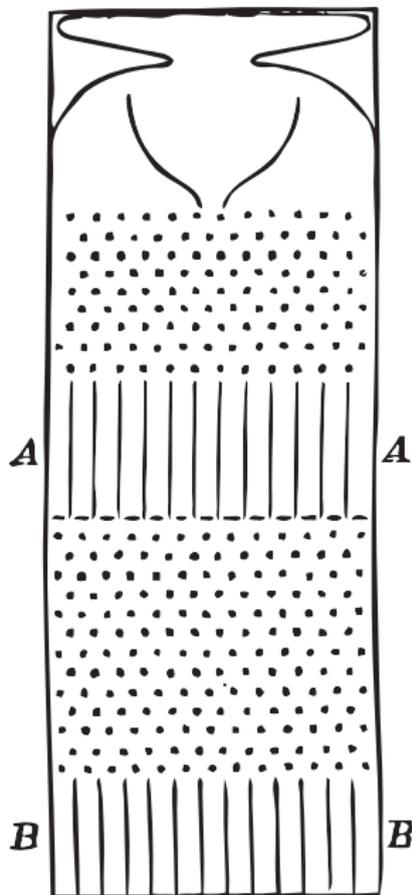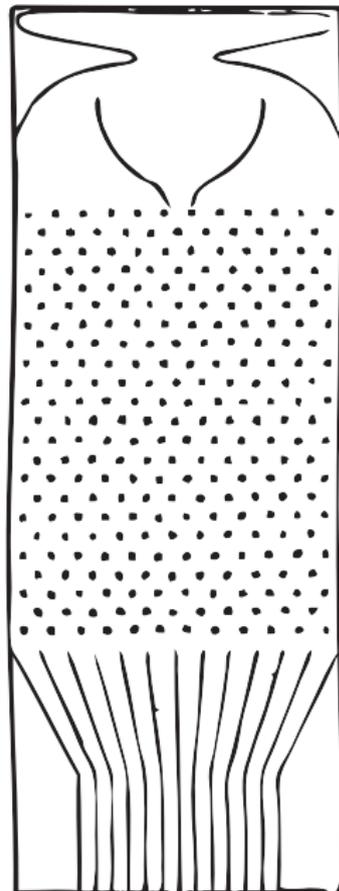
FIG. 7.   FIG. 8.   FIG. 9.

[I]n addition to [the constant effects of the mean and gravity] there were **a host of petty disturbing influences,** represented by the spikes among which the pellets tumbled in all sorts of ways. The theory of combination shows that the commonest case is that where a pellet falls equally often to the right of a spike as to the left of it.... It also shows that the cases are very rare of runs of luck carrying the pellet much oftener to one side than the other. (Galton 1877a, 495)
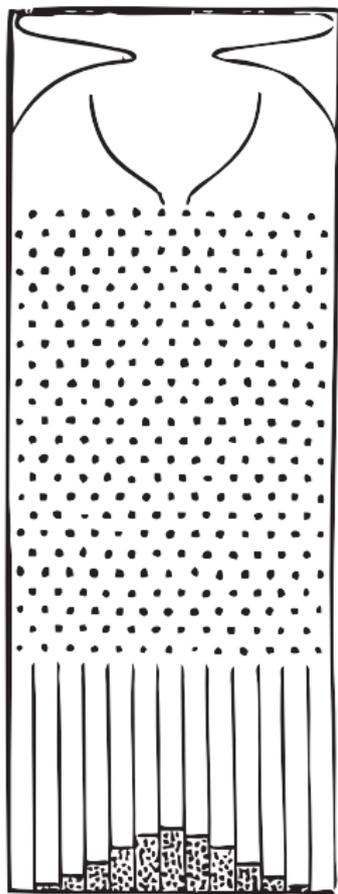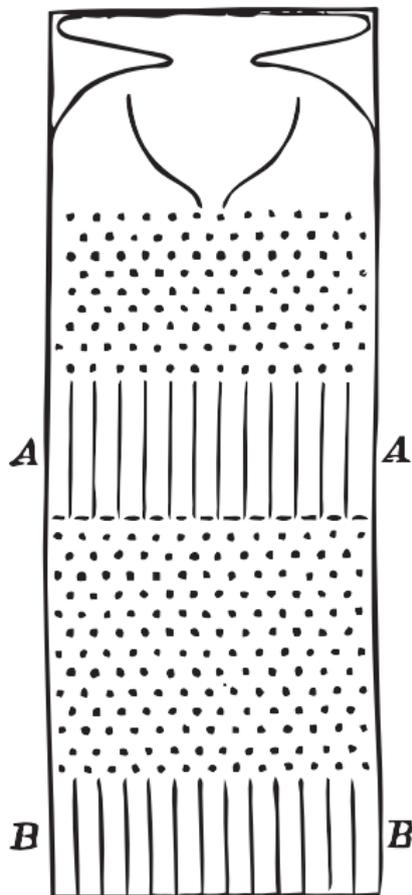
A A

B B
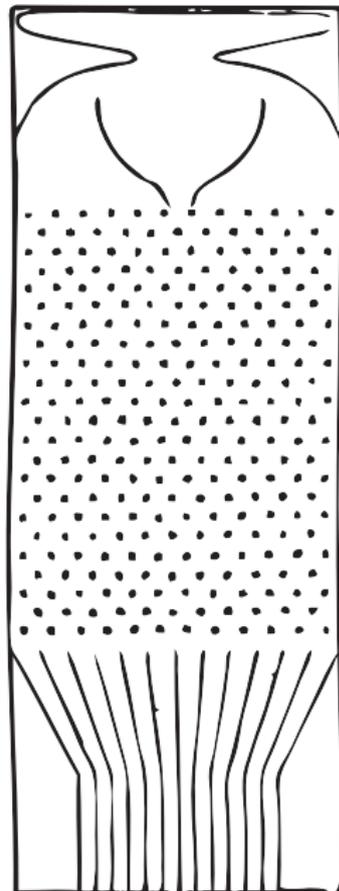
[A]lthough characteristics of plants and animals conform to the law, **the reason of their doing so is as yet totally unexplained.** The essence of the law is that differences should be wholly due to the collective actions of a host of independent *petty* influences in various combinations…. **Now the processes of heredity…are not petty influences, but very important ones.** (Galton 1877b, 512)

Galton's first descriptive move:
regression

REGRESSION
FROM
MID - PARENT
TO SON
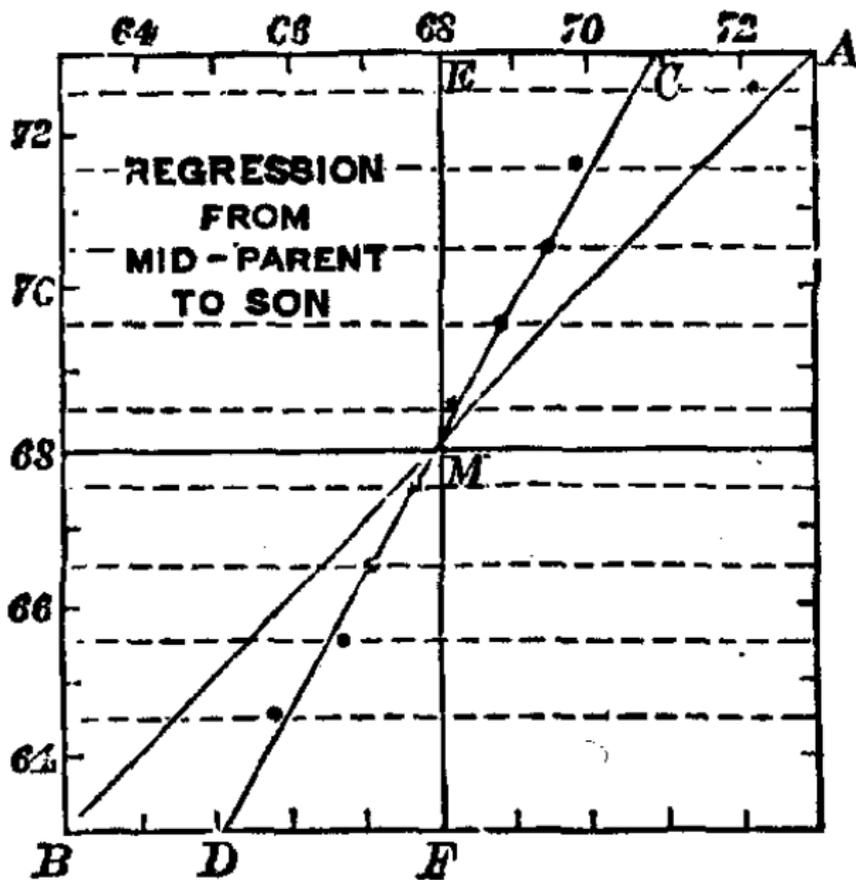
In other words, the proportion between the [average offspring] and the [average parental] deviation [from the norm] is constant, whatever the [averge parental] stature may be. I reckon this ratio to be as 2 to 3…. **I call this ratio of 2 to 3 the ratio of "Filial Regression."** It is the proportion in which the Son is, on the average, less exceptional than his [average parent]. (Galton 1889, 97)

The child inherits partly from his parents, partly from his ancestry. Speaking generally, the further his genealogy goes back, the more numerous and varied will his ancestry become, until they cease to differ from any equally numerous sample taken at haphazard from the race at large. Their mean stature will then be the same as that of the race; in other words, it will be mediocre. Or, to put the same fact into another form, the most probable value of the mid-ancestral deviates in any remote generation is zero. (Galton 1885, 1209)

Galton's second descriptive (theoretical?) move: **particulate inheritance**

It would seem that while the embryo is developing itself, the particles more or less qualified for each new post **wait as it were in competition,** to obtain it. Also that the particle that succeeds, must owe its success **partly to accident of position and partly to being better qualified** than any equally well placed competitor to gain a lodgement. (Galton 1889, 9)

The Biometrical School
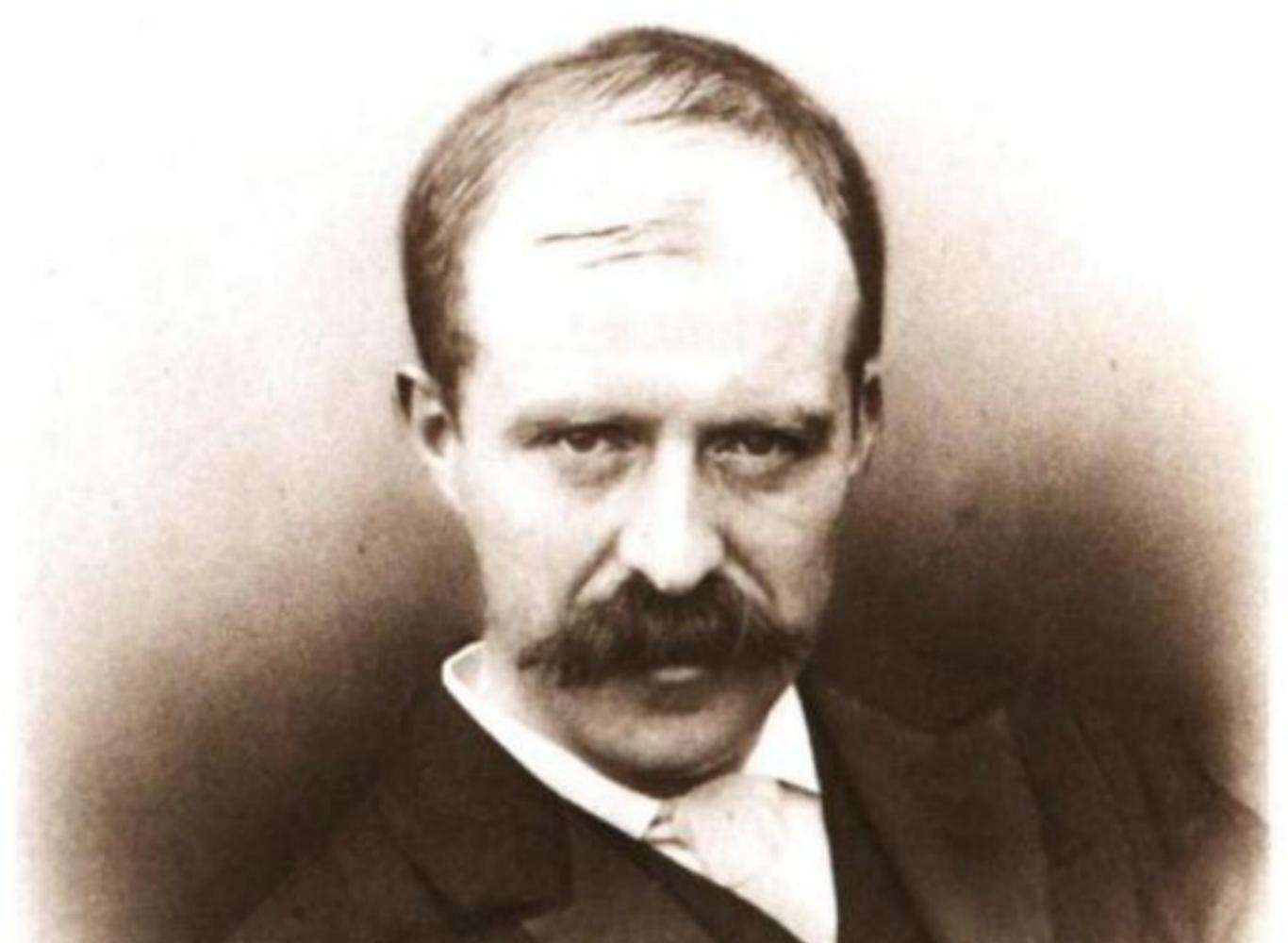
Refining the descriptive move: **the Law of Ancestral Heredity**

I reckon from these and other data, by methods that I cannot stop to explain, that the heritage derived on average from the mid-parental deviate, independently of what it may imply or of what may be known concerning the previous ancestry, is only $\frac{1}{2}$. Consequently, that similarly derived from a single parent is only $\frac{1}{4}$, and that from a single grandparent is only $\frac{1}{16}$. (Galton 1885, 1212)

Galton's Law of Ancestral Heredity … enables us to predict *à priori* the values of all the correlation coefficients of heredity, and forms, I venture to think, the fundamental principle of heredity from which all the numerical data of inheritance can in future be deduced, at any rate, to a first approximation.

[It brings] into one simple statement an immense range of facts, thus fulfilling the fundamental purpose of a great law of nature. (Pearson 1898, 386, 411)

It seems to me that the law of ancestral heredity is likely to prove one of the most brilliant of Mr. Galton's discoveries; it is highly probable that it is the simple descriptive statement which brings into a single focus all the complex lines of hereditary influence. If Darwinian evolution be natural selection combined with *heredity,* then the single statement which embraces the whole field of heredity must prove almost as epoch-making to the biologist as the law of gravitation to the astronomer. (Pearson 1898, 412)

Refining the theoretical move: **the statistics of particulate inheritance**

About pleasanter things, I have heard of and read a paper by one Mendel on the results of crossing peas, which I think you would like to read. It is in the Abhandlungen des Naturforschenden Vereines in *Brünn* for 1865 – I have the R.S. [Royal Society] copy here, but I will send it to you if you want it.

The point seems to me to be that the results indicate an exclusive inheritance with a very high parental correlation. (PEARSON/11/1/22/40.4.2, 1900-10-16)
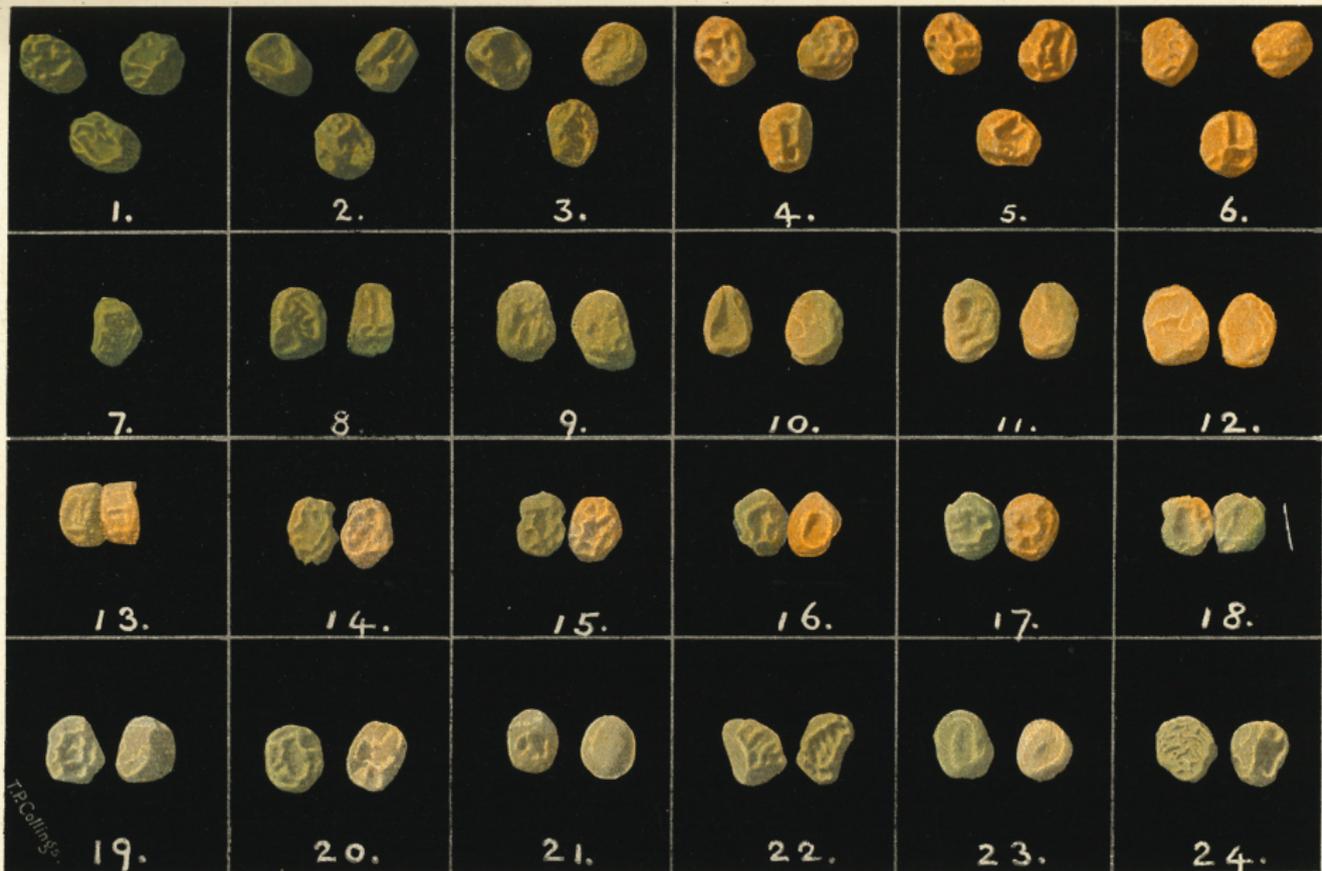
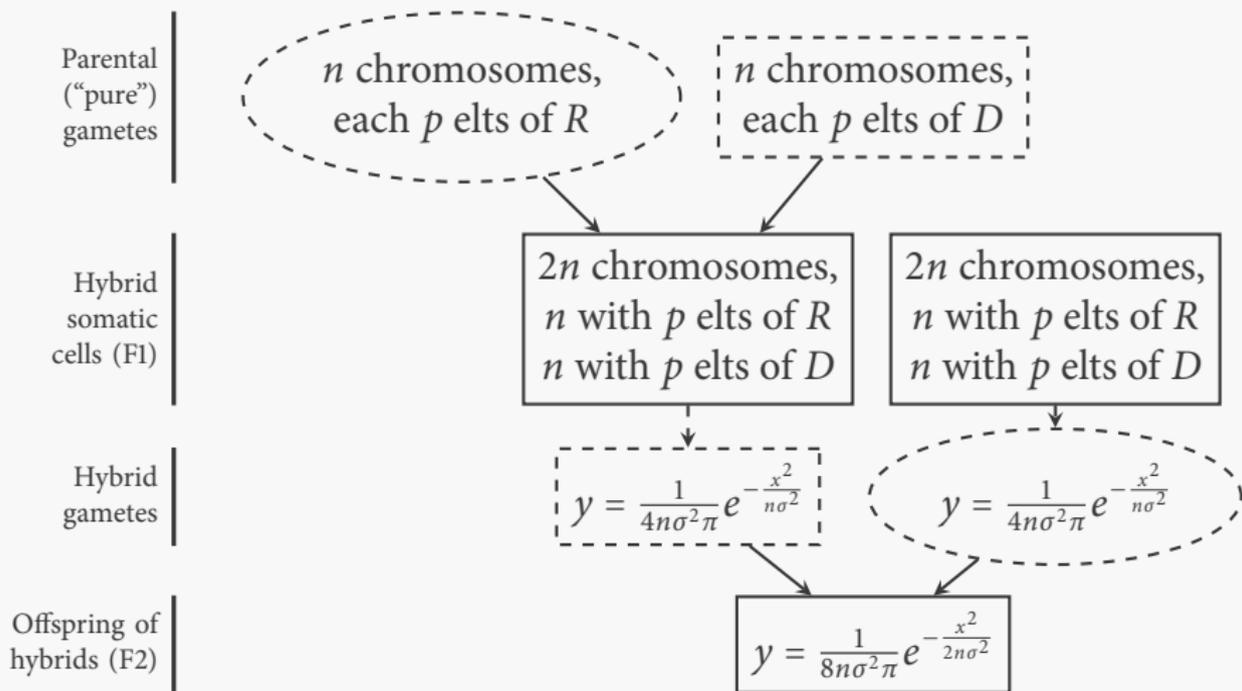[Weldon, from a public lecture:] The doctrine of pure gametes [Mendelian 'genes'] cannot be reconciled with the vast body of facts and data of heredity in human families and races collected and published by Francis Galton and Karl Pearson. (anon., 1905, 732)

It is easy to say Mendelism does not happen. But what the deuce does happen is harder every day! (Weldon to Pearson, PEARSON/11/1/22/40.9.2, 1903-03-18)

What Bateson does, and what all Mendelians do, is to take the diagram of frequency
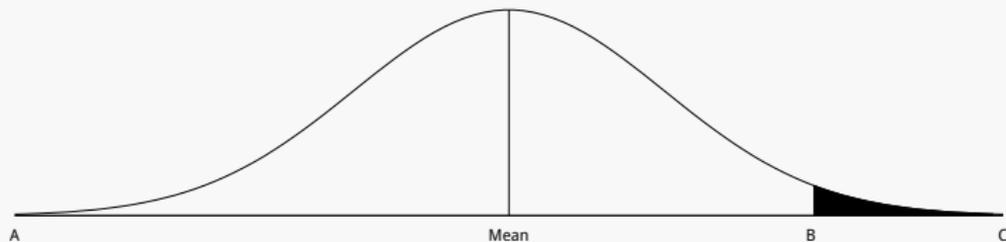
and to call a range AB one "character," and the range BC another "character" of a Mendelian pair. There must be a simple relation between AB, BC, and the [standard deviation] of the original system, which would make the chance that a grandchild falls within BC = ¼?
(PEARSON/11/1/22/40.7.3, 1902-06-23)

Parental ("pure") gametes	n chromosomes, each p elts of R	n chromosomes, each p elts of D
Hybrid somatic cells (F1)	$2n$ chromosomes, n with p elts of R n with p elts of D	$2n$ chromosomes, n with p elts of R n with p elts of D
Hybrid gametes	$y = \frac{1}{4n\sigma^2\pi}e^{-\frac{x^2}{n\sigma^2}}$	$y = \frac{1}{4n\sigma^2\pi}e^{-\frac{x^2}{n\sigma^2}}$
Offspring of hybrids (F2)	$y = \frac{1}{8n\sigma^2\pi}e^{-\frac{x^2}{2n\sigma^2}}$	

If this result stands, it will be just what one wanted to bring Mendelism into accord with the other things. It is just the reversion associated with definite forms of mating which Darwin spoke of. (PEARSON/11/1/22/40.12.14, 1906-02-15)

Why Reversion and Ancestry?

A difficult phenomenon to encompass in a traditional concept of heredity

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A way in which to attack the Mendelians?

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Eugenics?

Questions?

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