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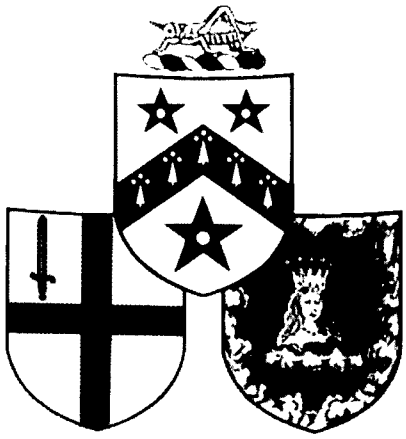

GENETICS, EVOLUTION AND EUGENICS

First of Two Lectures by

PROFESSOR HILARY ROSE & PROFESSOR STEVEN ROSE
Gresham Professors of Physic

1 November 1999

Gresham Lectures in Physic

Lecture 2, Monday 1st November 1999

Professor Hilary Rose and Professor Steven Rose

Mendel, Galton and Darwin.

Three key figures - Mendel for genetics, Galton for eugenics, and Darwin for evolutionary theory occupy the foreground of these next two lectures.
Charles Darwin 1809 - 1882
Gregor Mendel 1822 –1884
Francis Galton 1822- 1911

(slides of each)

The work for which each is best known is

Darwin: Origin of Species 1859
Galton: Hereditary Genius 1869
Mendel: Studies on hybrid plants 1865

In the background stands the figure of the late eighteenth century social theorist the reverend Thomas Malthus, whose pessimistic views about the inexorable rise and equally inexorable and painful fall of populations, so profoundly influenced Darwin. Malthus' essay, first published in 1798, was the precusor to those many books published during the second half of the twentieth century announcing the imminent global population overload. Just as on many previous occasions today's scaremongers have had to make their most recent retreat as the latest projections show that the world's population is failing to achieve their doom-laden predictions). As Malthus's title shows, his essay was a moral and social diagnosis and prognosis.

An essay on the principle of population; or , a view of its past and present effects on human happiness with an inquiry into our prospects respecting the future removal or mitigation of the evils which it occasions. (1798)

The human population, he pointed out, has the capacity to increase in geometric proportion. Thus if every couple rears four children to adulthood, in the second generation the four become sixteen, in the third, the sixteen become sixty-four, and so on. On the other hand historical records showed that efforts of human agricultural labour to increase the production of food could only do so in arithmetic proportion (two become four become six become eight...). So the availability of food would necessarily fall behind the numbers of mouths needing to be fed, and there would be a brutish and increasingly desperate struggle for existence. Attempts to mitigate this by welfare measures would only make matters worse. Darwin's diaries make clear that he first read Malthus in 1838, and that Malthus's account of the pressures created by the inexorable rise in population provided the framework through which his evolutionary theory could be constructed.

The concepts and ideas derived from the theories Darwin, Galton and Mendel developed in the mid 19th Century have intermingled in the history of genetics, eugenics and evolution right up till the present day. Mendel and genetics were neglected in the forty years from the appearance of his paper until the early 1900s, and it was evolutionary theory and eugenics, influenced by Malthus, that dominated the intellectual landscape of the last third of the 19th Century. Eugenics as political practice was not to appear until the present century, culminating in the horror of the Nazi death camps.

How we unpick the accounts of genetics, eugenics and evolutionary theory is essentially arbitrary. Nonetheless because genetics is our core concern we will begin with researches of the Abbé Gregor Mendel, carried out in his

monastery in Brno in Moravia on the Czech Slovak border. For many of us, this is the genetics we were taught at school, as although school biology is now full of molecular biology, molecular (or DNA genetics) was relatively slow to penetrate education. We all recognise the double helix and know it is an icon of our times, but for many of us we are still stuck in sweet pea genetics and don't connect to the current ideas of genomics.

But first back to sweet peas.

Mendel and the peas

Many plant breeders had recognised the famous mendelian ratios before his time - just as we will see that Darwin's evolutionary theory had many forebears. However, it took Mendel to recognise their significance. What he did which made his work different was to experiment, and to count. In the famous case, he studied several generations of sweet peas. One strain produced green peas, another yellow. These observed characteristics of the pea are called 'characters.' Mendel crossed them, and then crossed their offspring in their turn. In the first generation of crosses, all the offspring peas were yellow; the green form seemed to have disappeared. There were no intermediate forms, peas were either yellow or green – that is, the characters 'segregated.'

But in the second generation, he counted 6022 yellow and 2001 green peas. That is, three yellow to every one green. What had happened? How had the green disappeared and then appeared again? And why in those ratios?

Mendel argued that there must be latent in the peas what he called 'hidden determinants.' Each pea would have two copies of the determinants. True breeding ones would have two green (GG) or two yellow (YY). Cross them, and each would carry both yellow and green. But, he argued, the yellow

would be 'dominant' over the green, which was 'recessive,' and hence all the peas in the first generation would be yellow. These concepts of recessive and dominant are used throughout the entire subsequent history of genetics.

But to go back, the why question remained - why was the ratio 3:1 in the second generation? In a cross of two first generation hybrids, each containing one yellow (Y) and one green (G) determinant, the possible combinations in the offspring are:
1 GG, 1 YY and 2YG
Only the first of these will be green, and the remaining 3, the 1YY and the 2YG, will both be yellow. As the breeder has no way of knowing which of the yellow pea plants will be YG and which YY, and may breed from both, then the ratios in subsequent generations will become more complex.

transparency showing 3 to 1 ratios and how they arise

Its well known that Mendel's work was ignored for around forty years. Despite popular myth, this wasn't because he was an obscure monk who published obscurely, but basically because his famous 3:1 ratio turned out to be a very special case. Most characters didn't segregate in this way, even in other plants, and so his findings didn't seem to generalise. Which brings us back to Galton.

Galton and hereditary genius

Galton's interests were much more obviously popular; he was fascinated by matters of different handgrip strength, different height, different levels of intelligence - for him always referred to as 'genius'. At the great Crystal Palace Exhibition in 1851, he set up a mass participation experiment on comparative hand grip. Visitors were invited to squeeze a device which registered pressure; thus at the same moment they not only learnt about, but also took

part in the production of scientific knowledge. This brilliant popularising of science, which turned Galton's fellow citizens into temporary scientists, has rarely been bettered. Today some fifteen years after the Royal Society's launch of its initiative on the Public Understanding of Science, the Millennium Dome has no Galton-style experiments. There may be exhibitions of scientific and technological knowledge, but the 'interactivity' offered by the computer is still the interactivity of a knowledge consumer, not the interactivity of a temporary co-producer. Its a reasonable bet that the offerings of the Millennium Dome will lack the richness and the literally 'hands on' participation of the display of science and technology of a century and a half ago. In a few months we can test this prediction out for ourselves.

For Galton, testing handgrip was both about variance - that is the range of muscular strength- and also about heredity. In a chapter of his book Hereditary Genius, he writes:

> 'No-one doubts that muscle is hereditary in horses and dogs, but humankind are so blind to facts and so governed by preconceptions that I have heard it frequently asserted that muscle is not hereditary in men. Oarsmen and wrestlers have maintained that their heroes spring up capriciously, so I have thought it advisable to make inquiries into the matter. The results I have obtained will beat down another place of refuge for those who insist that each man is an independent creation, and not a mere function, physically, morally, and intellectually, of ancestral qualities and external influences.' (p296, 1950 reprint).

Here Galton sets down the determining powers of nature and environment. Ancestral influences and external influences may change their names but they haunt debate even today. For Galton, the ancestral influences always set the limit:

'There is a definite limit to the muscular powers of any man,
which he cannot by any education or exertion overpass.' (p 13)

Unlike peas which were either yellow or green, and not some intermediate mix, the characters Galton measured, like handgrip, or height, are distributed around the average for the population, and do not segregate. This distribution – known as Gaussian, for the mathematician who originally demonstrated it - forms what when plotted graphically takes on a bell like shape, the famous so-called 'normal curve.'

Bell curve transparency

So much for variance – but what about heredity? Galton found that the offspring of two parents of different heights tended to have a height (interheight) around the mean of the two parents - a phenomenon he called regression. Thus inheritance seemed to blend characters, and did not seem to be able simply to emerge as the result of Mendel's pairs of dominant and recessive hidden determinants.

Galton had measured and theorised variance in height and handgrip basing himself on the great Belgian statistician Quetelet and his work on the chest measurements of no fewer than 5738 Scottish soldiers (p26) and of 100,000 French conscripts. What both Galton and Quetelet delighted in was showing how their theoretical estimates of variance, based on a normal distribution corresponded very closely to the actual measured variation of height. Quetelet has a rather delicious note confirming his confidence in his theoretical estimates of variance. He notes that the claimed actual measures showed more very short young men than did his theoretical estimate. His suggestion is that as being short excluded men from conscription, the actual measures were likely to have been deliberately falsified. (Conscription, it

seems, was as unattractive in 19th century France as it is more generally today.) But the point so far as the development of biometry is concerned is that between them Quetelet and Galton established the notion of the 'average' or the 'mean', 'variation around the mean' and 'regression to the mean'. These are central to statistical thought to this day.

In 'Hereditary Genius' Galton sets out his belief that it is possible to conceptualise and measure genius just the same way that he and Quetelet had worked on measured biological difference. As a solid materialist Galton argues that

> 'If this be the case with stature then circumference of head, size of brain, weight of grey matter, number of brain fibres, etc.: and thence, by a step on which no physiologist will hesitate, as regards mental capacity. This is what I am driving at - that by analogy- there must be a fairly constant mental capacity in the inhabitants of the British isles, and that the deviations from this average - upwards towards genius and downwards towards stupidity - must follow the law that governs deviations from all true averages. (p28)

In order to develop his theory of hereditary genius, Galton assembled a list of 'eminent men' in a number of fields - military commanders, literary men, men of science, poets, musicians, painters and divines, and showed that in each group the figure he singled out had a number of - at least distinguished - close relatives or ancestors. Feminists have long criticised Galton's concept of hereditary genius in that it only includes men. This is not entirely accurate as a tiny handful of women such as the writers Bronte and de Stael, are included by Galton, but as 'literary men'. The precise alchemy of this tranposition is nowhere elaborated. However the generalisation holds overall. Anti-racists have similarly pointed out Galton's belief that genius was inexorably linked

to race. What he called Caucasians - that is, men of white European stock - were over-represented among the geniuses by contrast with the 'lowest' races – 'Negro' and Chinese.

Yet because genius was measured by Galton as social performance, in a society in which only one gender was given the opportunity to perform, and in which class and race privilege played an important part in the same process, the possibility of high performance was effectively restricted to pale elite males. To be fair a few non elite men did slip through into scientific eminence, from Huxley whose father was a school master to Faraday whose father was a blacksmith. But tautologies - that is, self-fulfilling prophecies - do work , not least statistically !

In Galton's model, women become the mere empty vessels through which male genius is transmitted. His analogy with bodily measurement silently collapses. For where he recognised that height of the offspring was influenced by the height of both parents - hence his 'inter-height' - no such concept of 'inter-ability,' let alone 'inter-genius ' exists. Given these roots it is unsurprising that the measurement of inherited mental ability (psychometrics and IQ) has had, ever since, Galton a long and exceedingly chequered history to which we will return.

Eugenics

But it is Galton's notion of variation or deviation from the average mental ability which was to stimulate eugenic theory - indeed he coined the very term, eugenics or 'the well-born science.' The logic was straightforward. If genius was inherited, then encouraging those with such higher qualities to breed was a matter of national concern (positive eugenics). Similarly, to discourage the breeding of the stupid (negative eugenics) was the other side of this coin. Thinking about national populations and their reproduction in this

way was part of the materialism which made comparing humans with animals simultaneously innovatory and powerfully common-sensical. Every plant and animal breeder, every farmer and gardener, was concerned to develop good productive stock. High yielding plants and animals were to be encouraged and selectively bred and the unproductive eliminated.

Darwin and evolutionary theory

This comparison of human breeding with that of plants and animals leads us conveniently back to Galton's cousin Darwin. It is not just that like his eugenicist cousin Darwin thought that the naturist thesis of hereditary male genius was self evident and that races were ranged in nature in intellectual hierarchical form. Thus:-

"If two lists were made of the most eminent men and women in poetry, painting, sculpture, music- comprising composition and performance-history, science and philosophy, with half a dozen names under each subject the two lists would not bear comparison"

And:-
"I do not believe that it is possible to describe or paint the difference of a savage and civilised man. It is the difference between a wild and a tame animal."
The Malthusian influence on his thought was strong:

"When two races of men meet, they act precisely like two species of animals – they fight, eat each other, bring diseases to each other &. But then comes the more deadly struggle, namely which have the best fitted organisation, or instincts (ie intellect in man) to gain the day." Desmond and Moore: p267

Even Darwin's central concept of natural selection as the mechanism of evolutionary change is, when he considers humankind, profoundly influenced by the cultural values and politics of men of his time and class.

"The more civilized so-called Caucasian races have beaten the Turkish hollow in the struggle for existence." Desmond and Moore: p653

Natural selection proposes that populations - species - evolve , that is they change over time. The idea of evolution, although heretical, was by no means new. Although especially in Anglophone countries Darwin is seen as occupying a special place as the evolutionary theorist, the idea of evolution was very much part of the intellectual climate of the nineteenth century as both the Industrial Revolution and European nations' imperial aspirations gathered pace.

Darwin's own grandfather Erasmus had written extensively about evolution. Charles Lyell, the geologist, had spelt out that climates and geography had changed gradually over great periods of time. Both France and Russia had their own traditions of evolutionary theory. The French tradition ran from Buffon to Darwin's immediate predecessor, the great, though much maligned French zoologist Jean Lamarck. Such theories which ran counter to the prevailing Christian religious orthodoxy of the immutability of species. This orthodoxy had been crystallised into the view that throughout the living world there was a 'Great Chain of Being' which ranked all species. It was the great Swedish taxonomist Linnaeus who defined and classified plant and animal species in the mid-eighteenth century. Linnaeus' work was simultaneously compatible with the Christian view that God had created each species separately and also provided the concept of species that was essential for evolutionary theory.

Slides –Linnaeus, Lamarck.

Lamarck's hypothesis was that characters or behaviours acquired during an animal's lifetime would tend to be passed on to its offspring, as in the famous example of the giraffe's neck, lengthened because of the efforts giraffes made to feed from tall trees.

Darwin had brooded over the idea that species were not immutable ever since his famous voyage on the Admiralty expeditionary ship, The Beagle, sent to chart the coast of south America in the 1830s, but had hesitated to publish them. ('It is like confessing to murder' he noted in his diaries). He was only spurred into doing so by receiving a note in 1859 from the much less wealthy and well-connected collector Alfred Russel Wallace, essentially setting out the same ideas.

Slide of Wallace

This led to brief notes from both Wallace and Darwin on the new theory to be read before the Linnaean Society, at Burlington House, (then as now opposite Fortnum and Mason's) with Darwin then rushing 'a sketch' of his theory into print in the form of:

The Origin of Species by means of Natural Selection, or The Preservation of Favoured Races in the Struggle for Life

Transparency of Ilkley Wells

to give it its full title. The first edition - of some 1200 copies - sold out within a day of publication and many further editions followed until Darwin's death in 1882. Despite the huge popular uptake, the elite scientific societies, The Royal Society and the Linnaean, were not anxious to encourage discussion of

th new dangerous ideas, so despite the immense sales and interest the thesis of evolution by natural selection was not explored publicly in elite scientific meetings. Indeed the President of the Linnaean society, in his annual report for 1859, noted that nothing of particular interest had been discussed that year.

Despite this down-playing by the scientific elite, the threat to religion in mid Victorian England was entirely obvious. Indeed Thomas Huxley, as 'Darwin's bulldog,' was to confront Bishop Wilberforce on precisely this God versus science issue. What were the origins of human beings? Were 'we' to be understood as the descendents of apes or as God's creation made in 'his' image. The debate was furious with Christians and biologists crossing and recrossing sides, meanwhile Darwin himself stood aside from the fray. The Origin said nothing about human origins, although its implications were immediately apparent. It wasn't until much later that Darwin came off the fence, so to speak, and committed himself to the view that humans were indeed descended from ape-like ancestors. Here he parted company from Wallace, which by contrast with Darwin's liberalism, was a Christian Socialist. Wallace sadly dissented from his great peer by insisting that during human evolution, a soul appeared which fundamentally separated humanity from the rest of creation. Darwin's political acumen in standing on the sidelines paid off, for we have the astonishing phenomenon that one of the 19th century's greatest intellectual heretics was eulogised and buried in Westminster Abbey.

In today's more secular times most of the various branches of Christianity in Europe have made an accommodation with evolutionary theory and quietly set aside the story of genesis. In the US however the creationists still claim genesis as a true account of human origins. In some states creationism and evolutionary theory are given compulsory equal time in the curriculum. Most recently would-be president Al Gore showed that he is sufficiently hungry to pick up fundamentalist Christian votes that to most scientists' and

many intellectuals' horror he demonstrated a sudden friendliness towards creationism. Natural selection may have displaced God in the origin stories of the West's secular culture but it would be foolish to ignore the extent of fundamentalist Christianity's cultural and political grip. Despite the demonisation of Islam, particularly but not only by the US, fundamentalist Islam joins hands with fundamentalist Christianity and Judaism in denouncing the blasphemy of Darwinian theory. The origins debate is by no means closed.

Yet anyone opening The Origin today would be surprised to discover that its opening chapters, far from discussing *natural* selection, speak instead of the very deliberate breeding of fancy pigeons and dogs. Indeed much of Darwin's lifelong correspondence was with animal and plant breeders to learn what they could tell him about artificial selection. His emphasis on pigeons and dogs was such that one reviewer of the book suggested that it would have been much better to cut out all the rest and concentrate on the pigeon breeding, when it would have made an ideal Victorian version of a coffee table book for gentlemen. (The study of plants and animals was deeply gendered. Botanising was fine for ladies but gentlemen could be interested in both plant and animal breeding).

But Darwin's intent was different. He believed that he first had to show that artificial selection could produce such dramatically different varieties as pouter versus tumbling pigeons, or poodles versus bulldogs, before going on to explore what natural selection might achieve. He goes on to discuss variation in living forms which could occur as a result of geological and climatic differences, and, above all, as a result of selection. How could such selection occur? It is here that, drawing on Malthus, he made the leap which differentiated his theory of evolution from all its predecessors. The idea can be expressed as a syllogism, in four simple propositions and two corrolories.

1. Like begets like, though with minor variations.
2. Some of these varieties are more favourable (to the breeder, or to nature) than others.
3. All creatures have the capacity to produce more offspring than can survive to reproduce in turn (think of the millions of eggs produced in each spawning by the cod, unused human gametes, or of seeds scattered by a willow tree).
4. The more favoured varieties are more likely to survive long enough to breed.
5. Hence there will be more of the favoured variety in the next generation.
6. Thus species will tend to evolve over time.

The contrast with Lamarck was that this seemed at last to provide a mechanism for evolutionary change. It wasn't because giraffes strove during their lifetime to eat from treetops that their necks got lengthened; it was rather that offspring which inherited slightly longer necks would be more likely to succeed in 'the struggle for existence' by being able to reach higher up the trees, and so over successive generations the average length of giraffes' necks would lengthen. The logic seemed - and still seems - compelling. So much so that Huxley kicked himself, saying 'how stupid not to have thought of that!' (Though Huxley's biographer, Adrian Desmond, suggests that he never really understood the full implications of the Darwinian mechanism however assiduously he championed it - it was rather that Darwin offered a thoroughly materialist account of human origins which was much to Huxley's anti-religious liking).

Some modern philosophers - notably Daniel Dennett - have taken natural selection to be a universal mechanism - a 'universal acid' Dennett calls it - not merely in biology but in the evolution of everthing from the planets to the development of scientific ideas. However, as we will discuss in later lectures, just how far natural selection is *the* only or fundamental mechanism of

evolutionary change remains a matter of intense debate. And it is important to remember that Darwin himself stressed that he never conceived of it as the *only* mechanism by which infinitesimal changes, over thousands of generations, could eventually accumulate, so as to result in the transmutation of a species. Indeed he went on to develop major additions to his theory, including sexual selection and what are now called founder effects, in which a small number of members of a species colonise new territory and rapidly adapt to - become modified - to suit the new conditions. This is of course the famous case of the finches on the Galapagos islands which Darwin visited during his Beagle voyage.

Fig of Darwin finches - and some personal reflections on the Grants research and the islands

Problems with evolutionary theory

And indeed it was soon under attack, and not only from the religious. The scientific problem came precisely because Mendel was ignored, whilst Darwin's disciples were influenced by the Galtonian observations of continuous variation and regression to the mean. Even assuming that a favoured variety did, as Darwin argued, have a better chance of surviving to adulthood better to breed in its turn, what was to ensure that it mated with a matchingly favoured partner so as to ensure that the favoured form was transmitted to their offspring? If it did not; if, as Galton argued, inheritance 'blended,' then the favoured variation would soon be lost by regression. Huxley and Galton therefore argued that if favoured change was to be preserved, then Darwin's gradualism, in which miniscule changes would gradually accumulate over generations, had to be abandoned. Instead evolution must occur by sudden, large leaps, or 'saltations.' But despite their begging Darwin to adopt this solution to his problem, he refused. To this life-long liberal, natural evolution, like political and social change, had to be

gradual.

In discussions of change in social theory Darwin's insistence on gradualism won out and 'evolutionary' change was seen as gradual to be equated with Fabian socialism, by contrast with the sudden, dramatic or 'revolutionary' changes of Marxism. Today in the context of the Third Way and the modernisation project, such a distinction between evolutionary and revolutionary roads to socialism appears as a debate from another age.

Nonetheless within biology, lacking a mechanism whereby change could be preserved - a mechanism which was forty years later to be provided by the rediscovery of Mendel - Darwin realised his theory had fundamental difficulties, even, towards the end of his life and in the last edition of The Origin, arguing for something like Lamarckian mechanisms involving the inheritance of acquired characteristics. And this debate too finds its echoes in modern evolutionary debate, pitting gradualists like John Maynard Smith against the 'punctuated equilibrium' theory of Niles Eldredge and Steven Jay Gould - a debate which just as in Darwin's day is also framed in political terms - in which the punctuated equilibrium theorists are seen as basing their biological ideas on revolutionary - Marxist - principles. But of this, more later.

Social Darwinism

Despite the attempts by biologists to separate Darwin's evolutionary theory and natural selection from its social and political context, ignoring or dismissing his comments on gender and race as at best minor aberrations, this refusal to see the man in the round, as a product of his own class, gender and race is highly contentious. Many historians see Darwin as inexorably linked with what came to be called Social Darwinism. Within social theory and popular culture the views of Galton's contemporary Herbert Spencer – who introduced the term "struggle for existence" - were enormously influential. Spencer argued that economic competition played in human society the same

role as natural selection in non-humans. Economic competition weeds out the unfit, preserving the fit, implying that the free market is the best condition under which competition and hence economic process could occur. He takes for granted that humans are innately selfish and acquisitive. Because of the slippage between Darwin and Social Darwinism, Darwin appears over the next hundred years as sometimes recruited to progressive movements, such as social liberalism and Marxism, and sometimes to belong along with Malthus, as a theorist for conservatism and fatalism.

We began by saying that Galton, Mendel and Darwin' biological narratives have been profoundly intermingled over the succeeding century and a half. What we have tried to do in this lecture is set out the fundamental importance of the discourses of eugenics, genetics and natural selection. Although the meaning of the terms changes, as our subsequent lectures will show, these will haunt the debates not only of the 20th, but of the 21st century.

Suggested reading

Adrian Desmond and James Moore: Darwin, Penguin 1992

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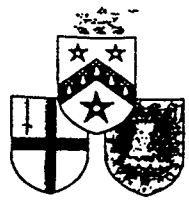

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Gresham College, Barnard's Inn Hall, Holborn, London EC1N 2HH
Tel: 020 7831 0575 Fax: 020 7831 5208
e-mail: enquiries@gresham.ac.uk
Web site : www.gresham.ac.uk