# THE SCIENTIFIC ORIGINS OF THE BRITISH EUGENICS MOVEMENT, 1859-1914.

McGill University, Montreal
December, 1990.

A Thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Master of Arts.

ISBN 0-315-72024-7

## Preface

I would like to thank my advisor, Professor Robert Vogel, whose example, guidance and patience, have helped and inspired me throughout my years at McGill. I would like to thank, as well, my colleagues in the history department who have been very helpful in our many talks over the years. Finally, a note of thanks to my family and friends who have sometimes suffered more than I to see this work completed.

## ABSTRACT

The origins of the British eugenics movement have often been investigated with reference to social, political and economic questions. Eugenics has been seen as a pseudo-scientific explanation for social problems - a response to the perceived imperial and economic decline of Britain in the late nineteenth century - concealing a number of class, racial and other prejudices. But eugenics can also be understood as the product of a certain type of scientific philosophy, derived in part from a Newtonian model of explanation and from scientific discoveries and advances in evolutionary theory, genetics and statistics. This thesis suggests that the credibility of eugenics rested on an interpretation of these scientific findings guided by a concept of scientific explanation which denied the legitimacy of teleological and non-physicalist approaches to the explanation of social life.

Les origines du mouvement eugénique en Grande Bretagne ont souvent été liées aux changements sociaux, économiques et politiques. Dans cette optique, l'eugénisme offrait une forme d'explication pseudo-scientifique, déguisant des préjugés de classes et de races, et répondant au sens de déclin économique et impériale à la fin du dix-neuvième siècle. Mais l'eugénisme tient aussi d'un certain type de discours scientifique emprunter en parti du modèle que Newton avait fourni pour la méchanique classique. En plus, des découvertes importantes dans le domaine de la génétique et le développement d'une théorie de la statistique intimement liées à l'eugénique semblaient confirmer le caractère scientifique de cette nouvelle science humaine. Dans ce sens, l'eugénique serait l'issue de la pensée scientifique elle-même et d'une conception de l'explication scientifique qui n'aurait aucune place pour une science humaine guidée par d'autres formes d'explication.

CONTENTS

# I. INTRODUCTION

> Of all the vulgar modes of escaping from the consideration of the social and moral influences on the human mind, the most vulgar is that of attributing the diversities of conduct and character to inherent original natural difference.
>
> \- John Stuart Mill.

## Science and Society

The genesis of this paper stems from a long standing concern over the dual legacy of the Scientific Enlightenment. While science has given to a part of humanity an unparalleled level of material comfort and a vast new understanding of nature, it has also confronted all of us with new dangers and difficult choices which force upon us ever more urgently the need to arrive at some kind of understanding and assessment of this legacy[1]. Today, as Daniel Kevles points out, eugenics has ugly connotations and the word is associated with oppressive measures, Nazism and a distortion of science. Eugenics has become an archetypical example among various scientists, academics and ordinary people of the dangerous paths to which a misapplication of legitimate science may lead. But even the unparalleled carnage of two world wars - the last of which was fought against an entire empire ostensibly based on a particularly noxious blend of racial and eugenic myths - has not eliminated the strangely persistent idea that racial or socio-economic differences between humans are grounded in a deterministic biology. Neither has the abundance of evidence debunking the major eugenic tenets and methods accomplished this end[2]. The British eugenics movement perceived itself and was, for a time, perceived by an important section of the scientific community as a legitimate application of scientific principles to social and political questions. It was this widespread credibility and its alleged basis in scientific fact which initially drew my interest. How could such a notion take hold of so many of the best minds of that age? It was with these concerns in mind that I approached this topic.

The "origins" of the eugenics movement in this paper thus refers to some of the factors which accounted for the acceptance of the basic principles of eugenics by an influential stratum of educated opinion, culminating in the establishment of scientific, academic and social institutions, the proliferation of a variety of books, articles and periodicals - in short, a "movement" - devoted to the cause of eugenics. Evaluations of the origins and nature of the movement in this sense have often stressed social, political, economic, or imperial prejudices or anxieties of certain social groups or classes in Britain. Several factors have been proposed as creating conditions favourable to the advent of eugenics: the apparent erosion of British imperial and military power (supposedly made evident, for example, in the recruitment for and in the events of the Boer War), the increased rivalry and competition from the Continent and America, the continued urbanization of the country and its attendant problems, even the downturn of the economy and the attack on laissez-faire policies in the late nineteenth and early twentieth centuries. In this light, eugenics is perceived as a response to deep changes in the country's domestic and foreign position by providing both an explanation for these changes and possible measures of "regeneration". In so doing, writers have stated that eugenics resorted to a wilful or unconscious distortion of legitimate science which concealed a variety of class, racial and gender biases while itself parading as a new and valuable science of society. In 1924 the eminent biologist J.B.S. Haldane (himself both a radical and eugenist), had complained that genetic theory was being used in Britain "to support the political opinions of the extreme right, and in America by some of the most ferocious enemies of human liberty" (Haldane, 1924, 291; Kevles, 126). A number of more contemporary works on eugenics have expressed a similar view. Donald Mackenzie, incorporating a Marxian analysis of eugenics, views it as an ideology of the emerging professional middle class which, however, was not confined to the "extreme right" but cut across all shades of the political spectrum. Many historians have placed eugenics in that complex of ideas associated with the slogan of "National Efficiency". In this perspective eugenics, much like the party of National Efficiency, was largely a product of social, economic and political anxieties of late Victorian and pre-war Britain[3].

In his investigation of the development of racialist thought in Victorian Britain, Douglas Lorimer has claimed that historians of science have exaggerated "the influence of scientific thought and tended to overlook the social and political context in which these ideas developed" (Lorimer, 131). With eugenics, however, this formula is reversed and it is the social, economic and political contexts which have received the most attention. In much of the work on eugenics comment on the scientific validity of eugenics and on the influence of biological and physical theories in shaping eugenic ideology has been rather limited[4]. The focus of eugenics as a political phenomena or as an "ideology" has tended to minimize the relation, if any, between British scientific philosophy and eugenics. In addition, the relation between the emerging sciences of evolutionary biology, genetics and statistics, despite the importance of these sciences to the advent of eugenics, have also been relatively neglected.

To some extent the evil associations presently associated with the word "eugenics" has perhaps encouraged a hasty dismissal of any significant relation between science and society in this regard. How could such an apparently obvious justification for racial and class domination be the product of serious and objective scientific thought? A common response is that eugenics really has nothing to do with science at all, that it is a phenomenon which is adequately understood as a response to nonscientific developments in British history and society. That is, it falls under the category of pseudo-science or "ideology". The problem with this view is that it ignores that eugenics was in fact perceived as a potential or new science of society by a significant cross-section of the contemporary scientific intelligentsia, especially among biologists and workers in the social field (see chapter II and Appendix).

Very few of the actors dealt with here (the Victorian and Edwardian scientific intelligentsia) believed they were acting on criteria other than those established by the most rigorous science of their day. Eugenists and others who sympathised with eugenics would not have recognized "National Efficiency" or eugenics as a simple and distinctly political or social response to social, economic and political problems but as a <u>scientific</u> one[5]. The ideology of National Efficiency as well as other political and social factors were indeed very important to the advent of eugenics. But the question remains as to whether the origins of the eugenics phenomena can be understood from the point of view of the participants - as a scientific theory aimed at understanding and solving social problems. Without wishing to minimize the importance of the immediate economic, political and social contexts, this paper will try to answer the question of the origins of the eugenics movement from the "scientific" perspective, i.e., in the sense of a set of ideas which were accepted and validated by a given scientific community at a given time[6]. By following this approach a number of significant connections between scientific thought and eugenics as a social theory may be revealed. Only some of these connections have been pursued in this study. These should be read as suggestive rather definitive statements on this theme.

The advance of scientific knowledge and its technological applications in the Industrial Revolution are among the most important developments in British and world history. Chapter III highlights the tremendous prestige and status of science and a part of its impact on educated opinion. Some of this impact is registered in the increasing belief in the "efficacy of science". Various writers almost since the inception of the Scientific Revolution hoped that a genuine science of society could be established echoing the precision and fruitfulness of physical science with its potentially tremendous benefits to "man's estate". The attempt to fashion a scientific sociology displays a deep admiration for physical science which, until almost the end of the nineteenth century, became the model of scientific investigation and procedure. An important tradition in British scientific philosophy assumed that social and political phenomena could be subsumed under physical categories developed for the natural sciences in an earlier age. This view proclaimed that, in essence, social and psychological concepts and categories could be "reduced" to those of biology and ultimately physics. Moreover, a certain notion of the "unity of science" reinforced the tendency to utilize concepts and approaches derived especially from classical physics in the investigation of important social problems. When many eugenists, therefore, used the language, concepts and methods of physical and biological science they were, for the most part, conforming to the highest canons - <u>as they conceived them</u> - of scientific inquiry.

The intellectual domination of this scientific philosophy partly explains the difficulty which opponents of the scientific sociology of eugenics had whenever they tried to challenge its basic tenets from a scientific basis.

Because of its close adherence to the predominant definition of science, opponents of eugenics often appeared as opponents of science as such. This also explains in part why the most important opponents of eugenics in the period up to 1914 came not from the scientific but from the religious realm. Whenever opponents of eugenics suggested that human attributes were not reducible to physical principles and could not be examined solely in the light of physical science, they could be charged with advocating "metaphysical" or supernatural concepts. This thesis suggests that the domination of this physicalist philosophy of science was one important factor in facilitating the acceptance of the basic principles of eugenics among the scientific community and the wider reading public of the time. The exclusion of important and distinguishing attributes of human social and individual life in the fashioning of a scientific sociology was thus an important element in the acceptance of eugenics.

Much of the vast literature on "Social Darwinism" (of which eugenics was an important part) seems to suggest that social and political doctrines based on Darwinian concepts were a "misapplication" of biological science and constituted a misreading of the scope and intent of Darwin's theory. My readings on the phenomena of "Social Darwinism" suggested that the idea that eugenics arose as a result of "misapplication" or distortion of legitimate science is perhaps flawed or incomplete. The notion that there was, on the one hand, a legitimate "scientific" Darwinism, and on the other, a nasty political and social application presently labelled "Social Darwinism" (eugenics, being a particularly cogent example of the latter) has been seriously questioned by the work of writers such as Robert M. Young and James R. Moore. An examination of the works of Victorian naturalists and other scientists showed that very often scientists themselves (including Darwin) made little differentiation between "social" and scientific Darwinism as presently conceived. This distinction is a product, as James Moore states, of a later time (chapter IV). Contemporaries perceived that Darwinian theory (as well as other advances in biological science) had direct implications for the scientific study of society and signalled a major change in their beliefs and values. Darwinian concepts and other biological findings, seemed to have an immediate relevance to educated contemporaries. These were rapidly incorporated into social theories like eugenics. Darwin, as well as other biologists were also influenced by the concepts and methodology of physical science. In many ways Darwinian biology furnished eugenics with a number of key principles and concepts which seemed to complete the edifice for a genuinely scientific sociology. One of the major outcomes of the triumph of Darwinian theory was its perceived elimination of "special status" previously granted to human social and mental life. The latter were now seen as finally brought within the orbit of scientific law and therefore of scientific control. This was strictly in keeping with some of the predominant ideas in British scientific philosophy examined in Chapter III. As a subspecies of that creature labelled "Social Darwinism", eugenics was not a "misapplication" of scientific Darwinism but simply a direct application of it. Its "ideological" character was partly a result of the extension of the physicalist paradigm into the social realm.

The establishment of eugenics coincided with the establishment of Mendelian genetics, evolutionary biology and statistics and the eugenics movement included illustrious names who made their scientific reputations in all three of these branches of science. Eugenics benefitted from its association with some of these figures and this also helped to bolster its scientific status in the minds of contemporaries. But equally important were developments in these fields which seemed to reinforce the scientific evidence for eugenics (chapter V). Among the most important of these developments was the overthrow of the theory of the inheritance of acquired characters and the formulation of the germ plasm theory. These developments seemed to bolster the case for eugenics which had always promoted the view that reform of circumstances and environment could never be as effective as a reform of the biological stock of the nation.

At the same time eugenics benefitted from its close association with statistical theory. Both Francis Galton and Karl Pearson, the most important scientific figures in the development of eugenics, were also among the most important figures in the history of modern statistics. Galton and Pearson forcefully advocated the application of statistical methods to the study of problems in biology and society. Pearson, in particular, believed that all scientific problems could be treated statistically. This helped eugenics gain more credence among some elements of the scientific community who were impressed with the apparent mathematical rigour of the new science.

While hereditarian ideas played a major role in shaping the principles, concepts and methods of a science of society, a consistent effort was also made to adopt concepts derived from physical science and apply them to the study of biological and social phenomena. Eugenics, as perhaps the most important element of that wider grouping presently called Social Darwinism, was not simply a product of the inevitable human failings of even reputable scientists nor was it a simple expression of the fact that scientists, too, are what is vaguely called children of their time. It was also not exclusively a political response to rapid changes in British society although all these factors are valid and important. This paper will attempt to show that the acceptance of eugenics was predicated on the acceptance of a certain set of <u>scientific</u> ideas which, for a substantial portion of the scientific intelligentsia, virtually defined science. It was also a result of the interpretation of scientific findings which seemed to bolster the case for a hereditarian approach to social problems.

The approach chosen here does not constitute, to paraphrase Robert Young, an attempt to replace an internalist history of science with an internalist history of ideas. The establishment of eugenics depended on a variety of different factors, many of which had little to do with any kind of articulated scientific or nonscientific theory. Though the focus is mainly on the development of scientific ideas and their reception by a select social group, this does not imply that this approach provides a sufficient explanation for the advent of eugenics or that it makes a definitive statement on the relationship between science and society. While one might describe this as a "critical internalist" perspective, material which might be construed as "external" will also be used. This paper seeks to avoid any a priori views as to whether scientific advance proceeds "internally" or "externally". The position taken in this regard is that there is, as yet, no definitive or universally accepted theory for understanding the social role of science, the processes and sources of scientific discovery and advancement or the general relationship between science and society. While utilizing some of the suggestions offered for such a theory by writers in the history, philosophy and sociology of science, no viewpoint will be automatically excluded from consideration.

The general approach favoured here follows Lord Acton's dictum - study problems not periods. As such, brief references stretching back three hundred years, some biographical and descriptive material mixed with analysis and comment, will be included in this work. In a work of limited scope, however, much important material must inevitably be omitted. Perhaps the most serious omissions in this paper relate to the history of anthropology and ethnology-- undoubtedly crucial to the development of all theories of racial and social hierarchy in the nineteenth century. The history of racialist thought has also not been investigated while the history of statistical theory has been given only cursory treatment. Despite these limitations, this study of the origins of the eugenics movement will attempt to draw out conclusions relevant to contemporary debates on the relation between scientific and social thought. I hope that this brief sketch will make a small contribution towards affording a better understanding and a fuller awareness of current problems in the relationship between science and society.

## NOTES

1. Two prime recent examples are the Human Genome Initiative (also called the Genome Project) and gene therapy in biology. The Genome Project involves a fifteen year, 3 billion dollar plan to map and sequence the entire human genome, the biological "blue print of a human being". Gene therapy aims at the treatment of a variety of hereditary and partly hereditary diseases by altering part of the genetic code of those afflicted. Both of these scientific projects promise to revolutionize medicine but also pose new, perhaps terrifying dangers (see for example H.M. Schmeck Jr., "DNA Pioneer to Tackle Biggest Gene Project Ever", New York Times, 4 October, 1988; Labouze, 1988, 75-84; Dorozynski, 1986, 313-19; Friedman, 1989). For a wider discussion of recent developments in biology and their numerous social and ethical ramifications see Suzuki and Knudtson, 1988. (This is only a small sample of some of the writing devoted to this topic and is meant only as an introduction).

Even a brief survey of recent developments would tempt one to agree with a recent commentator's assessment: "L'eugénisme à enfin les moyens de sa politique" (Latour, 359).

2. In what is arguably one of the best recent books about eugenics, Daniel Kevles states, "... in recent years, Galtonian premises have continued to figure in social discourse - notably in the claims of those arguing for a racial basis of intelligence, in certain tenets of human sociobiology, and in some proposals for human genetic engineering" (Kevles, ix). In our own country, the recent debate between Professor Rushton and Dr. Suzuki on the supposedly genetic basis for intellectual differences between the races illustrates both the tenacity of biological theories of human nature and the official disrespect with which those theories are held today by the mainstream of the scientific community. The debate also highlights the vital importance of confronting "Galtonian" claims squarely and providing an adequate description of the methods, aims and nature of genetic science to both the scientific and lay public. There is some question as to whether this is being done at all effectively at any stage (see "Professor defends ranking of races", Montreal Gazette, Sunday, 22 June, 1989; Reynold J.M. Gold, "Facing the truths of genetic research" and Michel Horn, "Academic Freedom: It may protect crackpots but it's not expendable" The Globe and Mail, Monday, February 13, 1989). For a wider discussion of the history of "scientific racism" see Alan Chase's rather rambling and polemical but highly informative The Legacy of Malthus. An excellent analysis which includes a valuable lesson in the debunking of tenacious myths is Gould, 1981.

3. G.R. Searle in The Quest for National Efficiency describes this phrase as a "political catchcry" of the early twentieth century (1971, 1). National Efficiency was a "political slogan" in the context of the Boer War disasters, and in preparation for the "Great Power rivalries of the twentieth century" (2).

Searle also offers a number of suggestions for an understanding of the appeal of eugenics up to 1914 which are similar in some respects to those of Donald Mackenzie. Following John Rex's Marxian critique of the abuse of IQ tests, he proposes that the attraction of eugenics "reflected structural changes in the economy". Some eugenists used available psychometric data "as a validation of class inequalities, hoping thereby to stabilize an economic order coming under attack from Radical politicians and labour militants." There is, however, some difficulty in maintaining this position, as Searle points out, since leading eugenists were also critics of contemporary industrial capitalism and very few businessmen supported eugenics. Eugenics also appealed to a wide variety of socialists. The fiercest opposition to eugenics came from Roman Catholics and "a certain type of individualist liberal." Nevertheless

> The main support for eugenics may have come less from the business community than from professional and academic circles, but it was the fear of the growing power of the Labour Movement which directed the behaviour of a majority of the original adherents. Significantly, the pioneers of genetics in Britain, almost without exception, were from comfortable middle-class backgrounds, and class prejudice all too often crept into their scientific work.
>
> More specifically, the growth of the eugenics movement can be seen as one particular response to the emergence of social welfare politics.

Eugenics, in this sense, provided an effective weapon for the "belabouring of the pre-war Liberal Government" to conservatives in search of more convincing ideologies than traditional appeals to self-help and individualism. It also appealed to a society in which science was held in high esteem but in which the existing power of 'amateurs' was sometimes blamed for the perpetuation of major social problems. In this sense, eugenics represented one of the many attempts at encouraging a "technocratic" approach to politics and the wider utilization of 'expert' knowledge. Searle also acknowledges that the changing fortunes of eugenics can also be explained "not simply as a response to external political stimuli, but in terms of intellectual developments within the academic world." Finally he suggests that "the increasing specialization, which has done much to destroy the synthesis that eugenics once embodied" is of equal importance in explaining the rise and demise of eugenics. The last two considerations are most relevant to the topic of this paper (Searle, 1976, 112-115).

4. Cowan 1972 and 1977, Mackenzie 1976 and 1981 and Kevles 1985 are notable exception to this rule. Cowan's work shows the importance of Galton's eugenic ideas in the development of the sciences of genetics and statistics before the beginning of the twentieth century. Mackenzie also traces the development of statistical theory as an outcome of eugenic concerns while Kevles is the most recent and comprehensive attempt to reveal the intimate connections between genetics, statistics and eugenics in both the United States and Britain. In all of these valuable works, however, eugenics is treated as a valuable spur - though a dangerously biased and flawed one - to scientific advance. This implies that while eugenics played a key role in the development of biological and statistical science, ultimately, it can itself be adequately understood as the result of non-scientific factors such as the class and race prejudice of eugenists in the social, political and economic context of late nineteenth century Britain. This thesis argues that eugenics can also be understood as the outcome (not only the stimulus) of a prevailing scientific philosophy and that this explains in part why the scientific community was so receptive to eugenic ideas. At the same time scientific evidence which seemed to bolster the hereditarian thesis confirmed the credibility of eugenics to the scientific community in the period before 1914.

5. The word "efficiency" itself, is perhaps an apt illustration of the connection between scientific and nonscientific ideas. The word has a generally understood meaning of "Adequate fitness ; power to produce a desired result" (Concise English Dictionary, 1968). But it has also become an important term in science, especially engineering, where it denotes "A measure of the performance of a machine, engine, etc., being the ratio of the energy or power it delivers to the energy or power fed to it... The thermal efficiency [for example] of a heat engine is the ratio of the work done by the engine to the heat supplied by the fuel..." (Oxford Scientific Dictionary, Oxford University Press, 1988).

6. The idea that the scientific community is the validator of scientific knowledge is associated with Kuhn's landmark book (see Kuhn, 170 and passim.). Other philosophers have suggested different criteria for a definition of science (e.g., Popper, 1959). A brief discussion of the relevance of these various concepts is offered in the beginning of

chapter III. This thesis proposes that Kuhn's perspective seems especially well suited to this kind of approach adopted here since it emphasizes the role of a given scientific community in affirming or rejecting a given set of concepts or "paradigms" which guide scientific thinking and activity. In this perspective, it is the scientific community which establishes a set of ideas and methods as "scientific". One of the advantages of this conception of science is that it eliminates the recourse to an extra-historical criteria of science and allows for the analysis of an older science in its own terms (Kuhn, 1970, 167n and esp. ch. XIII).

1 II. A PRELIMINARY SKETCH

a. Ancient and Modern "Eugenics"

G.R. Searle notes the kernel of the eugenic idea is ancient, harking back at least to Plato's Republic and Laws and reappearing in the modern world in such works as Moore's Utopia (Searle, 1971, ch.1; 1976, ch.1). As one author states, perhaps with some exaggeration; "Indeed, Plato's Republic can be read as a eugenics tract" (Haller, 3). In 1913, A.G. Roper believed that "The preface to a history of Eugenics may be compiled from barbarism, for the first eugenist was not the Spartan legislator, but the primitive savage who killed his sickly child" (Roper, 1). Finally, Darwin, citing Mitford's History of Greece reaffirms Sparta's ancient priority in controlled breeding and selection, stating that "a form of selection was followed, for it was enacted that all children should be examined shortly after birth; the well-formed and vigorous preserved, the others left to perish" (Darwin, Descent, 1936, 415; cf. Mitford, History of Greece, i, 282, n.d.). In one sense, then, eugenics is not an invention of the twentieth century. As G.K. Chesterton, a noted critic of eugenics, remarked, eugenics "is one of the most ancient follies of this earth" (Chesterton, 1910; Searle, 1976, 3).

The kernel of the eugenic idea, asserting the overriding importance of heredity, is indeed ubiquitous. The idea that special characteristics are bestowed on certain individuals or groups by birth is evident in the various meanings historically attached to words such as "blood", "race", "breeding" and "character". In Murray's dictionary of 1893, "blood", is defined as "...the typical part of the body which children inherit from their parents and ancestors; hence that of parents and children, and of the member of a family or race, is spoken of as identical, and as being distinct from that of other families or races". Words like "talent", "genius", "eminence" or "ability" according to Merivale, denote specifically inborn aptitudes (Merivale, 115-6). But with words such as "breeding" and "character" the isolation of the inborn as opposed to the acquired quality is less pronounced and both words may mean something close to "blood" or "talent" as well as (for breeding) "The rearing and training of the young; bringing up : formerly in sense of 'education'...The results of training as shown in personal manners and behaviour..." (Murray, 1893).

In the institution of kingship, according to Kern, we also find a fusion of "blood" or blood-right and kin-right deriving from the legitimist principle with other ideas which together constituted "capacity to rule" or "throne-worthiness".

> The early medieval king did not come to the throne through a simple personal right of inheritance. He did, it is true, as a rule possess a certain hereditary reversionary right, or at least a privileged "throne-worthiness" in virtue of his royal descent. But it was the people who summoned him to the throne with the full force of law, in as much as they chose from among the members of the ruling dynasty either the next in title or the fittest. The part played by the people or their representatives in the elevation of the monarch fluctuated between genuine election and mere recognition (or acceptance) of a king already designated. But at least the community gave legal assent to the prince's accession to the throne, and solemnly installed the new king in power (Kern, 1968, 12-13).

"The origin of this mingling of hereditary right with elective right", states Kern, "is lost in the darkness of primitive times". But a mysterious and magical inner virtue was attached to the lord of a primitive people, "a virtue which could be seen in the beaming eye of a prince of royal blood" (Kern, 13-14). This magical and hereditary quality of princely blood was further watered down by the encroachment of ecclesiastical imperatives throughout the middle ages (Kern, 27-61) and the hereditary principle seems to have become entirely joined to other legal and religious notions, apparently limiting or precluding its independent significance.

While vaguely diffused and co-mingled with other notions in western European thought, the hereditary principle remained an important factor in European politics and law. In a limited sense, it may be said to have consciously or unconsciously justified a number of beliefs and practices such as ancient infanticide, the ideal of the superiority of aristocratic or royal blood, and attitudes towards groups or individuals deemed inferior. "Eugenics", in this sense, is a recurrent theme in human history and prehistory.

But these views of the origins of the hereditary principle as they relate to "ancient eugenics" are, of course, a product of hindsight. It was not until the nineteenth century that a fully articulated theory of human inherited ability and disability, bringing the hereditary principle back to the fore, was finally worked out in Britain and given a name. The word "eugenics" was invented by Sir Francis Galton (1822-1911), cousin of Charles Darwin, pioneer of the statistical treatment of heredity, respected scientist and idiosyncratic Victorian genius. Galton was the founding father of eugenics. In his Inquiries into Human Faculty (1883) he offered a definition for the term derived from a Greek root meaning "good in stock" or "hereditarily endowed with noble qualities". He hoped that a science of eugenics could be founded dedicated to the improvement of the human stock by allowing "...the more suitable races or strains of blood a better chance of prevailing speedily over the less suitable" (Galton, 1883, 17). (We note again the erroneous and popular conception of "blood" as the hereditary element). In an article he published in 1904, Galton gave a further definition. Eugenics is

> ...the study of agencies under social control that

> may improve or impair the racial qualities of future generations either physically or mentally (Galton, 1904b, 82).

The reference to "agencies under social control" in this definition, underlines the expressly practical and ultimately political intent of eugenics. The essential point is to make biological science serve in the betterment of the community and individual. The link spelled out in Galton's definition between biology ("racial qualities") and social thought and action ("study of agencies under social control"), shows the "intermediate" character of eugenics, explicitly positioning itself between these two realms of thought. Thus eugenics could present itself as partaking <u>both</u> of a natural and social science including, as well, practical and theoretical elements. That few scientific contemporaries objected to the establishment of a science positioned in such a manner - a manner guaranteed to make the most mileage, politically and socially, of whatever biological science could discover - is an interesting comment on the assumptions and beliefs of that time. Like other programs to establish a scientific sociology in the eighteenth and nineteenth centuries but unlike its ancient predecessors, eugenics perceived itself as a bold new science of society which promised to revolutionize social thought and enable it to bring about lasting improvements in the biological fitness, and therefore, the general health, welfare and intellectual calibre of future generations. In the words of one prominent eugenist "The present writer believes that eugenics is going to save the world" (Saleeby, 1909, 182). Eugenics was also unlike most other attempts at constructing a science of politics, by the peculiarly unmediated character of its application of scientific principles. As G.R. Searle remarks, eugenics not only asserted that "politics should be made <u>analogous</u> to the operations of the physical sciences... but purports to be nothing less than the <u>direct application</u> of the laws of physical science" (Searle, 1976, 2).

Eugenics is also distinguished from other attempts at constructing a scientific sociology by its emphasis on heredity. Early eugenists made a sharp break between environmental and biological causative factors and stressed the "omnicompetence" of biological explanations of human faculty and behaviour. This was in marked contrast to the "environmentalist" tradition of British and especially Victorian science (see chapter III, especially IIIc.). To a large extent the scientific status of eugenics rested on evidence which supported this hereditarian thesis (see Cowan, 1977, 43 and passim.). At the same time the hereditarian conception turned out to be especially fruitful to the solution of a number of problems in social investigation and in the emerging science of genetics (see especially chapter V).

We may also assume that the magical or mysterious element anciently attached to heredity had not entirely disappeared in Victorian and Edwardian Britain. This was sometimes made evident in philosophies such as vitalism, a major competitor to reductionist and mechanistic theories of human nature like eugenics. In this context, biology and genetics could appear as guiding lights to the holy grail, the missing key which promised to unlock the complex and seemingly intractable problems of human individual and social life. If this was the case, the importance and the revolutionary claims made for a science of eugenics and its attraction to contemporaries are understandable.

The institutionalization of eugenics can be specified in the formation of two main organizations: the Eugenics Education Society, founded in 1907 in London and the Eugenics Record Office founded in 1904 and based at University College, London. The latter was renamed the Francis Galton Laboratory for the Study of National Eugenics by Karl Pearson in 1911. Both organizations were established with considerable assistance from Galton (Farrall, 1985, ch. IV, and below). In the case of the EES, Farrall notes that "It does not fall easily into the categories of other organizations with which we are familiar in late Victorian and early twentieth century England. It has some affinity and overlap with a number of other kinds of organization: the philanthropic society, the religious sect, the political movement, and the learned society" (Farrall, 1985, 4). The Galton Laboratory and it sister organization, the Biometric Laboratory (founded in 1902), were more academically oriented institutions which attempted to put eugenics on a more secure scientific footing. The Galton and Biometric Laboratories, together with the EES, constituted the two main wings of the eugenics movement as it emerged at the beginning of the twentieth century.

Other organizations, such as the Moral Education League, Charity Organization Society and the various Temperance societies, evinced considerable interests in hereditary questions and often co-operated but sometimes also quarrelled with the EES or the Galton and Biometric Laboratories. This widespread concern with hereditary questions attests to the timeliness of eugenics and demonstrates, as a number of historians mentioned above have stated, a significant shift in focus in social but also in scientific thought in early twentieth century Britain.

### b. Francis Galton

Eugenics greatly benefitted from its association with Francis Galton who, as one recent eminent biologist has stated, was "...one of the great biologists of the nineteenth century..." (Dobzhansky, 53). This section is devoted to certain aspects of Galton's life and his contribution to eugenics. Chapter V will examine some of his contributions to genetics and statistics and their relevance to the scientific credibility of eugenics.

Though his grandfather had been a Quaker, Francis Galton was born into a middle class Anglican family in 1822. Galton's father, Samuel Tertius Galton, was a successful Birmingham banker and his mother, Violetta Darwin Galton, was one of the many daughters of Erasmus Darwin. Francis was regarded as a child prodigy but he did not consistently distinguish himself in his studies. In 1839 he entered King's College Medical School in London but opted for mathematics at Cambridge (Trinity College) in 1840, despite a successful year at King's. He continued at Cambridge reading mathematics (initially following the honours program but ultimately contenting himself with a pass degree) and studying medicine at St. George's Hospital in London but with little enthusiasm or academic success. With his father's death in 1844, Galton was left a sizeable inheritance which allowed him to drop his studies and engage in extensive travels in the Middle East (1845-46), Scotland (1846-50) and South West Africa (1850-52). After returning home, he moved to London and married Louisa Butler and devoted himself to London social life and to writing a number of books including (for the Royal Geographic Society) Tropical South Africa (1853). He also wrote The Art of Travel (1855) a guide on "roughing it" and gave lectures on campaigning to British soldiers at Aldershot after the setbacks in the Crimean war. Between 1855-60 Galton wrote extensively on topics such as cartography, meteorology and geographic measurements and instruments (Cowan, 1977, 147-150).

Galton could quite rightly claim to be an heir to the scientific tradition of the eighteenth century. His maternal and paternal grandfathers had been founding members of the Birmingham Lunar Society, whose members had tried to establish a new scientific and political culture in Britain (Mazlish and Bronowski, 326-333; Russell, 104-5). By the

1850s he was already beginning to distinguish himself with a number of awards and honours. Between 1850 and 1860 he was awarded the Silver Medal of the French Geographical Society and the Gold Medal of the Royal Geographical Society, culminating, in 1860, with his election to Fellowship in the Royal Society. Between 1886 and 1910 he was awarded the Gold, Darwin and Copley Medals of that Society. He was given an honorary D.C.L. at Oxford in 1894, was knighted in 1909 and elected to an honorary Fellowship of Trinity College in 1910 (Galton Laboratory, 5). As one writer put it: "Fellow of the Royal Society, member of the Athenaeum, occasionally secretary of the British Association, he belonged to all the right 'clubs' and had all the right friends - Sir Richard Burton, Herbert Spencer, the younger Darwins - to qualify as a member of the intellectual establishment" (Cowan, 1977, 147).

After 1860, Galton began to fasten on the problems of heredity, publishing two articles for Macmillan's Magazine in 1865 which became the basis for his first book on the subject, Hereditary Genius in 1869. Basing himself partly on the accumulated knowledge of hereditary transmission as practiced by animal and plant breeders (as Darwin had done), Galton assumed that human "natural ability" might one day also be cultivated in a similar manner to produce not only higher physical but also higher intellectual and moral specimens. In his earliest works on the subject - "Hereditary Talent and Character" (1865) - Galton emphasized what he perceived as the dominating influence of heredity and minimized the influence of social or environmental factors in shaping men of "talent". By the latter he included all the eminent personalities who had succeeded in making their way into biographical encyclopedias such as the Dictionary of Men of the Time or Phillips' Million of Facts and "...those qualifications of intellect and disposition which lead to reputation"; the reputation which made "a leader of opinion...an originator" (Galton, 1869, 37-38). In 1874 he produced another book, English Men of Science: Their Nature and Nurture which was also aimed at proving how heredity predominates over environment in forming scientific talent.

Galton realized, however, that the analogy from animal and plant breeding was only suggestive and provided no positive proof for mental heredity in man. Using the biographical encyclopedias mentioned above, he compiled statistical data in an attempt to establish a higher than-normal correlation of "talent" for the children and relations of the aforementioned eminent personalities. "I can show that talent and peculiarities of character are found in the children when they have existed in either of the parents, to an extent beyond all question greater than in the children of ordinary persons" (Galton, June 1865, 158). This application of statistics to heredity became a distinguishing mark of Galton's work and he made significant contributions to statistics, anthropometry (the scientific measurement of the human body) and biometry (the application of statistics to problems in biology, heredity and evolution). Galton was almost legendary in his mania for counting and tabulating. "Whenever you can, count" he is said to have stated (quoted in Kevles, 7). It is not surprising, then, that he turned his mathematical mind toward the statistical analysis of heredity. Using what is now called normal or Gaussian distribution, Galton was among the first to apply these statistical concepts and measurements to populations. At the International Health Exhibition in the South Kensington Museum in 1884 he established an Anthropometric Laboratory from which he obtained vital statistics and other data for about 9,000 people (Kevles, 14). From the data gathered at the Exhibition and from the Record of Family Faculties - a questionnaire on heredity - as well as from his experimental findings on the heredity of the sweet-pea, Galton concluded that physical characteristics such as weight (in the sweet-pea) followed a normal distribution if the weight of the parent were taken as the mean (the centre line of the familiar bell curve) (Kevles, 15). Galton's Natural Inheritance (1889) argued strongly for the incorporation of mathematical probability in statistics and in the statistical treatment of hereditary variability. In the former capacity his work helped launch a new era in statistics. In the latter capacity, Galton helped to create a new science of biometry (or biometrics) which, in the days before the rediscovery of Mendel's papers, seemed to be a promising route for the scientific study of heredity.

Galton's most striking claim was that of mentaly hereditary - the view that a wide range of intellectual, moral, artistic characteristics were hereditary ("nature") and that the latter predominates over acquired or learned traits ("nurture"). He made a sharp distinction between nature and nurture and advanced what was claimed as scientific evidence supporting the predominance of the former. He utilized these findings to encourage more research into "natural ability" (such as intelligence) or into the "relative effects of nature and nurture" and to justify the establishment of a science of eugenics. Greatly impressed by Darwin's Origin of Species, Galton stressed the importance of acquiring new knowledge in biology and human heredity for the improvement of the race. He looked forward to the day when eugenics would become the means by which humanity would take charge of its own evolution, replacing the cruel and aimless work of natural selection by a rational and scientifically based "artificial selection" (Pearson, 1914-30, i, 207; Galton, August 1865, 327; Galton 1869, 349-350). In Galton's words, "what Nature does blindly, slowly, and ruthlessly, man may do providently, quickly, and kindly" (quoted in Kevles, 12).

Given this impressive list of accomplishments and awards as well as his family connections, it should not be surprising that Galton's name lent considerable credibility to the eugenics movement. In addition, much of his scientific work retained a great deal of credibility in the scientific community in subsequent years. As will be discussed below, Galton's study of heredity, despite serious flaws, made a lasting contribution to the science of genetics as it emerged in the twentieth century. This may also have greatly facilitated the acceptance of eugenics as a plausible biological and social scientific theory.

c. Karl Pearson.

After Galton, the most important scientific personality in the establishment of eugenics was Karl Pearson. Pearson, like Galton, descended from a Quaker line. Karl's father, William Pearson, - "an iron man" had moved to London from Yorkshire in order to pursue a legal career. Eventually William became a barrister and a Queen's Council, having made his name in the Chancery Courts. Born in London in 1857, Karl became the focus of his father's hopes and was expected to enter law school after Karl's brother, Arthur, had made a fortune through one of his father's clients. Karl began his higher education at University College School, London, where he spent a year with a private tutor before going to Cambridge (King's College) on a mathematical scholarship in 1875. Under teachers such as Cayley, Clerk Maxwell, Stokes and Todhunter, Pearson developed a keen interest in science and mathematics at Cambridge, graduating as third wrangler under the old Tripos system in 1879 with an honours in mathematics. In 1880 he was awarded a fellowship at Cambridge where he also delved into religious and philosophical thought. During his fellowship there he frequently made trips to Germany, studying law, philosophy and mathematics at Berlin and Heidelberg. Pearson's remarkably encyclopedic mind absorbed much of that country's scientific and social philosophy, the latter notably (and perhaps paradoxically) including both Johann Fichte's ideas on the state and an anti-imperialistic variant of German socialism[1]. Between 1880 and 1884 Pearson engaged in intensive studies on a wide range of topics, gave extension courses and substituted for absent professors. He published long reviews on Spinoza, the Reformation and German social life and thought in the fifteenth century (Kevles, ch.2; E.S. Pearson, part I). In the 1880s Pearson developed his interest in the philosophy and history of science, helping to publish W.K. Clifford's unfinished work on the Common-Sense of the Exact Sciences and Isaac Todhunter's History of the Theory of Elasticity. While engaged in the dissemination of this scientific literature he did not neglect social and political thought, publishing a daring and provocative collection of essays, The Ethic of Freethought in 1888.

In 1884 he was appointed to the chair of applied mathematics at University College. In 1890 he obtained a lectureship in geometry at Gresham College, London, where he helped to spread the awareness of the importance of applied statistics and probability. In the same year Pearson married Maria Sharpe (four years his senior), part of the circle of free thinkers and radicals he had helped create in London through the Men and Women's Club in 1885[2]. While his teaching duties and other activities prevented him from contributing much to his mathematical field in this period, he succeeded in making his reputation with his Grammar of Science, a philosophical treatise on science which was first published in 1892 and underwent four editions up to 1937.

While at Gresham, Pearson met Walter F.R. Weldon (1860-1906), Jodrell Professor of Zoology, at University College. Both men were working on a campaign to reform London University. Weldon had read Galton's Natural Inheritance in 1889 and was immediately impressed with the possibilities that Galton's statistical approach opened up for problems in morphology and evolutionary adaptation. Pearson had also read Galton's book but had remarked in that same year on the "considerable danger in applying the methods of exact science to problems... of heredity" ("On the Laws of Inheritance According to Galton", March 11, 1889 in Kevles, 28). Weldon and Pearson were destined to become close friends and scientific comrades-in-arms for the embryonic science of biometry. Through Weldon, Pearson met Galton and both succeeded in overcoming Pearson's doubts on Galton's methods, "enthusing a mathematician with his [Galton's] project of demonstrating Darwinian evolution by mathematical inquiries" (E.S. Pearson, "Introduction", Grammar, 4th ed., 1937, xi). His first major work on this topic, "Mathematical Contributions to the Theory of Evolution", published in the Philosophical Transactions of the Royal Society (1893), helped establish the theoretical foundations of modern statistics and opened up new and important tools for the study of heredity and evolution. Pearson was elected to the Royal Society in 1896.

While engaged in a famous and bitter dispute with William Bateson - an early champion of Mendelian genetics in Britain (see chapter V) - Pearson founded, with Galton and Weldon, Biometrika: a Journal for the Statistical Treatment of Biological Problems in 1901. With Weldon's death in 1906, Pearson turned increasingly to the application of statistical methods to eugenics. Although a grant from the Worshipful Company of Drapers in 1903 allowed him to carry on this work, his duties as professor of applied mathematics and geometry prevented him from giving full attention to this, his favoured branch of biometry. It was only after Galton's death in 1911, and the latter's endowment of a chair of eugenics at University College, that Pearson was able to devote his time to biometry, eugenics and to the development of the Biometric Laboratory which he directed until his retirement in 1933. As head of the new Department of Applied Statistics, Pearson virtually fused together the Galton and the Biometric Laboratories and made them an important and aggressive exponent of statistics, biometry and eugenics.

Pearson now had the money, staff and facilities to engage in extensive research in statistics, biometry and eugenics. He was a dominant personality and his colleagues both in Biometrika and in the Galton and Biometric Laboratories were marked with the Pearsonian zeal for biometry and eugenics. Characteristically, the hundreds of publications produced by Pearson and his disciples mixed important contributions to statistical theory and biometry with the hereditarian bias of eugenics. Like Galton, Pearson was convinced of the predominance of mental heredity and much of the published work demonstrates a consistent attempt to measure the "relative strength of nature and nurture" (usually, "nature" was found stronger), to provide evidence for the hereditary basis of a wide range of diseases and afflictions such as alcoholism, tuberculosis, and various mental defects. The hereditary basis of intellectual ability and other aspects of human character were a favoured theme; announcing in the Huxley Lecture to the Anthropological Institute in 1903 "We are forced, I think literally forced, to the general conclusion that the physical and psychical characters in man are inherited within broad lines in the same manner, and with the same intensity. We inherit our parents' tempers, our parents conscientiousness, shyness and ability, even as we inherit their stature, forearm and span" (Pearson, 1903, 204; Kevles, 32).

Pearson's greatest concern, like that of his mentor Galton, was to establish statistics, biometry and eugenics as academic disciplines and sciences in their own right. His success in convincing Galton and his scientific peers on the manner in which to do this is demonstrated by the establishment of Biometrika (still publishing) and the science of biometry, now an established branch of biology. In statistics, he is given credit for having established the product-moment formula for the regular coefficient of correlation, the theory of multiple correlation and regression and the chi-squared test - a measure of "goodness-of-fit" between a given theoretical curve and its experimental data. According to Kevles, "Pearson laid the foundations of modern statistical methods" (Kevles, 37; see also Haldane, 1958).

Statistics did become, as Pearson hoped, an important and far more sophisticated tool of analysis in a number of areas. While statistical analysis also became an important element in genetics, it fell short with regard to Pearson's most exaggerated claims. It did not become the primary tool of science in general, or even of eugenics, although eugenics and statistics have often closely collaborated in the past (see, for example, Gould, 1981). Pearson's and Weldon's sometimes heated rhetoric advocating the primacy of the statistical method may have contributed to the alienation of many biologists who might otherwise have been interested in its application to both biometry and eugenics. There were some, in any case, who were ready to help develop and establish the new sciences on this basis. But it did not, for that matter affect the evaluation of eugenics as a legitimate new biological science of society among many biologists and workers in the social field. This contention will be examined in the next section and in chapter V.

### d. The Question of Credibility

The advocacy of eugenics as a science of society by scientific personalities such as Pearson and Galton lent, as may be expected, a great deal of credibility to eugenics among the Victorian and Edwardian intelligentsia. This section will attempt to examine more closely who might be included in this group and what kind of ideas circulated among them. It will try to show that eugenist's claims to scientific status were taken seriously by a sizeable and important part of the Victorian and Edwardian scientific community. The next chapter will attempt to clarify the notion of "scientific community" in the context of nineteenth and early twentieth century Britain and what distinctions need to be drawn in this regard. For the moment, a three part distinction should be retained between: (a) members of the scientific community, (b) the educated public and (c) the wider society. The first group includes major figures in the history of biology, genetics and statistics as perceived both by posterity and by contemporaries[3]. These would include figures like Darwin, Wallace, Huxley, Galton, J.A. Thomson, August Weismann, William Bateson and Karl Pearson. (See Appendix for fuller list of names for groups (a) and (b)). The second group consists of non-specialist writers and contributors (in periodicals, books, learned and other societies) to questions touching on eugenics, genetics, population and social problems. This group would include people such as Leonard Darwin, Dean William Inge, Dr. C.W. Saleeby, Dr. Ettie Sayer and Arnold White. Personalities such as Ellis are difficult to place on this classification and may be included in the first or second group. There is, in any case, an unavoidably subjective element in this classification. The first and second groups often belonged to the same clubs and societies and contributed to the same publications, especially in the period before 1870. The "scientific community" often included members from this second group and there was much interchange between them and the first group. The third group is often left out of account in works touching on intellectual history for various, sometimes unavoidable, reasons. This group includes the lower classes.

In this paper, the fact that eugenic ideas were given a valuable forum and were extensively discussed in almost all the major periodicals and in the various scientific and general societies from about 1860 to 1914 is considered as partially indicative of the credibility of eugenics as a science and a social program[4].

The influence of British eugenic writings were spread far and wide, especially in western and northern Europe, throughout the British empire (Farrall, 1985, 209-210; Roll-Hansen, passim.) and in the United States[5]. Between 1910 and 1914, branches of the EES were established at Liverpool, Haslemere, Southampton, Belfast, Manchester, Birmingham, Brighton, Cambridge and Oxford in the U.K.; Dunedin, Christchurch, and Wellington, in New Zealand and in Sydney, Australia (Farrall, 1985, 209-210; Annual Report of the EES, 1909-1914). Semmel states that full and associate membership in the organization peaked at about 1,000 in 1913-14, which is comparable to the Fabian Society's 800 members in 1900 (Semmel, 1968, 59)[6]. Table 1, below, is a list of membership in the EES for the period 1909-1920.

Table 1

Membership of the Eugenics Education Society, 1909-1920.

| Year | Members | Associate Members | Total |
|---|---|---|---|
| 1909 | 112 | 229 | 341 |
| 1910 | 155 | 300 | 455 |
| 1911 | 196 | 331 | 527 |
| 1912 | 294 | 323 | 617 |
| 1913 | 406 | 307 | 713 |
| 1914 | 383 | 241 | 624 |
| 1915 | 377 | 237 | 614 |
| 1920 | 319 | 175 | 494 |

London branch only, no figures available for 1916-1919.

Sources: Annual Reports of the EES in Farrall, 1985, 211.

An international congress was held in 1912 in London and a committee established to organize the next congresses (held in New York in 1921 and again in 1932), which drew delegates and contributions from around the world[7].

As one author has noted, what the EES lacked in numbers it made up in its distinguished membership and patronage (Kevles, 57). Many of the leading scientists, medical men, politicians and thinkers of the day, were active or honorary members of the EES at one point in their lives. Examples from the political Left include, George Bernard Shaw, Havelock Ellis, Harold Laski, Sidney and Beatrice Webb (Roll-Hansen, 301; Freeden; Paul). From the Right or Centre we can include such illustrious names as Winston Churchill, A.J. Balfour, Neville Chamberlain and Galton himself[8]. The list of names of the board of the first International Congress of Eugenics reads like a who's who of British science and society and is a good indication of the calibre of much of the membership of the EES (International Congress of Eugenics, 1912). Farrall has compiled a series of lists and tables drawn from the Annual Report of the Eugenics Education Society. The first is a list of "Members of the Society Eminent in Their Own Right" (see Appendix 3 "Prominent Members of the EES"), and the second is based on the members of the council of the EES (Appendix 1 and 2). Both of these cover the period between 1909 and 1920. According to Farrall:

> The members of the council of the Eugenics Education Society were, in general, active supporters rather than well-known people whose names were used to bolster its image. Fifty-three of the one hundred and eleven council members contributed articles to the Eugenics Review. Many of the remainder addressed meetings on behalf of the society or worked on various sub-committees. The makeup of the council membership reinforces the findings from the DNB sample that the society was supported strongly by members of the academic and medical professions. The council members were also, in general, very well educated, the great majority having university or professional training. The leadership of the EES was dominated by well-educated members of the middle-class

professions of medicine, university teaching and science (Farrall, 1985, 220-1).

Another table, drawn from a random sample of forty members and twenty associate members taken from the membership lists for 1912-13[9] also corroborates the view that EES members came largely from the academic, professional and medical fields (see Appendix 4). If these samples are at all representative - which seems to be the case if we also include the number of illustrious people who were not members but wrote about and were involved in the eugenics movement - it would greatly substantiate the notion of eugenics as a "credible" scientific and social movement in pre-war Britain both in the scientific mind and to the wider educated public. According to Farrall,

> One special feature of the eugenics movement was its claim to have a scientific basis. The Eugenics Education Society was certainly well supported by scientists and the medical profession many of whom would have studied science at the university level. Support of eugenics from such a large segment of the scientific community was an indication that many took seriously its claims to be scientific. It is worth noting, however, that support for eugenics did not come evenly from all scientists. Biologists, as might have been expected, were more prominent than chemists or physicists. Among social scientists strongest support came from psychologists (Farrall, 1985, 229).

A striking claim is made, almost incidentally, by Nils Roll-Hansen of the attitude of geneticists towards eugenics up until the 1930s. Despite the important changes in the social and scientific contexts in the inter-war period which helped to cause a split between "orthodox" and "reform" eugenics[10] and had "an important restraining effect" on political proposals based on supposed scientific findings, "In the Nordic countries the complete rejection of eugenics on ground of principle was not a major alternative in the debate [on sterilization and other eugenic policies]".

Clearly, Roll-Hansen believes that the Nordic debate was characteristic of other countries and that the acceptance of eugenic principles by geneticists was even more pronounced in the period before 1915 (Roll-Hansen, 308).

There is some evidence, as well, that the middle and higher brow debates surrounding eugenics had influenced more popular opinion. Shortly before the establishment of the Eugenics Education Society, Pearson wrote to Galton, "You will be amused to know how general now is the use of your word '<u>Eugenics</u>'! I hear most respectable middle-class matrons saying, if children are weakly, 'Ah that was not a eugenic marriage!'" (Pearson to Galton, 20 June, 1907, in Pearson, iii, 1914-30, 323).

In sum, it would indeed appear that, at least up to 1914, eugenics was considered a respectable and legitimate scientific theory in both the restrictive sense (to the scientific community of the period) and the more informal sense as defined above. The concept of "scientific community" and its relevance to the scientific status of eugenics will be briefly examined. As already mentioned, the acceptance and credibility of eugenics rested to a significant extent on its claims to be a scientific theory. The next chapter will also examine this claim in relation to the wider history of British scientific thought.

## NOTES

1. There seems to be a marked contrast between this youthful period in Pearson's life where he opposed imperialism and ridiculed certain strains of Social Darwinism and the later intensively social-imperialistic Pearson, as portrayed by Semmel (Imperialism and Social Reform). In his earlier travels in Germany (1880-1884) Pearson spoke at working men's clubs on socialism, Marx and Lasalle (E.S. Pearson, "Introduction" to 4th edition of Grammar, in Pearson, 1937, viii). He warned that the impoverished millions of Ireland and London would "make themselves heard in the next twenty years..., and woe to those who then have their thoughts in Africa or Asia!". In Berlin he criticised the students who attended DuBois Reymond's lectures on Darwinism, for thinking that "some solution of their social difficulties is to be obtained from the theories of evolution"

> Poor fellows [he wrote], they go and listen attentively to the possibility of producing a permanent race of mules, as if that could be any cure for tea at six shillings a pound and no marmalade at one and four a pot (Pearson to mother, November 29, 1879, Karl Pearson Papers, Cabinet II, DI, in Kevles, 23 and note 16).

The contrast is slightly less marked, however, if we recall that the brand of Social-Darwinism prevalent at that time was still Spencerian, favouring a laissez-faire approach to politics. Pearson remained a consistent critic of this brand of Social-Darwinism, but went on, as we shall outline later, to develop a new more "social" and interventionist variant of the breed.

2. Pearson's intellectual and social milieu in this period included personalities such as Eleanor Marx, George Bernard Shaw, Sidney and Beatrice Webb, Havelock Ellis and Olive Schreiner. The Men and Women's Club arose from Pearson's conviction of the importance of "the woman question" and discussed such taboo subjects as prostitution, venereal disease, "preventive checks" (contraception), marriage, sexuality, women's economic opportunities and intellectual capacities. The Club included, at one time or another, people such as Schreiner and Annie Besant. Although the Club favoured easier divorce laws and a more relaxed sexual morality, they were not proponents of experimentation in this domain. Both Havelock Ellis and George Bernard Shaw were denied admission probably because their ideas were too radical on this score. The Club disbanded in 1889 (Kevles, 24-27; E.S. Pearson, part I).

See Yvonne Karp, Eleanor Marx, 2 vols., Pantheon Books, 1976, ii, 82-83; Norton, 1978, 27-28 ; Ruth First and Ann

Scott, Olive Schreiner, Schocken Books, 1980, 144-72 ; Phyllis Grosskurth, Havelock Ellis: A Biography, Alfred A. Knopf, 1980, 93-106.

3. By "posterity" I mean that their names figure prominently in books on the history of biology, genetics or statistics, as for example, Sturtevant (1965), or Nordenskiold, (1929).

4. This includes publications like Nature, which became, according to Young, a higher brow magazine for the nascent professionally trained scientist and more middle brow magazines like The Nineteenth Century (Young, 157 and passim., 1985d).

5. Eugenics organizations proliferated throughout the industrialized world at different times and places. In the United States, the high point of the movement was perhaps in the inter-war period with the formation of the American Eugenics Society in 1923. In general, eugenic ideas seem to have made at least as much an impact on public consciousness in America as in Britain. When Galton initially tried to spread his eugenic message in an article entitled "The Possible Improvements of the Human Breed Under the Existing Conditions of Law and Sentiment", (Galton, 1901) his lukewarm reception in England contrasted with the high profile his articles received in The Annual Report of the Smithsonian Institution (Washington, 1901, 523-538) and in the Popular Science Monthly (60, January 1902, 218-232; cf. Cowan, 1977, 199). If eugenic sterilization laws (permitting the state to force inmates in institutions or others deemed as carriers of a hereditary disease or pathological condition to undergo sterilization) are any indication of the success of eugenics, 25 American states had such laws on the books by 1930, beginning with Indiana in 1907. Similar laws were passed in all the Scandinavian countries by 1938, and discussed but not passed in Holland, Hungary, Czechoslovakia and Poland before the Second World War (cf. Roll-Hansen, 306; Kevles, 59-60; Chase, 1977).

There has been very little historical work on eugenics in this country. Angus McLaren (1990) is probably the first to deal exclusively with eugenics in Canada. Although I have not been able to thoroughly examine this work, McLaren also believes that the Depression period was "the high water mark" of eugenics with the formation of the Eugenics Society of Canada in 1930 (107) and the passage of "voluntary" sterilization laws in British Columbia and Alberta before 1933 (105). Both immigration and the fertility of French Canadians were major themes in Canadian eugenics. According to McLaren "English Canadian fear of French Canadian fertility gave the hereditarian debate a particular resonance" (9).

6. Daniel J. Kevles states that "nominal membership" never exceeded 1,700 (Kevles, 59).

7. See International Congress of Eugenics, London, 1912; New York, 1923 (vol.I); New York, 1923 (vol.II); New York, 1934.

8. For Winston Churchill, see Kevles, 63 and International Congress of Eugenics, 1912; for A.J. Balfour see Appendix 1 and 3, Farrall, 214n, 217, 217n, and Kevles, 63. For Neville Chamberlain see Farrall, 213n and Appendix 3. As Farrall points out, Balfour was only an honorary member.

9. Farrall did not compile a total membership list drawn from the Annual Report for each year from 1908 through 1920 because no lists were published during the war years of 1916-1918 and because (for other missing years) of the "great expenditure of time and money" this would have involved. The entire membership list was thus "surveyed solely for the purpose of identifying well-known people". I have taken this first general list of "eminent personalities" which appears within Farrall's text and presented it in the form of a table in Appendix 3. The random sample of the members of the Eugenics Education Society which Farrall has produced, covering the year 1912-1913, was apparently designed to obtain a more detailed and representative picture of the rank and file membership of the Society. The procedure Farrall used in compiling this second sample is described in 212 and 212n and has been verified by Mackenzie 1976, 499-532; and 1981.

10. Kenneth M. Ludmerer, argues that "by the end of the war [1918] the intellectual split between most geneticists and the majority of eugenists had become complete" (Ludmerer, 1972, 80-85). Roll-Hansen believes this is an exaggeration though it is

> quite clear that many geneticists backed away from active participation in the popular eugenics movement... The disillusionment of the geneticists is found in Europe as well as in the United States.
>
> However, the geneticists' change in attitude did not mean that they rejected the fundamental aims of eugenics... it was the means they criticized. The geneticists wanted a sound scientific application of genetics to social problems, and they feared the consequences of naive eugenic proposals... Thus conservative as well as radical geneticists turned to their laboratories to develop sound foundations for a new and better eugenics. The criticisms were mostly expressed in scientific journals and other

> technical publications, as well as more informally through personal contacts (Roll-Hansen, 305-6).

Both Kevles and Searle maintain a split between a new "reform" and an older "orthodox" or "mainline" eugenics which had its roots near the end of the First World War and crystallised by the early 1930s in the United States (Kevles, 169-172) and in Great Britain (Searle, 1979, 159-169). The relevance of these views for our purposes is that they confirm one of the hypotheses put forward in this paper: that the scientific community (here restricted to workers in genetics) widely accepted the fundamental principles of genetics. This seems especially true for the period up to 1914.

## III. THE SCIENTIFIC ROOTS OF EUGENICS

### a. The Social Organization of Science and Scientific Thought.

If, as Kuhn states, the scientific community is the validator and producer of scientific knowledge (Kuhn, "Postscript -1969", 178), eugenics may be said to have constituted a scientific theory in this sense. But the relevance of this concept must first be considered in relation to the scientific community examined in this paper. The general outlines of this community as it pertains to genetics and biology in the late nineteenth and early twentieth centuries need to be drawn. It is evident that sociological concepts such as "scientific community" cannot be adopted wholesale for an understanding of certain kinds of historical phenomena.

> What are the essential characteristics of these [scientific] communities?... The scientist must, for example, be concerned to solve problems about the behaviour of nature. In addition, though his concern with nature may be global in extent, the problems on which he works must be problems of detail. More important, the solutions that satisfy him may not be merely personal but must instead be accepted as solutions by many. The group that shares them may not, however, be drawn at random from society as a whole, but is rather the well-defined community of the scientist's professional compeers... The group's members, as individuals and by virtue of their shared training and experience, must be seen as the sole possessor of the rules of the game or of some equivalent basis for unequivocal judgments. To doubt that they share some such basis for evaluations would be to admit the existence of incompatible standards of scientific achievement. That admission would inevitably raise the question whether truth in the sciences can be one (Kuhn, 168).

This list, appears, in many of its points, to be a description of current scientific communities and would seem irrelevant to late nineteenth century communities. The existence of "professional compeers", "shared training and experience" for example, is difficult to apply to a society in which the scientific professional (especially in the biological sciences) or established professional training had yet to appear in any substantial way (see below). Moreover, in the period dealt with here, "problems of detail" and the perception of the scientific community as "the basis for unequivocal judgments" also seem premature since a variety of competing schools existed on various key issues of method and principle in biology and especially genetics. In Kuhnian terms, the latter had not yet acquired a "paradigm". Furthermore, as Merz states:

> British science, through all the centuries since the time of Roger Bacon, and in spite of the efforts of his illustrious namesake, has refused to congregate in distinct schools and institutions or to be localized in definite centres. The Royal Society, the Royal Institution, the British Association and many other smaller societies, have more or less started with the program of Lord Bacon, and have failed to realize it : everywhere the schemes of co-operation or organised scientific research have encountered the opposition of individual pursuits or of local interests (Merz, i, 249-50).

On this basis it would seem advisable that we reject the concept of "scientific community" entirely, for our purposes. This, however, would leave little else with which to evaluate the scientific status of eugenics and the degree of its acceptance by scientists. It is clear that a scientific community of sorts did exist in Victorian and Edwardian Britain and that in many respects it was the validator of scientific knowledge. Scientists, naturalists, and others communicated with each other in journals and books, joined scientific societies and formed various associations. In moments of crisis, such as followed the publication of Darwin's Origin, distinct "schools" and positions did in fact emerge. Merz, writing near the turn of the century, admits that the "individualist" character of

British science, as well as other "national peculiarities" were now changing as science was becoming increasingly cosmopolitan and contributing to the "international republic of learning" (Merz, i, 361).

It therefore seems clear that if a notion of "scientific community" as validator of scientific knowledge is adopted, the changing nature of the social organization of science must be kept in mind. In some of the period under review here, lay and scientific commentary and interpretation of nature overlapped. This is especially true for biology in the late Victorian and early Edwardian period. This complicates the application of the notion of scientific community as defined in Kuhn's neat sociological sense. It must be remembered that Darwin, Galton and most Victorian scientists, as well as earlier pioneers of the Scientific Revolution, wrote for a much wider audience than is the case for specialized scientists today. The books and articles they wrote were neither meant for nor confined to a scientific community as described above by Kuhn. The educational facilities which could train professionals and provide the cadre for such a sharply defined scientific community were often absent. Victorian gentlemen (and occasionally lady) "scientists" - especially in natural history - themselves were to a large extent what might presently be termed "amateurs"[1].

In biology, especially, scientific ideas circulated very widely. A unique kind of "apologetic" (see Merz, ii, 323-325) or popular literature flourished around British scientific thought in the nineteenth century - a literature which, until the end of that century - was taken quite seriously by writers such as Darwin, Wallace and Huxley. Indeed, the latter two writers devoted considerable amounts of energy on their own "popularizations" of Darwin's and other scientist's theories, often with religious questions in mind.

To some extent, and again in hindsight, we may attribute this phenomena to the "low development" of biological science at the time. Biology was for a long time perceived as a poor relation to the "harder sciences" of physics, mathematics and chemistry. Indeed, Popper once denied that evolutionary theory is a science at all because, according to his criteria, it cannot be falsified[2]. To some extent this view of biology and indeed of all natural history remained even after the rapid strides made in these fields of knowledge in the latter half of the nineteenth century. Biologists themselves suffered from what Lewontin describes as "physics envy" and were plagued by the apparent vagueness and uncertainty of their science as compared to physics. It would thus be reasonable to assume that eugenics, claiming itself as an applied biology, would have suffered at least as much odium as its "mother science". Physicists and other members of the community of "hard scientists" did not necessarily applaud the advent of the new sociology of eugenics. Some, like Lord Kelvin, opposed even Darwin's assumptions because they did not conform to his calculations as to the age of the earth. Others, like James Clerk Maxwell, objected to certain aspects of Galton's hereditary theory. Both seemed to defer, however, to the biologists, geologists and others on issues they judged outside of their competence. Perhaps what appears to be the conspicuous lack of comment on any of the Social Darwinisms (including eugenics) by physicists is a further indication of the physicist's reserve on this account. This seems to indicate that physicists accepted the authority of biologists and naturalists, though they felt free to criticize them whenever their conclusions seemed to conflict with established physical ones.

What is important, however, is not necessarily what the archetypical scientific community of physicists themselves believed but the influence of physical categories and concepts in the development of eugenics as a science. Biologists tried always to work within the framework of ideas recognized as "scientific" - that is, deriving in large part from physics. Because eugenics operated clearly within this framework of ideas, many biologists as well as others working in the social field and in psychology perceived it as a legitimate new social science. Moreover, according to the Kuhnian definition of "scientific community" the collective opinion of physicists would seem to be of less moment than the opinion of those working in the fields which would help to constitute the science of eugenics (most importantly, sociology, psychology, evolutionary biology, genetics and statistics). In this novel field, and despite the debt owed to physicalist ideas, the group of "professional compeers" who "must be seen as the sole possessor of the rules of the game or of some equivalent basis for unequivocal judgments" would not seem to necessarily include the community of physicists (for example). Because of this and also because of time constraints this paper has focussed mostly on scientists working in the biological field and fields relevant to eugenics. Their membership and support of eugenics as outlined in chapter II and elsewhere in this paper is considered as sufficiently indicative of the scientific status of eugenics.

Both the "amateurishness" of British science and the significant influence of the apologetic literature in the period before the 1880s has considerable bearing on the credibility of eugenics. Most of the basic ideas of eugenics were first formulated in this period, before the advent of the modern specialized scientific professional and before the acquisition of a "paradigm" in the science of genetics. This means that personalities like Galton or Spencer were provided a forum in respected journals and were accepted as members in the most prestigious institutions. The "scientific community" in Victorian and Edwardian Britain, then, seems to be a real but variable quantity and changes as we approach the twentieth century, the age of specialists and specialized periodicals and societies (Young, 1985d). Communities of this sort, as Kuhn stated in his 1969 postscript, can still be legitimately described as the producers and validators of scientific knowledge.

b. Scientific Thought in Historical Context.

Science, as one commentator remarks, is "a process of thinking about nature, of talking about nature, and of interrogating and using nature. That is, we shall describe science as an intellectual, a social, and a practical activity. It is only if we follow such a broad and comprehensive road that we can do justice to the complexity of science" (Knight, 11; Russell, 4). British eugenics was a very complex movement, positioned at the hub of a number of various political, scientific, social and economic issues. In seeking to understand the scientific claims made for eugenics, it is important to try and follow a "comprehensive road" but is also important to understand what was meant by "science" itself as expressed by some of its major exponents and through some of its main concepts. This raises problems of definition and demarkation, problems which plague the philosophy and history of science to this day. This is an especially acute problem in the history and philosophy of biology where, as Ernst Mayr states, the criteria for separating biological from other concepts is far from simple. His own tentative suggestions as to the distinctive rigour of science's methodology, testability, falsifiability and the establishment of non-contradictory paradigms, remain problematic (Mayr, 1982, 24-30; cf. Mayr, 22-3 on methodology and 77 on science and nonscience). Herbert Butterfield in 1957 had already criticized the "whiggish" interpretation of science in which every scientist was judged by the extent of his or her contribution to present scientific knowledge (Butterfield, 1957). In a similar vein, it would seem equally questionable to interpret every scientific concept solely in the light of contribution to present science. Thus, present rejection of eugenics as unscientific because it is not accepted by today's science seems dubious. The approach followed here is guided as far as possible by the opinions and writings of some of the major figures in the history of science - as judged and interpreted by the standards and views of nineteenth and early twentieth century British science. Certain figures who would perhaps not be included in a thoroughgoing internalist perspective - for example, Francis Bacon - because they made no major scientific discovery or experiments, are considered here as part of the British scientific tradition. This is not an arbitrary choice but reflects the perspective of eugenists themselves, as well as a sizeable proportion of the wider Victorian and Edwardian scientific community. By following this method a more historically accurate understanding of what Victorians and Edwardians understood as "science" may emerge. At the same time, the projection of present standards onto the past will be minimized.

As the following sections will try to show, the predominant (but not the only) definition of science in Victorian Britain was deeply influenced by physicalist philosophy. The scientific treatment of social questions for many Victorians and Edwardians, was predicated on a correct application of the methods, concepts, and language of natural science developed especially for classical physics onto biological, social and political thought. This was deemed an acceptable, perhaps even the only conceivably proper route for a truly scientific sociology. The domination or influence of certain scientific concepts may thus help to explain the acceptance of a science of eugenics by scientific contemporaries. The following sections will attempt to identify certain currents of scientific thought and how these helped to form a context in the latter half of the nineteenth century which was favorable to a biological view of human affairs in general and eugenics in particular.

c. The Efficacy of Science

There is an obvious point that needs to be made in the relation of science to eugenics. No proposal for social reconstruction based on science (biological or otherwise) could have achieved any kind of success had there not been a growing respect and appreciation for the efficacy of science in general and its potential for providing solutions to important social problems. Indeed, the viability of eugenics in the early twentieth century necessitated, as a prerequisite, that science be conceived as the only sure way to deal with the problems of a complex industrial society. The need for a solution to these problems was all the more urgent for, as Galton remarked, the "average standard of ability ... should be raised" lest we be swept into extinction like the animals and natives of colonized areas by our inability to adapt rapidly enough to meet the new conditions imposed upon us by "civilization".

> The number of the races of mankind that have been entirely destroyed under the pressure of the requirements of an incoming civilization, reads us a terrible lesson. Probably in no former period of the world has the destruction of the races of any animal whatever, been effected over such wide areas and with such startling rapidity as in the case of savage man... the human denizens of vast regions have been entirely swept away in the short space of three centuries, less by the pressure of a stronger race than through the influence of a civilization they were incapable of supporting. And we too, the foremost labourers in creating this civilization, are beginning to show ourselves incapable of keeping pace with our own work. The needs of centralization, communication, and culture, call for more brains and mental stamina than the average of our race possess. We are in crying want for a greater fund of ability in all

> stations of life; for neither the class of statesmen, philosophers, artisans, nor labourers are up to the modern complexity of their several professions. An extended civilization like ours comprises more interests than the ordinary statesmen or philosophers of our present race are capable of dealing with, and it exacts more intelligent work than our ordinary artisans and labourers are capable of performing. Our race is overweighted and appears likely to be drudged into degeneracy by demands that exceed its powers.

Galton proposed two solutions to prevent this impending catastrophe:

> ...We can, in some degree, raise the nature of man to a level with the new conditions imposed upon his existence, and we can also, in some degree, modify the conditions to suit his nature. It is clearly right that both these powers should be exerted, with the view of bringing his nature and the conditions of his existence into as close a harmony as possible (Galton, 1869, 344-346).

But despite the appeal to "modify the conditions to suit [man's] nature", Galton spent most of his writings arguing for the other solution - "raise the nature of man to a level with the new conditions." His attempt to ground this latter solution in science became the great raison d'etre of his life and his major claim to fame.

Galton, of course, was not the first to advocate a scientific approach to social problems. This approach had its modern origins in the Scientific Revolution of the sixteenth and seventeenth centuries. A new conception of the laws of nature which Halévy calls "Newtonian" is "defined as being no longer contemplative and theoretical but active and practical, as aiming at securing our domination over external nature through the knowledge of natural laws" (Halévy, 6). To this age must be given credit for adding a new layer of meaning to the ancient adage "knowledge is power". Among the most noteworthy of philosophers of this new practical conception of science was Francis Bacon, "the first statesman of science" (title of a Bacon biography by

A.G. Growther, 1960). For Bacon "the true and lawful goal of the sciences is none other than this: that human life be endowed with new discoveries and powers" (Bacon, Novum Organum, book I, Aphorism 81). The method by which this power over nature could be wrought, was by restoring "the commerce of the mind with things" (quoted in Farrington, 18), consulting nature instead of books alone. Bacon's hostility to medieval speculation and his advocacy of the method of induction without recourse to hasty generalization had a most powerful influence in Victorian scientific philosophy. Both Galton and Pearson remained admirers of Bacon and claimed to have used "Baconian principles" in their analyses of heredity[3]. Bacon's emphasis on the practical utility of scientific knowledge remained equally compelling throughout the eighteenth century. Thomas Sprat, Archbishop of Rochester and the first historian of the Royal Society, praised, as Trevelyan states, the practical objects of the Society "to increase the powers of all mankind and to free them from the bondage of error" (quoted in Trevelyan, 272)[4]. Groups like the Birmingham Lunar Society not only shared and spread this conviction but stressed the practical benefits to be derived from such a route[5] (Mazlish & Bronowski, 332-33, 335). During the Industrial Revolution, which powerfully demonstrated what mankind could do to fashion nature to its wants, the conviction of the efficacy of science and technology[6] spread also to sections of the working class. Indeed some historians have pointed to the proliferation of Mechanics' Institutes (concerned with the spread of scientific and technical education among artisans and the "labour aristocracy") in the first half of the nineteenth century as evidence of this trend[7].

The belief in the importance of science for practical and also intellectual advancement became something of a catch word for the nineteenth century. This was especially evident in various proposals for educational reform. Matthew

Arnold was only one of the better known advocates who argued for the reorganization of the education system in general and the promotion of scientific instruction in particular to meet the needs of the new age.

> Our dislike of authority and our disbelief in science have combined to make us leave our school system, like so many other branches of our civil organisation, to take care of itself as it best could. Under such auspices, our school system has very naturally fallen all into confusion; and though properly an intellectual agency, it has done nothing to counteract the indisposition to science which is our great intellectual fault. The result is, that we have to meet the calls of a modern epoch, in which the action of the working and middle class assume a prepondering importance, and science tells in human affairs more and more, with a working class not educated at all, a middle class educated on the second plane, and the idea of science absent from the course and design of our education (Arnold, 217-18).

In both Galton and Pearson, we find a strong desire to make science a more important force in their society. Pearson in particular believed that a scientific education also provided the basis for sound citizenship, "Modern Science, as training the mind to an exact and impartial analysis of facts, is an education especially fitted to promote sound citizenship" (Pearson, 4th ed., 1937, 13, passage emphasized in the original). This was an increasingly important virtue, Pearson believed, since the passage of the various reform bills had extended political responsibility to a larger section of the population. In Huxley's view, science, after a prolonged period in which it had been barren of practical benefits, had definitively put its stamp on the modern world. In Baconian language he claimed: "During the last fifty years, this new birth of time, this new Nature begotten by science upon fact, has pressed itself daily and hourly upon our attention and has worked miracles which have modified the whole fashion of our lives" (Huxley, 1887, 51-2).

Since the Enlightenment a powerful intellectual current was thus helping to shape that confidence in human reason which became a source of inspiration to later generations and a spur to the idea of scientific knowledge as the basis of action. The Victorian idea of "progress" itself rested largely on the new possibilities which the application of science to industry and human affairs promised (Houghton, 36-7). As Beatrice Webb stated in her autobiography "the mid-Victorian Time-Spirit" was characterized by a "belief in science and the scientific method" (Beatrice Webb, <u>My Apprenticeship</u>, quoted in Houghton, 1). By the turn of the century the view that scientific knowledge should be applied to social questions had, if anything, intensified. Proponents of eugenics, in particular, comparing the lamentable condition of scientific education in Britain to that on the Continent could state with much support:

> We have by one or other process to learn the national importance of science: to realize that science in the broadest sense, as educator and discoverer, is the mainspring of modern national life; that the future is to the scientifically trained nation which reproduces itself, maintains its health, develops its institutions, controls production, organizes its distribution, extends its territory, governs its subject races, and prepares its offensive and defensive services with scientific foresight and scientific insight (Pearson, 1919, 97).

<u>d. Natural Science as a Model for Social</u>

Although the new philosophy of science seems to have been slanted mostly towards the understanding and control of "external nature" (cf. Halévy above) and made its greatest strides in natural science, Bacon, for one, did not propose to limit his methods and concepts to this realm:

> It may also be asked... whether I speak of Natural Philosophy only, or whether the... other sciences, logic, ethics and politics, should be carried on by this method. Now I certainly mean what I have said to be understood by them all (<u>Novum Organum</u>,

book II, aphorism 127).

It is apparent, then, that almost at the very inception of the Scientific Revolution, science - which later becomes identified almost exclusively by the methods and concepts of the natural sciences, especially classical physics - becomes the proper vehicle for the understanding of individuals and society. A growing awareness of the potential and real power of science to multiply the bounty of nature arises simultaneously with a corresponding conception of science as competent to deal with political and social issues. This view, first formulated by Bacon, is then more fully articulated and gains increasing currency in the course of three centuries of progress in natural science. Most important, the application of natural scientific views to human affairs becomes more and more strongly rooted in British scientific and intellectual history.

An excellent example of this tendency can be found in the development of the associationist psychology. A number of important intellectual currents from Bentham's utilitarianism to David Smith's political economy have been traced to this network of ideas, derived by philosophers in part from Newton's work (Halévy, 6). Thomas Hobbes in Leviathan (Part I, ch.1-6) and John Locke[8] in his Essay Concerning Human Understanding (book I, ch.3, sect.6) both formulated the principles, the latter in his battle against the notion of "innate ideas". With Hobbes, the entire text of Leviathan is an explicit analogy between the physiological and other functioning of a human organism - defined mechanistically - with the proper functioning of a commonwealth. In David Hartley's Observations on Man, his Frame, his Duty, and his Expectations (1749) there is a more explicit connection to Newtonian theories. In Hartley's mind his "doctrine of associations" was linked to the "doctrine of vibrations" which he states

...is taken from the hints concerning the performance of sensations and motion, which Sir Isaac Newton has given at the end of his Principia, and in the questions annexed to his Optics; the [doctrine of association]... is taken from ... Mr. Locke and other ingenious persons of his time... (Hartley, ch.1).

The use of Newton as well as Locke was clearly intended to establish Hartley's psychology as a science, a branch of 'natural philosophy'. As Elie Halévy points out:

In this way Hartley openly introduced Newton's method and terminology into psychology. He reduced the explanation of the facts to the simplest possible terms, and brought all associations under the single heading of association through contiguity. He combined his psychological theory with a physiological theory, whose central idea was likewise borrowed from Newton, and in which 'vibrations in miniature' or 'vibranticules' took the place of the Cartesian 'traces' (Halévy, 8).

David Hume also attempted to "introduce the Experimental Method of Reasoning into Moral Subjects". He actually preceded Hartley in adopting the doctrine of the association of ideas as an interpretation of all mental processes in his Treatise of Human Nature (1738) and his Inquiry into Human Understanding (see Halévy, 9). However, for various philosophical reasons, Hume considerably weakened the possible application of this scientific principle to individuals and society (Halévy, 10-11).

These associationist theories and their social and political derivations were all modelled on the idea of the strong formative influences of the environment on human knowledge, character and perception. This seems to be true both in the natural scientific sense - as a theory of physiological psychology, and in social thought. John Stuart Mill summed up the utilitarian variant of the creed in which he had been raised :

In politics an almost unbounded confidence in the efficacy of two things : representative government, and

> complete freedom of discussion. So complete was my father's reliance on the influence of reason over the minds of mankind, whenever it is allowed to reach them, that he felt as if all would be gained if the whole population were taught to read, if all sorts of opinions were allowed to be addressed to them by word as in writing and if by means of the sufferage they could nominate a legislature to give effect to the opinions they adopted...
> In psychology, his fundamental doctrine was the formation of all human character by circumstances, through the universal Principle of Association, and the consequent unlimited possibility of improving the moral and intellectual condition of mankind by education (Mill, 1969, ch.4).

Galton and Pearson, despite their hereditarian prejudice, remained firmly in the grip of this empiricist tradition. A passage from one of Galton's books could be cited as a classic statement of the associationist psychology:

> The furniture of a man's mind chiefly consists of his recollections and the bonds that unite them. As all this is the fruit of experience, it must differ greatly in different minds according to their individual experiences. [A large part] consists of childish recollections, testifying to the permanent effect of many of the results of early education (Galton, 1919, 131).

And later:

> Our abstract ideas being mostly drawn from external experiences, their character also must depend upon the events of our individual histories... The character of our abstract ideas, therefore, depends, to a considerable degree, on our nurture (Galton, 1919, 132).

It would seem that Galton's theories on the primacy of heredity are in contradiction with the above statements. But heredity still predominates over "external experiences" because, though the latter are still important, they must pass through varying types of constitutions (hereditary natures). A given experience or stimuli will not have the same effect on each and every individual; this depends on the "sensitivity" of a given individual, which is a question of heredity[9].

Associationist theories are only one example of the many links connecting natural and social scientific thought maintained until the formative period of eugenics in the late nineteenth century. Throughout the eighteenth century schemes for the establishment of a science of politics also gained increasing prominence. Jeremy Bentham is perhaps among the most influential and well known philosophers advocating for a "new science" of law based on "the greatest happiness for the greatest number" (Mazlish & Bronowski, 442-43, 445-46). He also tried to "translate" physical conceptions to the social realm. Interestingly, his attempt to establish a mathematically calculable standard of legislation, as well as his intense interest in numbers and statistics (especially prevalent in An Introduction to the Principles of Morals and Legislation) foreshadows Galton's own love of numbers and his confidence in their ability to establish the proper course of action in any field[10]. In a section of Natural Inheritance entitled "The Charms of Statistics", Galton states:

> Some people hate the very name of statistics, but I find them full of beauty and interest. Whenever they are not brutalized, but delicately handled by the higher methods, and are warily interpreted, their power of dealing with complicated phenomena is extraordinary. They are the only tools by which an opening can be cut through the formidable thicket of difficulties that bars the path of those who pursue the Science of man (Galton, 1889, 62-3).

The influence of classical mechanics and its mathematical form is made evident in the attempts to create a scientific sociology or a new science of politics. Natural science, it was thought, provided the appropriate conceptual tools and theoretical framework for proper scientific investigation in any field. This is especially (but not exclusively) revealed by the intensive use of mathematical and quantitative language made manifest in Bentham's "felicific calculus" but also in Galton's and Pearson's approach to eugenics (see below). Mathematical language was considered the sine qua non of science. In the words of John Merz, which are particularly relevant for the development of biological thought in the nineteenth century,

> Modern science defines the method, not the aim of its work. It is based upon numbering and calculating - in short, upon mathematical process; and the progress of science depends as much upon introducing mathematical notions into subjects which are apparently not mathematical, as upon the extension of mathematical methods and conceptions themselves (Merz, i, 30).

The conviction that mathematics was the hallmark of true science was sometimes blamed for the failure of previous attempts at a scientific sociology - such as Spencer's. In Pearson's view sociology had substituted verbiage for solid mathematical treatment. What we need, said Pearson in a lecture delivered in 1912, is a scientific sociology inspired not by Spencer and Comte but by Darwin and Galton. He objects that a scientific sociology presently exists.

> Well, I study with great interest certain sociological journals published in widely separated parts of the world, with a view of ascertaining whether they will provide us with what we need - insight into human evolution. Roughly, I find about a third of their space is devoted to lists of what other people ... have written; another third to criticisms of what other people have published, and the remaining third to popular lectures or facile essays on social problems. Observation, measurement, experiment, are conspicuous by their absence; talk, endless talk, governed apparently by the pre-Baconian conception that verbal disquisition can solve scientific problems. When I read sociology as exists today, the sterile product of Comte and Spencer, I get no help at all in social problems (Pearson, 1914, 16-17).

Only mathematical treatment of any problem could lay sure foundations for our knowledge. Pearson, citing Lord Kelvin states:

> When you can measure what you are speaking about and express it in numbers, you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and

unsatisfactory kind (quoted in Pearson, 1914, 17).

The importance of mathematics and quantification, in this regard, should be clear. The Baconian principle advocated knowledge as the basis of action. Newtonian physics was interpreted as defining this knowledge as essentially mathematical in approach and mechanistic in form. One school of eugenics, as shall be outlined in a later chapter, was able to appropriate Darwinian theory and mathematicize or quantify human evolution, "throwing the door open", as Pearson said, to real knowledge of mental and social dynamics. This was an impressive accomplishment which, devoid of its furthest pretensions, made a lasting impact on biology. Herein lay an important part of the reason for the attractiveness of eugenics to many scientific contemporaries. It was an attraction which was not diminished by the mechanistic model (also borrowed from physics) of human faculty.

The use of statistics had been encouraged by Darwin's findings, as Merz stated in 1904, "and natural history is becoming to some extent an exact science. That it will ever be so to a very large extent is doubtful: it is one of the great merits of Darwin that he has introduced a special method into the sciences of nature - the method of judicious balancing of evidence" (Merz, ii, 339). This "judicious" method is what the proponents of eugenics and much of the scientific community who were impressed with the possibilities of eugenics, failed to sufficiently appreciate.

The advent of evolutionary biology in the 1860s appears to have signalled a shift from physical to biological approaches and principles in the investigation of individuals and society. But in many ways this apparent shift was itself superficial. As Mayr states:

> The word "biology" is a child of the nineteenth century. Prior to that date, there was no such science.

> When Bacon, Descartes, Leibniz, and Kant wrote about science and its methodology, biology as such did not exist, only medicine (including anatomy and physiology), natural history and botany (somewhat of a mixture)... The major innovations in biological thinking did not take place until the nineteenth and twentieth centuries. It is not surprising, therefore, that the philosophy of science, when it developed in the seventeenth and eighteenth centuries, was based exclusively on the physical sciences and that it has been very difficult, subsequently, to revise it in such a way as to encompass also the biological sciences (Mayr, 1982, 36).

Pearson's Grammar of Science, for example, largely utilized examples drawn from the physical sciences. It is clear, as will be outlined below, that many philosophers of science also conceived that both the concepts of biology and all biological processes could be "reduced" or understood in terms of physico-chemical principles. If biology could not claim an autonomous status without being labeled as vitalist or unscientific (Mayr, 1982, 36), this would be true for the social sciences also which were often perceived as a branch of biology.

e. Universality of Science: Uniformitarianism.

If a prevalent philosophy of science facilitated the acceptance of eugenics, it was by no means a universally held view at the time. There were still important obstacles to the establishment of a science of society based exclusively on mathematical methods and mechanistic principles. Among these obstacles was the religious notion that humankind had been granted a special status by the creator or that it was endowed by God with a soul which could not be "reduced" or understood exclusively in terms of mathematical principles or laws of motion. The well known debate between Wilberforce and Huxley on evolution epitomized the climax of this conflict[11].

But a debate pitting "uniformitarianism" against "catastrophism" preceded the debate on evolution and anticipated in many respects the controversy over Darwin's Origin. Charles Lyell in his Principles of Geology (1st ed., 1830-3) had already helped to establish the uniformitarian view (formulated earlier by Hume and Hutton) that the geological history of the earth revealed a basic continuity and had also forced a drastic extension of its past. Previously, theologians, scientists and laymen had fixed the age of the earth at approximately several thousand years, in accordance with calculations drawn from the Bible. Geology, according to Lyell, should not resort to supernatural explanations of the development of the earth's structure, although its origins (or so-called "primary causes") might still be viewed as the product of divine intervention. The point of this idea, states Himmelfarb, "was that no extraordinary powers were to be allowed in nature, no uncommon events alleged in order to explain the appearance of the earth; nature was assumed to be pursuing an orderly, regular, lawful course, uniform with that observed in our own time" (Himmelfarb, 84). Or, as the subtitle of Lyell's Principles expressed it in 1830, "An attempt to explain the former changes of the earth's surface by reference to causes now in operation." Darwin, who was greatly influenced by Lyell and wrote several books on geology before turning to the species problem, viewed his own evolutionary theory as a similar extension of this principle, overthrowing the notion that humans and other species had been specially and separately created by a supernatural agency[12]. As T.H. Huxley put it, "Darwin's greatest work is... the unflinching application to Biology of the leading idea and the method applied in the Principles to geology" (Huxley, 1888, 268). Galton also viewed eugenics as a similar extension of the principle of uniformity with respect to the physiological nature and possible future evolution of mankind. The importance of uniformitarianism thus lies also in the conception of science, or "principle of reasoning" which it helped to articulate. As Lyell states as early as 1829:

> My work... will endeavour to establish the principle of reasoning in the science... that no causes whatever have from the earliest time to which we can look back, to the present, ever acted, but those now acting; and that they never acted with different degrees of energy from that which they now exert (Letter from Lyell to Roderick Murchison, Jan. 15, 1829, in Lyell, i, 234).

Two points here are of relevance. The first states that science can allow no other causes but natural ones. Like Newton's conception of the universe, the earth is a self sustaining and maintenance-free entity and there is no need to resort to views assuming periodic supernatural intervention in the earth's history. The second principle is the extension of the field of these natural causes to include the history of the earth and, by implication, the origin of mankind.

It is clear that many contemporaries who objected to this theory conceived that science had overstepped the bounds of revelation and trespassed over the jurisdiction of scripture. Their view of this new "principle of reasoning" was that it robbed creation, especially mankind, of the special status that the Bible seemed to grant it. Lyell, however, had not gone into great detail about the origin of mankind and a reconciliation between theology and science, which had hitherto mostly worked together in the guise of natural theology, was still possible. But this is nevertheless an inkling of what was to come in the Darwinian debate. By treating individuals completely as an integral part of nature scripturalists believed science had reduced them to a "mechanism" devoid of the special attributes of "free will", "soul" or "spirit" which placed them above natural processes. Scientists reacted to these accusations in a number of ways. Some, for example, tried to reconcile the claims of theology and science while others, such as Huxley, asserted that theological concepts had no place in scientific discourse. According to Burrow, another group saw in the principle of Uniformity "a logical status and a numinous aura which made it a substitute for the idea of God" (Burrow, 211).

Whatever their diverse reactions, however, the principle of uniformity was consistently associated with a theory that rejected any "special status" for human origins, mental ability and society. After the publication of Darwin's Origin this association was made more explicit. A belief in Uniformity encouraged the obliteration of the divide - still held by many - between the sciences of nature and the sciences of individuals and society. This belief seemed to confront Victorian intellectuals with a choice between science and law or obscurantism. To deny that human social and individual life - that human behaviour and the higher faculties - were accessible to scientific analysis, would have appeared as a retreat into religion. This is revealed in a debate which Huxley conducted against Wallace on the "physical basis of life". In an essay written in 1870, Wallace claimed that natural selection cannot completely account for the mental and moral aptitudes of humans or their emergence from the lower animals (Wallace, 1871, 332-372c). Huxley, Wallace wrote, had concluded, in his "Physical Basis of Life" that our "thoughts are the expression of molecular changes in that matter of life which is the source of our other vital phenomena". To Huxley life, including human life and consciousness, were completely understandable in terms of bio-mechanical forces and interactions. Wallace argued - with Tyndall - that

> The passage from the physics of the brain to the corresponding facts of consciousness is unthinkable. Granted that a definite thought, and a definite molecular action in the brain occur simultaneously, we do not possess the intellectual organ... which would enable us to pass by a process of reasoning from the one phenomena to the other. They appear together but we do not know why. Were our minds and senses so expanded,

> strengthened, and illuminated as to enable us to see and feel the very molecules of the brain; were we capable of following all their motions, all their groupings, all their electrical discharges, if such there be, and were intimately acquainted with the corresponding states of thought and feeling, we should be as far as ever from the solution of the problem, 'How are these physical processes connected with the facts of consciousness?' The chasm between the two classes of phenomena would still remain intellectually impassable (J. Tyndall, Presidential Address to the Physical Section of the British Association at Norwich, 1869, quoted in Wallace, 1871, 361).

Natural Selection, according to Wallace, could not account for the development of these and other human attributes. Huxley's view that human consciousness is merely a product of the greater complexity of the molecules of protoplasm was rejected by Wallace. Matter and consciousness were radically distinct to Wallace and he argued that "You cannot have, in the whole, what does not exist in any of the parts..." (Wallace, 1871, 365)[13]. To this view Wallace added "speculations [which] are usually held to be far beyond the bounds of science" but appeared to be "legitimate deductions from the facts of science" (369-70). These speculations were expressed by the use of words such as "some other power", "some intelligent power", to account for these phenomena. In short

> ...I contemplated the possibility that the development of the essentially human portions of man's structure and intellect may have been determined by the directing influence of some higher intellectual beings, acting through natural and universal laws (Wallace, 1871, (notes) 372-372a).

Wallace's own categorization of his views as "speculations" expresses the well-founded apprehension that they would not be taken seriously by the scientific community. They were, in fact, rejected by Darwin. In the 1870s and 1880s this kind of reasoning became even more suspect and allusions to spiritual or religious intervention in the shaping of mind and will or other human attributes were eventually abandoned. Wallace's appeal to higher powers as well as their rejection demonstrates the difficulty of entertaining a view of human faculty in terms other than that developed for physical and biological science[14]. The alternative to the "scientific" view - as defined by contemporaries - seemed to lie solely and ultimately with ideas borrowed from religion or discredited theories such as vitalism. An alternative conception for the study of individuals and society which could take into account special human attributes without falling into supernatural explanations did not fully present itself until the beginning of the twentieth century.

Uniformitarianism, by eliminating the barrier to the scientific study of society, paved the way for the wide acceptance of concepts supplied not from theology but from science. Emile Durkheim makes this point with reference to postivism and the blurring of the distinctions between 'natural' and 'logical' categories:

> Pour qu'on put dire de certains faits qu'ils sont surnaturels, il fallait avoir déjà le sentiment qu'il existe un ordre naturel des choses, c'est-à-dire que les phénomènes de l'univers sont liés entre eux suivant des rapports nécessaires, appelés lois. Une fois ce principe acquis, tout ce qui déroge à ces lois devait nécessairement apparaître comme en dehors de la nature et, par suite, de la raison: car ce qui est naturel en ce sens est aussi rationnel, ces relations nécessaires ne faisant qu'éxprimer la manière dont les chose s'enchaînenent logiquement (Durkheim, Les formes élémentaires de la vie religieuse, Paris, 1912, quoted in Burrow, 212).

The stark opposition between the natural and the supernatural, the free and the determined was in part the product of the application of the Newtonian world picture to all phenomena in the context of a society still permeated by theological conceptions of creation. The implications for a scientific sociology which, given the tremendous prestige of physical science could not but be based on these ideas, were manifold. Most importantly, attributes peculiar to human social and individual life could not be accommodated within the theoretical framework constructed by this physicalist philosophy. This claim and some of its implications in relation to the advent of the scientific sociology of eugenics will be examined further in the next sections.

f. The "New Philosophy".

In 1868 T.H. Huxley delivered an address in Edinburgh entitled "On the Physical Basis of Life" in which he acknowledged the "novelty" of the idea suggested by the phrase "the physical basis of life" since "so widely spread is the conception of life as a something which works through matter, but is independent of it". Given the endless diversity of life, the notion that there is a physical and ideal unity underlying it, would appear difficult to believe. "In fact", he states, "when first apprehended, such a doctrine as this would appear almost shocking to common sense." Huxley then proceeds to paint a picture of human life as depicted by the most up to date science of his time. He asserts that a threefold unity (of power or faculty, of form, and of substantial composition) "does pervade the whole living world" (Huxley, 1868, 133).

> In physiological language this means, that all the multifarious and complicated activities of man are comprehensible under three categories. Either they are immediately directed towards the maintenance and development of the body, or they effect transitory changes in the relative positions of parts of the body, or they tend towards the continuance of the species. Even those manifestations of intellect, of feeling, and of will, which we rightly name the higher faculties, are not excluded from this classification, inasmuch as to everyone but the subject of them they are known only as transitory changes in the relative parts of the body. Speech, gesture, and every other form of human action are, in the long run, resolvable into muscular contractions and muscular contraction is but a transitory change in the relative positions of the parts of a muscle (133-34).

Huxley then argues for the consistency of scientific language; "If scientific language is to possess a definite and constant signification whenever it is employed, it seems to me that we are logically bound to apply to the protoplasm, or physical basis of life, the same conceptions as those which are held elsewhere..." (153). The same tendency that was earlier pointed out in the uniformitarian debate - the tendency to equate scientific principle as antithetical to notions of "special status" - is also exhibited in Huxley's address. He then warns his audience:

> But I bid you beware that, in accepting these conclusions, you are placing your feet on the first rung of a ladder which, in most people's estimation, is the reverse of Jacob's, and leads to the antipodes of heaven. It may seem a small thing to admit that the dull vital actions of a fungus, or a foraminifer, are the properties of the protoplasm, and are the direct results of the nature of the matter of which they are composed. But if, as I have endeavoured to prove to you, their protoplasm is essentially identical with, and most readily converted into, that of any animal, I can discover no logical halting-place between the admission that such is the case, and the further concession that all vital actions may, with equal propriety, be said to be the result of the molecular forces of the protoplasm which displays it. And so, it must be true that, in the same sense and to the same extent, that the thoughts to which I am now giving utterance, and your thoughts regarding them, are the expression of molecular changes in that matter of life which is the source of our other vital phenomena (154).

Huxley's views regarding the nature of human life, his belief in the materialistic basis of will, feeling, and intellect were not untypical of an important section of the Victorian scientific community. To a large extent he is rightly considered as the representative of late nineteenth century British scientific philosophy. He also recognized the deeply rooted anxiety which this "new philosophy" was stirring in the hearts of his compatriots, testifying, to the intimate intercourse between scientific and nonscientific thought in British intellectual history. In the early period under review here, the materialist assumptions underlying physicalist philosophy were not simply considered as necessary postulates of natural science having no direct bearing on the human realm. They were perceived as directly threatening cherished views on human nature and calling into question established ethical and religious principles.

> The consciousness of this great truth weighs like a nightmare, I believe, upon many of the best minds of these days. They watch what they conceive to be the progress of materialism, in such fear and powerless anger as a savage feels, when, during an eclipse, the great shadow creeps over the face of the sun. The advancing tide of matter threatens to drown their souls; the tightening grasp of law impedes their freedom; they are alarmed lest man's moral nature be debased by the increase of his wisdom (160).

But Huxley's philosophical position, despite his paradoxical description of humans and animals as "conscious automata", cannot be labelled as materialistic or deterministic. His conception of causation was Humean and he took refuge in an idealistic and skeptical philosophy which denied that nature demonstrated any kind of "necessity" or that it was possible to reach beyond natural phenomena and know of entities such as "spirit" (see also Huxley, 1874, esp. 210, 245). He warned, as well, of mistaking the symbols and concepts of scientific language for real entities (Huxley, 1868, 165). Huxley did believe, however, that human mental and physiological nature and capabilities could be reduced to physical and mathematical laws. This belief was tied up with a general understanding of the "unity" of science which assumed that all natural phenomena could be reduced to the laws of mechanics. In discussing chemistry, for example, he states:

> ... the tendency of physico-chemical science is clearly towards the reduction of the problems of the infinitely little, as it already has reduced those of the infinitely great world, to questions of mechanics (Huxley, 1887, 75, see also 75n).

And later:

> The ultimate aim of modern physical science is the deduction of the phenomena exhibited by material bodies from physico-mathematical first principles (Huxley, 1887, 96).

It is clear that this reductionist conception of science - or the view that all "physical science" could be reduced to "physico-mathematical first principles" - was the proper approach for biological science as well as the study of individuals and society. (It must be remembered that by "physical science", Huxley also includes biology, and leaves room for a nascent scientific sociology since human life also rests on a physical basis). Although he reserves comment, in these early essays, on Herbert Spencer's "Synthetic Philosophy" which tried to apply these principles to society and human faculty he does commend the attempt as "the first... to deal on scientific principles, with modern scientific facts and speculations." In contrast, "M. Comte, with which Mr. Spencer's philosophy is sometimes compared, though it professes a similar object, is unfortunately permeated by a thoroughly unscientific spirit, and its author had no adequate acquaintance with the physical sciences even of his own time" (1887, 102-3).

To a large extent the idea of an unbroken continuity between humankind and nature derived from an ancient debate (see, e.g., Lovejoy). But it was inherent, as well in a dominant conception of science of Victorian and Edwardian Britain. In the various schemes of the field of knowledge presented by August Comte, Herbert Spencer and Karl Pearson later in the nineteenth century, sociology, ethics, history, in short, what we would now call the "social sciences", were represented as fundamentally linked to biology and that biology could eventually be reduced to or was subordinate to physics. This constituted one of the bases for the unity of science but it also fixed the fundamental principles for a scientific sociology. From the standpoint of an influential philosopher of science[15] who was also instrumental in the establishment of eugenics as a scientifically credible academic discipline, science was a matter of "facts" and "classification of facts":

> The classification of facts, the recognition of their sequence and relative significance is the function of science, and the habit of forming a judgment upon these facts unbiased by personal feeling is characteristic of what may be termed the scientific frame of mind. The scientific method of examining facts is not peculiar to one class of phenomena and to one class of workers; it is applicable to social as well as to physical problems, and we must carefully guard ourselves against supposing that the scientific frame of mind is a peculiarity of the professional scientist (Pearson, 4th ed., 1937, 21).

As Pearson believed, the social sciences were rapidly reaching the consensus among its practitioners which also distinguished science from metaphysics:

> A similar if not yet so complete agreement is rapidly springing up in both mental and social science, where the facts are more difficult to classify and the bias of individual opinion is much stronger. Our more thorough classification, however, of the facts of human development, our more accurate knowledge of the early history of human societies, of primitive customs, laws and religions, our application of the principle of natural selection to man and his communities, are converting anthropology, folk-lore, sociology and psychology into true sciences (4th ed., 1937, 19).

And a few pages later suggests that

> Strange as it may seem, the laboratory experiments of a biologist may have greater weight than all the theories of the State from Plato to Hegel! (29).

It seems fairly clear that in Pearson's philosophy of science, the perceived universal applicability of science seems to have led to a view that human affairs could only be adequately addressed by science and that the proper branch of science to which they belonged was biology. Implicitly or explicitly various thinkers also believed that biological science could and should also be ultimately "reduced" to the laws of physics. As Comte had stated (although Mill here disagreed with his mentor), "the subordination of social science to biology is so evident that nobody denies it in statement however it may be neglected in practice" (Comte, Positive Philosophy (1853) ii, 112 quoted in G. Jones, 1). T.H. Huxley expressed a similar view in a lecture delivered at the South Kensington Museum in 1876. Having reviewed the origin of the word "biology" Huxley then asks "What ground does it cover?"

> I have said that in its strict technical sense, it denotes all the phenomena which are exhibited by living things, as distinguished from those which are not living; but while that is all very well, so long as we confine ourselves to the lower animals and to plants, it lands us in considerable difficulties when we reach the higher forms of living things. For whatever view we may entertain about the nature of man, one thing is perfectly certain, that he is a living creature. Hence, if our definition is to be interpreted strictly, we must include man and all his ways and works under the head of Biology; in which case, we should find that psychology, politics, and political economy would be absorbed into the province of Biology. In fact, civil history would be merged in natural history.

After further justifying this categorization by outlining the continuity between human and animal life, Huxley nevertheless concedes that the former has been treated by a different branch of science. This, however, is due not to the special status of the object of study.

> The real fact is that we biologists are a self-sacrificing people; and inasmuch as, on a moderate estimate, there are about a quarter of a million different species of animals and plants to know about already, we feel that we have more than sufficient territory. There has been a sort of practical convention by which we give up to a different branch of science what Bacon and Hobbes would have called "Civil History". That branch of science has constituted itself under the head of Sociology... we have allowed that province of Biology to become autonomous; but I should like you to recollect that it is a sacrifice, and that you should not be surprised if it occasionally happens that you see a biologist apparently trespassing in the region of philosophy or politics; or meddling with human

> education; because, after all, that is a part of his kingdom which he has only voluntarily forsaken (Huxley, 1876, 270-71).

It was partly because of this definition of science which perceived of human life solely as an integral part of the world of matter and motion that eugenics could be taken seriously by so many scientists.

The growing belief in the efficacy of science had brought a tremendous respect for the views of scientists among the educated public. It suggested, as well, the possible benefits to society if the same approach were applied to the study of the latter. The Bible had claimed "the poor are always with you". But it now seemed possible that the age long and seemingly intractable social evils of poverty, disease, crime, and alcohol, would soon be amenable to scientific understanding and, as such, to lasting, effective, scientific solutions. The success of Newtonian mechanics had shown the way, in method and principle, to the understanding of all natural phenomena. The development and wide acceptance of uniformitarian principles, had all but eliminated any scientific objection to the eradication of the boundary which had placed the human will, reason or soul above natural processes and therefore above scientific explanation. The gradual victory of the "New Philosophy" over theological dogma and over competing scientific theories had, it seemed to many thinkers, finally completed the theoretical framework for the study of individuals and society and suggested a definite approach to the investigation of social problems.

A truly scientific sociology would have to utilize the existing concepts outlined above. Eugenics was one candidate for such a sociology which could legitimately make this claim. Social, political and economic conditions provided the necessary impetus for the construction of a scientific sociology but most of the necessary conceptual tools had already been fashioned. As a theory of human faculty and mental heredity Galton's eugenics rejected the special status which religion claimed for human life. A critic of Galton's Hereditary Genius had already noted this aspect of Galton's work:

> There have always been some sacred regions to which the man who could not part with faith in the living God has prided himself that even Materialism could not penetrate. The Ego, the individuality, that which constituted the centre of his consciousness, has said, "I come forth from God". "Parents have been instrumental in God's hands in fashioning my physical frame, and even my animal temperament and the quality which my nature has assumed, but God is the father of my spirit." This respectable delusion is now swept away by our ... author [Galton] (quoted in Cowan, 1977, 137).[16]

As mentioned, the rejection of any "sacred region" which was alleged to be beyond scientific study became an integral part of a dominant tradition of Victorian and Edwardian scientific philosophy. Despite the views of Huxley and others who claimed that we can have no knowledge of concepts such as "will", "spirit" or "matter" and "necessity" as understood by theologians (Huxley, 1868, 161), in practice a working theory proposing a mechanistic model of human faculty and development as a replacement for the theological model became the hallmark of the establishment of a scientific sociology. Uniformitarianism, and the "New Philosophy" in general applied to the human subject, was inextricably linked to a new conception of human nature. Indeed, as indicated by some of the reactions to the New Philosophy, contemporaries seemed quite aware of what this new conception entailed. Summarizing his views of the nature of human life as "conscious automata" Huxley then asserted:

> As to the logical consequences of this conviction of mine, I may be permitted to remark that logical consequences are the scarecrows of fools and the beacons of wise men. The only question a wise man can ask himself, and which any honest man will ask himself, is whether a doctrine is true or false. Consequences will take care of themselves; at most their importance can

> only justify us in testing with extra care the reasoning process from which they result (Huxley, 1874, 244-45).

One of the "logical consequences" of this view, however, was that no scientifically legitimate opposition to eugenics, when it made its appearance at the turn of the century, could be seriously entertained. Through its most sophisticated and scientifically knowledgeable advocates, eugenics was perceived as and did in fact conform to the principles and concepts that virtually defined science. Opponents of eugenics who criticized it as taking no heed of the "special" attributes of man could easily be discounted as unscientific. Eugenists utilized and applied to the study of human faculty the most sophisticated and up to date physiological and psychological theories and helped in their further development[17]. Under Galton, Pearson and others, eugenics absorbed the latest discoveries and concepts of hereditary and statistical science. Indeed, in this respect and as will be outlined below, eugenics provided an important impetus for the development of these sciences to their present form. As a quantitative theory, eugenics also conformed to the highest principles of Victorian science and demonstrated its allegiance to the paradigm of classical physics. It is interesting to note how, in this regard, the adoption of mathematical form and symbols is still perceived as the hallmark of science[18]. As a theory which was often accused of "biological determinism", eugenists could simply point to physics itself, the most successful and "deterministic" science of all.

The ideological dimension of eugenics, what to us and to scientists like J.B.S. Haldane and H.J. Muller in the inter-war years looked like obvious justification of race, class and hierarchy was not so apparent then. In many respects these "ideological" factors were taken for granted by many intellectuals and scientists in Victorian and Edwardian Britain and were rarely challenged[19]. They were almost perceived as a given, while the role of a scientific sociology was often limited not to questioning the dubious hypotheses underlying these views but to explaining and expressing the dynamics of (already pre-established) human difference. It seems apparent that the science of the day, imbued as it was with notions drawn from classical physics, was incapable of scrutinizing these "ideological" elements in eugenics, as well as in other theories dubbed as positivistic or Social Darwinist. Like a blunted scalpel it lacked the conceptual and critical sharpness to carve away the ideological elements in this social theory. This was ironic because the attempt to eliminate bias and prejudice in the understanding of all phenomena had been one of the hallmarks of the Scientific Enlightenment. With the advent of evolutionary biology, the intimate connection between science and ideology was, if anything, intensified. As the next section will try to show, eugenics proceeded from and in many important ways, was an integral part of Darwinian biology.

NOTES

1. Contemporaries sometimes also perceived the "amateurishness" of British science, especially when comparisons were made to developments on the Continent. As Charles Babbage, F.R.S., Lucasian Professor of Mathematics at Cambridge, inventor of the "calculating engine" (perhaps the world's first computer), lamented in 1830, "The pursuit of science does not, in England, constitute a distinct profession, as it does in many other countries", consequently, "when a situation, requiring for the proper fulfillment of its duties considerable scientific attainments, is vacant, it becomes necessary to select from among amateurs" (Babbage, 6). Whether or not Babbage's assessment of the "scientific decline" was correct, many agreed with the evaluation that, as one outsider put it in 1837, "England is not the land of science; there is only a widely dispersed amateurishness" (J. Carriere, Berzelius und Liebig, ihre Briefe von 1831-1845, Munich and Leipzig, 1893, 134, quoted in Russell, 175). This was a frequent source of lament for writers such as Matthew Arnold, Huxley and Karl Pearson later in the century.

2. Lewontin, 1990; Popper, 1960. Popper has modified this stance in later statements about evolution.

3. Galton believed that Plato and Bacon were of the same intellectual rank, (1869, 342). Pearson displays what appears to be a prevailing admiration of "true Baconian principles" while denigrating others working in the "pure field of conception":

> ...[i]t is from men like Laplace and Darwin, who have devoted their lives to natural science, rather than from workers in the pure field of conception, like [John Stuart] Mill and Stanley Jevons, that we must seek for a true estimate of the Baconian method.

Pearson then includes a laudatory citation from Laplace on Bacon in a footnote (4th ed., 1937, 33, 33n).

Darwin at times also believed he was following "true Baconian principles" in the construction of his theory:

> After my return to England it appeared to me that by following the example of Lyell in Geology, and by collecting all facts which bore in any way on the variation of animals and plants under domestication and nature, some light might perhaps be thrown on the whole subject. My first note-book was opened in July 1837. I worked on true Baconian

> principles, and without any theory collected facts on a wholesale scale...(Darwin, 1898, i, 67-8).

Not a few writers have expressed their skepticism of this Baconian claim (cf. Himmelfarb, ch.7).

4. Significantly, Sprat continues, "...these two subjects, God and the soul, being only forborne: in all the rest they [philosophers] wander at their pleasure" (quoted in Trevelyan, 272).

5. Galton's father, as well as Galton himself were members of the Birmingham Lunar Society (for Galton's father see Russell, 104).

6. I recognize the distinction between abstract science and technology and am aware that some have advanced the view that technology, not science, played the crucial role in the Industrial Revolution. This is an interesting topic but need not detain us here since the important point is that people living under the Industrial Revolution gave a large amount of blame (or credit) indiscriminately to both. As Russell states, "science must be commonly <u>thought</u> to have conferred practical benefits to mankind" (Russell, 10). The distinction between science and technology or "pure" and "applied" thought is in many ways a product of a more recent age. As Hobsbawm states of the early Industrial Revolution "scientists still refused to make the subsequent distinction between 'pure' and 'applied' thought." Moreover, this period which was actually "technically rather primitive" nevertheless witnessed a tremendous change in the organization of production because the

> application of simple ideas and devices, often of ideas available for centuries... could produce striking results... The novelty lay not in the innovations, but in the readiness of practical men to put their minds to using the science and technology which had long been available and within reach... It lay not in the flowering of individual inventive genius, but in the practical situation which turned men's thought to soluble problems.

This turning of men's thoughts to soluble problems is perhaps the real value of Bacon's legacy (Hobsbawm, 59-60).

7. In fact some authors (e.g., Shapin & Barnes, 1977) also interested in the interaction between science and society, have suggested that these Institutes helped to establish more effective social control over the labour aristocracy in the context of a rapidly industrializing society. In this

sense, science is perceived as a most valuable weapon of the bourgeoisie. A persuasive citation is produced, authored by a student-labourer at one of the Institutes:

> Meeting, as both classes do, on the fair field of science, where all are as brothers, and pursuing, it may be, the same glorious objects, the wall of separation is removed forever, and the best possible guarantee given for the inviolable maintenance of the rights of property on the one hand, and peace and security of society on the other (Prize winning essay by a member of the Glasgow Mechanics' Institute. D.Burns, "Mechanics' Institutions: Their Objects and Tendencies", Glasgow, 1837, 56-7 quoted in Shapin and Barnes).

Russell, however, warns of too facile a view of science as an ideological tool and states: "...the available evidence suggests that the role of science in the Mechanics' Institutes was chiefly to minister to local patriotism, frequently to provide useful practical knowledge but only occasionally to serve as an instrument for controlling the turbulent society of England in the nineteenth century" (Russell, 173).

8. Locke's teachings, states Merz, "had been domiciled in France by Condillac and Helvetius. This philosophy, in its popular version, taught that all our thoughts and ideas were ultimately made up of sensations" (Merz, ii, 470). Pierre Jean Georges Cabanis, French philosopher and medical scientist (1757-1808), was among the most famous of Continental personalities to have credited Locke, "to whom philosophy is indebted for the greatest and the most useful impulse" (preface to Rapports du Physique et du Moral de l'Homme, 1802, quoted in Merz, ii, 470n). In his Rapports Cabanis states:

> Les opérations de l'intélligence et de la volonté se trouveraient confondues à leur origine avec les autres mouvements vitaux : le principe des sciences morales, et par conséquences ces sciences elles-même rentreraient dans le domaine de la physique ; elles ne seraient plus qu'une branche de l'histoire naturelle de l'homme : l'art d'y vérifier les observations, d'y tenter les expériences, et d'en tirer tous les résultats certains qu'elles peuvent fournir, ne différeraient en rien des moyens qui sont journellement employés avec la plus entière et la plus juste confiances dans les sciences pratiques dont la ceritude est le moin contestée (quoted in Merz, 470n).

9. In Galton's word:

> The only information that reaches us concerning outward events appears to pass through our senses ; and the more perceptive the senses are of difference, the larger is the field upon which our judgment and intelligence can act (Galton, 1919, 19).

Of course the degree of sensitivity of different groups or individuals varies widely, "The discriminating faculty of idiots is curiously low...". Often, states Galton, the latter are insensitive to heat, cold and severe pain. Conversely, sensitivity is highest among the intellectually ablest (20).

10. In a subsection of a chapter of his Inquiries into Human Faculty entitled "Nature Proceeds in Benthamite Fashion", Galton states:

> If we summon before our imagination in a single mighty host, the whole number of living things from the earliest date... to the latest future..., and if we cease to dwell on the miscarriages of individual lives or of single generations, we shall plainly perceive that the actual tenantry of the world progresses in a direction that may be described as the greatest happiness of the greatest number" (Galton, 1919, 2nd ed., 194-95).

11. Galton was apparently in attendance at this meeting (Forrest, 84).

12. But see Mayr, 1982, 375-381, for an opposing view.

13. It is interesting to note that contemporary philosophy of biology addresses this problem. While it has retained a mechanistic view of mind and consciousness, it has allowed room for a recognition of the unique properties of these attributes without falling into a vitalist or supernaturalist philosophy. This is manifested in the concept of emergence which, in the words of Ernst Mayr, asserts the potential of complex systems to manifest properties not existing in their components. This concept would have addressed Wallace's criticisms of Huxley without having had to resort to supernatural explanations, as Wallace did.

14. The view that scientific explanation should have no recourse to God or religious ideas was not universally accepted, however. Before the 1860s, British scientific thought was significantly influenced by the school of natural theology which advanced the view that natural

phenomena showed evidence of purpose and a Creator. Among the foremost exponents of this school was William Paley (Natural Theology, 6th ed., 1903) who had a considerable influence on Darwin. But even after 1860, many eminent personalities still argued against what was becoming the dominant scientific philosophy. In an essay directed against Darwin and arguing for the purposive rather than the accidental nature of variations in nature, the Duke of Argyll sought to restore religious explanation in scientific thought and criticized what he termed "Nescience".

> The objection of Mr. Darwin is founded on that disposition - so old in the history of Philosophy, and now as much revived - to dismiss as "Anthropomorphic" every conception of the Divine character and attributes which brings them into conceivable relation with even the highest character and attributes of Man. This is part of the philosophy of Nescience... (Duke of Argyll, 154. See also Young, 1985c, 1985d).

15. A.H. Sturtevant believed that Pearson's Grammar "had a great deal of influence" on laymen and fellow scientists (Sturtevant, 58), while Henry Adams writes that the "The fall or rise of half-a-dozen empires interested a student less than the rise of the 'Grammar of Science' (quoted in Kevles, 28).

16. This citation is attributed by Cowan to Merivale (1870) but I have not found it there.

17. For example, Galton pioneered the use of mental tests and physiological tests (e.g., Galton, 1919) which inspired Alfred Binet to further develop a quantifiable measure of intelligence. (Thomas Pogue Weinland, A History of the IQ in America 1890-1941, University Microfilms, 66-68 in Kevles, 77). Some of Galton's other contributions to science are discussed more fully in chapter V.

18. The relation between the sciences of genetics, statistics and eugenics is the subject of sections below. As for the adoption of mathematical language, Bronowski and Mazlish state:

> ...to this day, our confidence in any science is roughly proportional to the amount of mathematics it employs... We feel that physics is truly a science, but that there somehow clings to chemistry the less formal odor (and odium) of the cookbook. And as we proceed further to biology, then to economics, and last to social studies, we know that we are fast slipping down a slope away from science (Mazlish & Bronowski, 218).

19. Lorimer, however, makes an important distinction between a pervasive ethnocentric "insouciant assumption of Anglo-Saxon superiority by Negrophobe and Negrophile alike... [which] was not a prejudiced projection of guilt or frustration, but an entirely conventional assumption resting upon social attitudes shaped by the evident and accepted inequalities of class within England" and a later type of racialism (beginning in the 1860s) resting partly on a

> combination of a more pessimistic view of man's potential with a new determinism. This declared that biological inheritance governed the individual's physical, intellectual, and psychological attributes, and thus fixed at birth a person's place in the natural and social order (Lorimer, 202).

In this sense, eugenics (as well as other types of Social Darwinism) represented a qualitatively new type of racialism challenging both traditional liberal notions of individual self-help and older religious views on the status of human life and mind. While the changing social and political contexts are crucial in understanding the rise of this new racialism, it is evident that the form and content of scientific theories assume an increasingly determining role in shaping it. This is the subject of the next two chapters.

## IV. "SOCIAL DARWINISM" AND EUGENICS

### a. "Social Darwinism" and British Science.

Nowhere has the connection between British social and scientific thought attracted more comment than in the phenomena of Social Darwinism. Whatever framework one chooses to adopt in assessing this phenomena, its various manifestations attest to the intimate connection of science and social thought.

> Where it did not act directly, it acted indirectly. Trickling and filtering down to the masses, it permeated even the daily press, the current political and social ideas, the beliefs and aspirations of the sects and the Churches. Those who themselves explicitly reject the Darwinian creed yet cannot possibly escape from many of its implications. It runs throughout almost all the best of our time; it tinges our unformed public notions; it reappears under a hundred disguises in works on law and history, in political speeches and religious discourse, in artistic theories and vague social speculations. Our very novels and poems are full of latent Darwinian gems. If we try to think ourselves away from it we must think ourselves entirely away from our age (Darwin's funeral, Pall Mall Gazette, April, 1882).

While the "origins of the Origin" has become an industry in itself, most writers agree that Darwin borrowed widely both from the social and scientific literature of Britain and the Continent in the formation of his main concepts. Two examples frequently mentioned are Herbert Spencer's phrases "survival of the fittest" and "evolution" which became associated with Darwin's theories and Malthus' population concept[1]. In turn, social and scientific thought borrowed extensively from Darwin, and it is a particular kind of appropriation of the latter that has been labelled "Social Darwinism".

Often, Social Darwinism is represented as being a "distortion" of Darwin or a "misapplication" of legitimate science. This view is held by Himmelfarb:

> Even those who are entirely convinced of the validity of Darwin's scientific doctrines may be wary of their extension to political or social theory. ... More than most theories, Darwinism lent itself to such stratagems of persuasion, enjoying not only the prestige and authority attached to science but also the faculty of being readily translated into social terms. That this translation was necessarily free and loose was an added advantage, since it gave license to a variety of social gospels (Himmelfarb, 412)[2].

Darwinism did indeed lend itself to a variety of social applications. As George Bernard Shaw said, Darwin "had the luck to please everybody who has an axe to grind." Though an important distinction exists between Darwinian science and Social Darwinism, we must not make too wide a divide between them. In fact, the expression "Social Darwinism" was never used at the time, most writers content with the simple term "Darwinism"[3].

It would seem, indeed, that at times Darwin himself was a "Social Darwinist". After the publication of Darwin's Origin, a famous debate on "man's place in nature", was conducted by Huxley and others against religious and other opponents of evolution (see, for example, Huxley, 1893-4; Young, 1973; Young, 1985). A subsidiary but no less important debate was conducted by those who had already accepted the validity of Darwin's evolution. This debated centred on the implications and the effects of natural selection as related to human beings, a subject which Darwin had consciously avoided for a time.

> I think I shall avoid the whole subject as so surrounded with prejudice; though I fully admit it is the highest and most interesting problem for the naturalist (Darwin to Wallace, 1857, quoted in Farrall, 1985, 12).

But Darwin eventually dedicated an entire book to the question of natural selection as applied to humans (although most of it still dealt with other species). Recent researches into his notebooks and letters have also revealed apparently "ideological" factors in the construction of his scientific theory. As one writer states, "To the best of my knowledge the M and N notebooks contain the first presentation of an evolutionary view of society based on an evolutionary view of nature" (Schweber, 229-316)[4]. In his Descent of Man, Darwin seems to accept some of the leading ideas of eugenics. Acknowledging the work of Galton, W.R. Greg and his own colleague, Wallace, he states:

> With savages, the weak in body or mind are soon eliminated; and those that survive commonly exhibit a vigorous state of health. We civilized men, on the other hand, do our utmost to check the process of elimination; we build asylums for the imbecile, the maimed, and the sick; we institute poor-laws; and our medical men exert their utmost skill to save the life of every one to the last moment. There is reason to believe that vaccination has preserved thousands, who from a weak constitution would formerly have succumbed to small-pox. Thus the weak members of civilised societies propagate their kind. No one who has attended to the breeding of domestic animals will doubt that this must be highly injurious to the race of man. It is surprising how soon a want of care, or care wrongly directed, leads to degeneration of a domestic race; but excepting in the case of man himself, hardly any one is so ignorant as to allow his worst animals to breed (Darwin, Descent, 1936, 501).

While reading Hereditary Genius in 1869, Darwin congratulated Galton on his work and exuberantly wrote to him;

> I have only read fifty pages of your book... but I must exhale myself, else something will go wrong in my inside. I do not think I ever in all my life read anything more interesting or original... You have made a convert of an opponent in one sense, for I have always maintained that, excepting fools, men did not differ much in intellect, only in zeal and hard work; and I still think [this] is an eminently important difference (Darwin to Galton, 23 December, 1870?, in Darwin, 1903, ii, 41. See also, Pearson, 1914-30, i, plate 6).

In another letter, Darwin again comments favourably on his cousin's work and on Galton's plan for keeping a general registry of families of "superior stock" for possible future eugenic breeding (Galton, 1873a, 116): "Though I see so much difficulty," writes Darwin, "the object seems a grand one; and you have pointed out the sole feasible, yet I fear utopian, plan of procedure in improving the human race" (Darwin to Galton, 1903, ii, 43-4). Darwin doubts whether people would give the intelligent assent needed to make Galton's plan a practical possibility. Yet he also expresses his approval of the main principles of eugenics; his major hesitation being whether people would co-operate with Galton's scheme.

The point here is not to denounce Darwin's "ideological prejudices" but to show how these were an integral part of the science of his day. To Darwin's and Galton's contemporaries, the social implications of the theory _were_ an integral part of the science, or a legitimate deduction from the facts of evolution. The perception that eugenics, for example, was a misapplication of Darwin's theory was not one that scientifically minded contemporaries would have immediately recognized. The sharp distinction between Darwinian science and "Social Darwinism" is thus largely a product of hindsight. This explains why Wallace, for example, was led from his opposition to an individualistic type of "Social Darwinism", into a view partly based on supernatural concepts (see above). It explains also why the fiercest opposition to eugenics came not from scientists but from Roman Catholics and "a certain type of individualist liberal" (Searle, 1976, 112-115).

Because humans are biological creatures, subject to the same laws as the rest of nature, the proper scientific approach would be to study them in their proper framework: the one developed by physical and biological science. Darwin himself developed his transmutation theory in accordance with prevailing notions of what constituted good science. In the first half of the nineteenth century these were still for the most part influenced by evaluations of what Newton had done. Writers in scientific philosophy, sometimes also practicing scientists like the astronomer John F.W. Herschel, helped articulate this philosophy. In Herschel's view good science was "causal", showing not only how but why things happened. One could recognize a "true cause" (a vera causa) when one could actually see it in action or, otherwise, argue analogically from known causes to unknown ones (Herschel, 149; Ruse, 1982, 43-45). In his Autobiography Darwin credits Herschel as a major influence in his decision to take up natural history. He reveals his indebtedness to Herschel in the structure of the argument presented in his master work. Darwin begins Origin by describing the work of breeders in effecting lasting changes in domesticated plants and animals through their preserving and accumulating desirable variations ("Variation under Domestication"). He then outlines variation as ever-present in a state of nature ("Variation under Nature") before moving on to Malthus' doctrine of geometrical population increase ("Struggle for Existence") and finally to "Natural Selection; or the Survival of the Fittest". The movement of the argument here is from a known cause for changes in domesticated animals and plants - artificial selection - to an unknown cause for changes in the state of nature - natural selection. Darwin, in contrast to contemporary opponents of evolutionary theory, found in artificial selection a worthy analogy or a vera causa with which to propose natural selection as the mechanism of evolution.

In William Whewell's writings on the philosophy and history of science, another criterion of good science was proposed (Whewell, 1837; 1840). We know we have a vera causa, Whewell states, when all indirect evidence points to this cause and this cause is able to explain and unite in simple propositions, a wide variety of phenomena. In Newton's case, gravity fulfills this role, uniting the motion of earthly bodies, tides, moons and planets and other phenomena (Whewell, 1837; 1840; cf. Ruse, 1982, 46). Whewell called this a "consilience of inductions" and Darwin often used this aspect of his theory to justify it as a legitimate scientific hypothesis against critics who viewed transmutation or natural selection as an unwarranted and unprovable hypothesis.

> It can hardly be supposed that a false theory would explain, in so satisfactory a manner as does natural selection, the several large classes of facts above specified. It has recently been objected that this is an unsafe method of arguing; but it is a method used in judging of the common events of life, and has often been used by the greatest natural philosophers. The undulatory theory of light has thus been arrived at; and the belief in the revolution of the earth on its own axis was until lately supported by hardly any direct evidence (Darwin, Origin, 1936, 367).

Darwin's theory simply offered new conceptual tools and added greater prestige to an important viewpoint among Victorian men of science, that humans should be examined in the same light as the rest of nature and without recourse to God. The need to establish an independent science for the study of individuals and society was not ignored. Darwin's contemporaries, if not Darwin himself, assumed that the proper underpinnings of this study had finally been found.

It was in this general scientific and intellectual climate that one leading candidate for such a scientific sociology - eugenics - was put forward. The establishment of the Eugenics Education Society and the institutionalization of the Galton and Biometric Laboratories, were thus only a climax to a debate which had their roots both in the Scientific Revolution and in the nineteenth century debate surrounding evolution. The advent of eugenics, as a scientifically respectable attempt to found a scientific sociology and as subspecies of "Social Darwinism" was partly a direct product of a certain philosophy of science.

In addition, eugenics seemed particularly well situated in relation to late nineteenth century biology in that some of its major concepts flowed directly from questions arising out of Darwin's theory. Eugenics inserted itself forcefully into the post-Origin debate and offered solutions which were most convincing to a substantial part of the scientific community and the wider public. This will be the subject of the following section.

### b. Darwinism and Eugenics

In the nineteenth century, before the publication of Darwin's Origin, the works of several authors provide sufficient evidence for demonstrating that certain key ideas of eugenics were already in circulation. Two articles outlining human progress as due to a Malthusian pressure of limited food on a growing population were published in 1852 by Herbert Spencer. Between 1860 and 1890, states Farrall, eugenic ideas were discussed in British publications - before the founding of the Galton Laboratory and mostly before the invention of the word "eugenics" (Farrall, 1985, 10).

Darwin's Origin, was an important milestone in the development of eugenics and helped to direct scientific thinking into areas which would prove fruitful both to the development of biology and to the development of eugenics. The importance of Darwin for eugenics is due, firstly, to the renewed attention which the theory of evolution from natural selection cast on the mechanisms of heredity or variation and inheritance, as they were then called. In Darwin's theory, the transmutation of species depended upon two major factors: (a) population pressure (both intra and inter species competition) which established a struggle for survival and (b) variation which guaranteed that the offspring of a given organism would differ slightly from its parent(s). Variations which turned out to be favourable to an organism in the struggle for survival in its environment and in competition with its neighbours would be preserved and would enable that organism to pass on its superior constitution to progeny. Over the course of millennia these favourable variations would accumulate and modify the organism to better fill its place in the economy of nature. In time this selecting agency would result in the formation of a distinct line or species. Thus heredity is the "raw material" upon which nature "selects" and remains a central component of evolutionary theory. Galton, by focussing on these questions, had fixed himself to a strategic field in the history of biology. In the years before the rediscovery of Mendel's experiments, Galton's study of heredity provided important conceptual and experimental tools upon which both eugenics and the science of genetics would be based (chapter V).

Another central theme which eugenics picked up from the Darwinian debate on evolution was related to the question of "man's place in nature" (mentioned above) also conducted in the later nineteenth century by writers who had already accepted the validity of evolution. This debate revolved around the possibility that civilization had suspended the action of natural selection on human beings. This second debate will be described before moving on to Galton's work in genetics in the next chapter.

In 1864, A.R. Wallace, co-discoverer of natural selection, wrote an article for the Anthropological Review (May 1864) in which he expressed the view that natural selection applied mostly to the mind not the body of human beings (Wallace, 1864, 303-331; cf. Farrall, 17-18). Noting the unusual "dogmatism" which was attached to the question of the human race's origins, Wallace argued that human social organization (a product of mankind's unique mental and moral faculties) had largely supplanted the beneficial but ruthless effects of natural selection in shaping most of the human being's physical frame. In animals, the slightest infirmity could easily lead to death

> But in man, as we now behold him, this is different. He is social and sympathetic. In the rudest tribes the sick are assisted, at least with food; less robust health and vigour than the average does not entail death. Neither does the want of perfect limbs, or other organs, produce the same effect as among animals. Some division of labour takes place; the swiftest hunt, the less active fish, or gather fruits; food is, to some extent, exchanged or divided. The action of natural selection is therefore checked; the weaker, the dwarfish, those of less active limbs, or less piercing eyesight, do not suffer the extreme penalty which falls upon animals so defective (Wallace, 1864, 312).

As physical characteristics decline in importance, "mental and moral qualities will have increasing influence on the well-being of the race" (312). 'Nature' henceforth 'selects' those groups which exhibit the best and most cohesive social organizations, the products of specifically human mental and moral evolution.

> Tribes in which such mental and moral qualities were predominant, would therefore have an advantage in the struggle for existence over other tribes in which they were less developed, would live and maintain their numbers, while the others would decrease and finally succumb (313).

"Survival of the fittest", according to Wallace, must be seen as referring to the group rather than the individual. The beneficial variations which natural selection accumulates to shape the physical and behavioural structure of animals to suit them to a changing environment is confined, in humankind, to the development of its intellect alone (315). The sociable qualities and advantages which flow from the increasing primacy of mental evolution allows for more flexibility in adapting to wide differences and rapid changes in environment. The less socially developed tribes would gradually wane and the socially more developed gain ascendancy over "mentally undeveloped populations" (318). With increasing mastery over nature, humanity would find itself in larger and larger groups until "the world is again inhabited by a single nearly homogenous race, no individual of which will be inferior to the noblest specimens of existing humanity" (330)[5].

In another essay, however, Wallace claims that natural selection cannot completely account for the mental and moral aptitudes of humans or their emergence from the lower animals. This forms part of the basis of his "speculations" on the need to postulate the existence of higher beings (Wallace, 1871, 332-372c and above). Wallace's view of natural selection, like Spencer's notion of evolution was decidedly optimistic - mankind was heading for increasing harmony and perfection. But a less optimistic variant of the hypothesis of natural selection as applied to mankind also existed. An individualistic view of the struggle for existence was advanced by W.R. Greg in an 1868 article in Fraser's Magazine and in the two articles by Francis Galton already mentioned for Macmillan's Magazine in 1865. In Greg's view the supposed suspension of natural selection, did not have optimistic implications:

> The various influences of our social system combine to traverse the righteous and salutary law which God ordained for the preservation of a worthy and improving humanity; and the 'varieties' of man that endure and multiply their likenesses, and mould the features of the coming times, are not the soundest constitutions that can be found among us, nor the most subtle and resourceful minds, nor the most amiable or self-denying tempers, nor the most sagacious judgments, nor even the most imperious and persistent wills, but often the precise reverse - often those emasculated by luxury and those damaged by want, those rendered wreckless by squalid poverty, and whose physical and mental energies have been sapped, and whose characters have been grievously

> impaired, by long indulgence and forestalled desires (Greg, 326).

According to Greg, civilization, by suspending the action of natural selection, allowed the propagation of inferior types. At the same time, however, natural selection was still strongly active in inter-group competition:

> The principle of 'Survival of the Fittest' does not appear to fail in the case of races of men. Here the abler, the stronger, the more advanced, the finer in short, are still the more favoured ones; succeed in the competition, exterminate, govern, supersede, fight, eat, or work the inferior tribes out of existence (Greg, 98-9; Farrall, 1985, 17-20).

Within civilized societies, the suspension of the struggle for existence was producing an increasing number of misfits and inferior types of humanity, while between these same polities, it would seem, the struggle continued unabated.

Greg's was not the only voice who spoke in such ominous tones. The spectre of "deterioration" - often blamed on the conditions of urban life struck a responsive chord in Victorian society (see, for example, Morgan; Bridges; Stedman-Jones; and Searle, 1971). Fears about the deterioration of the British urban population as a result of the squalid conditions in urban slums had been a consistent theme in Victorian literature. After the publication of Darwin's Origin, some of this concern was linked to the notion that the continued proliferation of these urban groups could constitute a menace to the "race" and to British imperial power. Statistical data on military recruits (Rumsey, 466-72) and on a supposedly increased incidence of insanity, tuberculosis and cancer (Strahan, for mental illness, 83-5; tuberculosis, 194ff; cancer, 177-80) suggested that the race was physically deteriorating. Galton himself had contributed to this topic in an 1873 paper on "The Relative Supply From Town and Country Families to the Population of Future Generations" (Galton, 1873b, 19-26).

Greg's and Galton's articles provided an explanation for the phenomena, identified the "problem group" (to use a later phrase) and suggested that some control over marriage and some changes to the welfare system might help offset the deterioration. Foreshadowing Galton and eugenics, Greg also prohesied a possible utopia if these measures were rigorously adopted:

> A republic is conceivable in which paupers should be forbidden to propagate; in which all candidates for the proud and solemn privilege of continuing an untainted and perfecting race should be subjected to a pass or a competitive examination, and those only be suffered to transmit their names and families to future generations who had a pure, vigorous and well developed constitution to transmit...(Greg, 111-12).

But, as one reviewer surmised it, Greg was not a utopian (Field, 9). He advocated no concerted program to help speed up the progress of the race save that of a gradual enlightenment of the populace.

> We can only trust to the slow influences of enlightenment and moral susceptibility, percolating downwards and in time permeating all ranks. We can only watch and be careful that any other influences we do set in motion shall be such as are, when they work at all, may work in the right direction (Greg, 362).

Several reviewers of Greg's article commented that the solution to deterioration lay in strengthening rather than weakening the "social sympathies" which Greg held partly responsible for deterioration. Echoing Wallace's view, one eminent writer stated:

> As we have pointed out man is a social animal, and the social virtues, which are urged by some persons as causes of deterioration, are the very strength of the communities in which they have been naturally and necessarily developed (Lankester, 1870, 128).

These theories of degeneration were not new. Darwin's evolutionary concepts only helped to focus greater attention on the victims, created new terms and concepts which explained their meaning and wider import, and clothed them in scientific language. Thomas Malthus had, in a different context, warned against the nefarious long term results which would accrue from any attempt to suspend nature's work. But despite the theory of Malthus which some believed had "spread a gloom over the hopes and more sanguine speculations of man" and had "cast a slur upon the face of nature" (Hazlitt, "Mr. Malthus" 1825), Victorian social theory remained strongly committed to the efficacy of environmental change on human character. As noted above, this environmentalist framework had a long history in British science. Although science was viewed by many as capable of providing a solution to social problems, the dominant scientific outlook of mid-Victorian Britain was inimical to hereditarian explanations of human character and behaviour[6]. As Houghton states, one important trend in Victorian thought which was adopted from the rational philosophers of another age, was a belief in "the almost omnipotent effect of external circumstances on the shaping of mind and character, [and the Victorians] added the particular argument that by the control of environment human life might be vastly improved" (Houghton, 28). It was this kind of faith which helped to fire up groups like the Health of Towns Association and sanitary reformers (but otherwise "fiscal conservatives") like Sir Edwin Chadwick (Chase, 56-57; Finer, 237).

But Mill, while reaffirming the environmentalist credo, indicates that the biological approach to social problems was not unknown. Indeed he describes it as the "prevailing tendency".

> I have long felt that the prevailing tendency to regard all the marked distinctions of human character as innate, and in the main indelible, and to ignore the irresistible proofs that by far the greater part of those differences, whether

> between individuals, races or sexes, are such as not only might but naturally would be produced by differences in circumstances, is one of the chief hinderances to the rational treatment of great social questions, and one of the great stumbling blocks to human improvement (Mill, 1969, 162).

Yet the environmentalist position in mid-Victorian Britain probably remained the dominant one among intellectuals, scientists and social reformers. "Popular feeling", as Galton stated in his autobiography, "was not then ripe to accept even the elementary truths of hereditary talent and character, upon which the possibility of Race Improvement depends. Still less was it prepared to consider dispassionately any proposals for practical action" (Galton, 1908, 310). This is why he "laid the subject to one side for many years [1874-1901]" (Galton, 1908, 310).

By the beginning of the twentieth century, however, "popular feeling" had noticeably changed and eugenics had become established both as an academic and a popular movement. The reasons for this transformation are manifold. Many historians have dealt with the importance of urban "degeneration" and imperial anxiety as conducive to new views on human character and potential. But changes in the political, social and economic climate as expressed, for example, by the slogan of "National Efficiency" or by fears of "urban deterioration" cannot be adequately understood without reference to developments in the science of the day. Whether one opted for Huxley's, Tyndall's, Wallace's or any other scientist's approach, few thinkers, outside the religious opponents of evolutionism, rejected the Darwinian model as appropriate for the study of contemporary social problems. By the end of the nineteenth century, the study and treatment of social questions were increasingly influenced by this scientific theory. The scientific views which then dominated the treatment of social questions were many and diverse. Huxley's mechanistic philosophy epitomized one important approach to the study of individuals and society which greatly influenced Galton's and Pearson's perspectives. The importance of Wallace's social interpretation of human evolution, however, should not be underestimated, especially since it came from the co-founder of evolutionary biology. Other authors such as Petr Kropotkin, would make similar interpretations of evolutionary theory as applied to the human realm. Despite a prevailing view that Darwinism served mainly as a justification for laissez-faire individualism and competition, Wallace's social interpretation of evolution provides an example of a different kind of Darwinism. There were in fact as many varieties of this strain as there were of one of its products, eugenics[7].

But whichever Darwinist variant these thinkers chose to use, it is clear that their use of it was dictated by a view which accepted that social and political thought should be based on science. Thus eugenics cannot be dismissed as a simple manifestation of basically social, economic and political anxieties and a closer look at eugenist's claim that their theories were grounded in legitimate science is warranted. Eugenics obviously benefitted from the shift in the political climate. But it may equally have benefitted from new developments in science. This will be examined in the next Chapter.

<u>NOTES</u>

1. Spencer used the phrase "survival of the fittest" in 1852, (1852, 468-501). Although Spencer's terms gained well-known prominence, Darwin's assessment of him is rather uncharitable:

> Herbert Spencer's conversation seemed to me very interesting, but I did not like him particularly and did not feel that I could easily have become intimate with him. I think that he was extremely egotistical. After reading one of his books I generally feel enthusiastic admiration of his transcendent talents, and have often wondered whether in the distant future he would rank with the great men, as Descartes, Leibnitz, etc., about whom, however, I know very little. Nevertheless, I am not conscious of having profited in my own work by Spencer's writings. His deductive manner of treating any subject is wholly opposed to my frame of mind. His conclusions never convince me; and over and over again I have said to myself, after reading one of his descriptions, "Here would be a fine subject for half-a-dozen-years' work." His fundamental generalisations (which have been compared in importance by some persons with Newton's Laws!), which I daresay may be very valuable under a philosophical point of view, are of such a nature that they do not seem to me to be of any strictly scientific use. They partake more of the nature of definitions than of laws of nature. They do not aid me in predicting what will happen in any particular case. Anyhow they have not been of any use to me (Darwin, "Autobiography", Cambridge Mss., quoted in Himmelfarb, 227).

With Malthus, Darwin and Wallace seem to grant a great deal more. In <u>Descent</u>, Mathus' "ever memorable" <u>Essay on Population</u> is favourably cited. Indeed it was a crucial part of Darwin's theory:

> In October 1838, that is, fifteen months after I had begun my systematic inquiry [on the origin of species], I happened to read for amusement 'Malthus on Population', and being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favourable variations would tend to

> be preserved, and unfavourable ones to be destroyed. The result of this would be the formation of a new species. Here then, I had at last got to a theory by which to work... (Darwin, 1898, i, 68).

or the even more dramatic account of Wallace's discovery of the origin of species in the throws of malarial fever:

> At the time in question [1858] I was suffering from a sharp attack of intermittent fever, and every day during the cold and succeeding hot fits had to lie down for several hours, during which time I had nothing to do but to think over any subjects then particularly interesting to me. One day something brought to my recollection Malthus's "Principles of Population"...I thought of his clear exposition of "the positive checks to increase" - disease, accidents, war, and famine... It then occurred to me that these causes or equivalents are continually acting in the case of animals, also... Then it suddenly flashed upon me that this self-acting process would necessarily <u>improve the race</u>, because in every generation the inferior would inevitably be killed off and the superior would remain - that is, <u>the fittest would survive</u>... The more I thought over it the more I became convinced that I had at length found the long-sought-for law of nature that solved the problem of the origin of species (Wallace, 1905, i, 361-63).

2. This view seems to be held almost universally, across different shades of the political spectrum. In a discussion with E.P. Thompson (who also believes in a distinct Scientific and Social Darwinism), Perry Anderson states:

> Darwin's theories were not, of themselves, ideological: It was their <u>use</u> which was - and about this he [Thompson] says nothing at all. Yet Darwinism is probably the most dramatic case history of a scientific theory giving immediate birth to a social ideology. No other scientific discovery was ever as rapidly "politicized" as this. "The survival of the fittest" and "the natural law of selection" became a ruthless celebration of Victorian racism and imperialism: These axioms provided a benison for class society, and a mystique for militarism. They did so in the name of a <u>natural</u> destiny inscribed in the course of <u>things</u> (Anderson, 20).

See also, for example, Edward Thompson, The Poverty of Theory who tries to make a distinction between Darwin the scientist and Huxley the propagandist, and Jones, 1980, who makes a similar distinction between Darwin and Social Darwinism (Young, 1985b, 609-638).

3. In Jim Moore's lively article of the Radical Science Journal he suggests that "Social Darwinism" is largely an ideological creation of the post-Depression eras (1890s and 1930s) which then became a subject for academic disputation and

> a problem for historical scholarship when in America it seemed urgent to contrast a laissez-faire past with the beneficial stabilizing and unifying effects of state intervention during the Great Depression and the Second World War.

He later states:

> ..Social Darwinism is primarily a problem of our own making. I speak as a member of the professional middle class. The problem was formulated among sociologists and historians at different times and places. Initially it was a problem of theories and policies; latterly it became a problem of definitions and labels... Historians thanks to [Richard] Hofstadter [Social Darwinism in American Thought] projected the latter problem back into the decades immediately following the publication of the Origin of Species, as if 'Social Darwinism' had somehow been debated from the time Darwin's name became prominent. But the phrase was never used. 'Darwinismus' in Germany and 'Darwinism' in the English-speaking world quite sufficed to express all Darwin's intentions, all his allies' hopes, and all his critics' fears, without the gratuitous annexation of 'Sozial-' or 'Social' to the term. The routine distinction made today between 'Darwinism' and 'Social Darwinism' would have been lost on the author of the Descent of Man, and probably on most of his defenders until the 1890s. Only then with the 'revolt against positivism' and the professionalization of sociology, was it demanded that 'biological' theories should be clothed in 'social' garments in order to move more modestly through the new discipline. Only then, with this fragmentation of knowledge and its divorce from the general culture, did 'Social Darwinism' become a problem - an artifact - of bourgeois perception (Moore, 1986b, 61-63).

Moore makes some provocative points. Although he recognizes the phenomena currently labeled 'Social Darwinism' as a legitimate concept which describes (though only partially) an ideological and scientific grouping, his main concern seems to lie with the contemporary dangers of 'Social Darwinism' which is considered exclusively as a basically political reaction to developments in late nineteenth century British history. As I argue, 'Social Darwinism' ('Darwinism', I agree, would be more accurate) cannot be adequately understood unless we also examine its roots in British scientific thought. Though it may well be "an artifact - of bourgeois perception", these kinds of explanations neglect the possibility that scientific philosophy itself may supply part of the answer to the rise of "Social Darwinism".

4. Young recommends we look at the E Notebook, chapter 6 of Natural Selection, "Theory Applied to the Races of Man". In a letter to Lyell, Darwin, writing about the possible effects of inherited mental traits states "I look at this process as now going on with the races of man; the less intellectual races being exterminated" (Darwin to Lyell, 1859, in Darwin, 1898, ii, 211). See also, Greene, (1977, 1-27 and 1959, 419-446).

5. Herbert Spencer reached similar conclusions, based on his notion of the inherent progress (through conflict) of man, society and nature which culminates in the end of conflict and universal peace. But Spencer's view was of a struggle between individual's within a given group. Wallace rejected this notion, as did Pearson. The latter, however reached conclusions almost diametrically opposed to Wallace's.

It should also be remembered that neither Spencer's nor Wallace's optimistic views on evolution contradict the 'necessity' of exploitation or domination, especially of native peoples. Wallace also clearly expresses a prevailing belief that contemporary differences between Europeans, on the one hand, and the native peoples which they encountered, on the other, are due to the latter's "low and mentally undeveloped" status (318-19 and passim.). This point is highlighted in another essay, "The Limits of Natural Selection as Applied to Man". Wallace's essays, like that of so many social and scientific theorists in the nineteenth century, also read as both an explanation and a justification for European colonialism based on innate physiological and intellectual differences.

6. Another example of this kind of "environmentalism" is to be found in H.T. Buckle, History of Civilization in England, 2 vols., London, 1857-61. But see Merivale for a critique of environmentalism and the excesses of both Galton and Buckle.

7. Karl Marx, for example, wanted to dedicate a section of _Das Kapital_ to Darwin and also believed that "[the _Origin_ constituted] a basis in natural science for the class struggle in history" (Marx to Lasalle, Jan. 16, 1861, Marx, _Correspondence_, London, 1934, 125).

## V. THE ADVENT OF EUGENICS.

### a. Eugenics, Genetics and Statistics.

The argument based on the notion that civilization had suspended the beneficent action of natural selection was only one of many scientific arguments in favour of the "artificial selection" which eugenists propounded. In the same period (1870 to 1914) the scientific evidence in favour of eugenics received another boost from the field of hereditary science. Galton's hereditarian thesis was not simply the result of a priori reasoning or prejudice. By the first decade of the twentieth century, it was a view widely shared by scientists working in biology and by a large cross section of people working in philanthropy, education, medicine and other fields (see chapter II and Appendix).

Like the debate on natural selection and society, the period up to 1914 bears witness to a continuing attempt to follow through and articulate the Darwinian-physicalist framework across a broad spectrum of social and scientific thought. Sometimes, however, the extension of this framework provoked a renewed questioning of the validity of Darwinian theories in certain fields, such as in the developing science of genetics. In this case an unusually bitter struggle followed between proponents of "orthodox" Darwinism and rebel schools, the latter claiming the insufficiency of natural selection to account for transmutation and evolution. In this struggle Francis Galton and Karl Pearson, the two most important theorists of eugenics, played very significant roles, making lasting contributions to the science of heredity and establishing statistics as a powerful and sophisticated tool of social and scientific analysis. Both of their contributions to science have been seen as arising from a single minded devotion to the eugenic ideal. One can, however, also reverse this argument and show that the eugenic ideal was a legitimate inference from the scientific work conducted by Galton and Pearson. Moreover, they were not alone in scientifically corroborating hereditarian ideas. The same period witnessed the overthrow of the principle of the inheritance of acquired characters, the establishment of the doctrine of the continuity of the germ plasm and the advent of Mendelian genetics, all important milestones in the history of genetics. In none of these instances do we find a challenge to hereditarian ideas or to the main principles of eugenics. In fact, all of these seemed to bolster the case for a eugenic sociology.

In the latter part of the nineteenth century many biologists and other scientists remained convinced of the physicalist model as the proper route for their science. Indeed, in many cases, recent advancements and changes in physical theory played an important role in biological science. Many scientific workers outside of physics tried to remain au courant of these developments and strove to incorporate the new findings into their own fields. Important in this regard were notions of "causality", "force", and "matter" all of which were considerably modified as physical theory progressed. Of course, non-physicist's understanding of physical theory was sometimes crude and what exactly was borrowed from physics differed greatly from one (non-physicist) scientist to another. But what is significant is that, outside of the various vitalist schools of biology, the physical "paradigm" remained foremost in almost every scientist's mind and coloured each one's approach to their field. In short, it would seem that the physicalist approach to science was equated with the scientific approach, per se.

Eugenic science also was based on a physicalist paradigm. It conformed in almost every respect with accepted notions of what good science was. It is also true that there were different types of eugenic science, and there were (as in other sciences) popular or unsophisticated versions of eugenics based on very little understanding of physical or biological science. This paper, however, has focussed on the most philosophically sophisticated spokesmen and the most reputable scientists' understanding of eugenics. If eugenics is examined in this light, one can better understand the attraction it had for educated contemporaries. Eugenics can thus be understood not simply as an ideological accretion to "legitimate" science or a "distortion" of science but as a method and theory of sociological investigation directly deduced from the latest and best scientific work then available in conjunction with a dominant (physicalist) philosophy of science.

The creation of the two major institutions of the eugenics movement - the Galton and Biometric Laboratories and the Eugenics Education Society - can then be understood as a particular response to the various scientific debates of the day. The former more self-conciously attempted to solidify a correct methodological approach to eugenic science, while the latter tried also to spread eugenics as a new scientific gospel. In both cases eugenics was seen to conform in almost every respect to "good" science, was viewed as a logical interpretation and extension of Darwinian theory and did in fact emerge in large part from debates stimulated by Darwin's theory.

The following sections will trace the role played by some important eugenic protagonists in two strategically important scientific fields: genetics and statistics. Two points will be developed, firstly; that eugenic doctrine can be understood as a legitimate inference from prevailing scientific work (not only Galton's and Pearson's) and secondly, the nature of the connection between some of these theories and the physicalist tradition.

b. Genetics: From Lamarck to Weismann.

> The laws governing inheritance are for the most part unknown. No one can say why the same peculiarity in different individuals of the same species, or in different species, is sometimes inherited and sometimes not so; why the child often reverts in certain characters to its grandfather or grandmother or more remote ancestor; why a peculiarity is often transmitted from one sex to both sexes, or to one sex alone... (Darwin, Origin, 1936, 19).

The mechanisms of heredity were the missing pieces of Darwin's theory of evolution. The Origin, though it proposed that nature "selected" those organisms which manifested superior characteristics ("variations") in the struggle for life, and that these were heritable, did not fully explain how these characteristics themselves came into being. Darwin admitted in the Origin that these seem to be a product of chance, another word for our ignorance:

> I have hitherto sometimes spoken as if the variations - so common and multiform with organic beings under domestication, and in a lesser degree with those under nature - were 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, 1936, 101).

Notwithstanding this confession of ignorance, Darwin, as well as other writers, firmly believed that everything was heritable. In the "Sketch of 1842" Darwin wrote "There seems to be no part ... of body, internal or external, or mind or habits, or instincts which does not vary in some small degree and [often] some to a great amount" (41-42 quoted in Provine, 5). The notion that mental peculiarities could be inherited seems to have been equally acceptable to many of the leading biologists of the late nineteenth century. Darwin cites Galton approvingly on this topic in Variation:

> Some writers have doubted whether those complex mental attributes, on which genius and talent depend, are inherited, even when both parents are

> thus endowed. But he who will study Mr. Galton's able work on 'Hereditary Genius' will have his doubts allayed (1876, i, 451).

Darwin makes the same point in Descent:

> Besides special tastes and habits, general intelligence, courage, bad and good temper, &c., are certainly transmitted [in domestic animals]. With man we see similar facts in almost every family; and we now know, through the admirable labours of Mr. Galton, that genius which implies a wonderfully complex combination of high faculties, tends to be inherited; and, on the other hand, it is too certain that insanity and deteriorated mental powers likewise run in families (Descent, 1936, 414).

But for Darwin this doctrine of mental heredity did not imply that mental ability depended uniquely on inborn characteristics. This was because the sources of hereditary variability itself were perceived as partly due to the effects of circumstances and the habits of life. In Darwin's hereditary theory inborn qualities could be changed or acquired through the effects of the surrounding environment.

> With respect to mental habits or instincts, we are so profoundly ignorant of the relation between the brain and the power of thought that we do not know positively whether a fixed habit induces any change in the nervous system, though this seems highly probable; but when such habits or other mental attribute, or insanity, is inherited, we must believe that some actual modification is transmitted; and this implies, according to our hypothesis, that gemmules [see below] derived from nerve-cells are transmitted to the offspring (1876, ii, 388-89).

Despite his sometimes ungracious assessment of his predecessor, Darwin was driven into notions similar to Lamarck's[1] in his account of variation - i.e., that this was the result of changes in environmental conditions, the use and disuse of certain organs and parts of an organism, etc. Lamarck's classic example is of the giraffe's neck which supposedly attained its present length as the result of the habit of continuous stretching to reach the branches of tall trees. This "acquired characteristic" was deemed heritable such that the animal's descendants, over the course of ages, ultimately developed the typical long neck of present day giraffes (Curtis, 4-5). According to Lamarck:

> It is not the organs, that is to say, the nature and shape of the parts of an animal's body, that have given rise to its special habits and faculties; but it is, on the contrary, its habits, mode of life and environment that have in course of time controlled the shape of its body, the number and state of its organs and, lastly, the faculties which it possesses (Lamarck, 114).

Darwin, at first wishing to distance himself from Lamarck and because of problems with this theory (one could account for all of evolution on this basis), gradually came closer to the latter's views. In Origin Darwin suggested that variation is partly a product of the disruption of the reproductive system in the parent, due to changes in the environment, "Many facts clearly show how eminently susceptible the reproductive system is to very slight changes in the surrounding conditions". Under this scheme, the "indirect effects of the environment" (Origin, 1936, 16) were held accountable for variation. But as this view drew increasing criticism, Darwin began to emphasize the more direct influence of the environment giving increasing credence to the inheritance of acquired characters (Cowan, 1972, 397; Himmelfarb, 317-321). However Darwin tried to deal with the issue, the mechanism of heredity remained a constant weakness in his theory, throwing into question the centrality of natural selection itself as the guiding force of evolution and opening it to criticism from various quarters[2].

Darwin was not the only naturalist struggling in the quagmire of heredity. Before Galton, states Cowan, the observation of heredity demonstrated a confusing and contradictory array of phenomena. Prosper Lucas summarized the various interpretations of variation in 1847. Either diversity arises from the circumstances surrounding procreation and development (which Darwin also believed) or it is caused by a separate principle inherent in developing organisms (Cowan, 1972, 395). In the second case, no cause is sought for variation because it is an independent biological principle and is, like gravity, a causative force itself. Proponents of the first case gave a host of explanations for possible influences which may affect the developing organism, including differences in environment, nutrition, general condition of the mother and her fetal circulation at conception or between conception and birth; or as a result of the mixture of paternal and maternal influences (hybridization) and, possibly, the result of hereditary influences of remote ancestors (Lucas, i, 170-185 quoted in Cowan, 1972, 395-96).

The confusion over heredity was reflected in the use and meanings attached to various words. Indeed the word "heredity" itself was not then used to describe the biological relationships between two or several generations, since these were rather dimly perceived. Words such as "inheritance" and "variation" were used in several seemingly incompatible definitions, depending on the context in which they were used. At times inheritance was used to describe the tendency of like to reproduce like. At other times the tendency of like _not_ to reproduce like and "reversion" (the resemblance between offspring and grandparents or earlier progenitors) were also included under the rubric of inheritance. Often, reversion was perceived as a force _opposing_ inheritance or as "subsidiary case of the general inheritance principal" (Cowan, 1972, 389-413). Darwin, in his "Provisional Hypothesis of Pangenesis" (in _Variation_) tried to establish a theory of heredity which could bolster natural selection. But in many ways, he merely reflected the general confusion. He often implied that there were opposed and separate forces of inheritance; for example, inheritance proper and reversion, the latter manifesting the tendency for offspring to resemble remote ancestors, as in the case of the domestic pigeon:

> When two white, or red, or black pigeons, of well-established breeds, are united, the offspring are almost sure to inherit the same colours; but when differently-coloured birds are crossed, the opposed forces of inheritance apparently counteract each other, and the tendency which is inherited in both parents to produce slaty-blue offspring becomes pre-dominant (Darwin, 1876, ii, 22).

The confusion between inheritance and reversion was doubly compounded by that between "inheritance" (usually defined as the tendency for like to produce like) and "variation" (usually defined as the tendency for offspring to differ slightly from their parents). The boundary between inheritance and variation was far from clear. According to Cowan:

> Unfortunately no one was quite sure where inheritance stopped and variation began. At what degree of difference between parent and child does the principle of variation begin to work? If an offspring of two mice, both having tails 5 inches long, actually has a tail 5 1/2 inches long, should one say that this is evidence of variation at work? Or is it evidence of inheritance having failed to be exact? Or perhaps evidence of small perturbations of inheritance which are naturally to be expected? Or perhaps evidence that the offspring's tail was actually contributed not by the parents but by some long dead ancestor? (Cowan, 1972, 394-95).

The use of words like "forces" is significant. It shows the influence of ideas derived from physics in the biological realm. Characters which appeared in the offspring of hybrid crosses (dominance) were said to be "hereditary" because they seemed to be immune from the otherwise interfering effects of the environment. Characters which have great "hereditary power" were said to dominate in such crosses.

The use of the word "hereditary" as an adjective, writes Cowan, implied that inheritance was a vital property or a force, as the term "gravitational" implied the force of gravity (Cowan, 1972, 399). This force could be "strong", "weak", "capricious" or "deficient".

> Naturalists spoke of the "force" of inheritance or the "power" of inheritance or the "principle" of inheritance - just as they might speak of the "force" of gravity, the "power" of electric attraction, or the "principle" of inertia (Cowan, 1972, 399).

Darwin, for example, often wrote of inheritance as a "power":

> Metzger... found that certain kinds of wheat brought from Spain and cultivated in Germany, failed during many years to reproduce themselves truly; but at last, when accustomed to their new conditions, they ceased to be variable, - that is, they became amenable to the power of inheritance... (1876, i, 472).

Phrases such as "Fixedness of character, or the strength of inheritance..." (1876, ii, 39) often reveal the implicit physicalist model used by Darwin. Sometimes Darwin wrote as if he conceived that each variation "has its own proper exciting cause", (1876, ii, 240) indicating a struggle and/or combination of hereditary and environmental forces as a factor accountable for variation. Borrowing terminology from physics and chemistry, Darwin also writes of the "affinities" that certain types of gemmules have for each other (e.g, 1876, ii, 382). Galton also accepts the view of "mutual affinities" and "repulsions" as postulates "almost necessarily implied by any hypothesis of organic units..." (Galton, 1875b, 331). Herbert Spencer was an important figure in promoting this approach to the study of biology, as he was to the study of society. He expressed what in many biologists was an implicit physicalist model of heredity and wrote of variation as an outcome of "persistence of force" (1900, i, 3, 60-1, 220, 252-56, 334-5). Other naturalists sometimes revealed similar implicit allegiances to physicalism. G.J. Romanes in a series of letters to E.B. Poulton arguing against Weismann's attempt to disprove the inheritance of acquired characters claims that certain characters Weismann refers to were not inherited because they had not been part of the constitution of the species for a long enough time:

> The cases that you have in view are those where recently acquired characters are concerned; and where... according to my views, 'the force of heredity' is weak and quickly 'worn out' (Romanes to Poulton, 27 January 1890, in E. Romanes, 1896, 267).

Here Romanes seems to elucidate an "inertial" theory of heredity (Cowan, 1972, 400). The notion of inheritance as a force, often opposing or interacting with other forces, prevented a correct assessment of heredity as a <u>relationship</u> between generations. This latter view Galton, with his statistical work on numerical relationships between generations and his critique of the theory of the inheritance of acquired characters, was well prepared to receive.

Darwin's notion of variation, did not neatly fit into Lucas' summary above. He shared, with contemporaries, the concept of blending inheritance, the notion that parental traits blended equally to produce intermediate traits in the offspring[3]. Darwin also accepted the notion of particulate inheritance. This was an idea, originally credited to Spencer ("physiological units" in 1900, i, 335), which pictured the hereditary material as composed of small particles - Darwin called them "gemmules". These interacted in a number of complex ways to regulate and order hereditary transmission, embryological and physiological development, and were ultimately responsible for the differences and similarities between offspring and parent (variation, inheritance, etc.). The resemblance between the notion of particles, germs or gemmules and Newtonian corpuscles or Daltonian atoms should be noted[4]. Particulate inheritance was a fundamental assumption of Darwin's pangenesis hypothesis, the core of his theory of heredity. In Variation he summarizes this hypothesis:

> It is universally admitted that the cells or units of the body increase by self-division or proliferation, retaining the same nature, and that they ultimately become converted into the various tissues and substances of the body. But besides this means of increase I assume that the units throw off minute granules which are dispersed throughout the whole system; that these, when supplied with proper nutriment, multiply by self-division, and are ultimately developed into units like those from which they were originally derived. These granules may be called gemmules.

These gemmules are derived from every organ and part of the body and collect in the sexual organs to provide the material forming the next generation.

> They are collected from all parts of the system to constitute the sexual elements, and their development in the next generation forms a new being; but they are likewise capable of transmission in a dormant state to future generations and may then be developed... Hence, it is not the reproductive organs or buds which generate new organisms, but the units of which each individual is composed (Darwin, 1876, ii, 369-70).

Darwin's pangenesis idea thus conceived of the hereditary material, the gemmules (germ line, in modern parlance), as partly a derivation or product of body (somatic) cells. These would merely accumulate or gather in the reproductive organs, the latter serving as a channel or vessel for generation. This view was not new, Darwin cited John Ray's Wisdom of God (2nd. ed., 1698, 68), where the author stated that "every part of the body seems to club and contribute to the seed". This hypothesis established a link between internal (e.g., use and disuse of parts) as well as external environmental forces and the gemmules. The body cells, being subject to the effect of environmental conditions, would transmit these effects to the gemmules which they throw off, thereby affecting the form and nature of subsequent generations.

> On any ordinary view it is unintelligible how changed conditions, whether acting on the embryo, the young or the adult, can cause inherited modifications. It is equally or even more unintelligible on any ordinary view, how the effects of the long-continued use or disuse of parts, or of changed habits of body or mind, can be inherited. A more perplexing problem can hardly be proposed; but on our view we have only to suppose that certain cells become at last structurally modified; and that these throw off similarly modified gemmules. This may occur at any period of development, and the modification will be inherited at a corresponding period... (1876, ii, 388-89).

In this manner, Darwin explained both the possibility of the inheritance of acquired characters and the complexity of the phenomena of variation, inheritance and reversion. Combined with natural selection, it seemed that no other explanation could account so well for the wonderful and multiform fact of adaptation - the close fit between an organism and its environment.

Contemporaries were not overly impressed with this hypothesis[5], Darwin complaining that "Although my hypothesis of Pangenesis has been reviled on all sides, yet I must still look at generation under this point of view" (Darwin to Alphonse de Candolle, 18 January, 1873 in Darwin, 1903, i, 348). Galton, despite his initial skepticism toward the notion of the inheritance of acquired characters, liked the theory because it seemed to open up this field of science to statistical treatment. By conceiving of the hereditary material as composed of small, independently acting units, Galton correctly perceived that "the theory of Pangenesis brings all the influences that bear on heredity into a form that is appropriate for the grasp of mathematical analysis" (1869, 373). After the publication of Hereditary Genius, warmly received by Darwin in 1869 (see above), Galton suggested a method by which pangenesis could be tested. Darwin believed that the gemmules circulated freely in the body after being "thrown off" by their parent cells. If this was so, it might be possible to produce mongrels from animals of a pure strain by injecting the blood of a foreign strain into the circulatory system of the pure one and then allowing the latter to breed (Galton, 1870-71, 393-410; Cowan, 1977, 170). The gemmules from one strain would thus be presumably transferred to another (via blood transfusion) and the resulting offspring should show characters belonging to the foreign strain. The hypothesis that the hereditary material was particulate and circulated throughout the body and that this could account for the various phenomena of heredity would then be greatly corroborated.

Darwin was greatly interested in the results of Galton's difficult experiments and for over one year corresponded regularly with him and was kept constantly informed on his progress. A breed of silver-gray rabbits were chosen as the most convenient and suitable subjects, but the technical difficulties, especially in the area of blood transfusion, were great. Galton nevertheless managed to carry out the experiments and a number of offspring from transfused parents were produced. The results did not confirm Darwin's hypothesis. Not one mongrel had been produced. By March of 1871 Galton reported to the Royal Society, "The conclusion from this large series of experiments is not to be avoided, that the doctrine of Pangenesis, pure and simple, as I have interpreted it, is incorrect" (Galton, 1870-71, 404)[6].

To Galton, the experiments in pangenesis confirmed his skepticism with regard to the inheritance of acquired characters. In the development of Galton's "doctrine of heredity" after 1871, he set out to establish the opposite thesis, that acquired characters are mostly not inherited. He did, however, maintain a small scope for the inheritance of acquired characters and the pangenesis hypothesis but as a subordinate part of his own theory. He also retained completely the principle of particulate inheritance. In "On Blood-relationship" (Galton, 1871-72) and "A Theory of Heredity" (1875b) he established the outlines of his "stirp" theory. Galton believed that the total hereditary material of an individual was derived from parents and more remote ancestors. He named this material the "stirp" from the latin, stirpes, for root (1875b, 330). The stirp is composed of two general categories: a "latent" stream and a "patent" or "personal" stream. The latter is an offshoot of the stirp which develops into the adult organism and "constitutes the person manifest to our senses" (1871-72, 394). The existence of a latent stream was suggested by the phenomena of reversion, where peculiarities not manifested in the parents, but manifested in grandparents and more remote ancestors often re-expressed themselves in the offspring. Darwin also believed in the existence of a latent stream ("dormant" gemmules) (1876, ii, 370) which seemed to indicate that certain characters could indeed exist unexpressed in the parents (or any individual) in a latent form and be passed on to progeny. But Galton greatly enhanced the role of the latent stream, making it the most important factor in hereditary transmission (1871-72, 398, 399). In Galton's view, the latent stream would be transmitted almost unaffected by environmental forces to the next generation. On the other hand, the gemmules which had developed in the parents (patent or personal elements) would die with the parents. Immediately after fertilization the gemmules from the parent's latent stream would segregate into two streams, one, by "Class representation", would ultimately be expressed in the bodily structure of the offspring; while the other ("the residue") would remain latent. The latter would divide once again before reproduction (by "Family Representation") into patent and latent elements, the latent stream being passed on to the subsequent generation. Galton did not go into much detail on the nature of the two types of segregation, except to state that they are products of random aggregations and that the first is a result of competition between gemmules for a place in the developing structure of the organism ("segregation by Class Representation"), while the other segregates on the basis of "family representation" (1871-72, 395, 397, and figures 1 and 2; Cowan, 1977, 174-75). Repulsions and affinities, played a role in the aggregation of gemmules but little more was stated about this. Galton tried to show, contradicting Darwin, that the latent stream is only faintly affected by the patent.

> It is indeed hard to find evidence of the power of the personal [patent] structure to react upon the sexual elements that is not open to serious objection...
>
> The conclusion to be drawn from the foregoing arguments is, that we might almost reserve our belief that the structural cells can react on the sexual elements at all, and we may be confident that at most they do so in a very faint degree; in other words, that acquired modifications are barely, if at all, inherited, in the correct sense of the word (1875b, 346).

For Galton, the contention that the sexual elements are unaffected by the personal was simply another way to say that acquired characters are not inherited. The phenomena of inheritance, reversion and variation could all be explained mostly by reference to the sexual elements or the "stirp". The recourse to environmental forces as disturbing elements responsible for variation was unnecessary in Galton's theory. By eliminating the hopelessly complex influences of the environment and centering on the stirp, Galton greatly simplified and conjoined what appeared as capricious phenomenon. But if the environment played only a minor role in variation, inheritance and reversion, how could the stirp, a minuscule agglomeration of germ cells provide the infinite diversity observed everywhere? Galton answered this question by suggesting that the stirp was the repository not simply of the characters of both parents ("direct descent") but also of grandparents, and even more remote ancestors (though in an increasingly feeble degree):

> The hypothesis of organic units enables us to specify with much clearness the curiously circuitous relation which connects the offspring with the parents. The idea of its being one of direct descent, in the common acceptation of that vague phrase, is wholly untenable, and is the chief cause why most persons seem perplexed at the appearance of capriciousness in hereditary transmission. The stirp of the child may be considered to have descended directly from a part of the stirps of each of its parents, but then the personal structure of the child is no more than an imperfect representation of his own stirp, and the personal structure of each of the parents is no more than an imperfect representation of each of their own stirps (1875b, 346).

The concept of stirp, conceived as combining and recombining in various sexual unions in a given family line, is sufficient to explain all the phenomena of heredity. Inheritance (the tendency for like to produce like) is not a force opposing or differing from reversion or variation, each in various inexplicable ways subject to the influences of surrounding conditions, but is simply a consequence of the stirp being composed of a large number of elements (or "gemmules") derived from a common family line which then have a greater chance of expressing themselves in offspring. Variation is likewise to be expected in a population which has not been inbred ("impure") because every parent carries, transmits and combines elements of a widely varying sample of the previous population (their ancestors). Some of these elements, appearing to diverge from family likeness, will sometimes also be inherited. Both variation and inheritance are a consequence of the nature of the strip and not opposed or separate forces:

> One result of this investigation is to show very clearly that large variation in individuals from their parents is not incompatible with the strict doctrine of heredity ["inheritance"], but is a consequence of it wherever the breed is impure (1871-72, 402).

Variation and inheritance, in this sense, are both products of chance; of two random samples from a population which consists of highly diversified groupings of gemmules, creating in their combination a new sample drawn from them. Likeness and non-likeness can both be accounted for by the same source if we assume the notion of particulate inheritance acting in probabilistic fashion. As mentioned above, Darwin also believed in a latent or dormant stream of gemmules and that this could account for reversion in some cases. Galton expanded the role of the latent stream and eventually realized that the phenomena of reversion was explicable as a normal consequence of certain types of statistical data and analyses, i.e., the tendency for certain characteristics such as weight and height to fall back ("revert") or group around a population mean. Galton calculated the units of deviation from this mean and dubbed it the "coefficient of reversion" (Galton, 1877, 7). Later realizing that the reversion coefficient was a product of statistical manipulation itself and was not confined to heredity he renamed it the "coefficient of regression" (Galton, 1886, 246-263). Most of the phenomena of heredity - inheritance, variation and reversion, could thus be explained as normal consequences of the laws of chance acting on a multitude of more or less independent units.

Vague as it was and completely devoid of cytological study, Galton's stirp theory was a remarkable anticipation of modern genetics in more than one sense. The strict separation that Galton establishes between hereditary and acquired characters ("nature and nurture") and the great role he assigns to the latter came very close to the doctrines, usually associated with August Weismann, of the continuity of the germ plasm, i.e., the principle that the hereditary material (germ plasm, sex cells or gametes) are stable entities, unaffected by body (somatic) cells or the environment. Weismann's view, at the foundations of modern genetics, claims that variation in multicellular, sexually reproducing organisms is a product solely of the interaction of (male and female) germ plasm and also attacks the prevalent theory of the inheritance of acquired characters. Unlike Galton, Weismann's view is founded on a great deal of cytological and other evidence but the conclusions are essentially the same[7]. Weismann himself acknowledges Galton's precedence in discovering the principle of germ plasm (Weismann to Galton, 23 February 1889, in Pearson, 1914-30, iv, 340-41; see also Weismann, 1889, 172 and his note 3). Galton, like Weismann, clearly perceived the function of sexual reproduction in assuring genetic variability, he made a clear distinction between somatic and germ cells, as well as between latent and patent elements-what we would now call genotype and phenotype. His understanding that the germ cells of the parents represented the genetic endowment of previous generations classes him among the first to appreciate the population aspect of heredity:

> We cannot now fail to be impressed with the fallacy of reckoning inheritance in the usual way, from parents to offspring, using those words in their popular sense of visible personalities. The span of the true hereditary link connects... not the parent with the offspring, but the primary elements of the two, such as they existed in the newly impregnated ova, whence they were respectively developed (1871-72, 400).

In all of these cases Galton anticipated some of the major concepts of modern genetics. In addition, his theory conformed in all respects to Pearson's and Whewell's attributes of good science. It explained, in the simple concept of "stirp", various previously disconnected phenomena while limiting recourse to notions of opposing "forces". The uniting power of Galton's theory was, according to Cowan, Galton's main contribution to genetics. This is most easily followed in the new definition he established for the word "heredity". As Galton wrote in 1908:

> The current views on Heredity were at that time [1870s] so vague and contradictory that it is difficult to summarize them briefly... It seems hardly credible now that even the word heredity was then considered fanciful and unusual. I was chaffed by a cultured friend for adopting it from the French (1909, 288).

Darwin and other writers often used the term "inheritance" but, as mentioned above, this word had a number of contradictory meanings. Biologists, in the aftermath of Darwin's Origin had not fixed a precise meaning for the object of their study (see Cowan, 1972, 398-9, 409). Galton, by subsuming all the phenomena of "inheritance", "reversion" and "variation" under one head - "heredity" - and establishing this not as a field of conflicting and allied forces but as the sum total of all biological relationships between one generation and the next, gave biologists a most fruitful definition with which to work (Cowan, 1972, 403). The noted biologist J.A. Thomson, in a book dedicated to Weismann and Galton[8] clarifies the meaning of heredity:

> By heredity we do not mean the general fact of observation that like tends to beget like, nor a power making for continuity or persistence of characters - to be opposed to the power of varying - nor anything but the organic or genetic relation between successive generations: - all that the organism is or has to start with in virtue of its hereditary relation to parents and ancestors (Thomson, 13).

Galton may also have possibly paved the way for the acceptance of Mendelian genetics in Britain which, in many essentials, fitted quite well into Galton's schema. Because of his acceptance of particulate inheritance and his mathematical turn of mind, Sturtevant states of Galton:

> The question has often been raised: Would any biologist have appreciated Mendel's work if he had seen the paper before 1900? My own candidate for the most likely person to have understood it is Galton, because of his interest in discontinuous variation [see below], his mathematical turn of mind, and his acceptance of Weismann's view that the hereditary potentialities of an individual must be halved in each germ cell (Sturtevant, 22).

But, perhaps like Mendel, stirp theory never received the attention it merited in the period before Weismann's formulation of the germ plasm theory. It was only in the 1880s, with a renewed questioning of the presumed evidence for the inheritance of acquired characters and with the advent of the germ plasm theory, that scientists returned to Galton.

Cowan, in her work on Galton, traces the development of his ideas (as do Kevles and Mackenzie), to his eugenic faith. According to Cowan

> Galton's concept of heredity - incorporating inheritance, reversion, and variation and measurable in the physical appearance of populations - was also inseparable from his eugenic ideal and from his early passion for counting. It was the eugenic ideal that led him to the conviction that everything was hereditary, and it was his passion for counting that led him to search for something to measure and for probabilistic models. Ironically, the spread of this definition among literate men was also dependent upon the eugenic ideal, because it was through the growth and development of the eugenics movement that the definition became part of the intellectual currency of a new generation (1977, 189).

Though Galton's idée fixe of hereditary power and its social and political expression in his eugenic philosophy may have been a major determinant in the development of his scientific ideas, so was his experimental work with Darwin on pangenesis, on the heredity of the sweat pea, in statistics, pangenesis, anthropometry and in various other studies. If acquired characters are not inherited - and it was soon discovered, as Galton had intimated, that precious little evidence for acquired characters actually existed, and if inheritance is particulate, there is only a further small step to Galton's and Weismann's formulations. Since environment is not the source of genetic variability, there remains only the germ plasm ("stirp") itself. One need only consider the germ plasm the repository of a vast potential of possible characters, a small portion of which appears at random in each individual offspring to account for most of the hereditary phenomena previously explained under the various conflicting heads. This Galton supplied by considering the stirp as the repository not simply of the characters of the mother and father but as primarily those of an entire family line. Galton was undoubtedly influenced by his eugenic convictions to seek out an explanation for the phenomena of heredity. But the conclusions he reached transcended ideological motivations and marked an important advance in the study of heredity. Indeed it was probably the scientific value of Galton's findings that convinced so many of his educated contemporaries to embrace the new science of eugenics.

In the 1880s, Galton abandoned his search for a physiological theory and mechanism of heredity. Some writers have commented that this was due solely to his eugenic concerns. Having found a scientific theory which could support the hereditarian thesis at the base of eugenic ideology, Galton was satisfied and moved on to other fields. His work on hereditary theory does not appear in Natural Inheritance or in his autobiography and he made no claims for precedence when August Weismann developed a similar theory almost twenty years after Galton had published his. According to Cowan, scientific precedence did not matter to Galton and he cared only for a viable scientific theory to support eugenics:

> Stirp theory was closely linked to eugenics; neither theory made sense without the other. Galton needed stirp because stirp invalidated the inheritance of acquired characters. When Galton worried about the physiological basis of heredity, he was not participating in a scientific debate, he was actually having an argument with himself: "Can eugenics be given a scientific basis?" Once we understand this we understand why he dropped the stirp theory so soon after proposing it; he was convinced of its validity and it really did not matter what others might think. Once he found a physiological explanation that made sense of his social theory, he dropped it - not realizing that perhaps he should have claimed it as a major contribution to the development of biology (Cowan, 1977, 178-79).

That there is an abundance of evidence for the importance Galton attached to eugenics as a social theory and a political program is not to be denied. It is equally clear that scientific theories of heredity played an important role in shaping social and political thought. But Cowan's view that Galton cared little for his theory of heredity and that all he wanted was a scientific theory to back up his a priori eugenic philosophy is puzzling. While it is true that stirp theory made eugenics seem plausible, many who believed other theories favouring the hereditarian principle, like early proponents of Mendelian genetics in Britain, were also favourably predisposed to eugenic ideas. It is also difficult to see why, if Galton was so obsessed exclusively with eugenics and, realizing the importance of a scientific theory of heredity in advancing it, he would have so easily "dropped" or neglected this theory. If he wished to spread and enhance the scientific credibility of eugenics throughout Britain, then surely it did matter what "others might think", especially if those others were reputable biologists and scientists. Galton correctly perceived and repeated many times that the cause of eugenics could only be advanced by first establishing it as a proper science (see for example, Galton 1904b). There is also little reason to assume, despite the biographical data that Cowan produces, that eugenic ideology was of greater importance, in Galton's thinking, than his desire to further the cause of hereditary science. Both "ideological" and scientific motives may be said to have been intimately linked and perhaps grown out of each other in Galton's work - his scientific thinking bolstering his eugenic social theory and vice versa. If he turned away from a theory of heredity in his later life it was not only because he was "having an argument with himself" in order to establish a personally satisfying social theory. His object was to spread and increase knowledge of heredity and he believed that this would help the further acceptance of eugenics among scientists and the general public. In the scientific context of the time, this was not an unreasonable assumption. He turned away from hereditary theory partly because others were now doing this work and, to some extent, basing themselves - as we have seen - on Galton's conceptions. In addition, biology was becoming more and more professionalized and Galton may have felt, in his declining years, that it was time to cede center stage to younger people with more powerful and sophisticated means and scientific arguments. If he claimed no precedence for his theory of heredity, it was not necessarily because he cared little for it but because he realized that Weismann's formulations (for example) were conceptually wider than his and were the product of greater experimental and observational technique and that his theory was not completely akin to Weismann's. It may also have been simply, as one author states, that "Galton was too courteous to argue priorities" (Froggatt & Nevin, note 18).

But in another sense it is probably incorrect to say that Galton turned away from a theory of heredity. Stirp theory was taken increasingly seriously by biologists in the 1880s. Through the statistical work he carried on with Pearson and the biometricians after his foray into hereditary theory, Galton probably believed he was merely continuing along one of the paths which his earlier physiological theory seemed to be pointing. Given that heredity is subject to the laws of chance and Galton's love of quantification, his turn to statistical investigation, after his short but insightful foray into the mechanisms of heredity, is understandable. As he had repeatedly stated (e.g., Galton, 1907), the development of statistical theory provided the most reliable bases for the development of both hereditary theory and eugenics. Galton's eugenic ideas were confirmed and justified by both his stirp theory and prevailing theories of heredity and he now felt it was time to devote his energies to the development of statistics. In short, it would seem plausible to say that Galton's eugenics was as much a logical deduction from his scientific work as it is true that his scientific work was partly motivated by his eugenic ideas.

The challenge to the inheritance of acquired characters and the establishment of the hereditarian thesis was politically and socially significant to others besides Galton and Pearson. The implications of this scientific finding were clear and direct to a number of writers:

> If acquired modifications are impressed on the offspring and on the race, the systematic moral training of individuals will in time produce a constitutionally moral race, and we may hope to improve mankind even in defiance of the unnatural selection by which a spurious but highly popular philanthropy would systematically favour the survival of the unfittest and the rapid multiplication of the worst. But if acquired modifications do not tend to be transmitted, if the use or disuse of organs or faculties does not similarly affect posterity by inheritance, then it is evident that no innate improvement in the race

> can take place without the aid of natural or artificial selection (Ball, 8).

If it was true that the "genetically weaker" were multiplying more rapidly then the "fit" (a widely held view at the time) and that biological science had confirmed that the former could never be converted into the latter, one could understand the urgency and necessity of eugenics. Eugenics, in this light, is thus not exclusively a "distortion" of hereditary science in the service of prejudice but a legitimate deduction from a coherent and fruitful theory of heredity and evolution. It is, viewed in context, an applied biology.

The ascendancy of Galton's and Weismann's hereditary theory in the period 1870-1914 coincided neatly with the rise of the eugenics movement and its two main institutions, the Eugenics Education Society and the Galton and Biometric Laboratories. The key elements in the rationale for such organizations remained, in the eyes of its founders and followers, scientific and practical. Science had already proved its powerful ability to transform life and knowledge. Recent investigations confirmed that heredity was the dominant factor in accounting for socially important human traits and it was under the logic of these arguments that eugenics flourished and established itself as an embryonic science of society.

The domination of the hereditarian thesis in social questions was evident in the formation of the EES. This organization stemmed directly from a series of meetings held by the newly created Sociological Society between 1904 and 1906. At the first of these meetings, in May 1904, Galton read his "Eugenics: Its Definition, Scope and Aims" in which he presented eugenics as a new science of social improvement and as the basis of a new national religion. As Abrams states, at this time sociology was dominated by eugenics. Eugenics promised, with its basis in solid biological science and mathematical method to establish sociology as an exact science. This was a most attractive proposition to social theorists and others working in the social field who felt acutely the contrast between the vagueness and conflicting theories of sociology and the precision and evident progress of natural science. Many of the people present at the 1904 meeting later went on to help form the EES, A.C. Haddon, F.W. Mott, A.E. Crawley, Havelock Ellis, E.B. Poulton, Archdall Reid, C.W. Saleeby, and Dr. Alice Vickery (Farrall, 1985, 207). But the EES also included a "moral" element composed of a rebel group of the committee members from the old Moral Education League (Farrall, 1985, 206) who were also instrumental in its creation. In a series of meetings in November and December of 1907 rules were drawn up and a council of twenty one members established to organize the EES. The "moral" element was conspicuous in the new Society but the basis of this morality was not Christian ethics but eugenic scientific ones. Fairly rapidly, branches spread in other parts of Britain and the Empire and in other parts of the industrializing world (see chapter II). The EES and its branches and sister organizations throughout the world henceforth spread the hereditarian message in all areas of life and thought and it was not until 1914 and the inter-war years when biologists, social scientists, philanthropists and others began to mount a concerted attack on the hereditarian thesis and its ideological pretensions. The EES survives to this day under the name of Eugenics Society and the Eugenics Review under the name Journal of Social Biology.

c. Statistics and Biometry.

Statistical theory was a major component of eugenics in the period between 1895 and 1914. Its development under Galton and Pearson needs to be looked at more closely in order to understand its role in elucidating the phenomena of heredity and their relation to the wider question of the acceptance of eugenics.

Statistical work was well established in mid-Victorian Britain, and a number of private and state agencies - such as the Royal Statistical Society (founded in 1834) - specialized in the type of large scale quantitative work essential to a complex civilization (Mackenzie, 1981, 7-9 and his note 5). But before Galton statistics were largely divorced from mathematical theory, more specifically, probability theory[9]. His use of statistics, opened up the application of the higher mathematical theory to diverse applications, and marked a "...sharp and irreversible departure from the mere data gathering that had characterized the science in midcentury" (Kevles, 17).

The "law of frequency of error" or "error curve" arose in the eighteenth and nineteenth centuries partly out of the realization by scientists in astronomy and physics that few things in nature could be measured with complete accuracy[10]. Measurement was liable to error due to limitations in the accuracy of instrumentation, observation and experimental technique. But because it was often possible to make more than one measurement, error theory could utilize this to provide a firm estimate of the margin of error in any given measurement. Error theorists showed that the most reliable way to improve accuracy was to multiply measurements of a given quantity and calculate the mean of all errors thus collected. This mean would constitute the most reliable estimate for a given measurement. The measurements produced in this way were found to conform to what is now called "normal" (or Gaussian) distribution, a bell shape, whose tip was closest to the mean. A quantity termed the "probable error" was devised to estimate the amount of error one would likely encounter in a given measurement.

Error theory was widely known in Britain and had already been applied by the Belgian astronomer and statistician Quetelet to the measurement of human physical differences (Quetelet, 1849; Mackenzie, 1981, 57). Galton was introduced to error theory through his friend, the geographer William Spottiswoode and applied this theory in his Hereditary Genius (1869). In that book Galton claimed to have proved that intellectual ability, amongst other human attributes, was distributed normally. The normal distribution of characters appears then to have confirmed the idea of particulate inheritance and mental heredity and suggested to Galton that one could dispense with the hypothesis of the inheritance of acquired characters (see Cowan, 1972, 408). By the measurement and observation of outward traits in a population (including intelligence) one could formulate a theory of heredity in purely statistical language. This Galton first formulated in a crude form in the second part of "Hereditary Talent and Character" (1865). It claimed that an individual's heredity was the product of parents, grandparents and more remote ancestors in descending geometric proportion.

> The share a man retains in the constitution of his remote descendants is inconceivably small. The father transmits, on an average, one-half of his nature, the grandfather one-fourth, the great-grandfather one eighth; the share decreasing step-by-step in a geometrical ratio with great rapidity[11].

This sequence, later dubbed "Galton's Law of Ancestral Heredity" by Karl Pearson, Galton viewed as "a statistical law of heredity which appears to be universally applicable to bisexual descent" (Galton, 1897, 401-13). Karl Pearson eventually modified this "law" and injected it with more sophisticated mathematical treatment. He would emphasize, as well, that it was a purely descriptive formulation and advanced no physiological theory of heredity. It was not, he said, "a biological hypothesis, but the mathematical expression of statistical variates... which can be applied... to many biological hypotheses" (Pearson, 1896, 253-218). Galton, however, retained a physiological theory of heredity (the stirp), the ancestral law apparently corroborating the stirp theory and vice versa (Froggatt & Nevin, 6). In the attempt to apply this law, test his stirp theory and find a measurable way of reckoning heredity, Galton developed two important statistical concepts: regression and correlation.

As noted previously, Galton's discovery of regression developed out of his discovery of reversion in heredity as a generalized statistical principle. Correlation developed out of Galton's interest in Alphonse Bertillon's attempt to develop a system for identifying criminals based on physical measurements of the head, limbs and other parts. Galton viewed Bertillon's system as redundant, measuring different dimensions of the same person as if these were independent variables whereas one variable, in these cases, undoubtedly had some influence over the other, i.e., tall people were likely to have longer limbs. Galton at first tried to assess whether these characteristic were independent by tabulating figures such as height and arm length against each other. He noticed that the distribution of one character measured against another followed the familiar pattern he had previously drawn in his measurements of regression. Thus measures of two different entities such as arm and leg length could, as in regression, be expressed mathematically. This measure he dubbed the coefficient of correlation and perceived that regression was merely a special application of the coefficient of correlation. Expressed as a number from minus one to plus one, this coefficient could provide a measure of the degree to which one variable could depend on the other. This innovation proved tremendously significant in fields such as biology and sociology where a number of independent variables are often perceived as simultaneously at work in producing an observed result. Pearson vastly improved Galton's statistical theory, the eminent biologist J.B.S. Haldane claiming that "It is not too much to say that the subsequent developments of mathematical statistics are largely based on Pearson's work between 1893 and 1903" (Haldane, 1958, 15)[12].

It is interesting to note the development of Pearson's and Weldon's thinking in this regard. After reading Natural Inheritance, Pearson expressed agreement with Galton's hereditary thesis:

> The general conclusion one must be forced to by accepting Galton's theories is the imperative importance of humans doing for themselves what they do for cattle, if they wish to raise the mediocrity of their race ("On the Laws on Inheritance according to Galton", Pearson Papers, CV D6, 34 quoted in Mackenzie, 1981, 88).

But he also expressed skepticism towards the idea of applying statistical methods to social and biological problems:

> Personally I ought to say that there is, in my opinion, considerable danger in applying the methods of exact science to problems in descriptive science... the grace and logical accuracy of the mathematical processes are apt to so fascinate the descriptive scientist that he seeks for sociological hypotheses which fit mathematical reasoning (Ibid., 2).

Weldon, on the other hand, cared little for the eugenic implications of Galton's theories and was more attracted to the statistical method. It was Weldon who helped Pearson overcome his initial hesitations by showing him the very real possibilities which statistics offered for biology[13]. Pearson, once introduced to the possibilities of statistics, embraced the new science with an almost religious fervour. He became convinced that with the development of Galton's statistical insights, science had found the ultimate tool of both biological and social investigation. For Pearson, the concept of correlation opened up the entire field of social science to quantitative and precise treatment. Philosophically more sound and flexible than the concept of "causation", correlation seemed to be the key instrument for future social investigation. It did indeed become an important tool in a number of fields and, like eugenics itself, became a controversial one in its application to mental testing. In 1930 Pearson wrote,

> Thousands of correlation coefficients are now calculated annually, the memoirs and textbooks on psychology abound in them; they form... the basis of investigations in medical statistics, in sociology and anthropology... Formerly the quantitative scientist could think only in terms of causation, now he can think also in terms of correlation. This has not only enormously widened the field to which quantitative and therefore mathematical methods can be applied, but it has at the same time modified our philosophy of science and even of life itself (Pearson, 1914, 21-22, 24-25).

It was Galton and especially Pearson who most forcefully pressed statistics as the prime tool not only of biological science and eugenics but of all science as such. In this advocacy of the primacy of statistics, Pearson and biometry encountered the fierce opposition of another tradition of biological science. The occasion of the conflict between the two schools can, once again, be picked up in another series of questions opened up by Darwin's theories.

d. Discontinuous/Continuous Evolution

Darwin's acceptance of the inheritance of acquired characters connected with a major stream of British science and philosophy, which, as already noted, stressed the powerful formative forces of external conditions. But his views as to the nature of variation and inheritance caused considerable problems for the theory of natural selection. In Darwin's theory the development of species was conceived as due mostly to the gradual accumulation of small individual differences and variations rather than to large, sudden, discontinuous "sports" or monstrosities (in modern terms, mutations). Impressed with the reality of adaptation in the natural world, it was difficult for Darwin to believe that these could ever have arisen suddenly.

> It may be doubted whether sudden and considerable deviations of structure such as we occasionally see in our domestic productions... are ever permanently propagated in a state of nature. Almost every part of every organic being is so beautifully related to its complex conditions of life that it seems as improbable that any part should have been suddenly produced perfect, as that a complex machine should have been invented by man in a perfect state (Origin, 1936, 38).

Darwin also believed that the saltationist view which held that natural selection operated on "sports" was wrong because these were unstable and would be swamped through continuous blending inheritance with normal varieties (Provine, 1971, 13; Origin, 1936, 39).

These views were rejected by various authors (including Huxley) who showed that small individual differences could never, as a matter of observable fact, accumulate the necessary modifications of structure to form new species. After a certain amount of "improvement" in a given breed, offspring would tend to revert back in the direction of their previous form.

> Although many domestic animals and plants are highly variable there appears to be a limit to their variation in any direction. This limit is shown by the fact that new points are at first rapidly gained, but afterwards more slowly, while finally no further perceptible change can be effected (Jenkin, 285).

Darwin's commitment to a theory of gradual transmutation by selection of small variations may in part be attributed to the adage he adopted from Lyell in the uniformitarian debate

- that "Natura non facit saltum" ("nature makes no leaps"). Huxley, on his part, believed that "saltationism" or evolution by sudden jumps, was the only way that natural selection could be reconciled with the geological record which showed innumerable gaps between living forms. He believed that this was not contradictory to uniformitarian principles. In a letter to Lyell before the publication of Origin he stated:

> The fixity and definite limitations of species, genera, and larger groups appear to me to be perfectly consistent with the theory of transmutation. In other words, I think transmutation may take place without transition.
>
> Suppose that external conditions acting on species A give rise to a new species, B; the difference between the two species is certainly a definable amount which may be called A-B. Now I know of no evidence to show that the interval between the two species must necessarily be bridged over by a series of forms; each of which shall occupy, as it occurs, a fraction of the distance between A and B...

Huxley then illustrates his point by an analogy drawn from chemistry:

> In an organic compound, having a precise and definite composition, you may effect all sorts of transmutations by substituting an atom of one element for an atom of another element. You may in this way produce a vast series of modifications - but each modification is definite in its composition, and there are no transitional or intermediate steps between one definite compound and another. I have a sort of notion that similar laws of definite combination rule over the modifications of organic bodies, and that in passing from species to species "Natura fecit saltum" [nature makes leaps] (Huxley to Lyell, 25 June, 1859, in Huxley, 1900, i, 189).

Galton sided with the saltationist camp in this debate. Indeed his examination of variation and especially his discovery of regression in populations could not but lead him to this view. If ordinary heredity works to preserve the species type through the tendency towards reversion, then sudden discontinuous changes seemed to be the most likely source of speciation. Already in Hereditary Genius, Galton proposed a "quantum" hypothesis of organic stability which clearly implied a saltationist position. By 1894 Galton confidently reiterated that "Many, if not most breeds have their origin in sports" (Galton, 1894, 365).

Galton was placed in an awkward position in this regard, however, since his biometric disciples, Pearson and Weldon, became staunch advocates of the gradualist position. Weldon was a key figure in this debate. He had been appointed Lecturer in Invertebrate Morphology at Cambridge in 1884 and Professor of Zoology at University College in 1890, replacing his former teacher, E. Ray Lankester. In 1899 he again succeeded Lankester to the Chair of Comparative Anatomy at Oxford until his untimely death in 1906 (Farrall, 1985, 60-61). Weldon's attraction to Galton's methods stemmed from his dissatisfaction with traditional morphology which seemed to be stagnating compared to other branches of biology since Darwin. At the time, Weldon's field was dominated by the view that "ontogeny recapitulates phylogeny" or that the embryo in development passes through a series of stages which correspond to its adult phyletic ancestors (see Mayr, 474-76; Gould, 1977b). Combined with the Darwinian view, this approach encouraged the attempt to construct genealogical trees and more accurate classifications of organisms to answer questions of evolutionary descent. Weldon became increasingly disenchanted with this approach and turned to variation for possible answers to his scientific questions (Provine, 1971, 38). In 1889 Weldon read Natural Inheritance and was convinced of the efficacy of Galton's methods for the solution of problems in morphology and variation. Moreover, they promised to revolutionize these fields, turning them into exact sciences. In four papers between 1890 and 1895 he attempted to show the applicability of Galton's methods to problems of morphology and natural selection in animal populations[14]. In his 1893 paper Weldon boldly asserted the competency of Galton's methods to deal with these problems and at the same time articulated the main principles of biometry:

> 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) the percentage of animals which exhibit a given amount of abnormality with regard to a particular character; (b) the degree of abnormality of other organs which accompanies a given abnormality of one; (c) the difference between the death rate per cent in animals of different degrees of abnormality with respect to any organ; (d) the abnormality of offspring in terms of the abnormality of parents and vice versa. 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 deviation 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, 329).

Galton and Pearson were very interested in Weldon's work and helped and encouraged Weldon, then a mathematical novice, in his biostatistical efforts. Together with others they approached the Royal Society in 1894 to establish a Committee for Conducting Statistical Inquiries into the Measurable Characteristics of Plants and Animals. Galton was selected chairman, with Weldon, Francis Darwin, A. Macalister, R. Medola and E.B. Poulton as members (Provine, 1971, 32-33). The association of Galton, Pearson and Weldon marks the beginning of the biometric school which, taking the cue from Darwin, was based on the notion that species and races were not "types" but fluctuating "populations" which could be measured and correlated with statistical accuracy (Farrall, 1985, 68; cf., Mayr, 1959).

Weldon and Pearson continued to work with Galton, despite the fact that they disagreed with him on the issue of discontinuity in evolution. Weldon's hopes for the future of morphological and evolutionary studies were founded on the orthodox Darwinism of continuous selection of small differences. The statistical methods he and Pearson advocated were especially suited to the treatment of evolution as seen from this perspective. But very soon the challenge from the saltationist camp would seriously put into question the entire enterprise of biometry and the primacy of statistics as a tool for the analysis of evolution. The challenge came first and foremost from William Bateson (1861-1926), a former student and close friend of Weldon and leader, after 1900, of the Mendelian school in Britain. Bateson's belief in saltationism predated his adoption of Mendelism (Provine, 1971, 35-44). Ironically, he drew much inspiration from Galton's works which advanced a similar view. Galton was pleased with Bateson's monumental Materials for the Study of Variation (published in 1894) and especially with the latter's support for discontinuous evolution. Galton had held this unorthodox position for many years "but all along I seem to have spoken to empty air", he wrote.

> It was, therefore, with the utmost pleasure that I read Mr. Bateson's work bearing the happy phrase in its title of 'discontinuous variation'... (Galton, 1894, 369).

In fact Mendelism could just as well account for graded characters such as height as it could for discontinuous characters such as eye colour or flower colours in certain species[15]. But Bateson interpreted Mendel's results as a confirmation of his saltationist thesis (see Bateson, 1902) and this was how his biometric opponents also understood it. In this sense the famous battle between Mendelians and biometricians was in essence illusory[16].

In 1900 Mendel's work was rediscovered on the Continent by Hugo de Vries, Carl Correns and Erich von Tschermak (Mackenzie, 1981, 120). William Bateson who was to eventually coin the words "genetics", "allelomorph" (later changed to "allele"), "zygote" and other important terms (Sturtevant, 32; Bateson, 1902), immediately adopted the new approach. He gathered around him a number of colleagues at Cambridge who began to develop Mendelian studies in Britain. Bateson's group based their work on a reading of Mendel's experiments which presupposed the existence of elementary units we now call genes. But at the time these were not seen as necessarily existing material entities but as theoretical postulates explaining observed patterns of heredity. Mendelian genes were generally perceived as occurring in pairs, passing from parent to child unchanged but liable to segregation and random recombination without blending. Bateson's group also used statistics in their studies of heredity but of a more elementary nature than that found in biometric analysis. With assumptions about the dominance of certain Mendelian factors (often single genes or gene pairs) observable in offspring, Mendelian genetics could theoretically explain many patterns in heredity. The impact of Mendelism was profound and world wide. During the course of the century increasing evidence of its reality was produced by scientists throughout the world. Unfortunately for the biometric cause, Mendelism was associated with discontinuous evolution and, as such, perceived as opposed to the orthodox Darwinian theory of evolution by small continuous variations. In effect the biometricians were defending Darwinism against what was perceived, until 1918, as a Mendelian challenge to this theory.

The conflict between the two schools has been studied by a number of authors (Farrall, 1975 and 1985, 74-102; Provine, ch.2 and 3; Mackenzie, ch.6; Norton, 1973). Here only a sketch of its relevant features and outcome can be given. Weldon's papers and discussions at the Royal Society, the Linnaean Society and the British Association led to a flurry of personal letters and exchanges in Nature between Weldon, Pearson, Bateson and a number of other biologists. Some of the early letters were favourably predisposed to Weldon's approach (e.g., Thiselton-Dyer, 1895). Within a short time, however, the tone of these letters had degenerated considerably and the acerbic confrontation between biometricians and Mendelians did not subside until after Weldon's death in 1906. In June 1895 Nature refused to publish any more polemics on the subject but the struggle between the competing schools was not thereby ended (see Provine, 49). In the same year Galton's Statistical Committee at the Royal Society issued its first report which included Weldon's papers on the death rate of C. moenas and an attack on Bateson's saltationist thesis (Weldon, 1895, 360-62). Bateson responded to this challenge by writing to Galton against Weldon's methods and conclusions. Galton gave the letters to Weldon and he and Bateson then engaged in a series of letters, questioning each other's work and the aims of the Committee (Provine, 1971, 49). Galton, accepting both Weldon's enthusiasm for biometry and Bateson's saltationism, suggested that Bateson and others should join the Committee. The Committee was enlarged when Pearson joined in December 1896 with Bateson, Lankester and F.D. Godman following suit one month later. It became quickly apparent, however, that the enlarged Committee was going to change methodological direction. In February 1897, the Statistical Committee was renamed the Evolution Committee of the Royal Society and few of the new members expressed any enthusiasm for biometry. The elaboration of Galton's Law of Ancestral Heredity by Galton and Pearson between 1897 and 1900 served only to sow increased confusion and antagonism within the renamed Committee[17]. By 1900 Galton, Pearson and Weldon had all resigned from the Committee and Bateson's group was left in complete control (Provine, 1971, 55). In

October Weldon wrote to Pearson "Do you think it would be too hopelessly expensive to start a journal of some kind?" (Pearson, 1906, 35) to which Pearson suggested the name Biometrika. At the time, both he and Pearson were skeptical as to their chances of publication through the newly reorganized Evolution Committee[18], Pearson writing to Galton: "[it] is clear that if the R[oyal] S[ociety] people send my papers to Bateson, one cannot hope to get them printed" (Pearson to Galton, 13 Dec., 1900, in Pearson, 1914-30, iiiA, 243). They began to seek resources for the creation of their own journal which was launched, with Galton's help, in June of 1901. Three years later, Galton succeeded in convincing Sir Arthur Rucker, Principal of the University of London, to establish a fellowship in eugenics (with Galton's financial backing). By January 1905, Edgar Schuster, a former student of Weldon's, was named first Fellow in National Eugenics (Farrall, 1985, 106-7). With Ethel M. Elderton as assistant, they formed the staff of the Eugenics Record Office, according to Farrall "one of the first biological research institutions established in Britain" (Farrall, 1985, 104-5). Schuster resigned his Eugenics Fellowship one year later to be replaced by Pearson who became Director of the Eugenics Record Office (later renamed the Galton Laboratory). Despite his busy schedule, Pearson managed to attract a number of students interested in mathematical statistics and a grant was awarded him by the College which he used to establish what was later called the Biometric Laboratory (Farrall, 1985, 110). The Galton and Biometric Laboratories were virtually fused when Pearson accepted the directorship of the former in 1906. After Galton's death in 1911, Pearson was appointed first Galton Professor of Eugenics in accordance with the terms layed out in Galton's will. With the new appointment and funding, Pearson could now devote his considerable energies as head of a new Department of Applied Statistics and Eugenics. The

Biometric and Galton Laboratories were both placed under this Department and Pearson retained his Directorship of each, slightly expanding the Galton Laboratory with the funds left over from Galton's benefaction (Farrall, 1985, 112-13).

Pearson imposed his strong grip on these institutions until his retirement in 1933. Along with his editorship of Biometrika, his position assured that the biometric school became a centre of advanced statistical analysis and, in this respect, was of major importance in the history of statistics and biometry (see e.g., Haldane, 1958). The various publications and lectures given through its auspices, assured biometry a voice which Pearson and Weldon felt would have been stifled by the influence of the Mendelian school. But with respect to biological questions, biometry was left relatively outside the pale of important developments in this field until less adamant proponents of statistical biology showed that biometric methods were not incompatible with Mendelian genetics.

Pearson viewed the biometric school as the truly scientific centre of eugenic science. He remained aloof from the EES and feared that enthusiasts from that organization would discredit eugenics as a legitimate science. Believing Galton had not distinguished clearly enough eugenics as a social creed and eugenics as a science he stressed that biometry should work gradually and patiently at establishing itself as a legitimate scientific field.

> Our experience in the Biometric Laboratory had taught us the serious length of time it takes to collect statistical data and afterwards to reduce them fully by modern statistical methods, whereas Galton was undoubtedly eager for quick returns; he approved brilliant essays in the monthlies, and wanted to see marked progress in the acceptance of Eugenics in his own day; he had not yet fully differentiated Eugenics as a science from Eugenics as a creed of social action (Pearson, 1914-30, iiiA, 296-7).

Despite this cautious admonition, however, Pearson was as much convinced of the scientific basis of eugenics as his master Galton or any enthusiast in the EES. The great majority of the memoirs produced by the biometric school and under Pearson's guidance were all directed towards corroborating Galton's hereditarian thesis. In addition, Pearson published innumerable pamphlets, hosted popular and scientific lectures all united by their strong advocacy of eugenics, statistics and biometry. The fusion between biometry and eugenics which he welded is striking evidence of his inability to free himself from the hereditarian thesis. But significantly, the conflicts in which biometricians fought with Mendelians were rarely in defense of this thesis but revolved mostly around the statistical method itself as a legitimate tool of analysis in biology. In essence, as the next section will try to show, this conflict pitted two opposing conceptions of science.

### e. Biology and Physical Science

In presenting the biometric case for evolutionary studies, Weldon and Pearson also stressed another advantage for the statistical method: it offered simple numerical descriptions and formulae without reference to any physiological theory of heredity. This is emphasized in one of Weldon's papers:

> It is to be observed that numerical data of the kind here indicated, contain all the information necessary for a knowledge of the direction and rate of evolution. Knowing that a given deviation from the mean character is associated with a greater or less percentage death-rate in the animals possessing it, the importance of such a deviation can be estimated without the necessity of inquiring how that increase or decrease in the death-rate is brought about, so that all ideas of 'functional adaptation' become unnecessary. In the same way, a theory of the mechanism of heredity is not necessary in order to measure the abnormality of

offspring associated with a given parental abnormality. The importance of such numerical statements, by which the current theories of adaptation, &c, may be tested, is strongly urged (Weldon, 1895, p.381).

This "theory-free" science fit perfectly the philosophy which Pearson had advanced in his Grammar, and for which he commended Galton's theory of ancestral heredity. Science does not explain but merely describes, ideally in compact mathematical form, a host of sense impressions. This is precisely what biometry was trying to do with heredity and explains Weldon's and Pearson's antipathy to Mendelism. Like an earlier primitive understanding of Newtonian mechanics which assumed the real existence of entities such as "force" or "causation", Mendelism also implies a kind of "plasmic mechanics":

> What I venture to think that we require at the present is not a hypothetical plasmic mechanics, but careful classification of inheritance for several grades of relationship, for a great variety of characters, and for many types of life... such inventors [of plasmic mechanics] are like planetary theorists rushing to prescribe a law of attraction for planets, the very orbital forms of which they have not first ascertained... The numerical laws for the intensity of inheritance must first be discovered from wide observation before plasmic mechanism can be anything but the purest hypothetical speculation (Pearson, 1901, 121).

Bateson's school, while recognizing the importance of statistical work, refused to believe that heredity could be understood in terms of statistics alone. The elaboration of a physiological mechanism, they argued, was a necessary part of hereditary science. In the debate between Mendelians and biometricians carried out in the pages of Nature, another zoologist commented on this aspect of Weldon's work:

> ...he [Weldon] cannot shut out others from the most interesting and most important fields of biology in this way... If a certain deviation is shown to be associated with an increased or

> decreased chance of life, we want to know how it acts, and no statistical Gallio can prevent us trying to find out (Cunningham, March, 1895, 510).

In another letter on Weldon's work with C. moenas, E. Ray Lankester makes another interesting philosophical point:

> [Weldon's mathematical] methods of attempting to penetrate the obscurity which veils the interactions of the immensely complex bundle of phenomena which we call a crab and its environment, appear to me not merely inadequate, but in so far as they involve perversion of the meaning of accepted terms and a deliberate rejection of the method of inquiry by hypothesis and verification, injurious to the progress of knowledge (Lankester, 16 July, 1896, 246).

Weldon then cited Hume, Kant and Mill to justify his methods (Weldon, 1896, 294). Lankester demurred from this foray into philosophy, accepting the validity of statistics as an adjunct to the method of hypothesis and experiment (Lankester, 30 July 1896, 294) while Weldon, in his turn, accepted the validity of the search for a physiological mechanism of heredity but stressing, once again, that this was not necessary for discovering the rate and direction of evolution (Weldon, Sept., 1896, 80). Weldon reiterated his commitment to the statistical method in his Presidential Address to the Zoology Section of the British Association (1898, 887-902). This drew criticism from Cunningham and George Henslow, a botanist and lecturer at St.Bart's Medical School (Farrall, 1985, 84 and note 63), the latter repeating that Weldon was trying to replace the experimental method by statistics (Henslow, 1898, 594-5; Farrall, 85). At a famous meeting of the British Association in 1904, the conflict came to a head with Weldon stating that the Mendelian hypothesis was "cumbrous and undemonstrable" (see "Zoology at the British Association", 538-41). While Pearson also criticized the Mendelians' inability to produce figures "consonant with the theory they were supposed to illustrate" he also offered an olive branch and advocated further investigation to settle the issue. Bateson reacted harshly; according to Pearson, the latter "dramatically holding aloft the volumes of this Journal [Biometrika] as patent evidence of the folly of the [biometric] school, and refusing the offer of a truce in this time-wasting controversy" (Pearson, 1906). Weldon, was probably the most vociferous opponent of Bateson and Mendelism. Committed to the theory of continuous evolution he had earlier criticized Bateson's Materials for the Study of Variation (1894) which supported the opposing thesis.

While this debate raged on, it rarely questioned the assumptions of hereditarian ideas. What was at stake in the debate was neither the physicalist model of heredity, nor the direct implications for social theory which were perceived to flow automatically from the hereditarian thesis. The conflicts between the competing schools were based on two major differences: (a) continuous or discontinuous evolution (the biometricians assumed the former); (b) primacy of the statistical over the "hypothetical" and experimental method. Both of these differences were inter-related. If evolution was continuous, it would seem possible to measure the effects or direction and rate of natural selection by incremental morphological changes in large populations. A physiological mechanism of heredity would be useful but would not be crucial to problems of this sort. If, however, evolution proceeds by sudden jumps, then the importance of statistical analysis would be restricted and would seem incapable of measuring or predicting the presumably sudden shifts in the characters and behaviours of populations. In this case, a physiological theory would be indispensible to account for such shifts. At bottom was the crucial issue of the proper methodological and philosophical approach to science. In the debate, many biologists revealed a prejudice against treating biological phenomena in numerical terms, this despite the invocations of Bateson and even Mendel as to its obvious importance in experimental work. The biometricians accurately assessed this attitude as irrational, although their own claims for a biometrical science were also often assessed as, at the very least, inflated. In hindsight, as indicated above, biologists and historians have judged that there was really no incompatibility between the two approaches.

Bateson criticized Pearson's and Weldon's approach largely on a misunderstanding of Mendel, conscripting the latter to his saltationist cause, whereas Mendelian principles could in fact be reconciled with gradualism and statistical methods. On the other hand, both Pearson and Bateson accepted the hereditarian thesis. Pearson's own allegiance to eugenics has already been noted. Bateson was no less enamoured with the social and political program which Mendelian hereditary science appeared to point to.

> How hard it is to realize the polymorphism of man! Think of the varieties which the word denotes, merely in its application to one small society such as ours, and of the natural genetic distinctions which differentiate us into types and strains - acrobats, actors, artists, clergy, farmers, labourers, lawyers, mechanics, musicians, poets, sailors, men of science, servants, soldiers, and tradesmen. Think of the diversity of their experience of life. How few of these could have changed parts with each other. Many of these types are, even in present conditions, almost differentiated into distinct strains... I never cease to marvel that the more divergent castes of civilized humanity are capable of interbreeding and of producing fertile offspring from their crosses. Nothing but this paradoxical fact prevents us from regarding many classes even of Englishmen as distinct species in the full sense of the term (Bateson, 1912, 16).

Moreover, as William Coleman writes in a fascinating essay on Bateson, the latter also based his own approach to variation partly on a physicalist conception of biology, although of a different kind than either Darwin, Galton or Pearson. Galton's and Darwin's theories of heredity were, in keeping with the dominant tradition of British scientific philosophy, strictly materialistic ones. Material particles, probably complex molecules, were seen as the major determinant of human physiological development. In this conception of heredity, every individual (and all his faculties) is the end product of the development of hereditary particles, originally gathered together by chance: "Each man should be viewed as a chance aggregate of organic elements, giving rise to a fairly stable overall structure..."

> ...the organized structure of each individual should be viewed as the fulfillment of only one out of an indefinite number of mutually exclusive possibilities. His structure is the coherent and more or less stable development of what is no more than an imperfect sample of a large variety of elements (Galton, 1889, 18).

This belief did not go unchallenged by other biologists, although it became more and more evident with the development of genetic science in the twentieth century that hereditary transmission and development did indeed have a material basis. Curiously, as will be shown below, a major challenge to this view emerged from the leader of Mendelian genetics in Britain. Another challenge came from the brilliant Scottish physicist James Clerk Maxwell (1831-1879). Maxwell, directly challenging Galton's materialistic premises in the latter's "Blood-relationship", pointed out that such tiny material particles as were assumed to regulate transmission and development could not possibly account for the complexity and specializations evident in living things,

> ... the smallest living being visible under the microscope does not contain more than about a million organic molecules. Some exceedingly simple organisms may be supposed to be built up of not more than a million similar molecules. It is impossible, however, to conceive so small a number sufficient to form a being furnished with a whole system of specialised organs.

> Thus molecular science sets us face to face with physiological theories. It forbids the physiologist from imagining that structural details of infinitely small dimensions can furnish an explanation of the infinite variety which exists in the properties and functions of the most minute organisms (Maxwell, 42).

Galton seems to have largely ignored or been unaware of Maxwell's challenge because he continued in later essays to assume a materialistic basis for heredity. In Galton's first major essay on heredity, "Blood-relationship" he uses the vague appellation "structureless element" or "structureless germ", (1871-72, 394). This, Maxwell implies, was an attempt to evade the objections which "molecular science" was making against traditional materialistic interpretations of heredity:

> Some of the exponents of this theory of heredity have attempted to elude the difficulty of placing a whole world of wonders within a body so small and so devoid of visible structure as a germ, by using the phrase structureless germ [here Maxwell cites Galton's "Blood-relationship"]. Now, one material system can differ from another only in the configuration and motion which it has at a given instant. To explain differences of function and development of a germ without assuming differences of structure is, therefore, to admit that the properties of a germ are not those of a purely material system (Maxwell, 42).

Galton's use of the word "stirp" in his "Theory of Heredity" instead of the phrase "structureless element" (or "structureless germ") which he had used earlier in "Blood-relationship", completely side-stepped this objection. Galton retained the traditional materialistic theory (as did other biologists), believing most likely that it was consonant with all that science (especially physical science) had to say on the subject. Karl Pearson, who was probably much more informed on the subject of physical theory and was a major philosopher of science in his own right, evaded the problem in another way. He dropped all reference to a physiological theory of heredity or to any "metaphysical" speculations about matter or force. He focussed instead on statistics and biometry, believing that these were most in keeping with the methods and ideals of science (see below).

In Bateson's scientific philosophy, biological phenomena could equally be reduced to physical laws. Unlike Galton and Huxley, however, he resisted the attempt to sum up the processes of heredity in materialistic terms, as due to the chemical interaction and combination of complex molecules. The elucidation of this theory was eventually perceived as among Mendel's greatest contributions to genetics. Ironically, the man who had done the most to spread Mendel's ideas in the English-speaking world would have none of it. His physicalism was predicated not on a materialist reductionism but on a <u>kinetic</u> one in which "force" rather than "matter" was the fundamental entity. It has been noted how important "force" was in pre-Galtonian studies of inheritance. The approaches of other writers of biology such as Spencer, Richard Owen, or St.George Mivart were also predicated on similar bases. Bateson's own work as a morphologist, previous to his involvement in hereditary theory, had impressed him with the rhythmical, repetitious and symmetrical qualities of organisms (for example, zebra's stripes, segmentation of worms). He may thus have been directly or indirectly influenced by work on spectral analysis which suggested that matter was not Newton's "form'd Matter in solid, massy, hard, impenetrable moveable Particles".

> The small hard body imagined by Lucretius, and adopted by Newton, was invented for the express purpose of accounting for the permanence of the properties of bodies. But it fails to account for the vibrations of a molecule as revealed by the spectroscope (Maxwell, 44).

Maxwell evoked Lord Kelvin's "vortex atoms", defined as swirls or centers in the "primitive fluid" (the luminiferous ether) to explain the vibratory phenomena observed by spectral analysis (Maxwell, 45). Maxwell had also claimed, against Galton, that biological phenomena could not be explained by reference to material particles as conventionally conceived. In addition, the spectral patterns which implied a vibratory or kinetic conception of "matter" were demonstrably capable of producing consistent patterns. Here was an explanation for regularity and order which did not depend on traditional atomistic materialism. Biological phenomena, including hereditary transmission, growth and various types of symmetrical and rhythmical patterns might also be ultimately explained by the same dynamic vortex theory. In a letter to the zoologist, F.B. Borradaille Bateson reveals his underlying conceptions of the mechanisms of heredity:

> But a living thing is not matter. It is a system-vortex, Cuvier called it - through which matter is passing. If you watch an eddy run along the dust, or through water, you will see a system - through which matter is passing - rise, <u>increase</u>, and decline. Such a system imitates the normal mechanical attributes of life fairly well. (The chemical admittedly not, but they can be paralleled anywhere, and in plenty of vortices too, I don't doubt). If we could make a vortex which would continue to divide spontaneously, we should - consciousness apart - have a rude but not ineffective, or unsatisfactory, model of life. I mean, one which would satisfy the grosser tests we biologists know; whether the philosopher would be content is another matter (Bateson to Borradaille, Merton 28 January 1924, <u>Bateson Papers, Baltimore</u> 36, quoted in Coleman, 270).

It is, according to Coleman, partly because of this mindset and partly due to other elements of Bateson's thought that the latter resisted the chromosome theory - a theory affirming the material basis of heredity - after most other biologists had become convinced of it (Coleman, 304). The same philosophical predisposition also explains Bateson's antipathy to biometry. Hypotheses, such as Bateson's "system-vortex", were an important and necessary part of the biologist's work and should not or could not be eliminated. The Mendelian school proudly carried on this tradition and criticized the biometrician's pretended scientism.

> You can not (it seems to me) reduce natural history, as Prof. Weldon proposes, to an unimaginative statistical form, without either ignoring or abandoning its most interesting problems, and at the same refusing to employ the universal method by which mankind has gained new knowledge of the phenomena of nature - that, namely, of imaginative hypothesis and consequent experiment (Lankester, 20 August 1896, 366).

But Pearson's school was based on a conception of science which specifically tried to excise all "metaphysical" thinking from science. The phenomenalist and idealist philosophy expressed in Pearson's <u>Grammar</u> predisposed him to treat the Mendelian approach as imbued with unnecessary postulates and riddled with unseen and unprovable entities. Against this, he asserted the statistical approach which needed no speculation but aimed simply for a description of (internal) sense-impressions in compact, economic language. This was, for Pearson, Weldon and other scientists the true method and goal of science.

This philosophy would seem to have been at variance with traditional conceptions of physical science which did postulate unseen entities and forces like "atoms", or "gravity". It would also seem to be at variance with the entire concept of "causation", assumed by Newton but shown by Hume and Kant to have no necessary existence in the physical world. Pearson ingeniously solved this problem and articulated a view of physical science which had been gaining ground in the two centuries after Newton's death. The attempts to characterize physical science as a strictly "causal" one, illustrating the universe's functioning according to unwavering axioms called the laws of motion, gravity, etc. was in essence a metaphysical accretion and was entirely unnecessary to it.

> The conclusions of the physicist and the chemist are based on average experiences, no two of which exactly agree; at best they are routines of perception which have a certain variability. This variability they may attribute to errors of observations, to impurities in their specimens, to the physical factors of the environment, but it none the less exists and, when it is removed by a process of averaging, we pass at once from the perceptual to the conceptual, and construct a model universe, not the real universe (Grammar, 2nd ed., 1911, 154).

And further:

> It is this conception of correlation between two occurrences embracing all relationships from absolute independence to complete dependence, which is the wider category by which we have to replace the old idea of causation. Everything in the universe occurs but once, there is no absolute sameness of repetition. Individual phenomena can only be classified, and our problem turns on how far a group or a class of like, but not absolutely same things which we term 'causes' will be accompanied or followed by another group or class of like, but not absolutely same things which we term 'effects' (Grammar, 2nd ed., 1911, 155).

In this philosophy of science all knowledge (and scientific knowledge is the only knowledge worthy of the name) is united by this common descriptive methodology and not in the nature of the facts examined (Grammar, 4th ed., 1937, 17). Pearson's scientific philosophy was thus able to reconcile the split between biological and physical science. This he did by both "probabilizing" physics and showing that biology and indeed all phenomena are similarly reducible to effective description through the statistical method. In a letter to Galton about the latter's lecture "Probability: The Foundation of Eugenics", Pearson explains:

> On May 21st I lectured to the Philosophical Club (a club of Oxford lecturers and dons) on 'The possibility of a wider category than causation'.

> This lecture starts from the idea that no two physical entities are exactly alike, e.g., not even two atoms are precisely identical. They form a class with variation about a mean character. Hence even in physics the ultimate basis of knowledge is statistical - the category is of course correlation and not causation. The main difference is that in physics the correlation coefficients are nearly unity, but in biology they diverge considerably from unity... [I]n this second lecture I shall assert that probability is the basis of <u>all</u> knowledge (not only of eugenics)... (Pearson to Galton, 22 April, 1907 in Pearson, 1914-30, iiiA, 314).

Mendelism, by its postulates of "unit-characters", and the like did not easily fit into this scientific philosophy:

> It is no discredit to the great structure of modern physical chemistry to assert that the absolute sameness of the molecule is only a statistical sameness, and that an ultimate individuality, of variation within the class, may be hypotheticated as a means of describing new developments which may hereafter be observed once powers of discrimination are finer. Individuality within class differentiation has been hitherto confined to vital forms; absence of individuality and persistency asserted of inorganic matter. What if the sameness and persistence be merely a relative distinction? What if the attempt of some biologists to replace vital variation by 'unit' characters be really a retrogressive change, and the persistency and absence of individuality to which they appeal as comparable with chemical changes be ultimately a false analogy, because the sameness of chemical theory is a <u>statistical</u> experience which may ultimately admit differentiation within the class? (<u>Grammar</u>, 2nd ed., 1911, 153).

Pearson's scientific philosophy, by abandoning "metaphysical" postulates, did not thereby abandon physicalism as the model which biology should follow. The success of physical science, in his estimation, was a result of its earlier mathematicization and this was why biology and social science should follow the same route. His elimination of "metaphysical" concepts in physics was simply a refinement of scientific philosophy which, with the aid of Galton, could now be utilized for the development of vast new areas of knowledge.

By applying statistical principles and methods to variation - an important innovation at the time - and by dropping the widely held idea of the inheritance of acquired characters Galton and Pearson were able to make important contributions to both statistics and genetics. But according to Kevles, Galton's use of statistics for the solution to problems in heredity was not due to a realization that biology needed mathematics (Kevles, 13). It was largely the result of his firm belief in their ability to solve any type of complex problem. In many ways, this was because of a personality quirk, a factor which Kevles attributes to Galton's inner turmoil.

> To plum intangible human depths was to risk self-perception. To enumerate human characteristics required no penetration beneath the phenomenological surface and established a wall of numerical objectivity between the observer and the forces of the heart (Kevles, 12).

Though this might be true, Galton's belief that statistics could illuminate the most complex problems, was also true. This is borne out by his application of statistical methods in biology, which proved tremendously fruitful. And, as previously discussed, the application of mathematical methods to natural phenomena was supported by an important tradition in British scientific thought. While Galton erred, like his disciple, Karl Pearson, in the inflated claims for the new science, the latter seems to have become blinded by the apparently objective nature of the statistical approach. Galton, on the other hand, was not averse to what Pearson might have called "metaphysical speculation". Both his stirp theory and his eugenic pronouncements are indications that he accepted the necessity of conceptual thought as an adjunct to empirical work in science. Pearson, however, seemed almost to have equated this approach as an invitation to error and fought ferociously for the statistical method as the surest past to scientific certainty. Ironically, Pearson's assumptions about the objectivity of statistical analysis and his aversion to "philosophical speculation" were the sources of his deepest errors.

Galton's scientific work is played down in Cowan's conception of the origins of his scientific ideas but it is apparent that, to a great extent, they are a logical result of his scientific work and are not exclusively, as various authors suggest, products of an ideological or personal motivation. Eugenics would not have been accepted as a scientific theory if contemporaries had perceived that it was essentially an ideological doctrine clothed in scientific dress. A scientific basis for eugenics had to be provided and this was what Galton and other thinkers and scientists did. Their scientific theories were taken seriously _as_ scientific theories by contemporaries and cannot be reduced exclusively to ideological or personal justifications for an ultimately political program, even in hindsight. This was especially true since Galton's theory of heredity, his statistical innovations applied to the same subject and his disciple's development of the latter actually grew in credibility until the inter-war period. Taking the lead from Galton, Pearson's contributions have been assessed as at least equally important, laying the foundations of modern statistics and the science of population genetics.

Galton's hereditary theory could not be detached from its eugenic implications. Part of the reason for this has been mentioned and revolves around the peculiarly intimate connection between British scientific thought and scientific knowledge. In this context, scientific theories were quickly absorbed by reformers, philanthropists, social workers and professionals and were made the basis of specific legislative proposals or other types of action in the social field (see, for example, Farrall, 1985, esp. ch.7, "Eugenics and Alcoholism: A Scientific Solution for a Social Problem?"). The fact that few eugenic proposal were ever enacted in Britain should not be taken as a sign that its scientific credentials were seriously questioned. Eugenic enactments did encounter opposition firstly, from the more cautious members of its own ranks but also from a certain section of liberal individualist and Catholic thought. These groups, however, could mount no effective counter-attack against the hereditarian thesis at the base of eugenic ideology. What scientific conflicts arose against Galton's and especially Pearson's methods in the biometrician-Mendelian debate were not directed against the hereditarian thesis as such and thus were never an attack on eugenic principles. In fact, both Mendelians and biometricians claimed Galton as their forebearer. William Bateson, the champion of Mendelian genetics in Britain, equally shared Galton's eugenic concerns. Galton's scientific contemporaries, as well as Galton himself, based their views of the world on science, and the scientific view seemed to suggest the necessity of eugenics. If acquired characters are not inherited and yet everything from religious predisposition to intelligence, to our physical forms were inherited (and even Darwin believed that everything was heritable) then schemes aiming at the modification of circumstances to improve society and individuals are mostly bound to fail.

Galton's critique of the inheritance of acquired characters and his contribution to genetics stem from the same source: his division of life processes between "nature and nurture" and the paramount importance he attached to the former. The complex of motives which led to the development of both his scientific work on genetics and statistics and of eugenics ideology can best be understood as a combination of personal, ideological and scientific elements, none of which can be disregarded if we wish to understand the rise of eugenics in Britain. Clearly, the scientific work of Galton, the biometric school and other eugenists, played a major part in the establishment of eugenics as a credible science. Moreover, the development of hereditarian principles as well as the conflict over the correct method by which to test these, were an integral part of the scientific debates which followed the trails blazed by Darwin and earlier British scientific philosophy. In this regard, the role played by the physicalist conception of science was significant. Physics remained the model science upon which biology and social science should be based. This was true both of Pearson's biometric school and of Bateson's Mendelians. Whether the model was vibratory force (Bateson) or quantitative phenomenalism (Pearson) or traditional materialism (Galton) each had their roots in a particular understanding of the concepts of physics. The possibility of positing a separate and independent status for biology, was not open to scientists imbued with a fundamental belief in the "unity" of science and a distaste for what smacked of "metaphysical" or religious notions. If two other elements are added - the belief in the efficacy of science to solve all problems and find all truths and the practical bent of British scientific philosophy - we can understand why so many biologists and workers in the social field were attracted to eugenics. Here was a theory and practice of the social organism whose founders were recognized as "on the cutting edge" of biological science, who developed mathematical techniques - the hallmark of science - and whose basic principles remained consistent with dominant traditions of scientific philosophy. Only sentimentalists and religiously motivated opponents, it would seem, could resist the opportunity which eugenic science offered for the solution to social problems.

## NOTES

1. Jean Baptiste Lamarck was one of the most famous naturalists of his time (1744-1829). But see Mayr, (687-89) who traces the belief in the inheritance of acquired characters to ancient times and states that "it was the standard concept of the eighteenth century, held by all outstanding biologists of the period, including Buffon and Linnaeus".

2. See, for example Samuel Butler, who states that "the 'Origin of Variation,' whatever it is, is the only true 'Origin of Species', (1910, 263). Darwin could conceivably have dispensed with any detailed explanation of inheritance and variation at all, taking these for granted - a reasonable procedure considering the vast amount of variation in nature which should strike even the most obtuse observer. He could simply have assumed variation to be a natural fact needing no further explanation. Hooker in fact made this argument, stating "I incline to attribute the smallest variation to the inherent tendency to vary; a principle wholly independent of physical conditions" (Hooker to Darwin, March 17, 1862, in Hooker, 1918, i, 37). In short, he could have treated these like a "black box" (see Mayr, 682). The point, however, is that variation kept nagging Darwin and he was in fact not content to "black box" it but devoted at least 900 pages (Variation) to the problem. As Mayr states:

> For Darwin an "inherent tendency to vary" [Hooker's view] probably smacked of the same spirit as Lamarck's "inherent tendency toward perfection." To accept genetic variability simply as another manifestation of the imperfection of the organic world was not sufficiently "causal" enough for Darwin... In an age when only those processes were scientifically respectable that obeyed a "law", it was not admissable to acknowledge stochastic perturbations (Mayr, 1982, 685).

For Galton, these "stochastic perturbations" were not synonymous with an irreducible capriciousness in nature but were themselves subject to laws - the laws of probability.

3. But unlike other writers on inheritance, Darwin did not seem to believe that the hereditary material of the father and mother fused completely in the offspring. This is due partly to his simultaneous belief in the hereditary material as composed of unit particles (see below) which he conceived as retaining their integrity even when mixed with other

particles. In a later edition of Variation he states that it would "be more correct to say that the elements of both parent species exist in every hybrid in a double state, namely, blended together and completely separate" (quoted in Mayr, 779-80).

4. But see Sturtevant who traces particulate inheritance and pangenesis to the ancient Greeks and remarks on Aristotle's critique of Hippocrates' views in this regard (Sturtevant, 2).

5. See, for example, Duke of Argyll, 153-60; Jenkin, 149-171; letters from Darwin to Hooker 23 Feb., 1868, in Darwin, 1898, ii, 260-61; Darwin to Wallace 27 Feb., 1868, in Darwin, 1898, ii, 262-3.

6. Darwin reacted rather harshly to this judgement, accusing Galton of having misinterpreted his theory. Darwin stressed that he had never claimed that the gemmules circulated in the blood "...or about any fluid proper to any circulating system" (Darwin, 27 April, 1871, 502). Galton answered this letter the following week (Galton, 4 May, 1871, 5-6), ingratiating himself to his "wise and most respected chief" and concluding with the phrase "Vive Pangenesis". But Galton remained convinced of his position, especially as regards the non-inheritance of acquired characters. This was made evident by the publication of his "Theory of Heredity" (December 1875, 80-95, revised in 1875b, 325-48) which directly challenged the inheritance of acquired characters and by a series of letters between Galton and Darwin (Pearson, 1914-30, ii, 181-90).

7. G.J. Romanes, in attempting to rescue the hypothesis of the inheritance of acquired characters places Galton's theory between Darwin's and Weismann's, though closer to the latter. Galton's theory is more acceptable than Weismann's to Romanes because Galton admits of some scope for the inheritance of acquired characters and often reserves judgment on whether or not to rule out this explanation for variation. Weismann, in contrast, leaves no room for such views in his germ plasm theory. According to Romanes

> ...germ-plasm resembles stirp much more than closely than it does gemmules [Darwin's theory], seeing that the theory of stirp is founded on the postulate of "continuity" in exactly the same manner as is the theory of germ-plasm... we may say that his [Weismann's] theory of heredity is, as regards all essential points, indistinguishable from that of Galton.
>
> The truly scientific attitude of mind with regard to the problem of heredity is to say, as

> Galton says, "that we might almost reserve our belief that the structural [i.e., somatic] cells can react on the sexual elements at all..." [this passage from Galton already cited in text above]... [However] no matter how faintly or how fitfully the substance of heredity may be modified by somatic tissues, by external conditions of life, or even by so-called spontaneous changes on the part of the substance itself, numberless causes of congenital variation are thus admitted, while even the Lamarckian principles are hypothetically allowed some degree of play [in Galton's theory] (Romanes, 1899, 106-7).

8. The dedication reads: "I dedicate this book, with their kind permission, to Francis Galton and August Weismann, whose magistral studies of heredity have made us all their debtors."

9. The Victorian statistical movement, states Mackenzie, was largely composed of social reformers who, in the tradition of British empirical investigation, wished to produce and utilize facts to advance their social programs.

> The statisticians wanted more than voluntary and legislative action in the fields of public health and education: they were also free traders, supporters of the new poor law (if not framers and administrators of it), opposed to trade unions and working class radicals, suspicious of factory acts (Cullen, 11 and 147 in Mackenzie, 1981, 8).

Probability theory was an "old and respectable area of study", marked by Laplace's Théorie Analytique des Probabilités (1812). But apart from actuarial work done for commercial and life insurance companies, ..."it was on the whole a body of work with but little practical application, and one which was largely stagnant in nineteenth century Britain" (Mackenzie, 1981, 8 and note 7).

10. Helen Walker states:

> The term probable error originated among German mathematical astronomers who wrote near the beginning of the nineteenth century. The early use of the term is in certain memoirs dealing with astronomy, geodesy, or artillery fire, where the writer is attempting to make the best possible determination of the true position of a point from a series of observations all of which involve an element of error. A deviation from the true position of the point, or more commonly from the

> mean of the observations, of such a magnitude that, if the number of observations be indefinitely increased, one half of the errors may be expected to be numerically greater and one half numerically less than this value, is then termed the 'probable error' (Walker, 50, in Mackenzie, 1981, 57. [**N.B.** I have not found this passage in Walker's article])

11. Galton believed that each sex contributed equally to the nature of the offspring. Thus when he wrote "father", "grandfather", etc., he probably meant "mid-parent", "mid-grandparent", etc., the mean between mother and father each of which contribute equally to the offspring.

12. Most of Pearson's most important contributions were developed in a series of papers entitled "Mathematical Contributions to the Theory of Evolution" published mostly in the Philosophical Transactions of the Royal Society (series A). In these essays, Pearson developed a number of standard tools now used in all types of statistical work, including the chi squared test, standard deviation, correlation and regression coefficients and a number of mathematical tables (see Farrall, 1981, 88 and note 67, for a full list of this series).

13. Pearson was further goaded into action on behalf of biometry by Lord Salisbury's criticisms of natural selection which the latter believed could not be demonstrated. Salisbury concluded that Darwinism was implausible and advocated a re-examination of creationist theories (Marquis of Salisbury, 1894). Pearson's scientific philosophy rebelled against such a reactionary turn in biology. He believed that biometry might be a way to stifle this "new bigotry". If a quantitative measure of the effects of natural selection could be provided, Darwinism would be vindicated and Salisbury and his ilk would be silenced. Pearson's neo-positivist philosophy of science was an important consideration in this "biometric defense of Darwinism". Clearly, if all knowledge derives from sense-impression, Darwin's natural selection needed solid, preferably quantitative buttressing. It was indeed difficult to deny that, as Salisbury wrote, "no one had ever witnessed natural selection". Galton's laws of regression and correlation could perhaps do the job. With statistical analysis one could establish, in true scientific style, not absolute "causes" but exact correlations (see below).

14. Weldon worked mostly with the crustaceans, including a variety of the common shrimp (Crangon vulgaris) and shore crab (Carcinus moenas). He began by showing that variations in local populations followed Galton's normal distribution

(Weldon, 1890, 445-53). Weldon then applied Galton's correlation techniques to two different species (1892, 2-21). In these two papers, Weldon believed he had found a new way to establish a species "type" or race. Using Galton's methods, a species could now be defined probabilistically rather than in ideal terms (Farrall, 1985, 65). In addition, correlations between organ parts within a species could perhaps help uncover unsuspected physiological relationships.

> ...the results recorded lead to the hope that, by expressing the deviation of every organ from its average in Mr. Galton's system of units, a series of constants may be determined for any species of animal which will give a numerical measure of the average condition of any number of organs which is associated with a known condition of any one of them. A large series of such specific constants would give an altogether new kind of knowledge of the physiological connexion between the various organs of animals ; while a study of those relations which remain constant through large groups of species would give an idea, attainable at present in no other way, of the functional correlations between various organs which have led to the establishment of the great sub-divisions of the animal kingdom (Weldon, 1892, 11).

In two later studies (1893 and 1895) Weldon tried to show natural selection at work (via selective death rates of certain variations) in crabs and attacked the saltationist school (see also Farrall, 1985, 62-88 ; Norton, 1973).

15. Mendel's experiments with peas (Pisum) dealt mostly with discontinuous characters but he also described hybridization experiments with the colour of flowers of Phaseolus. In the first generation, crossing of white and purple varieties yielded all purple flowers. The seeds taken from these hybrids, however, yielded a series of colours from purple red to pale violet to white. According to Mendel

> even these enigmatical results, however, might be explained by the law governing Pisum if we might assume that the colour of the flowers and seeds of Ph. multiflorus is a combination of two or more entirely independent colours, which individually act like any other constant character in the plant (Mendel, 30; cf. Provine, 1971, 57-58).

Thus Mendel's theory could account for graded as well as discontinuous variations.

16. Norton claims that "any conflict between the two groups was, logically speaking, a phony conflict" (1975, 85). This became evident in later years when R.A. Fisher published his paper on "The correlation between relatives on the supposition of Mendelian inheritance" (Fisher, 1918) regarded as "the first to successfully synthesize two hitherto distinct and opposed approaches to the science of heredity..." (Norton, 1975, 537-553). The fusion of the two approaches has been viewed as giving birth to the science of population genetics (see, for example, Provine, 1971).

17. The various "reformulations" of this "law" increased the confusion of many biologists. Pearson developed Galton's initial ideas into far more sophisticated expressions but may have altered them beyond recognition. The advent of population genetics later in the century, writes Provine, "showed that Galton's law was irrelevant and it simply dropped from sight" (Provine, 1971, 54. Also Provine, 1971, 52-54 and his Appendix for what this author sees as incompatible formulations of Galton's law).

18. In the same month Pearson submitted and read an abstract of a paper to a meeting of the Royal Society. Bateson, in attendance at the meeting and appointed as one of the referees over Pearson's paper, drew up detailed criticism of it and told Pearson he had prepared an unfavourable report. Without his permission, Bateson's criticisms were distributed among the other referees before Pearson's full memoir was presented. Pearson protested at this unusual procedure and Bateson apologized. The apology was accepted, and the paper was eventually published. But Pearson maintained his commitment to a new journal, inviting Bateson's contributions or criticisms. Despite the temporary cordiality between Bateson and Pearson, in the preface of the first issue of Biometrika, the editors alluded to "the coldness of welcome often afforded to new departures in science".

## VI. CONCLUSION

I have tried to trace the development of certain fundamental ideas in British scientific philosophy and their relation to social thought. The influence of physical ideas have been noted in various areas such as utilitarian philosophy, the associationist psychology and sociology. Biology was also dominated by physical categories - to use Lamarck's phrase it was conceived as a branch of "terrestrial physics". Darwin's theory of pangenesis, certain aspects of his evolutionary theory, Galton's stirp theory as well as Bateson's biological ideas all demonstrated their indebtedness to physicalist ideas. Pearson's statistical science was also inspired by the belief, articulated by Lord Kelvin and others, that only number and quantity could provide adequate understanding of complex phenomena. In short, "science" was virtually defined as physical science and physical science became the model of scientific inquiry per se. The physicalist outlook or what Huxley called "the New Philosophy" has been described as a genuine world view, incorporating a number of elements which have been briefly examined. These included a materialist philosophy of nature, a deterministic conception of natural law, a mechanistic model of the operation of the universe and the view that all phenomena could be reduced to the laws and principles of physical science and mathematics. The principle of the uniformity of nature was integrated into this _weltanschauung_ as a necessary postulate of science without which scientific reasoning as such could have no secure basis. At the same time, contemporaries understood this "principle of reasoning" as underscoring the continuity of human life with nature and its laws. This was most dramatically revealed in the Darwinian debate on "man's place in nature" and on the status and nature of the human mind.

J.C. Greene has described this philosophy, emanating out of the Enlightenment and the Scientific Revolution, as a major component of modern European thought. While older notions survived well into the twentieth century, the medieval fusion of Christian and Graeco-Roman ideas was in large part supplanted by a view of the universe which conceived of everything as a mode of "matter in motion" (Greene, 1986). Intellectually, eugenics belongs to the period of sharpest conflict between both views and greatly benefitted by the ascendancy of the scientific-physicalist conception in the latter half of the nineteenth century. The high point of the physicalist domination of social thought was exhibited in the rise of various types of positivisms in the late nineteenth and early twentieth centuries. Eugenics represented a particular variant of this tendency fusing physicalism with Darwinian concepts in the attempt to create a sociology dedicated to achieving the accuracy, certainty and fruitfulness of physical science.

The domination of physicalist categories in scientific inquiry had a number of important consequences in biology and social thought. Biological thought, in the attempt to follow what was interpreted as proper scientific procedure, tried to rid itself of metaphysical, religious and other ideas such as vitalism which posited a separate force or special status for living things. Organisms were perceived as subject to the same laws as the rest of nature. They were composed of the same substance and animated by the same mechanistic rules. To some writers, such as Huxley, the human mind itself was no exception. In this scientific philosophy, consciousness could either be ignored as tied to religious or metaphysical notions or treated as eventually reducible to law and scientific principle. But by positing an intrinsic inviolability and irreducibility of the human essence the older views had often acted as a bulwark against the idea of human interference in the most private and sacred spheres of life such as marriage and reproduction.

What was called mind, consciousness, mental faculty and sometimes soul was traditionally perceived as separate and irreducible, perhaps a product of a force as yet unknown or an expression of the divine in the human. With the advance of science as defined above, this bulwark was removed. Mind, consciousness, the soul, it was claimed, derived from matter and could be explained without reference to "metaphysics" or the supernatural. The road now lay open to the scientific manipulation of the most intimate aspects of human life. There was no longer, in principle, any reason that marriage, reproduction as well as welfare, taxation, education, and social policy in general should not conform to the superior knowledge of science. Mind, being thus secularized, became subject to a type of scientific rationality which claimed to be able in due time to engineer and improve it better than nature or God had as yet done. The decline of religious and other doctrines limiting the scope and competence of the physicalist-scientific outlook was thus one of the necessary preconditions to the acceptance of Social Darwinist thought in general and eugenics in particular. Without this decline it would be difficult to explain the wide credibility given to what were, after all, shocking concepts to Victorian middle-class morals - breeding humans like humans breed cattle. The rise of natural science was the reverse side of the coin of the decline of religion and metaphysics. Once biological phenomena were perceived as subject to law, the possibility of utilizing this knowledge for the betterment of the species - a practice which had hitherto been confined to domesticated plants and animals - was now theoretically open. The view that knowledge should be the basis of action, including intervention in the social sphere, gained considerable credence in the late nineteenth century and what I have called the growing belief in "the efficacy of science" assured that this knowledge would be based on a scientific and not on a religious or other conception of life.

Although in many respects evolutionary theory represented a new methodological and conceptual departure in biological science, contemporaries usually perceived Darwin as having finally brought biology into the realm of science and scientific law. Darwin himself believed that he was following the strictest "Baconian principles" and often made comparisons between his theory and others in physical science. He was also powerfully influenced by the prevailing definition of science. From the eugenic standpoint the most important consequence of Darwin's theory was its reduction of biological phenomena to law, its destruction or marginalisation of metaphysical and religious notions of human origins and status and its elucidation of the basic principles of social and biological development. Eugenic science was not simply an ideological accretion to evolutionary theory but represented an attempt to "fill out" the conceptual framework Darwin had established in the social sphere. The role of eugenics within this framework was to bring Darwin "up to date" by applying his concepts to contemporary society and by establishing a science for the practical application of this knowledge. Eugenists and other writers feared that civilization had suspended the beneficent action of "natural selection" and that their society was allowing a rapid multiplication of the "unfit". The explanatory power of these concepts, their apparent applicability and relevance to contemporary developments and to widespread social problems, convinced a broad section of educated opinion of the feasibility of eugenics both as a "pure" diagnostic science of social ills and as a prescriptive or "practical" science of social reform. In the aftermath of economic depression in the early 1870s and mid 1880s, military and Imperial setbacks and the growing deterioration of urban life, contemporaries found in eugenics both an explanation and a possible answer to these problems. It would be wrong, however, to conclude that social, political and economic factors are a sufficient explanation for the emergence of the eugenics phenomena. Eugenic science belonged to a long tradition of British scientific philosophy which asserted that only through scientific knowledge could society be set upon the surest and best path to social betterment. Most of the scientific evidence in the period examined seemed to support the case for a eugenic interpretation of society and reform. Although factors "external" to science played a key role in the advent of eugenics, to contemporaries who were imbued with the scientific philosophy described here, it was also largely a question of drawing the proper conclusions from the available evidence. The conclusions pointed to eugenics as a most promising route to the solution of social ills and the "regeneration" of society as a whole. In this light the acceptance of eugenics is little more than a reflection of the prevailing faith in science among the British educated classes.

A necessary adjunct to the establishment of eugenics as a science was the development of two important other sciences - heredity and statistics. As a science focussing on the "inborn qualities of a race", eugenics needed a much more secure knowledge of the nature and processes of heredity before a credible and practical scientific sociology could be erected upon it. In this capacity the work of Francis Galton as well as that of other important biologists provided excellent scientific justification for eugenics. The once widely held belief in the inheritance of acquired characters and the theory that germ cells are influenced by various environmental factors had provided an important argument for reformers and philanthropists who argued that betterment of human circumstances was the key to the betterment of society. In many respects these views also reflected a long standing assumption in British science and philosophy about the efficacy of environmental forces in shaping mind and body. The work of Galton, Weismann and other biologists helped to undermine these assumptions. The establishment of the principle of the continuity of the germ plasm proved especially significant in bolstering the hereditarian thesis, the view that "nature" predominates over "nurture", a fundamental axiom of eugenics. The advent of Mendelian genetics did not significantly alter this picture. Both Mendelians and anti-Mendelians could be found arguing for eugenic principles of social reform. If anything, early Mendelian genetics provided confirmation of the hereditarian thesis by demonstrating the irrelevance of environmental forces in accounting for hereditary transmission and development. If environmental reform could effect little lasting change in the quality and "fitness" of individuals and society then the only rational path of reform was biological.

From another direction, the development of statistical science by Galton, Pearson, Weldon and other biometricians, seemed to provide an invaluable tool perfectly fitted to the analysis and diagnosis of social and psychological phenomena. Statistics had the added advantage of high esteem because of the value attached to mathematical form in science. It may have benefitted, as well, from the shift in physical science from a simple Newtonian causal-mechanistic world view to a probabilistic one in the beginning of the twentieth century[1]. This new philosophy, articulated by authors such as Ernst Mach on the Continent and by Karl Pearson in Britain, expressed the idea that all phenomena could be known only in probabalistic terms. Causality should either be considered as a metaphysical idea having no place in science or as part of the spectrum of correlation. In either case statistical theory was advanced as the instrument by which to grasp this new world of probability. Under Pearson statistics developed rapidly and was destined to spread its influence in psychology, biology, sociology and other fields.

The application of statistics to biology was justified in many ways. As a method especially suited to the resolution of highly complex problems in which many variables interact, statistics was perceived as especially suited to the investigation of living things. The philosopher Charles S. Peirce also expressed the view, although it was not widely commented on at the time, that "The Darwinian controversy is, in large part, a question of logic. Mr. Darwin proposed to apply the statistical method to biology" (Peirce, 1877). Biometricians also understood their science as a logical development of Darwinian theory and as an extension of science into previously impenetrable realms. The claim was made by Pearson and other biometricians that statistical analyses neither advanced nor required any hypothesis. As a "theory-free" instrument of science, it therefore constituted the securest foundation of all biological knowledge.

The mathematicization of biology was not universally supported, however, and many biologists found themselves in bitter opposition to this trend. Many biologists believed that biometry represented an attempt to expunge the method of legitimate hypotheses and concept formation in biology. They also appealed to Darwin's works and the progress of science in general to justify their approach. Their strong commitment to this method of science reveals an underlying conflict between two scientific philosophies. But the significance of the battle between biometricians and Mendelians was in what was <u>not</u> at issue - the physicalist paradigm and the hereditarian thesis. Eugenic science could be based on both approaches to the study of biology. This was made evident in the pages of the <u>Eugenics Review</u> to which both schools contributed and in the pro-eugenic pronouncements of Mendelians themselves. That Mendelian genetics was not inimical to eugenics is also proven by the existence of the American eugenics movement, itself dominated by Mendelian genetics. The formation of an independent biometrical science dedicated to the further development of eugenics and statistics is a testament to the energy and resourcefulness of its prime movers - Karl Pearson and his master Francis Galton. The creation of the Biometric and Galton Laboratories and the journal Biometrika, were also due to the "cold shoulder" given to the new science by Bateson and other Mendelians. Biometricians felt that only with the launching of an independent school with its own publications and facilities would the new science be given a fair hearing. Under Pearson statistical science was harnessed to eugenic goals and this helped to promote the status of eugenics as science in its own right. The association of eugenics and statistics had a number of important consequences in the controversy over mental testing, in education and in other areas over the course of the twentieth century. Despite Pearson's efforts, however, biometry and statistics did not become the sole method of eugenics. All three "sciences" continued to develop independently throughout the inter-war era. Eugenists continued to utilize findings from a wide number of fields and from various types of approaches. In the 1930s, after Pearson had retired from the field, biometry and Mendelism were fused together in the science of population genetics.

The formation of the Eugenics Education Society as well as the wider eugenics movements can thus be understood as partly due to important developments in science, especially evolutionary biology, statistics and genetics. It was also partly a result of developments in the economy, society and politics in the late nineteenth and early twentieth centuries. The latter, providing an atmosphere of crisis, probably increased the receptivity of contemporaries to radical new doctrines and to eugenics in particular. A number of writers, sometimes called "externalists", have already examined these in relation to the origins and growth of British eugenics (see chapter I). This paper has focussed on the former factors, i.e., on developments in science and scientific philosophy which have been relatively neglected in the literature on eugenics. In this sense this work has adopted what may be called a "critical internalist" perspective. But it can be seen that both sets of factors are complimentary rather than contradictory and must be taken together as a whole in any attempt to explain the advent of eugenics. This complimentarity, moreover, illustrates the limits of categorizations such as "internalist" or "externalist" in the case of eugenics. It is clear that many, if not most, of the scientists working in the social and biological fields accepted eugenics as a possible new science of society. If we accept the Kuhnian definition of science in which the scientific community is the sole validator of what constitutes "science", then we must conclude that eugenics was, in fact, a science. The externalist claim that eugenics was a "distortion" of science or was a product of class bias seems to miss the point that few contemporaries saw it that way or that the bulk of the scientific evidence supported eugenists' claims. Ironically, the externalist view that eugenics was an "ideology of the professional middle-class" and thus that its scientific pretensions were a disguise or mask of objectivity concealing deep class and race prejudices, is curiously similar to the stereotyped "internalist" position. We are presented with a model which conceives of an "objective" science, on the one hand, and a "distorting ideology" on the other. While both views differ as to whether the latter can significantly influence the former, neither questions the notion of an "objective" or "real" (for lack of a better word) science. Although "externalists" would be the last to admit it, this position reveals an implicit view of science which is perceived as inherently "value-free", though perhaps amenable to manipulation and distortion. In the battle to prove that "external" factors can influence scientific discovery, externalists have glossed over the fact that legitimate scientific concepts and hypotheses, when applied indiscriminately, can themselves help to produce "ideologies" like eugenics. Eugenics is one example of an ideological science which emerged from the application of physical categories and methods to society. The net result of this was to foster a system of ideas which ignored attributes specific to human social and individual life and encouraged the transgression of traditional ethical values and established rights in the name of science and progress.

The ideological content of eugenics was inherent in physicalist philosophy itself, in part because this approach could not accommodate or even recognize distinctive features appropriate to the human realm. These distinctive features revolve around the questions of the ends or purposes of human action and behaviour and these, in turn, call for an examination of meaning, value and a philosophical critique of knowledge and explanation as an integral part of social science. The absence of this self-critical element in eugenics explains to a large degree the very possibility of such an "ideological" science. In the conjunction of "eu" and "genics", the "eu", as Hobhouse states, is approached unproblematically, as a given. What constitutes the "fit" or "survival value" or the "good" is rarely questioned. Karl Pearson could write:

> One thing only is fixed, the direction and rate of change of human society at a particular epoch. It may be difficult to measure, but it is none the less real and definite. The moral or good action is that which tends in the direction of growth of a particular society in a particular land at a particular time (1888, 428).

From this uncritical position which bases the social good on a conception of the natural Pearson can, despite his professed socialism[2], advance statements like the following:

> No thoughtful socialist, so far as I am aware, would object to cultivate Uganda <u>at the expense of its present occupiers</u> if Lancashire were starving. Only he would have this done directly and consciously, and not by way of missionaries and exploiting companies (1897, i, 111; Pearson's emphasis).

This attitude towards other societies is paralleled by a similar attitude towards sections of Pearson's own society, whether called the "feeble-minded", the "undeserving poor", the "pauper" or the "residuum". It was an attitude that was far from being unique to eugenics. But eugenics typifies, perhaps more than any other scientific doctrine, a dangerously uncritical spirit of positivistic science. It is an attitude that challenges accepted values and beliefs while simultaneously maintaining an uncritical acceptance of racial and class domination as a scientific given. On the one hand, we are to understand that examinations of the good, of ethics and morality are either "metaphysical" questions unworthy of serious scientific attention or that their nature and functioning can only be adequately understood through notions of "survival value" and the like. On the other hand, the hierarchical division of society and the world is not treated as similarly transient phenomenon, open to critical scrutiny, but as a result of permanent facts of nature.

In the inter-war period, eugenics continued to influence statistical as well as non-statistical approaches to social thought and action. At the same time, it became the target of increasing criticism from biologists, sociologists and other academics and professionals. Before 1914 the sociologist L.T. Hobhouse, already began to criticize the encroachment of eugenic ideas in the development of British sociology and affirmed the need to establish an independent sociology freed from the constraints of biological explanations of behaviour. Like Huxley, Hobhouse argued that natural selection and the struggle for existence were not adequate concepts with which to approach the study of society since these have been largely supplanted in the case of human society by other factors. While he recognized that eugenic proposals about restrictions of marriage for certain cases of feeble-mindedness were possibly justified, he warned that a general program of "racial improvement" could easily become a weapon in the hands of the most aggressive.

> We might eliminate the feeble-minded, but who would ever eliminate the too strong-minded? The superman type, the Junker, the profiteer, the soulless efficient, are between them the scourge of the earth. The rest of us who want to live in peace and get on with the work of civilized life may well feel that if it come to elimination, we are much less likely to eliminate than to be eliminated by them (Hobhouse, 1927, 116; Hobson & Ginsberg, 1931, 146-7).

Hobhouse rejected the view that social ills could be understood as a consequence of biological degeneration or the multiplication of the unfit. He also launched a frontal attack against what he perceived was a justification of "caste" by pointing out that poverty is not equivalent to "unfit" and that "fitness" itself is rather ambiguous and is also not equivalent to what may be termed socially desirable (Hobson & Ginsburg, 1931, 147-148). Trained in philosophy at Oxford, Hobhouse deplored its devaluation in the dominant scientific philosophy of his day. He ascribed to this disdain much of the errors from which eugenics sprang. He recognized the philosophical bases of eugenic science in the mechanistic world view which sociology had imported from physical science.

> ...it is often supposed that the distinctive object of science as opposed to humanistic or philosophical treatment is to resolve the mental into the material, the purposive into the mechanical, life and mind into physico-chemical forces. This is a mistake in definition: it is not in the distinctive character of science to assume any general explanation at the outset. It is the object of science to ascertain the facts with accuracy and completeness (Hobhouse, 1927, 240, 241).

Against the physicalist concepts of matter, force and mechanism, Hobhouse asserted the categories of "purpose" and "organism" as the operative concepts in the social sciences. The mechanistic conception, states Hobhouse, presumes phenomena to be composed of elements which can be understood in isolation from each other. Each element is perceived as subject to a causative agent or force. But in organisms, each part or element effects the other and the whole organism. A part cannot be understood without understanding its place in the whole.

> The true corrective... to the mechanical view is the conception of the organism as a totality wherein all elements and all life processes modify one another and lose that independence which, as genuinely mechanical processes, would be attributed to them (Hobhouse, 1908, 275, 276).

The actions of an organism sometimes display simple mechanistic rules, such as in reflex actions. But in other forms of behaviour, especially in human social life, this explanation is found lacking and the concept of purpose must be invoked. Hobhouse defines purpose as "A whole [which] acts purposively in so far as its acts are determined by their own tendency to produce results affecting the whole" (Hobhouse in Carr, 1918, 67; Owen, 1974, chapters 2 and 3). In purposive action behaviour is conditioned by a perceived end or result. In mechanical action a result is also obtained but this result does not condition the behaviour of the mechanical elements or the whole mechanism. A machine cannot change its actions to conform to changing purposes or unforseen contingencies. Because purpose is a "causal" factor in human life, and because actions can be suited to an almost infinite number of purposes, social scientific inquiry cannot legitimately ignore the category of purpose in accounting for human behaviour. Explanations which posit only biological or environmental factors as sufficient causes of human behaviour thus eliminate from the start the most significant things about it. While the expulsion of teleology from Darwin's work was a major advance in evolutionary biology, in social and psychological thought this amounted to a massive sidestepping of the central issue and an amputation of the proper object of study.

Hobhouse's critique of physicalism in social thought was a signal that the high point of eugenic influence in the scientific community had passed. In Germany Max Weber and other thinkers were elaborating a new logic of social inquiry which helped to clarify and distinguish explanation and understanding in the social and natural sciences (see, for example, Weber, 1977a, 24-37; 1977b, 38-55). The scientific opposition to eugenics was dramatically increased in the period following the downfall of Nazism and fascism in Europe. Article 2 of the United Nations' Universal Declaration of Human Rights and the "Statement on the Nature of Race and Race Differences" signed by a host of illustrious geneticists and anthropologists in 1951 expressed a revulsion against racial myths in particular and hereditarian ideas in general. Article 6 of this Statement states that

> The scientific material available to us at present does not justify the conclusion that inherited genetic differences are a major factor in producing the differences between the cultures and cultural achievements of different peoples or groups. It does indicate, on the contrary, that a major factor in explaining such differences is the cultural experience which each group has undergone

("Statement on the Natue of Race and Race Differences" reprinted in Comas, 1961, 303-325).

Thus both historical experience and the development of social and scientific thought have been instrumental in shaping intellectual approaches to the study of human social and individual life in the post-war era. Developments in natural science, especially in genetics, psychology and sociology, have exhibited a much more complex picture of reality than was conveyed in the scientific philosophy of the early part of this century. Physical science itself is no longer universally conceived as the model science in which certainty and accuracy reign unquestioned. This has done much to limit the applicability of natural scientific concepts outside their specific realms. But whether scientists have been correct or not in the social conclusions they attach to their findings, these continue to have a lasting impact on educated and popular opinion. In the past conclusions have been reached asserting that cultural differences, differences in intelligence and behavioural traits are grounded in biology. Sometimes these findings, like the infamous twin studies of Sir Cyril Burt, were eventually found fraudulent. At other times, such as with the pre-war mental testing of American soldiers, wrong conclusions were derived from faulty methods and procedures. In recent years biological conceptions of human society, of intelligence and social differences have made "a comeback". It remains to be seen whether the latest attempts in establishing a "Sociobiology[3]" will suffer the same fate. But research in the sensitive zone between biology and human social life, even when conclusions apparently contradict accepted beliefs and cherished values, is not always a product of "error" so conceived. Eugenic science, whether it was Galton's work on heredity or Pearson's tabulations of the relative influence of nature and nurture, was rarely "wrong" in this sense. Indeed, from the point of view of genetics and statistics, Pearson and Galton were ahead of their time and may have contributed, on the whole, a great deal to present day knowledge. The "error" of eugenics, as has been argued, was deeper and stemmed from a widely held conception of science and the ramifications of this conception once it was applied to social thought and other fields outside of physics. The conceptual foundations of eugenic thought, derived from physicalist philosophy, approached a world in which only "matter in motion" could be observed and in which purpose, value and meaning were irrelevant to the outcome of experiments or observations. From the perspective of physicalist science, the proper and unsentimental grasp of human and social phenomena was through the categories of "matter in motion" (Greene, 1986).

To some extent this approach to the study of social and human life is possibly due to the position of biology in the sciences. Biology may be said to belong to both the social and the natural scientific spheres of inquiry. As G.G. Simpson states:

> Insistence that the study of organisms requires principles additional to those of the physical sciences does not imply a dualistic or vitalistic view of nature. Life... is not thereby necessarily considered as nonphysical or nonmaterial. It is just that living things have been affected... for billions of years by historical processes... The results of those processes are systems different in kind from any nonliving systems and incomparably more complicated. They are not for that reason any less material or less physical in nature. The point is that <u>all</u> known material processes and explanatory principles apply to organisms, while only a limited number of them apply to nonliving systems... Biology, then, is the science that stands at the center of all science... And it is here, in the field where all the principles of all the sciences are embodied, that science can truly become unified (Simpson, 1964, 106-107).

Without wishing to comment on the last assertion, it nevertheless becomes clearer why social, biological and physical thought merge so often and so easily together. If biology is in fact "the center of all science", then biological findings do and will have important consequences for social thought. In this sense, biological conceptions of human life are not solely the product of a culture which establishes physical and biological science as the models of scientific inquiry and applies them uncritically to all phenomena. We are also biological and physical beings and it is not difficult to see how categories and explanatory models designed to explain these are often taken as sufficient to explain all aspects of biological systems, including ourselves. The problem, however, seems to lie in the "cognitive monopoly", as Habermas calls it, of an approach which claims exclusive title to genuine knowledge. Scientific thinking seemed not to have recognized the necessity of drawing important distinctions in method and concept between various realms of inquiry. Historically, as in the sterilization movement of the 1920s and 1930s in the United States, the consequences of such thinking have often resulted in the violation of cherished principles of ethics, notions of equality and human rights. But the moral opposition to these measures in a scientific culture like ours is often either insufficient or inadequate to seriously impede the "progress of science" for very long. What seems to be required is, a continuous challenge to this "cognitive monopoly" by the further development and articulation of the nature of explanation in social scientific inquiry. Moreover, the connection with prevailing power structures and ideas must not be clouded over by pretensions of scientific objectivity. Especially in social inquiry of all types, the examination of ends, purposes and ultimately values need to be properly integrated into social thought. A critique of knowledge as an integral part of a scientific philosophy would enable science to adequately fit these essential elements into its general outlook. Only with a genuine increase in this critical spirit wedded to the humanistic values for which science exists can we hope to master the forces we have unleashed. Ironically, it was science itself that had been foremost in cultivating the critical spirit and advancing humanist philosophy. Ultimately the reunion of philosophy and science would help restore the original purpose and highest aspirations of the Enlightenment tradition - that science become the vehicle of the fuller realization of human potential and human liberation.

# NOTES

1. In many ways this shift, constituting a kind of "probabilizing" of the archetypical science of physics, seemed to justify the establishment of a social science independent of the concepts and methods of physical science. As Hobhouse states:

> It was not till physical science had achieved the final triumph of the later nineteenth century that it began to doubt its own assumptions and a reconstruction set in, of which the end is not in sight, but which has gone far enough to shake the apparent simplicity and seemingly axiomatic character of mechanistic principles and to justify those who study the world of mind, of ethics, politics, religion and art in pursuing their course without the uneasy belief that their ultimate results can be nothing but superficial appearance, the underlying causes of which must be ultimately traceable to the mechanical interaction of physical particles (Hobhouse, 1937).

On the other hand, by substituting the idea of cause and mechanism for probability and correlation, this new philosophy was able to smooth out some of the very real differences of method and concept between the natural and social sciences. This smoothing out was an important part of Pearson's philosophy. If all phenomena can be known only probabilistically then the higher methods of statistics can be applied across the board and can be relied on to provide the best possible knowledge in any field.

2. This is not to say that socialist thought is completely free of the tendency to subsume ethical principles under the type of rational-scientific process described here. Indeed, this has been the subject of well known debates over Marxian philosophy. But an important tradition in European socialism, represented in Britain partly by the SDF was generally more critical of the type of social-imperialism advanced by Pearson, the Webbs and other reformers. Pearson's formulations though far from unique, remain peculiar (see Semmel, 1960 for an outline of Pearson's variant of "socialism").

3. This term has been most often associated with E.O. Wilson's book <u>Sociobiology</u> (1975) and with the views of authors like Dawkins (<u>The Selfish Gene</u>, 1976). See Midgley, 1979 for an interesting discussion of "Selfish Genes and Social Darwinism".

# VII. APPENDIX

## 1. List of Some Members on the Council of the EES, 1909-1920 and Main Source of Biographical Information.

Between 1908-1920, 120 people served on the council of the Eugenic Education Society. The list below does not include honorary members Arthur Balfour, Geikie, the Duchess of Marlborough, and August Weismann. Nine members resided outside Great Britain and Farrall made no attempt to gather information on them. Out of the 111 council members remaining, no information was available on 28 and minimal information was available on 40. Of the latter, 11 were known to have medical qualifications, 5 were listed as "Dr.", 8 were listed as B.A. or M.A., 2 had the title "Professor", 10 had the title "Sir" or "Lady". These forty also include an admiral, an alderman, a Justice of the Peace, and a lady awarded the O.B.E. Of the remaining 43, 20 were already included in Farrall's "Random Sample" (see 3. Random Sample..."), viz., Armstrong-Jones, Bond, Carr-Saunders, Crichton-Browne, D'Arcy, Ellis, Fisher, McDougall, Mond, Mott, Moulton, Nettleship, Pinsent, Poulton, Schiller, Arthur Schuster, Seligman, Seward, Spearman, and Welldon. As in the random sample below, academics and doctors make up more than half the names. The remaining 23 are:

Major W.P. Colfox, M.P. (REES)
Montague Crackanthorpe K.C. (ER, 5, 1913-14, 342)
Major Leonard Darwin (ER, 34,1942-3, 109)
Mrs. S. Gotto (Neville Rolfe) (ER, 47 1955-6, 194, 214)
Dr. M. Greenwood (University of London Calendars)
David Heron (Directory of British Scientists, 1963)
Major H.E. Hillis (Who's Who, 1914)
Dean W.R. Inge (Oxford Dictionary of the Christian Church)
T.N. Kelynack M.D. (British Journal of Inebriety)
Miss A.H.T. Kirby (ER, 1909-20)
Prof. James A. Lindsay (Who was Who 1929-40)
Prof. E.W. MacBride (Who was Who 1929-40)
Mrs. G. Pooley (see George H. Pooley, Who's Who 1914)
Walter Rea, M.P. (Who's Who 1914)
G. Archdall Reid (Who's Who 1914)
Dr. C.W. Saleeby (British Journal of Inebriety, 1909-14)
Dr. Ettie Sayer (Who was Who 1916-28)
E.H.J. Schuster (Pearson, 1914-1930)
Dr. J.W. Slaughter (ER 1908-14)
Dr. W.C. Sullivan (ER 1 1909, 56-8)
Sir John Arthur Thomson (Who was Who 1929-40)
W.C. Dampier Whetham (Who's Who 1914)
Arnold White (Who was Who 1916-1928)

Source: Farrall, 220 and note 37.

2.a. Occupations of the EES Council Members, 1908-20.

| Occupation | Well-documented number | Total |
|---|---|---|
| Medical | 26 (a) | 10 |
| Academic | 18 | 16 |
| Politicians | 4 | 3 |
| Clergy | 3 | 3 |
| Social Work | 3 | 3 |
| Scientists | 2 | 2 (b) |
| Writers | 2 | 2 (c) |
| Military Officers | 2 | 1 |
| Lawyers | 1 | 1 |
| Housewives | 2 | 2 |
| Not Known | 48 (d) | 0 |
| Total | 111 | 43 |

Source: Farrall, 221.

(a) Includes 5 who had the title "Dr." but about whom no further information was available.
(b) Includes Col. H.E. Hillis, F.R.S. who was a military officer specializing in military engineering.
(c) Includes Havelock Ellis whose writings were largely scientific.
(d) Includes eight people who had university degrees and ten with the title "Sir" or "Lady".

2.b. Description of Some of the People in Table 2.

Ten of the academics had already achieved eminence in their various fields when they served on the council in the years before 1920. These were mostly in the biological (MacBride, Poulton, Seward and J.A. Thomson) and social sciences (McDougall, Spearman, and Seligman [antrhropologist]. Other academics included: F.C.S. Schiller, W.C.D. Whetham, F.R.S. [writers of books and articles on eugenics], Sir Arthur Schuster (prominent physician) and Prof. J. A. Lindsay (Prof. of Medicine at Queen's College, Belfast). Four of the remaining six were involved in biometric work at the Galton Laboratory: Dr. M. Greenwood, (received medical training and lectured on vital statistics at the Univeristy of London), David Heron (Pearson's chief assistant). Heron's work as council member of the EES was probably curtailed because of a clash between the EES and Pearson. Trained as a mathematician, he went on to a carrer as an actuary. Edgar Schuster studied under Weldon and had been the first Galton Research fellow in eugenics. R.A. Fisher was also interested in biometry about which he wrote articles in the Eugenics Review and Biometrika.

Medical members include Armstrong Jones, Bond, Crichton-Browne, and Mott [psychiatrists]. Others concerned with social problems were: Dr. Ettie Sayer (a strong supporter of the women's sufferage movement and member of the National Society for the Welfare of the Feeble-Minded), Dr. T.N. Kelynack, Dr. C.W. Saleeby (both prominent members of the British temperance movement), Dr. C.W. Sullivan (prison medical officer and concerned with problems of crime (see "Eugenics and Crime", ER 1, 1909-10, 112n).

Social workers also concerned with social problems: Mrs. (later Dame) E.F. Pinsent, Miss A.H.T. Kirby (who did much work on behalf of the mentally ill), Mrs. S. Gotto (later Mrs. S. Neville-Rolfe) who was the first secretary of the Society and one of its prime movers, received an O.B.E. for her work in the war time movement against venereal diseases).

Other politicians included, Major W.P. Colfox and Mr. Walter Rea. Both were not of outstanding prominence but they helped further the EES's political aims), and Baron Moulton (who had an almost honorary position as one of the Society's vice-presidents).

Three prominent clergymen: Bishop Welldon, Archbishop D'Arcy and Dean Inge.

Two professional writers, Havelock Ellis and Arnold White (The latter published, inter alia, "Nomad Poor of London", Contemporary Review, 47, May, 1885, 714-26; "Colonization and Emigration", Contemporary Review, 49, March 1886, 375-81; "A Typical Alien Immigrant", Contemporary Review, 73, Feb. 1898, 241-50).

Major Leonard Darwin, son of Charles, became president from 1911. He seldom missed committee or council meetings and was usually chairman at public meetings and lectures conducted by the EES. He wrote many articles in the ER and represented the Society at national and international conferences. He was, according to Farrall, a moderating influence in the EES, and encouraged political activity but not the view that it was the only answer to Britain's problems (unlike, e.g., C.W. Saleeby, see Saleeby, 1909; 1914 and 1921).

Source: Farrall, 218-225.

3. Prominent Members of the EES, 1913-1914.

| | |
|---|---|
| University post (academics): (1) | 29 |
| Politicians: (2) | 6 |
| Medical practitioners: (3) | 6 |
| Clergymen: (4) | 3 |
| Social workers: (5) | 2 |
| Research scientists: (6) | 2 |
| Authors: (7) | 2 |
| Businessmen: (8) | 1 |
| Patron of literature and arts: (9) | 1 |
| Total "prominent members": | 52 |
| Remainder: | 8 |
| TOTAL: | 60 |

Adapted form Farrall, 213-218

(1) Consisting of some of the most important figures in population genetics and evolutionary theory: Ronald A. Fisher, J.B.S. Haldane, Patrick Geddes and J. Arthur Thomson, E.B. Poulton, and A.M. Carr-Saunders. Others who had some influence on the study of the inheritance of intelligence, Cyril L. Burt, Charles E. Spearman.

(2) Including A.J. Balfour (honorary member) and Neville Chamberlain (member of Birmingham branch); William Joynson-Hicks, Home Secretary and Sir Arthur Steel Maitland, Minister of Labour under Baldwin's Conservative government (1924-29); Baron Moulton, former Liberal M.P. and Lord Justice of Appeal 1906-1912 was also vice-president of the EES.

(3) Four of these working in the psychiatric field.

(4) Both were schoolmasters; Edward Lyttleton, headmaster of Eton an James Welldon, later Dean of Manchester and headmaster of Harrow. Two other prominent clergymen included Charles D'Arcy, Archbishop of Armagh and William Inge, professor of divinity and later Dean of St.Paul's Cathedral.

(5) Not professionally trained but voluntary philanthropists. Includes Lady Henry Somerset, president of the World Women's Christian Temperance Union and Dame Ellen Pinsent, member of the Royal Commission on the Treatment of the Feeble-Minded (1904-1908) and Commissioner for the Board of Control of the Feeble-Minded.

## 4. Occupations of the Members of the Random Sample.

This random sample was drawn by Farrall from the membership lists of the EES from 1908 to 1915 and from 1919 to 1920. It was designed to form a picture of the rank and file members of the EES. The procedure by which Farrall has compiled this table is explained in Farrall, 1985, 212 and note 22.

| Occupation | |
|---|---|
| Academic | 6 |
| Medical | 3 |
| Social Work | 2 |
| Writer | 2 |
| Clergy | 1 |
| Military Officer | 1 |
| Wife (a) | 5 |
| Lawyer | 1 |
| Director of Art Museum | 1 |
| Local Government | 1 |
| Part-time author (b) | 2 |
| No Information | 35 |
| Total | 60 |

(a) All were wives of prominent people.
(b) These two members are known only because of the one or two books they wrote.

Source: Farrall, 227.

# BIBLIOGRAPHY

Abbreviations:

CP Clarendon Press, Oxford.
CUP Cambridge University Press, London.

## Primary Sources:


Arnold, Mathew. Higher Schools and Universities in Germany, Macmillan, London, 1874.

Babbage, Charles. Reflections on the Decline of Science in England, reprint by Pickering & Chatto, London, 1989 of the B. Fellowes 1830 edition in vol. 7 of The Works of Charles Babbage (11 vols.).

Bacon, Francis. Francis Bacon. A Selection of his Works, edited by S. Warhoft, MacMillan, Toronto and London, 1965.

Bagehot, Walter. Physics and Politics, Colonial Press, New York, 1899.

Ball, W.P. Are the Effects of Use and Disuse Inherited? Humboldt Publishing, New York, 1890.

Bateson, William. Mendel's Principles of Heredity, CUP, 1902.

--- "Biological Fact and the Structure of Society", (Herbert Spencer Lecture, 1912) in Oxford Lectures on Philosophy 1910-1923, CP, 1912.

Bentham, Jeremy. An Introduction to the Principles of Morals and Legislation, Hafner Publishing, New York, 1948.

Bridges, J.H. "Influence of Civilization on Health", Fortnightly Review 6, n.s., August 1869, 140-162.

Butler, Samuel. Life and Habit, first published 1878, Wildwood House 1981 re-issue, of London, 1910 edition.

Carr, H. Wilden (ed.). Life and Finite Individuality, Williams & Norgate, London, 1918.

Chesterton, G.K. Illustrated London News, 66, 12 March, 1910.

--- Eugenics and Other Evils, Cassell, London, 1922.

Comte, Auguste. The Positive Philosophy of Auguste Comte, 2 vols., tr. and condensed by Harriet Martineau, Chapman, 1853.

Cunningham, J.T. "The Statistical Investigation of Evolution", Nature, 51, 28 March, 1895, 510.

--- "Organic Variations and Their Interpretation", Nature 58, 20 October, 1898, 593-4.

Darwin, Charles. "Pangenesis", Nature 3, 27 April, 1871, 501-2.

--- The Variation of Animals and Plants Under Domestication, 2 vols. 2nd edition, D. Appleton, New York, 1876.

--- The Life and Letters of Charles Darwin, edited by Francis Darwin, 2 vols., D. Appleton, New York, 1898.

--- More Letters, edited by F. Darwin & A.C. Seward, 2 vols., D. Appleton, New York, 1903.

--- The Origin of Species (6th edition) and The Descent of Man (2nd edition), Random House Modern Library, New York, 1936 reprint.

--- The Autobiography of Charles Darwin 1809-1882 with original ommissions restored, edited by Nora Barlow, Collins, London, 1958.

Duke of Argyll. "On Variety as an Aim in Nature", Contemporary Review 12, May, 1871, 153-60.

Ellis, Havelock. "The Sterilization of the Unfit", Eugenics Review 1, 1909, 203-206.

Field, James A. "The Progress of Eugenics", Quarterly Journal of Economics 26, Nov. 1911, 1-67.

Fisher, Ronald A. "The Correlation Between Relatives on the Supposition of Mendelian Inheritance", Transactions of the Royal Society of Edinburgh 52, 1918, 399-433.

--- The Genetical Theory of Natural Selection, CP, Oxford, 1930.

Galton, Francis. "Hereditary Talent and Character", Macmillan's Magazine 12, June 1865, 157-66 and August 318-27.

--- Hereditary Genius: An Inquiry into its Laws and Consequences, MacMillan, London, 1869; 2nd edition, MacMillan, London, 1892.

--- "Experiments in Pangenesis", Proceedings of the Royal Society 19, 1870-71, 393-410.

--- "Pangenesis", Nature 4, 4 May, 1871, 5-6.

--- "On Blood-relationship", Proceedings of the Royal Society, 20, 1871-72, 394-401.

--- "Hereditary Improvement", Fraser's Magazine, Jan. 1873a, 116.

--- "The Relative Supply From Town and Country Families to the Population of Future Generations", Journal of the Royal Statistical Society 36, March 1873b, 19-26.

--- English Men of Science: Their Nature and Nurture, MacMillan, London, 1874.

--- "A Theory of Heredity", Contemporary Review 27, December 1875a, 80-95.

--- "A Theory of Heredity", (revised version of 1875a) Journal of the Anthropological Institute of Great Britain and Ireland 5, 1875b, 325-48.

--- "Typical Laws of Heredity", Proceedings of the Royal Institution of Great Britain 8, 9 Feb. 1877, 282-301.

--- "Regression towards Mediocrity in Hereditary Stature", Journal of the Anthropological Institute of Great Britain and Ireland 15, 1886, 246-63.

--- Natural Inheritance, Macmillan, London, 1889.

--- "Discontinuity in Evolution", Mind 3, n.s., 1894, 362-72.

--- "The average contribution of each several Ancestor to the total Heritage of the Offspring", Proceedings of the Royal Society 61, 1897, 401-413.

--- "The Possible Improvements of the Human Breed under the Existing Conditions of Law and Sentiment", Nature 64, 31 Oct., 1901, 659-665.

--- "Eugenics: Its Definition, Scope and Aims", Sociological Papers 1, 1904a, 43-99.

--- "Eugenics: Its Definition, Scope and Aims". Abridged reprint of 1904a in Nature, 70, 26 May, 1904b.

--- Probability, the Foundation of Eugenics, Herbert Spencer Lecture delivered 1907, CP, Oxford, 1907.

--- Memories of My Life, Methuen, London, 1908.

--- Inquiries into Human Faculty and its Development, (1st ed., 1883) 2nd. edition, J.M. Dent, London, 1919.

Galton Laboratory. A List of the papers and correspondence of Sir Francis Galton..., Galton Laboratory, University College, London, 1976.

Greg, W.R. Engimas of Life, Kegan Paul, Trench, Trubner & Co., London, 1873.

Haldane, J.B.S. "Eugenics and Social Reforms", The Nation and the Athenaeum 35, 31 May, 1924, 291-93.

--- "Karl Pearson", New Biology, no.25, 1958, 7-26.

Hartley, David. Hartley's Theory of the Human Mind. Reprint of Joseph Priestley's abridged edition of 1775, edited by J. Johnson, AMS Press, New York, 1973.

Hazlitt, William. "Mr. Malthus" in The Spirit of the Age, or, Contemporary Portraits, 1825. Oxford University Press reprint, London, 1954.

Henslow, George. "Organic Variations and Their Interpretations", Nature 58, 20 Oct. 1898, 594-5.

Herschel, John F.W. Preliminary Discourse on the Study of Natural Philosophy, Longman, London, 1831.

Hobbes, Thomas. Leviathan. Penguin Books, Harmondsworth, 1976.

Hobhouse, L.T. "The Law of the Three Stages", Sociological Review 1, July 1908, 262-279.

--- Social Evolution and Political Theory, Columbia University Lectures, New York, 1911.

--- Mind in Evolution, MacMillan, London, 1915.

--- "Are Physical, Biological and Psychological Categories Irreducible?", in Life and Finite Individuality, edited by H. Wilden Carr, Williams & Norgate, London, 1918.

--- Social Development, Its Nature and Conditions, Henry Holt, New York, 1927.

--- "Comparative Ethics", Encyclopaedia Britanica, 14th edition, 1937.

Hooker, Joseph Dalton. Life and Letters of Sir Joseph Dalton Hooker, edited by Leonard Huxley, 2 vols., Murray, London, 1918.

Hume, David. Treatise of Human Nature (1738), Pelican Classics, Penguin Books, Harmondsworth, 1969.

--- An Inquiry Concerning Human Understanding (1748), Bobbs-Merill Educational, Indianapolis, 1955.

Huxley, Julian. Evolution in Action, Signet Science Library, New York, 1933.

Huxley, T.H. "On the Physical Basis of Life" (1868), Method and Results in Collected Essays.

--- "On the Hypothesis that Animals are Automata and its History" (1874), Method and Results in Collected Essays.

--- "On the Study of Biology" (1876), Science and Culture in Collected Essays.

--- "The Progress of Science" (1887), Method and Results in Collected Essays.

--- "Obituary [notice of Charles Darwin]" (1888) reprinted in Darwiniana.

--- Man's Place in Nature and other Anthropological Essays (1893-94) in Collected Essays.

--- Collected Essays of T.H. Huxley, 9 vols., Georg Olms Verlag, New York, 1970 reprint of 1893 edition.

--- Darwiniana, D. Appleton, New York, 1896.

--- Life and Letters of Thomas Henry Huxley, edited by L. Huxley, 2 vols., D. Appleton, New York, 1900.

--- Evolution and Ethics and Other Essays, reprint of 1896 edition, AMS Press, New York, 1968.

International Congress of Eugenics (London). Problems in Eugenics, Eugenics Education Society, London, 1912.

--- 2nd (New York). Eugenics, Genetics and the Family, Williams & Wilkins, Baltimore, 1923.

--- 2nd (New York). Eugenics in Race and State, Williams & Wilkins, Baltimore, 1923.

--- 3rd (New York). A Decade of Progress in Eugenics, Williams & Wilkins, Baltimore, 1932.

Jenkin, Fleeming. "The Origin of Species", North British Review 46, 1867, 149-171.

Lamarck, Jean Baptiste. Zoological Philosophy, tr. by Hugh Eliot, University of Chicago Press, Chicago and London, 1984.

Lankester, E. Ray. On Comparative Longevity in Man and the Lower Animals, MacMillan, London, 1870.

--- "Are Specific Characters Useful?", Nature 54, 16 July, 1896, 245-6.

--- "The Utility of Specific Characters", Nature 54, 20 Aug., 1896, 365-6.

Lucas, Prosper. Traité philosophique et physiologique de l'hérédité, 2 vols., Chez J.B. Ballière, Paris, 1847.

Lyell, Charles. Life, Letters and Journals of Sir Charles Lyell, (2 vols.) edited by Katherine M. Lyell. AMS Press, New York 1983 reprint of 1881 J. Murray, London, edition.

Malthus, T.R. Essay On the Principle of Population, R.D. Irwin, Homewood, Ill., 1963.

Marquis of Salisbury. [Presidential Address] British Association Report, 1894, 3-15.

Maxwell, James Clerk. "Atom", Encyclopaedia Britanica, 9th ed., Edinburgh, 1875.

Mendel, Gregor. Experiments in Plant Hybridization, tr. by The Royal Horticultural Society with footnotes and commentaries by William Bateson, Harvard University Press, Cambridge, 1958.

[Merivale, Herman]. "Galton on Hereditary Genius", Edinburgh Review 132, July, 1870, 100-125.

Merz, John T. A History of European Thought in the Nineteenth Century. 4 vols. Republication of 1904-1912 edition, Dover Publications, New York, 1965.

Mill, John Stuart. _The System of Logic_, 4th ed., London, 1856.

--- _Autobiography and Other Writings_, edited by J. Stillinger, Houghton Mifflin, Boston, 1969.

Morgan, J.E. _The Danger of Deterioration from the too Rapid Increase of Great Cities_, Longmans, Green, London, 1866.

Mudge, G.P., "The Menace to the English Race and to its Traditions of Present-Day Immigration and Emigration", _Eugenics Review_ 11, 1919-20, 202-212.

Murray, J.A.H. _A New English Dictionary on Historical Principles_, Oxford University Press, 1893.

Nordenskiold, Erik. _History of Biology_, tr. by L.B. Eyre, A.A. Knopf, New York, 1929.

Pearson, Karl. _The Ethic of Free Thought_, Unwin, London, 1888.

--- "Mathematical Contributions to the Theory of Evolution III. Heredity, Regression and Panmixia", _Philosophical Transactions of the Royal Society_ Ser. A 86, 1896, 253-318.

--- and Alice Lee. "Mathematical Contributions to the Theory of Evolution VIII. On the Inheritance of Characters not Capable of Exact Quantitative Measurement", _Philosophical Transactions of the Royal Society_, Ser. A 195, 1901, 79-150.

--- _National Life From the Standpoint of Science_, lecture delivered 1901, 2nd edition, A & C Black, 1905.

--- "On the Inheritance of the Mental and Moral Characters in Man, and Its Comparison with the Inheritance of the Physical Characters", _Journal of the Royal Anthropological Institute of Great Britain and Ireland_ 33, 1903, 179-237.

--- "Walter Frank Raphael Weldon", _Biometrika_ 5, 1906, 1-52.

--- _The Scope and Importance to the State of the Science of National Eugenics_, CUP, 1909.

--- _The Groundwork of Eugenics_, 2nd edition, Dulau, London, 1912.

--- _The Problem of Practical Eugenics_, 2nd edition, Dulau, London, 1912.

--- _Social Problems: Their Treatment, Past, Present and Future_, lecture delivered 1912, CUP, 1914.

--- The Function of Science in the Modern State, 2nd ed., CUP, 1919.

--- The Life, Letters and Labours of Francis Galton, 3 vols. in 4, CUP, 1914-30.

--- The Grammar of Science, 1st ed. 1892, Walter Scott, London, 1892; 2nd ed. A & C Black, 1900; 3rd ed. A & C Black, London, 1911; 4th ed. J.M. Dent, London, 1937.

Peirce, Charles S. "The Fixation of Belief", Popular Science Monthly 12, November, 1877, 1-15.

Poulton, E.B. (ed.). Essays Upon Heredity and Kindred Biological Problems, CP, Oxford, 1889.

Quetelet, A. Letters on the Theory of Probability, Layton, London, 1849.

Romanes, G.J. Life and Letters of G.J. Romanes, 2nd edition, edited by E. Romanes, Longmans, Green & Co., London, 1896.

--- An Examination of Weismannism, 2nd edition, The Open Court Publishing Company, Chicago, 1899.

Roper, A.G. Ancient Eugenics, B.H. Blackwell, Oxford, 1913.

Rumsey, Henry W. "On a Progressive Physical Degeneracy of Race in the Town Populations of Great Britain", Transactions of the National Association for the Promotion of Social Science, 1871, 466-472.

Saleeby, C.W. Parenthood and Race Culture. An Outline of Eugenics, Cassell, London, 1909.

--- The Progress of Eugenics, Cassell, London, 1914.

--- The Eugenic Prospect: National and Racial London, T. Fisher Unwin, London, 1921.

Schiller, F.C.S. Eugenics and Politics, Constable, London, 1926.

Schuster, Edgar. Eugenics, Collins, London, 1912.

Spencer, Herbert. "A Theory of Population deduced from the Laws of Animal Fertility", Westminster Review 57, April, 1852, 468-501.

--- "Progress: Its Law and Causes", in vol. I, Essays Scientific, Political and Speculative, 1901.

--- Essays Scientific, Political and Speculative, 3 vols., Williams & Norgate, London, 1901.

--- Principles of Biology, revised and enlarged, 2 vols., D. Appleton, New York, 1901.

Strahan, S.A.K. Marriage and Disease: A Study of Heredity and the More Important Family Degenerations, Kegan Paul, London, 1892.

Thiselton-Dyer, W.T. "Variation and Specific Stability", Nature 51, 14 March, 1895, 459-61.

Thomson, J.A. Heredity, J.A. Murray, London, 1908.

Wallace, A.R. "The Development of Human Races Under the Law of Natural Selection" (1864), in Contributions.

--- "The Limits of Natural Selection as Applied to Man" (1871), reprinted in Contributions.

--- Contributions to the Theory of Natural Selection, Macmillan, London, 1871.

--- My Life: A Record of Events and Opinions. 2 vols., Chapman & Hall, London, 1905.

Weber, Max. "'Objectivity' in Social Science and Social Policy" in Dallmayr and McCarthy, Understanding and Social Inquiry, 1977a.

--- "Basic Sociological Terms" in Dallmayr and McCarthy, Understanding and Social Inquiry, 1977b.

Weismann, August. "The Continuity of the Germ-plasm as the Foundation of a Theory of Heredity", in Poulton (ed.)., Essays Upon Heredity, CP, 1889.

Weldon, W.F.R. "The Variations occuring in Certain Decapod Crustacea - I. Crangon vulgaris", Proceedings of the Royal Society 47, 1890, 445-53.

--- "Certain Correlated Variations in Crangon vulgaris", Proceedings of the Royal Society 51, 1892, 2-21.

--- "On Certain Correlated Variations in Carcinus moenas", Proceedings of the Royal Society 54, 1893, 318-29.

--- "Report of the Committee for Conducting Statistical Inquiries into the Measurable Characteristics of Plants and Animals". Includes "Remarks on Variation of Animals and Plants", Proceedings of the Royal Society 57, 1895, 360-82.

--- "The Utility of Specific Characters", Nature 54, 30 July, 1896, 294.

--- "Utility of Specific Characters" Nature, 54, 3 Sept., 1896, 80.

--- [Presidential Address to the Zoology Section of the British Association], British Association Report, 1898, 887-902.

Whewell, William. History of the Inductive Sciences, J.W. Parker, London, 1837.

--- Philosophy of the Inductive Sciences, facsimile of 2nd ed. of 1847, Johnson Reprint, New York, 1967.

"Zoology at the British Association", Nature 70, 29 Sept., 1904, 538-41.

## Secondary Sources:

Abrams, Philip. The Origins of British Sociology 1834-1914, University of Chicago Press, Chicago and London, 1968.

Anderson, Perry. "Socialism and Pseudo-Empiricism", New Left Review, 35, Jan-Feb. 1966.

Bellomy, Donald C. "Social Darwinism Revisited", Perspectives in American History 1, n.s., 1984, 1-129.

Burrow, J.W. Evolution and Society, CUP, 1966.

Buss, Alan R. "Galton and the Birth of Differential Psychology and Eugenics: Social, Political and Economic Forces", Journal of the History of the Behavioural Sciences 12, 1976, 47-58.

Butterfield, Herbert. The Origins of Modern Science 1300-1800, G. Bell, London, 1957

Chase, Alan. The Legacy of Malthus, A.A. Knopf, New York, 1977.

Clagett, M. (ed.). Critical Problems in the History of Science, University of Wisconsin Press, Madison, 1959.

Coleman, William. "Bateson and Chromosomes: Conservative Thought in Science", Centaurus 15, 1970, 228-314.

Comas, J. "'Scientific' Racism Again?", Current Anthropology 2, Oct., 1961, 303-325.

Cowan, Ruth Schwartz. "Francis Galton's Contribution to Genetics", Journal of History of Biology 5, Fall, 1972, 389-412.

--- "Nature and Nurture: The Interplay of Biology and Politics in the Work of Francis Galton", Studies in History of Biology 1, 1977, 133-207.

Cullen, M.J. The Statistical Movement in Early Victorian Britain, Harvester Press, Hassocks, Sussex, 1975.

Curtis, Helena. Biology, Worth, New York, 4th ed., 1985.

Dallmayr, F. and T.A. McCarthy (eds.). Understanding and Social Inquiry, University of Notre Dame Press, Notre Dame, Indiana, 1977.

Dawkins, R. The Selfish Gene, Oxford University Press, Oxford, 1976.

Dictionary of Scientific Biography, 16 vols., Scribner, New York, 1970-80.

Dobzhansky, Theodosius. Mankind Evolving, Yale University Press, New Haven, 1962.

Dorozynski, Alexander "How the new genetic therapy could change peoples' lives", Impact of Science on Society (UNESCO) 6, 1986, 313-19.

Eisenhart, Churchill. "Karl Pearson", Dictionary of Scientific Biography, Scribner, New York, 1970-80.

Ellegard, Alvar. Darwin and the General Reader, distributed by Almqvist & Wiksell (Stockholm), Gothenburg, 1958.

Farrall, Lyndsay A. "Controversy and Conflict in Science: A Case Study - the English Biometric School and Mendel's Law's", Social Studies of Science 5, 1975, 269-301.

--- "The History of Eugenics: A Bibliographical Review", Annals of Science 36, March, 1979, 111-23.

--- The Origins and Growth of the English Eugenics Movement 1865-1925 (published PhD. thesis), Garland, New York and London, 1985.

Farrington, B. Francis Bacon, Philosopher of Industrial Science, Collier, New York, 1961.

Fichman, Martin. "Ideological Factors in the Dissemination of Darwinism in England, 1860-1900" in Everett Mendelsohn (ed.), Transformation and Tradition in the Sciences, 1984.

Finer, S.E. The Life and Times of Sir Edwin Chadwick, Methuen, London, 1952.

Forrest, Derek W. Francis Galton: The Life and Times of a Victorian Genius, P. Elek, New York, 1974.

Freeden, Michael. "Eugenics and Progressive Thought: A Study in Ideological Affinity", Historical Journal 22, Sept. 1979, 645-71.

Friedman, Theodore. "Progress Towards Human Gene Therapy", Science 224, 16 June, 1989, 1275-1292.

Froggatt, P. and N.C. Nevin, "Galton's 'Law of Ancestral Heredity': Its Influence on the Early Development of Human Genetics", History of Science 10, 1971, 1-27.

Gould, Stephen J. Ever Since Darwin, Norton, London and New York, 1977a.

--- Ontogeny and Phylogeny, Harvard University Press, Cambridge, 1977b.

--- The Mismeasure of Man, Norton, New York, 1981.

Greene, John C. "Biology and Social Theory in the Nineteenth Century. Auguste Comte and Herbert Spencer", in Clagett (ed.), Critical Problems in the History of Science, 1959.

--- "Darwin as Social Evolutionist", Journal of the History of Biology 10, 1977, 1-27.

--- "The History of Ideas Revisited ", Revue de synthèse, 4th series, July-Sept., 1986, 202-27.

Hagstrom, Warren O. The Scientific Community, Basic Books, New York, 1965.

Halévy, Elie. The Growth of Philosophic Radicalism, tr. by Mary Morris, Faber & Faber, London, 1952.

Haller, M. Eugenics: Hereditarian Attitudes in American Thought, Rutgers University Press, New Brunswick, New Jersy, 1984.

Himmelfarb, Gertrude. Darwin and the Darwinian Revolution, Norton, New York, 1968.

Hobsbawm, E.J. Industry and Empire, Penguin Books, Harmondsworth, 1969.

Hobson, J.A and M. Ginsberg. L.T. Hobhouse, Allen & Unwin, London, 1931.

Hodson, Kathleen. "The Eugenics Review 1909-1968", Eugenics Review 60, 1968, 162-74.

Houghton, W.E. The Victorian Frame of Mind, Yale University Press, New Haven, 1957.

Jones, Greta. Social Darwinism and English Thought, Harvester Press, Sussex and Humanities Press, Atlantic Highlands, New Jersey, 1980.

Kern, Fritz. Kingship and Law in the Middle Ages, tr. by S.B. Chrimes, B. Blackwell, Oxford, 1968.

Kevles, Daniel J. In the Name of Eugenics, University of California Press, Berkeley and Los Angeles, 1985.

Knight, David M. The Nature of Science, Andre Deutsch, London, 1976.

Kohn, David (ed.) The Darwinian Heritage, Princeton University Press, Princeton, N.J., 1985.

Kuhn, Thomas. The Structure of Scientific Revolutions, 2nd ed., enlarged, University of Chicago Press, Chicago, 1970.

Labouze, Eric, "Automatic DNA sequencing and the human genome sequencing project", Impact of Science on Society (UNESCO) 38, 1988, 75-84.

Latour, Bruno. Actes du colloques Génétique, Procréation et Droit, Arles, Actes/Sud-Hubert Nyssen, 1985.

Lewontin, Richard C. "Fallen Angels, Wonderful Life", New York Review of Books, 14 June, 1990.

Lorimer, Douglas A. Colour, Class and the Victorians, Leicester University Press, Holmes & Meier Publishers, Leicester, 1978.

Lovejoy, Arthur O. The Great Chain of Being, Harvard University Press, Cambridge, 1953.

Ludmerer, Kenneth M. Genetics and American Society, Johns Hopkins University Press, Baltimore, 1972.

Mackenzie, Donald. "Eugenics in Britain", Social Studies of Science 6, 1976, 499-532.
--- Statistics in Britain 1865-1930, Edinburgh University Press, Edinburgh, 1981.

Mayr, Ernst. "Darwin and Evolutionary Theory in Biology", Evolution and Anthropolgy, The Anthropological Society of Washington, Washington, D.C., 1959.

--- The Growth of Biological Thought, Belknap Press of Harvard University Press, Cambridge, 1982.

Mazlish, Bruce & J. Bronowski. The Western Intellectual Tradition, Harper & Bros., New York, 1960.

McLaren, Angus. Our Own Master Race, McLelland & Stewart, Toronto, 1990.

Mendelsohn, Everett (ed.), Transformation and Tradition in the Sciences, CUP, 1984.

Midgley, Mary. "Gene-Juggling", Philosophy 54, 1979, 439-458.

--- "Selfish Genes and Social Darwinism", Philosophy 58, 1983.

Moore, James R. The Post Darwinian Controversies, CUP, 1979.

--- "Crisis without Revolution: The Ideological Watershed in Victorian England" Revue de synthèse 4th series, 57, Jan.-June 1986a, 53-78.

Moore, Jim. "Socializing Darwinism" Radical Journal of Science, 20, Nov. 1986b, 38-80.

Norton, B.J. "The Biometric Defense of Darwinism", Journal of History of Biology 6, 1973, 283-316.

--- "Metaphysics and Population Genetics: Karl Pearson and the Background to Fisher's Multi-factorial Theory of Inheritance", Annals of Science 32, 1975, 537-553.

--- "Karl Pearson and Statistics: The Social Origins of Scientific Innovation", Social Studies of Science 8, Feb. 1978, 27-28.

Owen, J.E. L.T. Hobhouse, Sociologist, Ohio State University Press, Columbus, 1974.

Pastore, Nicholas. The Nature-Nurture Controversy, Kings Crown Press, New York, 1949.

Paul, D. "Eugenics and the Left", Journal of the History of Ideas 14, 1984, 567-590.

Pearson, E.S. "Karl Pearson: An Appreciation of Some Aspects of His Life and Work", part I in Biometrika, 28, 1936, 193-257 and part II in Biometrika, 29, 1937, 161-248.

Popper, Karl. The Logic of Scientific Discovery, Basic Books, New York, 1959.

--- The Poverty of Historicism, Basic Books, New York, 1960.

Provine, William B. The Origins of Theoretical Population Genetics, University of Chicago Press, Chicago, 1971.

Roll-Hansen, Nils. "The Progress of Eugenics: Growth of Knowledge and Change In Ideology", History of Science 26, 1988, 295-331.

Rose, Hilary & S. Rose (eds.). The Political Economy of Science: Ideology of/in the Natural Sciences, MacMillan, London, 1976.

Ruse, Michael. Darwinism Defended, Addison-Wesley, London, 1982.

Russell, Colin. Science and Social Change. MacMillan, New York, 1983.

Schweber, Silvan. "The Origin of the Origin Revisited", Journal of the History of Biology 10, 1977, 229-316.

Searle, G.R. The Quest for National Efficiency, University of California Press, Berkeley, 1971.

--- Eugenics and Politics in Britain 1900-1914, Noordhoff International, Leyden, 1976.

--- "Eugenics and Politics in Britain in the 1930s", Annals of Science 36, March, 1979, 159-169.

Semmel, Bernard. Imperialism and Social Reform, Harvard University Press, Cambridge, 1960.

Shapin, Steven and B. Barnes. "Science, Nature and Control: Interpreting Mechanics' Institutes", Social Studies of Science 7, 1977, 31-74.

--- "Darwinism and Social Darwinism: Purity and History" in Shapin, S. and B. Barnes, Natural Order, 1979.

--- (eds.). Natural Order: Historical Studies of Scientific Culture, Sage Publications, Beverly Hills, 1979.

Simpson, G.G. This View of Life, Harcourt, Brace & World, New York, 1964.

Stedman-Jones, G. Outcast London, Penguin Books, Harmondsworth, 1971.

Sturtevant, A.H. A History of Genetics, McGraw-Hill, New York, 1965.

Suzuki, David and Peter Knudtson, Genethics. The Ethics of Engineering Life, Stoddart, Toronto, 1988.

Trevelyan, G.M. English Social History, Penguin Books, Harmondsworth, 1982

Walker, Helen. "The Relation of Plana and Bravais to the Theory of Correlation", Isis 10, 1928, 466-84.

Wilson, E.O. Sociobiology, Harvard University Press, Cambridge, 1975.

Young, Robert M. "The Historiographic and Ideological Contexts of the Nineteenth Century Debate on Man's Place in Nature" in Young and Teich (eds.), Changing Perspectives in the History of Science, 1973.

--- and M. Teich (eds.) Changing Perspectives in the History of Science, Heinemann, London, 1973.

--- "Malthus and the Evolutionists: The Common Context of Biological and Social Theory" (1985a) in Young (ed.), Darwin's Metaphor.

--- "Darwinism is Social" (1985b) in Kohn (ed.), The Darwinian Heritage.

--- "The Impact of Darwin on Conventional Thought" (1985c) in Young, Darwin's Metaphor.

--- "Natural Theology, Victorian Periodicals, and the Fragmentation of a Common Context" (1985d) in Young, Darwin's Metaphor.

--- Darwin's Metaphor: Nature's Place in Victorian Culture, Cambridge Univerity Press, New York, 1985.