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THE POPULARISATION OF ELEMENTARY SCIENCE THROUGH POPULAR SCIENCE BOOKS, c.1870-c.1939

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ABSTRACT

This thesis investigates the popularisation of science in terms of the implicit images of science, and the explicit claims about science, which popularisers communicate through their exposition. In particular, it traces the fortunes of 'public science' through the popular science book from c.1870-c.1939.

The introductory chapter addresses the breadth and limitations of the study, its periodisation, and also explains the choice of the popular science book as the medium for analysis. Chapter 2 explains the defining features and historical contexts of the genres used in the thesis, which have been constructed to monitor different approaches to the presentation of science through time. The thesis is then divided into three chronological periods: the late Victorian c.1870-c.1901, the Edwardian c.1901-c.1914, and the inter-war c.1918-c.1939. These periods are explored in two main ways. Firstly, in chapters 3, 5, and 7, the content and style of series presenting elementary science are examined in the broad context of developments within science, society, and the publishing industry for the three periods under consideration. Secondly, the popularisation of 'public science' is analysed in terms of the personalities and the topical popularising issues of each period. Thus, chapter 4 delves into the popular writings of Victorian Scientific Naturalists, such as T.H.Huxley, J.Tyndall and J.Lubbock and compares them with that of Christian popularisers in the late Victorian period, while chapter 6 investigates the popularisation of eugenics as public science in the Edwardian era. Finally, in chapter 8 the public science writings of members of the Social Relations of Science movement, such as H.Levy, L.Hogben, J.B.S.Haldane, and J.Huxley are studied in relation to the popularisation of A.Eddington and J.Jeans.

To the bibliography at the end of the thesis is added a critical analysis of the series of books used in the study.

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Finally, this thesis is dedicated to my grandad, who died while it was in progress, and who refused to believe that man had walked on the moon because he felt it was beyond the realms of 'common sense'. I think I now begin to understand why he felt that way...

CHAPTER 1.

1 - The scope and periodisation of the study.

In a recent "thumbnail historical review of science popularisation"(1), A.J.Meadows concluded that the history of popularisation should be studied not only for its intrinsic interest, but also because "a historical perspective raises questions concerning some of the automatic assumptions made by the media today."(2) In particular Meadows was thinking of the change in approach to science popularisation that has taken place between the Victorian age, where he feels more of an effort was made to integrate scientific knowledge into the experience of ordinary human beings, and the contemporary era, where the modern media's fixation with newsworthiness dominates its presentation of science. This is one interesting shift of emphasis which deserves attention, yet there are many more issues related to the history of popularisation than those concerning styles of communication, important though these are. For example, did popularisers in the past feel that science should be studied as an end in itself, and, if so, why? Or did they feel that there were more pressing social, religious and political reasons for popularising? How, why and when did the doctrine of 'pure' science come to be popularised, with its commitment to a system of values which had 'objective knowledge' as the sovereign good? Why was it that the movement for the social responsibility of science in the thirties never questioned the neutrality of science itself? And so on.

Of course, this thesis cannot hope to answer conclusively any of these questions, but it does intend to begin to sketch a context for popularisation which will contribute to an understanding of all these issues for the period c.1870 to c.1939.

Within the history of popularisation, the date c.1870 has been claimed to be significant, in general terms, because, whereas "popular science in, say, 1830 reflected the world which God had made; in 1870, it reflected

what man could make of the world."(3) For, from approximately this date, science began to have a central role in man's political plans for the development of society.(4) Certainly, from c.1870 onwards, science in Britain became an increasingly professionalised and organised activity(5), whilst scientific naturalism became a broad cultural phenomenon. (6) The year 1870 also saw the enactment of the Elementary Education Bill. For all these reasons, this year seemed an auspicious, albeit approximate , date from which to begin an analysis of popularisation.

The study was then divided into three broad periods of time: the late Victorian c.1870-c.1901, the Edwardian c.1901-c.1914, and the inter-war c.1918-c.1939. This was done in order to analyse three 'eras' of popularisation. The first covering the Darwinian 'revolution', with the interaction between Victorian Scientific Naturalists and Christian popularisers, the second being an age when eugenic ideas became widespread. In fact, there is a great deal of overlap in the late Victorian and Edwardian periods; and it is now more usual to study the years from 1880-1914 en bloc as a time when liberal orthodoxy was challenged.(7) Because, however, such periodisation did not suit the topics in which this study is interested, the traditional periodisation of political history was adopted, using the death of Queen Victoria as a convenient date at which to 'change' period. Such periodisation is not quite so artificial as it might at first appear, however, since Huxley and Tyndall both died in the 1890s, while 'mass' journalism came into being at this time. The final block of time considered is sandwiched between two World Wars, and its existence as a 'period' is rarely questioned. In terms of popularisation this third era was chosen for examination because it was dominated by modern physics and the Social Relations of Science Movement.

Thus, while seventy years, in many ways, constitutes a rather ambitious length of time on which to base such a broad cultural study, what the study lacks in detailed observation, will hopefully be gained in added historical

insight into the changes which popularisation underwent during decades when the registered electorate of the U.K. increased from 16.4% to 96.9% of the population (8), and when education changed from being state assisted (Forster's Act of 1870)to being state supervised (Balfour's Act of 1902). These were also years when laissez-faire was ousted in favour of collectivism as the fundamental ideology of political leadership(9), a time when Marxism and Fascism developed from ideas into social realities, and when the scale of warfare escalated in terms of national conscription and technological hardware. For all these reasons this 'lifespan' of seventy years seemed a period ripe for investigation.

2 - Models of popularisation.

Whilst popularisation has been a concern among scientific men and women since the seventeenth century (when natural philosophers began to use an increasingly mathematical and abstract approach that was foreign to the daily lives of the majority of the population), historical and sociological interest in the problems of science popularisation has only produced research in the past twenty years or so. Early studies concerned with science popularisation, such as R.C.Tobey's The American ideology of national science, 1919-1930, rarely bothered to explain what they meant by the term popularisation, and this has been a problem which has flawed the majority of such studies. (10) Recently, however, sociologists such as T.Shinn and R.Whitley have begun to define the processes of popularisation. For example, in his essay "Knowledge producers and knowledge acquirers: Popularisation as a relation between scientific fields and their publics"(11), Whitley has sketched the traditional usage of the concept of popularisation. He argues that this usage tends to assume that scientists belong to a structured, monolithic intellectual elite of knowledge producers, who have, in some way, to communicate with a diffuse mass of ignorant knowledge consumers, who passively and atomistically receive such knowledge, without giving any

feedback to the knowledge producer. Whitley contrasts this traditional usage of popularisation with his own, in which the audience belongs to groupings, which are identifiable by their shared backgrounds and concerns, and in which the scientific community is not monolithic but is composed of distinct groupings. Within this usage of the concept of popularisation, interaction between the producers of scientific knowledge and the general laity is necessarily a process involving more than an injection of knowledge from the 'expert' to innoculate the laity against 'irrational prejudices'. Rather, Whitley's view of popularisation is that it is an interactive process involving the participation of the audience as well as that of the scientist, and that popularisation does in fact affect the pursuit of science. These claims have been validated by J.Lancashire's recent and unpublished research on the popularisation of science through general science periodicals in Britain c.1890-c.1939, where she concludes that:

> "the process of popularisation is most constructively viewed as a relationship between scientific fields, scientific practitioners and the readership at which general science periodicals were targeted.."(12)

Consequently, the present study, which also focusses on members of the 'scientific community', partly views popularisation as a relationship between scientific fields, scientific practitioners and the readership at which elementary popular science books (see below) were targeted.

One of the main contentions of this thesis, however, is that the popularisation of scientific knowledge is intended to gain wider social support for ideological convictions and beliefs. Yet this is an area which lies somewhat beyond the scope of Whitley's model of popularisation with its internal dymanics almost exclusively concerned with the relationships between scientific fields and their publics. This problem can be rectified, however, by incorporating Whitley's model of popularisation into a 'power theory'(13), which would take more external factors into a consideration

of popularisation by emphasising power relationships. The 'power theory' most relevant to popularisation is, of course, that of hegemony. Although there are various theories of hegemony (14), the Gramscian formulation of hegemony provides the 'power theory' for the present thesis.

Gramsci's concept of hegemony is that it is a relation, not of domination by means of force, but of consent by means of political and ideological leadership. Such leadership is gained via struggle, through which a hegemonic class, or part of a class, combines the interests of other classes and social forces with its own interests. Within this concept ideology is not class-based, but acts as a cohesive force which binds together a bloc of diverse classes and social forces. Consequently, this study is not a crude Marxist examination of the relationship between popularisers and the means of production! Rather, within this Gramscian framework, the popularisation of science is perceived as part of a complicated hegemonic process in which ideologies interact. Such interaction takes place in every sphere of life, from watching the Royal Institution's Christmas lectures on television, taking part in science lessons at school, and reading popular science books or consulting encyclopaedias and dictionaries, to reading science-fiction, paying attention to media coverage of technological disasters, or even shopping for additive-free, low-fat food products.

This study obviously does not, from such a perspective, see popularisation mainly as an issue about how to define scientific facts, but as a way of establishing as facts, in the social context, certain ideological propositions about science in a specific historical period. For example, such propositions might well concern the degree of compatibility of science with religion, the nature and function of 'amateur' science, the role of science and the scientist in a 'democratising' society, or whether science should, or could, be accessible to the general public, and so on. Such propositions will be analysed in relation to the populariser's social, political and religious beliefs, as part of a wider hegemonic process in which factors 'external' to the scientific community must be taken into consideration.

It is in this way that the Gramscian concept of hegemony provides the theoretical point of departure for the thesis by placing popularisation in a wider ideological context of the differing interests of 'social forces', such as evangelism and scientific naturalism, liberalism and socialism etc., over which type of image of science to present to the general public.

Within this framework, the focus of the study is the published popularising material of practitioners of science, since the popularisers whose writings are analysed in detail are all members of the 'scientific community'. As has been mentioned above, this is not to suggest that such a community was, at any point, a monolithic, homogenous grouping, but rather that it was comprised of a number of different groupings, and that the popularisers under discussion represented a variety of viewpoints within such a community. These viewpoints ranged from those groups of practitioners of 'high' or academic science, to those belonging to an experiential, inductivist 'low' science as typified by many participants in late Victorian natural history.(15) The present writer will also be mainly concerned with an analysis of the popularisation of orthodox science, rather than that of deviant science(16) because this was the type of science which most of the primary source material (discussed below) was attempting to popularise.(17)

One attitude to popularisation which it has been argued was significant within 'high' science throughout the period c.1870 to c.1939, has been identified by F.Turner as "public science". Turner clarifies this concept by claiming that:

> "Public scientists do not propagate scientific knowledge for its own sake, and their work may have little or nothing to do with the actual motivations or goals of scientific research. Rather they consciously attempt to persuade the public or influential sectors thereof that science both supports and nurtures broadly accepted social, political, and religious goals and values, and that it is therefore worthy of receiving public attention, encouragement and financing. The pursuit of public science has involved lobbying various nonscien-

tific elites, persuading the public or government that science can perform desired social and economic functions, defining as important those public issues that scientists can address through their particular knowledge or expertise, stressing professional standards among scientists, and defining the position of scientists vis-a-vis other rival intellectual or social elites, such as the clergy. At the same time the public scientist remains both scientist and citizen, and his statements may and usually do reflect honestly held civic opinion as well as views that aid the position of science in the community."(18)

This concept is better clarified within a Gramscian framework (where all popularisation is considered ideological) by saying that the public scientist above all, wishes to reform or revolutionise society by organising it in accordance with his perception of 'scientific' principles.

Following Turner's "speculative probe into the character of British public science"(19), and with the above qualification in mind, this thesis sets out to determine to what extent public scientists were able to promote the idea, through popularisation, that science was crucial to social, political and ethical developments from c.1870-c.1939; and, following the Gramscian theory of hegemony, to what extent the promotion of public science was checked, at a popularising level by rival viewpoints.

3 - The popular science book as the focus of the study.

To research the history of popularisation is to wander in an historical no man's land somewhere between the territories of the social historian and the historian of ideas. Previous studies of popularisation illustrate this problem, for they tend either to examine popularisation through a broad context of books, periodicals and institutions(20), or they pursue an ideological phenomenon in an unempirical manner.(21) The former type of study,overwhelmed by its data,tends to the descriptive, with plenty of

statistical analysis but with only rather weak generalisations about movements and currents of opinion, while the latter generalises to its heart's content from a very narrow social context. Indeed, to wed the two types of analysis is a rather tricky procedure entailing the focus of ideological movements and the empirical validation of a wealth of data. This thesis attempts to balance these two approaches by studying the development of the popularisation of science through books in a period when public science has been claimed to be of especial significance.(22)

Books have a special interest for such a study in that a book gives the author the greatest freedom to develop his ideas, using illustrations, examples and metaphors, in a way in which the contingencies of time and space do not allow him to express himself quite as freely in a magazine article or newspaper report. Consequently, if the idea is taken literally that "the exposition of science is not itself a science but a branch of literature,"(23) then books offer the greatest scope for a study of expression and style which may well be of significance in examining the presentation of ideological viewpoints. They have the disadvantage, perhaps, that their potential audience is usually more limited than that for a popular periodical or newspaper. On the other hand, a broad empirical study based on published books enables differing trends in popularisation to be reconstructed, and allows comparisons to be drawn between a wide variety of popularisers' methods of popularisation, which a study of a few major journals or newspapers could not offer.

One of the major difficulties of such a broad-based empirical study, however, is the sheer abundance of primary sources, especially when such a study is based on a period after 1850.(24) There are two main solutions to this problem. Firstly, a short historical period such as a decade could be chosen for analysis. At most such a study could only reveal aspects of popularisation at that time, while a better idea of the perennial problems of popularisation could be obtained from a study of a more extended period.

Moreover, a study based on a longer period of time would enable the writer to relate any changes in popularisation to a changing social situation. This being the case, a second approach to the problem is to limit the material in some historically acceptable way. Such an approach is adopted in the present study by focussing on series of popular science books. According to the Anglo-American cataloguing rules, a series is:

> "a number of separate works issued in succession and related to one another by the fact that each bears a collective title, generally appearing at the head of the title page, on the half title, or on the cover; normally issued by the same publisher in a uniform style, frequently in numerical sequence."(25)

A series thus differs from a periodical in that individual monographs do not necessarily appear at frequent and regular intervals, but more usually appear at infrequent and irregular intervals, and usually in batches of several monographs. This, broadly speaking, is the definition used in this thesis, although one serial is also considered, which shares the defining features of a periodical, except that from its conception it was planned to be of finite length.

When studying the popularisation of science it is useful to distinguish between two main types of series. Firstly, there is the natural history series of books, which consists of books thematically linked through their natural history content. Throughout the period under consideration, such series usually included the description natural history in the title of the series, and conveyed information about the flora and fauna of the countryside. Because of the importance of the identification of species for natural history, popular science books in such natural history series tended to be more highly illustrated than those in other types of series. Depending on the size and lavishness of the illustrations, some natural history series (with smaller, less intricate sketches) were mainly used for fieldwork, whilst other series using gorgeously, and expensively,

coloured plates were intended for collection and show. Because, however, interest in natural history began to fade in the twentieth century, as Darwinism became less controversial, and as participatory interest in science waned(26), series of natural history handbooks do not appear to have had such a high profile after the Great War.(27) The type of natural history series which did survive was that which offered lavish coloured plates of birds, flowers and animals. For example, Allen Lane found it a financially astute move to republish the Victorian naturalist, J.Gould's natural history works in the late 1930s at 1s. a volume in his series of 'King Penguins'.(28)

Aside from the natural history series, it is convenient to classify all the other series analysed in this study as 'general science series'. In the late Victorian and early Edwardian eras, any non-fiction series which featured science (as opposed to natural history) was a 'general science series'. That is, series which gathered together non-fiction books on a variety of subjects ranging from the natural sciences to the social sciences, and beyond to the humanities like history and philosophy, would be published under a series title which usually featured the word science. Apart from the occasional specialist non-fiction series, the majority of non-fiction series from c.1870-c.1905 seemed to use the word science in its comprehensive original Latin meaning of 'all knowledge', suggesting a broad unity of subject matter. R.MacLeod has argued that many series existed in this form at this time because of the German influence of Wissenschaft,and the fashionable belief in evolution as a Weltanschauung, uniting a plethora of topics. (29)

In the years leading up to the Great War, however, a change in the form of this type of series started to occur which began to render the concept of a general science series obsolete for the non-vocational adult market. For books in such non-fiction series began to be differentiated according to specific categories. In publishers' catalogues listing volumes in a given series, section headings began to appear, such as: science, literature,

history, philosophy etc., as knowledge began to be segregated according to particular disciplines. The non-fiction series no longer offered a general body of knowledge, but separate and distinct bodies of knowledge; and the titles of such series from the late Edwardian era through to the Second World War reflect this change. In the latter half of the period under study, titles evoke a more arbitrarily imposed unity reflecting, for example, the contemporaneity of the subject matter, as in the 'Today and Tomorrow' series, or that the same audience were intended to read all the books, as in the 'People's Books', or, more generally, that all the different aspects of knowledge were being presented inexpensively at the same price, as in 'Macmillan's Sixpenny Self-Help Library'.

This change in the form of the non-fiction series probably occurred because, from the 1880s onwards, a growing number of school text-books used in the teaching of the natural sciences were published as science series. Thus, for the non-vocational adult market, publishers required a series title which would not be reminiscent of school, and would not lead to confusion as to its potential audience. Similarly, the emergence of sections within series probably reflected the increasing demarcation of specialised knowledge by the growing army of professionals within society. For, throughout the period under study an increasing number of scientists had academic qualifications and/or positions.(30)

For the first half of the period studied in the present thesis (i.e: c.1870-c.1905) the English Catalogue of Books provides near-complete lists of all series published in England, which has proved an invaluable aid in finding as many popular science series as possible. For the period c.1905-c.1939, however, no such lists are available(31),and, therefore, more random empirical techniques have to be adopted, such as looking under publisher's names and relevant subject headings in the British Library catalogue of books, and in the English catalogue of books.(32) Finally, because the English catalogue of books has been instrumental in helping to

construct a manageable empirical basis for this thesis, the study in inevitably centred in England.

For these reasons, this thesis cannot claim to be an 'exhaustive' study of the popularisation of science in Britain through general non-fiction and natural history series c.1870-c.1939, but offers an exploratory empirical basis for its analysis and conclusions which will probably be more pertinent to the English context than to that of either Scotland or Ireland.

4 - Historiographical issues relating to a study of popularisation based on books.

In order for any analysis of the popularisation process to be made, popular science books have to be placed in a wider context. We need, for example, to know something of the popularisers' lives and the commercial history of the publishing houses which have helped to produce them, as well as their critical reception. Consequently, letters, manuscripts, accounts and reviews have been consulted where possible.(33)

The part of the popularisation process which such historical analysis reveals, however, is mainly the part played by the popularisers themselves, and gives very little direct information about the readership, and how such texts actually influenced the various publics they reached. Some information can, however, be deduced about audiences from this type of study.

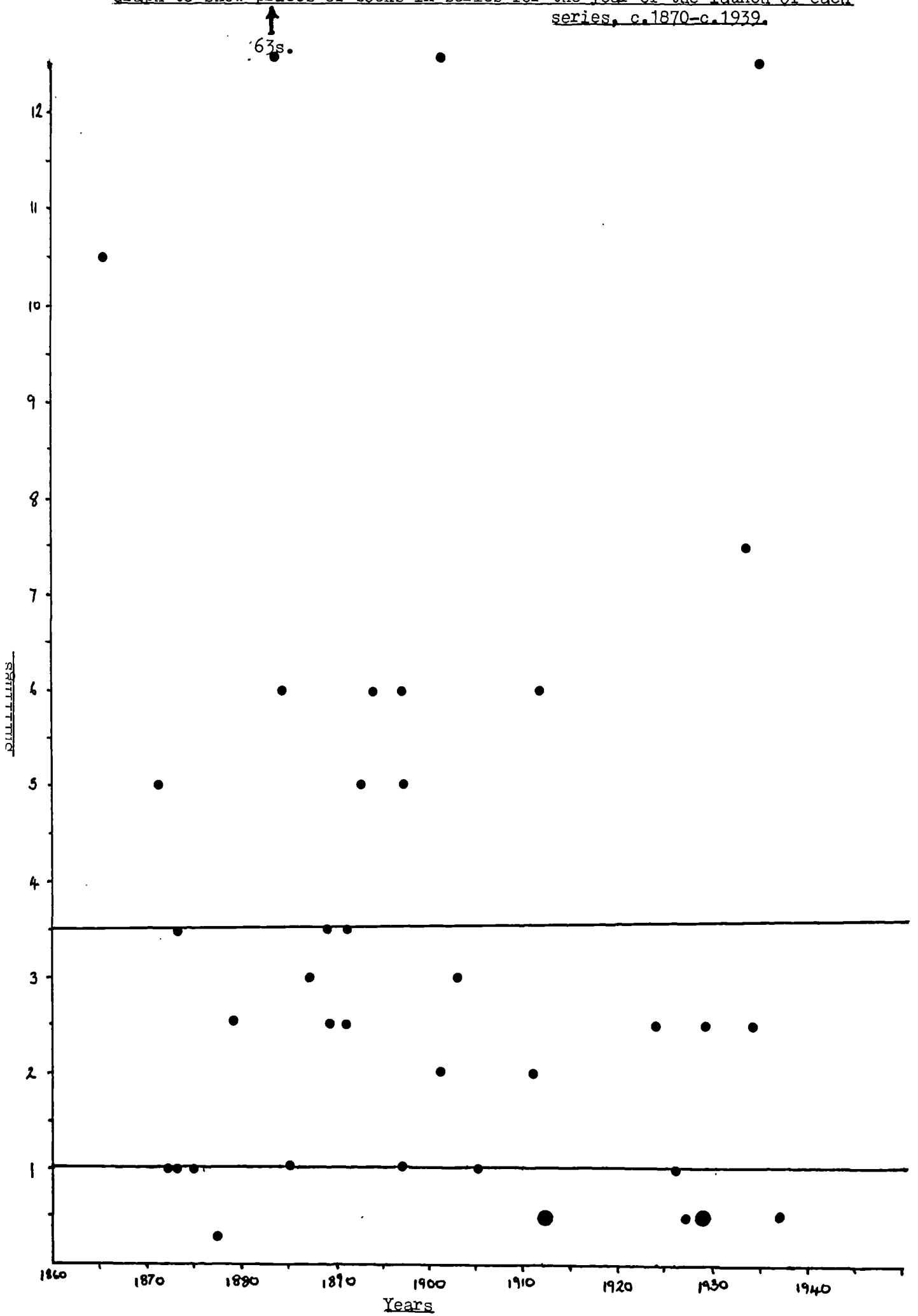
There are several major types of audience for science popularisation, of which it is convenient to distinguish the following: Firstly, there are other scientists within a given discipline who may want to have access to information in another field of that discipline, and then there are other scientists who are not part of the discipline being popularised, as well as interested professionals who are not necessarily scientists but who have had an advanced scientific education. Secondly, there are policy makers in the spheres of government, business and military decision-making.

Thirdly, there are teachers and students at all levels of institutionalised education. Finally, there is the 'general public', who may very well, as individuals, fit into any of the other types of audience given above, and, who, have the added power, in a liberal democracy, of being citizens who play a part in policy making. None of these audiences is, therefore, mutually exclusive. Audiences are, however, historically specific, and although all of these five main audiences for science popularisation existed in one form or another during the period under study, this thesis is concerned with the development of science popularisation for the audience of the lowest common denominator, namely the 'general public', who cannot be assumed to have had a science education, but who are usually assumed to be of adult status.

This large, heterogenous audience, nevertheless, can be assumed to have a general structure (especially in terms of a study which is concerned with a book reading audience) in terms of a shared, basic education. Thus, the main audience on which the thesis focusses is a reasonably literate public, which has gone beyond a basic elementary education, and which is usually expected (by publishers and popularisers) to have some knowledge of the arts and humanities. Other audiences do, however, emerge from time to time; for example, in the late Victorian era some popularisers targeted a semi-literate audience educated to a very elementary level.

Further general distinctions can be made about book-reading audiences by the prices at which books were marketed. (See graph below) For example, it would seem likely that those marketed at a shilling and below were primarily aimed at lower-middle and upper-working class audiences, while those marketed at 2s. to 3s.6d. were aimed at more prosperous middle-class audiences. Books marketed above the 3s.6d. threshold would probably have been bought by the upper middle classes, the landed gentry, and institutions with a book-buying budget. It will be shown that an analysis of style and content tends to bear these generalisations out. One notable exception was 'Primers for the Age of Plenty', priced at 12s.6d., of which Hogben's

Graph to show prices of books in series for the year of the launch of each series, c.1870-c.1939.



Mathematics for the million and Science for the citizen were both bestsellers indicating a sale among a range of audiences. Furthermore, natural history books were more expensively priced because of the cost of illustration, and, as will be indicated, this did not necessarily (although sometimes it did) reflect a class bias in the intended audience. In terms of the cost of living the potential audience for books was rising throughout the period c.1870-c.1939, particularly among the upper-working and lower-middle class audiences as the number of clerical jobs grew. The price of books relative to income fell for all audiences during the period under study.(34)

While little empirical evidence can be given to 'prove' that the attitudes and opinions of popularisers corresponded to the attitudes and opinions of their audiences, given that popularisation is an interactive process it seems safe to believe that popularisers and their audiences must, to a greater or lesser degree, share some values. This is especially true when, as this thesis contends, the popularisation of scientific knowledge is intended to gain wider support for a particular ideological position. For if this is so then popularisation must fit into the audience's framework of concerns, as well as expressing the priorities and approaches of the practitioner of science. Furthermore, with the growth of public funding and the expansion of suffrage, the present writer will show that such practitioners expected and encouraged feedback from popularisation in terms of public pressure. Therefore, it seems reasonable to believe that there is some correlation between the presentation of scientific knowledge, and the consequent image of science held by the general public. Because of the problematic relationship, however, between text and reader the present study is able to speak with greater authority about the presentation of science, than about the reception of that presentation.

5 - Explaining the term 'popular science book'.

Any text used to communicate science to anyone outside a narrow specialism, including other scientists, (even in the same broad discipline, such as physics) can be termed a popular science book, since it is attempting to communicate with someone outside of the esoteric research group. R.Whitley has constructed a table to indicate the main types of popularisation, and this provides a useful starting point for any analysis of popularisation.(35) See Table 1. For example, because this thesis is looking at popular science books regarded at the time as elementary(36), they will largely belong to Whitley's category which has a low degree of formalisation and technical precision, and a low degree of controvertibility of arguments. In other words, such texts rely on diffuse, discursive means of communication, since they cannot rely on the reader having a basic scientific knowledge, and because of this large knowledge gap between the reader and the science there is a greater risk of distortion of information occurring through communication. Some elementary texts, however, from the late Victorian period could fit into any of the other types of popularisation on Whitley's table, since before professionalisation and academic qualifications became central to the pursuit of scientific research, the division of popularisation into types based on epistemological levels is not helpful. For, whereas Whitley's table was constructed to analyse contemporary popularisation through a variety of media, the present study is analysing popularisation through a specific medium in a given historical period, and, therefore, a much more detailed and historically relevant typology can be constructed for its purposes based on different styles of presentation, which will give a better idea of the range of books taken by the present study to be 'popular science books'. See Table 2. This tabulated typology suggests a way in which elementary scientific texts can be differentiated in terms of the expository method and stylistic features that they exhibit, and will be discussed in greater detail in chapter 2. The framework of this typology

Table 1: Types of popularisation

Degree of formalisation and technical precision

Degree of controvertibility of arguments	Low	High
Low	Discursive accounts of certain knowledge as in, for example, mass media presentation of high status science	Technical accounts of certain knowledge as in text-books
High	Discursive accounts of conclusions presented in considerable detail and with extensive reasoning, as in many human sciences seeking general recognition.	Technical accounts of detailed conclusions and reasoning as in, for example, general review articles for other scientists and professionals.

Taken from R. Whitley, 'Knowledge producers and knowledge acquirers'.

Table 2: Types of popularisation in popular science books, c.1870-c.1939

Genres	Scholastic genre	Journalistic genre	Encyclopaedic genre	Recreational genre	Practical genre	Romantic genre	Polemic genre
Expository method	Basic factual exposition of detailed information. Stresses learning by rote, the memorisation of scientific theory.	Basic factual exposition of new discoveries, inventions and innovations. Stresses occurrence of events rather than giving detailed information. Focusses on newsworthiness.	Basic factual exposition designed for quick and easy reference. Focuses on quick grasp of definitions and of 'definitive' exposition.	Basic factual exposition of detailed information requiring practical participation in simple, demonstration experiments. Stresses learning by observation, and amusement.	Stresses learning by induction. Basic factual exposition requiring practical participation in simple field exercises, leading to the possibility of elementary creative participation in science at the 'frontiers' of knowledge.	Imaginative and emotional exposition of both established scientific theory and new discoveries, inventions and innovations. Stresses unity and harmony of Nature. Often adopts some type of spiritual theme.	Imaginative and emotional exposition of new discoveries, inventions and innovations, setting them firmly in a societal context. Often using Utopian/ dystopian themes. Usually short, following one basic argument.
Stylistic features	Uses a lot of technical language. Stresses definitions, makes copious use of headings and italics. Often uses lists, tables and diagrams to convey information.	Short, factual sentences stressing a science's topicality, its striking features and practical applications. Some use of diagrams and illustrations.	Usually a series of entries either organised alphabetically or by subject, which are well-indexed. Some use of diagrams and illustrations. Attempts to convey the whole of knowledge or the whole of an area of knowledge.	Uses basic language of instructions, often following a recipe format. Some use of illustrations. Diagrams are often used to help explain how to conduct the experiments.	Uses basic language of instructions. Often well illustrated to help identification of field subjects. Usually pocket-sized and well-indexed for use in the field.	Uses a lot of metaphorical language, Romantic poetry, well-known fiction. Often uses impressionistic analogies, involving time or travel. Some use of illustrations. No tables or diagrams.	Use of rhetorical devices to make points quickly and bluntly. Humourous analogies and satire may be used. Rare use of illustrations except for the odd cartoon. Some use of statistical tables.
Presentation	Text-book	News format	Encyclopaedia or dictionary of knowledge	Roughly analagous to a cookery book.	Handbook for quick and easy reference	Like a personal notebook or journal	Essay or pamphlet

was not derived from any theoretical foundation, be it sociological, philosophical or linguistic on the structure of expository texts. On the contrary it was adduced from empirical research of primary sources.

Historians tend to be critical of the creation of genres, saying that they create ahistorical, static categories which are not helpful in understanding past realities.(37) To a certain extent this criticism is undoubtedly valid. However, when approaching an historical study largely through the empirical analysis of a large group of primary sources, it is noticeable that such a group can be divided into types, and also that these types develop in different ways with time. Thus, the typology given in Table 2 proved a useful analytical construct with which to monitor changes in the presentation of science through popular science books, but the genres are constructions of which the popularisers themselves would hardly have been conscious.

To go some way to answer the charge that such genres are static and ahistorical, chapter 2 helps to place each of these genres within historical contexts in terms of the objectives of the various authors who wrote popular science books in these particular styles. Using these genres, the thesis then proceeds,in two main ways, chronologically through the three periods under consideration.Firstly, each period is analysed (in chapters 3, 5 and 7 respectively) in terms of series presenting 'elementary' science and natural history, to establish general trends and changes in the presentation of science through books. This is then followed,in chapters 4, 6 and 8, by an analysis of the popularisation of public science in each period through the writings of popularisers involved in the most topical science issues of the time.

Footnotes

1 - J.Meadows, 'The growth of science popularisation: A historical sketch', Impact of science on society, 1986, 144, pp.341-6.

2 - Ibid., p.346.

3 - D.Hinton, 'Popular science in England, 1830-1870', University of Bath Ph.D. thesis, 1979, p.408.

4 - "By the end of the nineteenth century, both the evolution of scientific knowledge and that of ruling ideologies in the nations of Western Europe made a revision of the relationship between science and political power possible."

I.Grabner and W.Reiter, 'Meddling with "politicks" - some conjectures about the relationship between science and utopia', in Sociology of the sciences, 1984, 8, pp.235-61, p.242.

5 - D.S.L.Cardwell, The organisation of science in England, London, 1972.

6 - See, for example, A.H.Dupree, 'Christianity and the scientific community in the age of Darwin', in D.C.Lindberg and R.L.Numbers (eds.), God and nature, London, 1986, pp.351-369.

7 - See, for example, F.Bedarida, A social history of England, 1851-1975, London, 1979.

Also, F.M.Turner, 'Public science in Britain, 1880-1919, Isis, 1980, 71, pp.589-608.

8 - F.Bedarida, op. cit. (7), p.142.

9 - See, for example, R.Barker, Political ideas in modern Britain, London, 1978.

10 - For a fuller discussion of this, see, J.Lancashire, 'An historical study of the popularisation of science in general science periodicals in Britain, c.1890-c.1939', University of Kent Ph.D. thesis, 1988.

11 - R.Whitley, 'Knowledge producers and knowledge acquirers: Popularisation as a relation between scientific fields and their publics', Sociology of the sciences, 1985, 9, pp.3-31.

12 - Op. cit. (10), p.328.

13 - P.Abrams, Historical sociology, Shepton Mallet, 1982, chapter 1.

14 - For example, both L.Althusser and N.Poulantzas have distinctive Marxist theories of hegemony which I do not think satisfactorily escape the charge of historicism. As I am not a Marxist I prefer to fall into the Gramscian trap of historism.

For Gramsci's theory of hegemony, see, A.Gramsci, Selections from the prison notebooks, London, 1971; especially the sections entitled 'The state and civil society', and, 'Problems of philosophy and history'.

Because Gramsci is notoriously ambiguous, it is also necessary to state which interpretation of his writing I am following. In this respect the following works have been especially helpful:

R.Simon, Gramsci's political thought, London, 1982.

S.Hall, B.Lumley and G.McLennan, 'Politics and ideology: Gramsci', in Centre for contemporary cultural studies, On ideology, London, 1978, pp. 77-106.

15 - S.Sheets Pyenson, 'Low scientific culture in London and Paris, 1820-1875', University of Pennsylvania Ph.D., 1976, pp.14-15.

16 - "Deviant science is that which is rejected by the orthodox scientific experts, and which they may label 'pseudo-science'; however, it has its own body of supporters who claim it to be a science."
R.G.A.Dolby, 'Reflections on deviant science', in R.Wallis (ed.), On the margins of science, Keele, 1979, pp.9-49, p.11.

17 - The term 'popular science' where occasionally used, alludes to the popular ideas and assumptions about science in general currency at particular points in time, which should be made clear by the context of the narrative.

18 - F.M.Turner, op. cit. (7), p.590.

19 - Ibid., p.590.

20 - D.Hinton's study, op. cit. (3).

21 - R.C.Tobey, The American ideology of national science, 1919-1930, Pittsburgh, 1971.

22 - Because "it became more civic-minded and state-oriented."
F.M.Turner, op. cit. (7), p.592.

23 - Anon., 'The expositors of science', Times literary supplement, 1 May,1937. Quoted in op. cit. (3), p.168.

24 - P.Burke, 'Oblique approaches to the history of popular culture', in C.W.E.Bigsby (ed.), Approaches to popular culture, London, 1976, pp.69-85, p.72.

25 - Books in series, 1876-1949 (Original, reprinted, in-print and out-of-print books, published or distributed in the U.S. in popular, scholarly and professional series). New York, 1982, p.viii.

26 - D.E.Allen, The naturalist in Britain, London, 1976, p.245.

27 - In fact, this study did not find any such series designed for the use of a general adult audience between the Wars.

28 - J.E.Morpurgo, Allen Lane: King Penguin, London, 1979, p.149.

29 - R.MacLeod, 'Evolutionism, internationalism and commercial enterprise in science: The International Scientific Series, 1871-1910', in A.J.Meadows (ed.), Development of science publishing in Europe, Amsterdam, 1980, pp.63-95.

30 - Op. cit. (5).

31 - In 1905 the English catalogue of books stops listing series of books published in favour of listing professional journals published. Obvious other sources, such as the periodical The bookseller, do not list series of books published, but only individual titles. Unfortunately Britain lags behind America in rich bibliographical source materials for popular literature, like that cited in footnote 25 above.

32 - Other 'techniques' included scouring any surviving publisher's advertisements and lists, and keeping an eye continually open when visiting libraries and secondhand bookshops.

I am also hugely indebted to Professor Crosland for the use of his private collection of popular science books.

33 - I failed to obtain information about possible archive material from many publishers. Among these were:

The Society for the Promotion of Christian Knowledge.

A. and C. Black (now responsible for the copyright of Ernest Benn ltd. publications).

Eyre Methuen (now responsible for the copyright of Williams and Norgate publications).

Hamlyn (now responsible for the copyright of George Newnes publications)

Allen and Unwin.

Searches for reviews were made in a variety of periodicals, including:

The Saturday review.

Nature.

Notes and queries.

The new statesman.

Because of the length of period under consideration, however, and the fact that lists of books reviewed rarely appeared in indexes, such searches were not always fruitful.

34 - In 1850, the middle-class annual wage ranged from approximately £60 for a clerk to approximately £1,000 for a doctor with a fairly fashionable practice.

In 1913 a clerk earned approximately £100 a year, whilst a doctor earned approximately £400 a year.

In 1924 a clerk earned approximately £240 a year, whilst a doctor earned approximately £750 a year.

In 1935 a clerk earned approximately £260 a year, and a doctor earned approximately £1,000 a year.

All information from J.Burnett, A history of the cost of living, Harmondsworth, 1969, pp.233-4 and 298-9.

35 - Op. cit. (11), p.16.

36 - That the content of books was taken by contemporaries to be 'elementary' was deduced from title, preface and introductory chapter.

37 - P.Vartanian, 'Popular culture studies: A problem in socio-cultural dynamics', Journal of popular culture, 1977-8, 11, pp.281-9, p.282.

CHAPTER 2

METHODS OF PRESENTATION

1 - Introduction

Elementary science was presented in a great variety of ways through the medium of the book between 1870 and 1939. The main focus of the present study is books which were written with the express purpose of communicating the scientific knowledge of the period, at an elementary level, to an adult audience. For the period under consideration, it is convenient to classify popular science books into four main types of scientific exposition in which the writer either gave an essentially factual account of science, or he romanticised science, or he presented science as a participatory hobby, or, finally, he wrote of science in a polemical manner. These types are not mutually exclusive and occasionally overlap, but, in general, a popular science book will fit into one of these main genres of presentation. As this chapter will indicate, different types of exposition were popular at different times during the period being studied, and not one of these four general methods of presentation remained static, they changed to adapt to the audience demands of the time.(1) Some methods of presentation, however, are not considered in as detailed a way as others in this chapter because it seemed more logical to discuss them further at a later point in the text.

The best-known genre of exposition for any subject,using the medium of the book, is probably the scholastic, or text-book, type of presentation. Consequently, the present chapter begins with an exploration of that genre.

2 - Science as fact

a)- The scholastic genre of exposition

The presentation of science as a series of facts, is, perhaps, best characterised by the school text-book with its diagrams, definitions and headings. This scholastic genre of presentation has endured for many centuries as the traditional and predominant method of elementary exposition. Texts written in this style differ in structure from texts in other genres in that they are exceedingly systematic in organisation. Writers of such texts make copious use of headings and subtitles, and also use italics to emphasise definitions and important facts, so that note taking from such texts is easy, since the relevant information is emphasised for the reader, and is not clothed in metaphorical or emotive language.

At first sight such a genre may seem incompatible with the aims of modern science, which from Bacon onwards, have stressed the importance of experience and experiment in the acquiring of knowledge, and which began by reacting against the stranglehold of the scholastic method. At the level of scientific exposition, however, inductive reasoning generally remained a rhetorical device, rather than becoming part of the educational method. This was because natural philosophy, to a certain extent, had to adapt to the educational conventions of the era, in order gradually for it to become acceptable as a subject fit for formal education.(2)

There were, however, more pragmatic reasons why the 'founding fathers of modern science', were willing to utilise the scholastic method of education. For example, Lavoisier's, Traité élémentaire de chimie, published in 1789, adopted a text-book formula which enabled Lavoisier to describe the various experiments demonstrating the composition of water both by analysis and synthesis without referring to any of the disputes that had arisen over them.(3) Hence, the text-book offered a comfortable style for the purposes of the propagandist, since its format suggested an accepted body of knowledge, from which the reader extracted information, without

questioning the authority of the text. Indeed, the scholastic genre proved to be well-adapted to the exposition of science, since it had traditionally been used to present a form of deductive reasoning and to acquaint the student with a specialist vocabulary; and thus the genre was readily adapted to the exposition of scientific theories and their requisite technical languages. And so, by the late nineteenth century, the text-book was as familiar to expositors of science as it was to teachers of the more traditional subjects.

Although the text-book format of presentation has proved successful over the centuries in the context of the time-tabled, institutional processes of education, its marketability among an adult, leisure audience might appear surprising. Of course, primary and secondary education were not widespread in the early and mid-Victorian period, and this, combined with the strong self-help ethic that was in vogue at the time, goes some way to explaining the continuation of the scholastic genre in a popular, leisure context. By the late Victorian era, however, with the 1870 Education Act, more people had experience of institutional education, while the text-book itself was becoming the bread and butter publication of the publishing houses which specialised in non-fiction, like, for example, Macmillan. During this transitional period in the educational habits of the British public, publishers and popularisers had to hedge their bets as to the continuing appeal of the text-book in a leisure market. The geologist J.Jukes made their predicament clear in the preface to his School manual of geology, where he said that his text, although primarily intended for the use of schoolchildren, "is also offered to grown-up persons who have no time for a more extended study of the science."(4) Also, at a time when science was not legally established on any school curriculum, it was a financially astute move to sell texts written in the scholastic genre to members of the general public as well as to schools.

One advantage the scholastic genre did have for an adult with a little leisure, was that since the genre is always written in a lucid, and somewhat terse manner, with very little figurative language, and usually not involving much discursive thought, it is successful in presenting knowledge in a way that is quickly and easily absorbed. Thus, a reader working long hours in full-time employment might be able to snatch an education using such elementary text-books. It is argued below (5) that, in the late Victorian era, such dual purpose texts were largely marketed, aside from their institutional sales for schools, for the benefit of the working-class general reader.

In order to capture the more sophisticated middle-class reader at this time, however, the presentation of science as fact had to lose its school text-book connotations. This became increasingly necessary, the more widespread elementary and secondary education became, since the adult general reader of every class then tended not to welcome texts which were reminiscent of his schooldays.

On the other hand, there were features of the scholastic genre of exposition which many popularising scientists were loth to relinquish. For this genre was very successful through its text-book format, in presenting science as an ordered activity with a framework of laws and principles, which systematically classified and quantified the natural world. Such a presentation of science focussed on the problem of analysing and assessing certain discrete parts of the natural world by the methods known to be adopted by a particular science. For these reasons the scholastic genre was a valuable method of exposition for the late Victorian public scientists on two counts. Firstly, the genre presented the scientist as somebody who 'deconstructed' the world, found out how it worked, and then rebuilt it according to scientific laws, and this gave the scientist a claim to authority based on positive, rational reasoning. Secondly, because this reasoning was claimed to be inherently rational, it was, therefore, by implication, accessible to anyone who could follow a lengthy,

graded learning process, which could be offered through text-books. In other words, because the late Victorian public scientists were trying to create a meritocratic pyramid of knowledge, which gave the professional scientist, positioned at its apex, authority, the scholastic genre of exposition fitted such requirements very well.

Consequently, in the late Victorian era, one way of escaping the traditional text-book presentation of science, while retaining scholastic attitudes towards exposition, was to emphasise the observation of facts. For example, the geologist Jukes, mentioned above, tended to employ a deductive presentation of information, with the theoretical framework preceding the demonstrable 'facts', then offering a detailed description of these facts, and requiring the reader to go out and observe them in this theory-laden light. Thus, for example, having been told how the earth was formed, the reader would then be presented with observable facts such as,

> "The first and most obvious fact is that there are beds which are naturally distinct from each other..
>
> "The very fact of the beds being separate proves that they were formed at separate times."

And, finally,

> "In fig.7 these facts of lamination and stratification are represented in a rough diagrammatic fashion.."(6)

The reader was then told to go out and verify these facts by observation.

Among public scientists at this time, a similar educational approach, the heuristic method, also featuring the observation of facts, but this time allied with 'inductive' reasoning, was being popularised by, amongst others, the chemist H.E.Armstrong and the zoologist T.H.Huxley. This educational method was taken up with alacrity at an advanced level in the newly instituted teaching laboratories of the period. At an elementary level, however, this new descriptive emphasis, while it may have contributed to a greater accuracy in the illustration of popular science books, was

not of great benefit to the adult general reader, since it was really geared more to the needs of a formal education system with skilled teachers, than to the one-way communication of a text read without supervision. It remained, however, a method of written exposition which was popular with the late Victorian public scientists.(7)

Another way of adapting the text-book to the requirements of the adult general reader in the late Victorian era, was to use them to present a more advanced level of information, akin to that found in university teaching of the period. Under this style of presentation, the text offered carefully documented academic evidence for the theory being put forward, treating the reader as an intellectual peer. Many science series of the period use this style, such as the 'International scientific series' and the 'Contemporary science series', but, of course, by the end of the nineteenth century, the increasing specialisation and professionalisation of the natural sciences made this a far less viable method of exposition.(8) It was still in use, however, in the Edwardian era in series like the 'Home university library'.(9)

Yet, increasingly, popularisers presenting science in a mainly factual way, relaxed the formal scholastic mood of their texts, without relaxing the scholastic attitude to exposition. Take the following extract from Grant Allen's book The story of plants as an example:

> "What you mean most by a flower is a mass of red or yellow petals, conspicuously arranged about the true floral organs."

But,

> "it is the stamens and pistils (or carpels) that are the true flowers..and an enormous number of flowers possess these organs alone, without any conspicuous petals or other coloured surfaces."(10)

Thus, the authoritarian way of presenting information which was common to the scholastic genre was being upheld, since the popular perception of the flower was dismissed as ignorant, and the scientific perception

was then superimposed on top of it. In this way the reader's common sense was being 'refined',in the Huxleyan sense (11), before his very eyes.

b)- The journalistic genre

As has been mentioned, with the increased specialisation of knowledge, and the rapid growth of a popular press, scholastic texts in the Edwardian era became less rigidly structured in the style of a text-book.They adopted the form of a general summary, or an extended journalistic-type report.(12) Although such texts were still presenting science as a series of facts, they used shorter sentences, a simpler vocabulary, and even used the odd colloquial expression, thereby creating a slightly more informal approach. For example, here is part of the passage in which G.F.Chambers, in his text The story of the weather, published in 1897, introduced the reader to the idea that knowledge of the weather involved an interdisciplinary approach:

> "..Quitting the surface of the earth again, and having to consider, for instance, a thunderstorm, we are face to face with the Science of Electricity. Another common feature of a thunderstorm is a rainbow. In order to learn what a rainbow is, and how it is formed, we must dive into the Science of Optics.."(13)

The emphasis of such texts was also changing away from the static text-book presentation of knowledge to a concern with reporting very topical scientific events, giving a basic, factual exposition of new 'discoveries', 'inventions' and innovations. A good example of this is to be found in J.Munro's text The story of electricity, published in 1905, which revels in the exposition of the gadgetry, serious and trivial, which the science of electricity had given the world, gadgets such as:

> "The 'Domestic Telegraph', an American device, which is a little dial apparatus by which a citizen can signal for a policeman, doctor, page, or carriage, as well as a fire engine, by the simple

act of setting a hand on the dial."(14)

It has been argued in a recent paper that in contemporary popular scientific literature:

> "it is more crucial to know that something has occurred than it is to know the minutiae of the occurrence itself. Here, knowing is more relevant than knowledge proper."(15)

Where the presentation of such information through popular, elementary books is concerned, this change in emphasis from'knowledge'to'knowing' started to occur in the Edwardian era. This change was largely due to the increasing circulations and influence of the daily press, along with a decline in the vogue for rigorous self-education in the tradition of Samuel Smiles, which in turn was linked with the provision of primary and secondary education. This will be discussed further in chapter 5.

c)- The encyclopaedic genre

Texts included in this genre are usually one volume works, offering a synopsis or general outline of knowledge in which science either consitutes a large part, or all of the information presented. Such texts intend to offer quick and easy access to knowledge, and, for this reason an understanding of the organisation of information within the text is important for the reader to grasp, and is usually set out in the preface or introductory section. Generally, information in such texts is either organised alphabetically, or by subject, and is well indexed. Because of the amount of material each text in the encyclopaedic genre attempts to convey, they tend to be thick, heavy books (often quarto size) designed for desk use, rather than being the more convenient octavo size of the majority of popular science books. The amount of knowledge which such texts convey means that they tend to feature brief, factual entries accompanied by illustrations, presumably because a one-inch woodcut or engraving can impart more information than the equivalent space taken up by the narrative, and also to

make the presentation more appealing by providing a visual distraction.

At the beginning of the late Victorian period, general and scientific texts in the encyclopaedic genre were still attempting to offer the reader a definitive and 'literal', non-popularised presentation of knowledge,(16) which subject dictionaries and one-volume cyclopaedias had been offering since the late eighteenth century. For example, R.Phillips' text A million facts was published in a new edition in 1872 which the publishers, Ward, Lock and Tyler, claimed to have updated to the contemporary state of knowledge from its first publication in 1839, by a supplement of a mere 28 columns, to keep up with the author's original claim to be "in advance" of "the march of intellect".(17) The text ranged from information on measures and weights, through facts from the sciences and arts, to general information on the colonies, commerce etc, finishing with biographies and theological statistics. It possessed no illustrations but several tables of information. Phillips, himself, thought the text would be useful to "students and literary men..politicians, readers of newspapers and journals..and summer residents at country seats."(18) In other words, it offered itself as an educational tool, a reference work, and a recreational device for those with the leisure to browse.

Following this tradition for such definitive, 'literal' works, the publisher Samuel Orchard Beeton launched his series of dictionaries in the late 1860s as "valuable and trustworthy" books of reference.(19) These subject dictionaries covered science, art, literature, geography, history and biography. The information in each dictionary was arranged alphabetically, with plates of half a dozen woodcuts accompanying (approx.) every 150 entries; the entries themselves being brief, factual and authoritative. Beeton claimed each dictionary to be "a repertory of useful knowledge, which may be at all times consulted, with complete confidence in its fulness and accuracy."(20)

By the late 1870s and early 1880s, however, texts in this encyclopaedic genre were less concerned to offer unadulterated information, as to offer the reader a general outline, or popular introduction to a subject or subjects. This change was probably due to the recognition of the rapid growth of specialised knowledge in a society with an increasing number of experts. One of the architects of this new 'dip into' format of presentation was George Newnes with his famous weekly paper Tit-bits, which offered a montage of snippets of information, great literature etc. Following this trend, some texts in the encyclopaedic genre during this period began to change structure. No longer did such texts rely on one author, but tended to be written by several authorities, each contributing popular articles or chapters on their own specialism. In this way, texts in the encyclopaedic genre began to appear less like reference books and more like either collections of articles or normal books structured around chapters. For example, Cassell's Science for all, published in six volumes from 1877-82 and edited by R.Brown, offered articles written by various authors on differing topics, not organised in any schematic way. The idea being that the reader, having perused these volumes, would have a good general knowledge of science. To sustain the interest of this dilettante reader, the text was liberally illustrated, the subtitle to the volumes being "Pictorial wonders and beauties of common things". Similarly, Cassell's Popular science, published in 24 parts at sevenpence each (in paper covers) between 1903-4, consisted of a collection of articles written by various authors, not organised in any schematic way. This work, as its title suggests, was clearly intended to be a vehicle for the popularisation of science. Its editor, A.S.Galt, introduced the text by claiming that "it is worthwhile to popularise" and attacked the idea that "'popular science' may be read as 'inexact science'."(21) The general topics covered by the articles were; photography, astronomy, microbes, plants, geology, modern inventions, e.g.: electricity, and insect and animal life. The

articles themselves, veered between straightforward didactic prose and journalistic-type reports depending on the author. The text was well illustrated, with one or more photographs on every page because Galt felt that for popularisation "pictorial representation is essential to the proper elucidation of knotty problems."(22) Following this belief, the illustrations were properly integrated into the text, with the reader being directed to look at them at certain points in the narrative.

Other books in the encyclopaedic genre, such as texts in Hutchinson's 'Concise knowledge library' adopted the book format, structuring information into chapters written by different authors. Although these texts were generally well indexed, their use as a reference work really relied on the reading of the appropriate chapter, as no section or paragraph headings were used.

This change in emphasis in the encyclopaedic genre, from a belief in the 'literal' unadulterated presentation of knowledge to a commitment to popularisation occurred more dramatically in those texts devoted to natural history, where it was accentuated by the Darwinian 'revolution' in thought. For example, an examination of the various editions of Cassell's Natural history between 1870 and 1914, reveals that in the editions up to, and including that of 1896, the 'literal' unembellished presentation of knowledge held sway with each edition offering a complete series of descriptions of animal life. These descriptions were held together as a unity by the classificatory system of the seven main animal kingdoms: vertebrata, arthropoda, mollusca, echinodermata, vermes, coelenterata, and protozoa. Each edition of this type presented a full reference work, as useful for naturalists concerned with the identification of species, as for the recreational pursuits of the layman. In the 1913 edition of the Natural history, however, its author, F.M.Duncan, offered a popularisation of the Darwinian theory of evolution, choosing representative types of animal to carry the 'story' rather than, as in the old type of natural history, attempting

to describe exhaustively all animals in each discrete, classificatory sub-kingdom.

After the Great War, the encyclopaedic genre of text continued to respond to the growing specialisation and professionalisation of knowledge by developing in two main directions. Firstly, with the rapid growth of knowledge it became more common in the inter-war period for texts in the encyclopaedic genre to be devoted to one subject, such as The science of life, first published in 1931 and written by H.G.Wells, J.Huxley and G.P.Wells, which offered a "précis of biological knowledge",(23) and J.A.Thomson's text Biology for everyman, published in two volumes in 1939, which intended to "provide Everyman with a clear, authoritative and reasonably detailed picture of life in its manifold forms."(24) Other texts in the encyclopaedic genre during the inter-war period drew more strongly, however, on the Tit-bits tradition of offering snippets of information on a variety of topics. In this vein, for example, was E.Hawks' text The marvels and mysteries of science, published in 1939. This text was divided up into four sections as follows: the wonders of the heavens, the earth, the constitution of matter, and, the marvel of living things. In each section the information was presented in short, factual paragraphs, with copious use made of paragraph headings. The information ranged from the reporting of theories (such as Helmholtz's theory of contraction concerning the origin of the universe), to the presentation of 'trivial' facts (such as that there are between 20-40,000,000 leaves on a pine tree). Clearly, factual data still fascinated some readers as it had in the early Victorian period.

What had changed in the intervening century, however, was general cultural assumptions about knowledge, as evidenced in the changing format of the encyclopaedic genre. By 1939 no one volume popular text claimed to present definitive, 'literal' knowledge on every subject as they had in the mid-to-late Victorian era. Rather, the encyclopaedic genre had adapted to accomodate areas of expertise and the rapid growth of knowledge by presenting

general outlines of, and popular introductions to, scientific knowledge, usually written by a variety of expert authors.

3 - Science as romance

In many ways, the romantic genre of exposition can be seen as a response to, and revolt against, the style of exposition presented by texts in the scholastic genre outlined above, and drew on the Romantic inspiration of the late eighteenth and early nineteenth centuries, since this was a time when, for some people, the scientific study of nature came to be blended with an aesthetic vision of Nature. Thus, one of the main distinctions between the romantic genre and that of the scholastic, was that the former presented subjective insights drawn from personal experience, whilst the latter tended to present knowledge in an almost exclusively technical and formal way. Perhaps, however, the most obviously striking thing about such a genre as the romantic was its enthusiasm for nature as an aesthetic and moral experience, as opposed to the detached and purely rational perception of its existence fostered by the scholastic genre of exposition.

One obvious stylistic feature which clarifies this difference between the romantic and the scholastic approach to knowledge was the different uses made of language by the two genres. For example, the scholastic genre concentrates on defining things logically and accurately, since "the aim is to get rid of ambiguity as far as possible and to establish semantic precision combined with sharability by all normal observers."(25) The romantic genre, however, used open, metaphorical language which avoided clear-cut concepts and exact logical relations, since for the romantic, reality was basically an irreducible pluralism which could not be accurately defined. Consequently, the romantic genre of exposition was soft-focus, intuitive, spontaneous and impressionistic, and hence was inherently antithetical to the rational,sharp-focus, routine exposition of the scholastic genre. For, since reason was not enough, from the romantic viewpoint,

the romantic style of exposition tried to speak to the 'soul' through the reader's imagination, thereby making a deeper impression than would the methodical, elementary exposition of the text-book. Popularisers using the romantic genre of exposition attempted to involve the reader's imagination in the text by using metaphorical language, anthropomorphism, impressionistic themes using the concepts of time and travel, and, occasionally, by quoting poetry.

The three great influences on this type of scientific exposition in the late nineteenth century were Carlyle, Emerson and Ruskin, whose names were frequently cited, and whose works were often quoted in such popular texts of the late Victorian era. Tyndall, in particular, found Emerson a great inspiration.(26)

Carlyle was influential in two main ways.Firstly, he more than any other British writer in the mid-to-late Victorian period, helped to associate scientific ideas with romantic imagery. One example of this is the passage in Sartor resartus where the concept of romantic love is presented in terms of an analogy with the theory of electricity, which concludes:

> "..in the conducting medium of Fantasy, flames-forth that fire-development of the universal Spiritual Electricity, which, as unfolded between man and woman, we first emphatically denominate LOVE."(27)

Thus, at a stylistic level, Carlyle's writings kept alive the romantic use of scientific metaphors. Carlyle's second main contribution to scientific exposition in the romantic genre was his philosophical belief that rationalism was compatible with transcendentalism. For example, in Sartor resartus, Professor Teufelsdrockh is cast in a sympathetic light because:

> "with all this Descendentalism, he combines a Transcendentalism..
>
> "'To the eye of vulgar Logic,' says he, 'what is man? An omnivorous Biped that wears Breeches. To the eye of Pure Reason what is he? A Soul, a Spirit, and divine Apparition.. '"

Carlyle continues, saying:

"For matter, were it never so despicable, is Spirit, the manifestation of Spirit: were it never so honourable, can it be more?"(28)

This latter quotation captures the essential quality of scientific exposition in the romantic genre, that quality being the spiritual dimension to material reality, and any populariser wishing to emphasise this dimension in the period 1870-1939 tended to use this genre in order to do so.

The main contribution of the American writer Emerson to this romantic type of exposition was his belief that the poetic imagination could impose a unity upon a fragmented, differentiated reality. This belief was undoubtedly underpinned by Emerson's religious convictions which supported a natural theological interpretation of the world, claiming that "the use of natural history is to give us aid in supernatural history.."(29), and that "visible nature must have a spiritual and moral side."(30) This religious conviction was an immense influence on some of the leading popularisers of Victorian Scientific Naturalism.

Ruskin, on the other hand, appealed more to the opponents of Victorian Scientific Naturalism, and his Proserpina has been convincingly linked with the sentimental flower books of the late Victorian era which thrived in a natural theological culture.(31) Like Carlyle and Emerson, Ruskin distrusted science, but unlike these former writers, he was an Evangelical contemporary of the Victorian Scientific Naturalists,and made several outspoken attacks on 'modern' science with its emphasis on rational deconstruction and analysis.(32) Possibly this was why he was venerated by popularisers of natural theology, rather than by the Victorian Scientific Naturalists. Certainly his belief in the 'Law of Help' ("Government and cooperation are in all things and eternally the laws of life. Anarchy and competition, eternally..the laws of death." (33)) set him at odds with those who held dear the Darwinian theory of natural selection. At any rate, his belief that the process of understanding did not require complete knowledge of the facts interested a whole generation of popularisers in Britain in the late nineteenth century,for reasons which will become clearer in chapter four.

This interest was not surprising, since by the mid-to-late Victorian era, Romanticism had become part of popular culture, in the form of a cloying sentimentalism which, it has been argued, was part of the mood which instigated wide reaching social reform.(34) The anthropomorphism of many natural history texts of the period, along with the craze for animal portraiture, were also part of this 'Romanticism' which resulted in the Wild Birds Protection Act of 1880, the creation of the Royal Society for the Protection of Birds in 1904, and the earlier formation of the Royal Society for the Prevention of Cruelty to Animals. At a more middlebrow level, the Romantic holistic approach to nature, with its emphasis on the interrelatedness of natural phenomena, probably helped to prepare the way for the new ecological fieldwork which Darwinism had instigated.(35)

The exposition of certain topics such as natural history, geology and astronomy were more obviously part of this popular romantic mood, for the reasons given below, than were chemistry or physics in the late nineteenth century. Most particularly, natural history, drawing on the traditional form of the naturalist's notebook, was ripe for romantic exposition at this time allowing, as it did, scope for the keeping of subjective, spiritual 'nature' diaries.(36)

In astronomy, the romantic genre of presentation was widespread, since the subject of the heavens with its religious connotations was culturally ripe for a spiritual, poetic type of exposition. The French populariser C.Flammarion, whose books were published in translated editions in Britain in the late nineteenth century, was particularly skilled in this style of popularisation. For example, he concluded his text Astronomy for amateurs, published in Britain in 1903 with a chapter entitled "Life, universal and eternal" which attempted an explanation of Flammarion's mystical beliefs about cosmic unity, as follows:

> "Life is everywhere. From the bottom of the seas, from the valleys and the mountains, from the vegetation that carpets the

soil, from the soil of the fields and woods, from the air we breathe, arises an immense, prodigious and perpetual murmur. Listen! It is the great voice of Nature.."(37)

Similarly, the theme of evolution gave a romantic feel to many textual expositions of geology in the late Victorian and Edwardian eras, since the idea of evolution actively involved the imagination, or as Rev.C.A. Hall said in his book Romance of the rocks,

"Using his hammer and chisel patiently and skilfully in splitting the rocks the student of the rocks may bring to view, 'shapes of shells and forms of creatures in old worlds', which will appeal to his imagination, and help him to picture the life of past ages."(38)

In a similar way, the theme of evolution could be used as a romantic expository tool in all the biological sciences. For example, Lubbock, in his text The beauties of nature, retold a Teutonic creation myth which explained the form, colour, and names of many plants and animals (39), and then went on to say

"Recent attempts to explain the facts of Nature are not less fascinating, and, I think, more successful. I shall never forget hearing Darwin's paper on the structure of the Cowslip and the Primrose, after which even Sir Joseph Hooker compared himself to Peter Bell, to whom

A primrose by a river's brim
A yellow primrose was to him,
And it was nothing more.

We all I think shared the same feeling, and found that the explanation of the flower then given, and to which I shall refer again, invested it with fresh interest and even with new beauty."(40)

All of these romantic texts conveyed more than factual expositions of scientific theory, they also asserted that a mystical, or spiritual perception of the natural world was important, since as E.Clodd said

in his popular text The story of creation:

> "A dogma learned is only a new error - the old one was perhaps as good; whereas a spirit communicated is a perpetual possession."(41)

After the Great War, this type of exposition featuring poetry and fictional themes to create the impression that there was more to science than reason and logic, sustained its popularity. The early twenties were, after all, a time when writers like Bergson, Freud, Jung, and Nietzsche were fashionable among a middlebrow audience, a time when Reason and Intellect were under attack. Some British popularisers of science obviously felt part of this, largely Continental, move away from nineteenth century rationalism. The geologist E.Greenly, for example, introduced his subject in the following way in 1927:

> "Unsophisticated Early Man, wiser in his simplicity than some of his posterity, spoke of the Earth as the Great Mother,"

but, Greenly continued,

> "we are far more than children of the Earth. From birth to death we are of the Earth's own body. In our most exalted moments, we are of the Earth's own life."(42)

In texts like this, the romantic genre of exposition with its mystical overtones, survived the Great War, and continued to be used, as it had in the late nineteenth and early twentieth century, by popularisers wishing to stress the spiritual significance of the natural world. For example, in this context, this method of exposition became a particularly important part of the popularisation of modern physics which is discussed in some detail in chapter 7 and chapter 8.

4 - Science as hobby

Whereas the presentation of science as fact utilises the reader's memory, while the presentation of science as romance appeals to the reader's imagination, the presentation of science as hobby accentuates the participat-

ion of the reader at a practical level. Indeed, one of the fundamental motivations for a populariser of any period to present science as hobby is the belief that science cannot be adequately presented merely by text. In many ways this belief is part of the British empirical, Baconian tradition which dates from the seventeenth century. For Bacon hoped to replace what he believed to be the sterile sophistries of scholasticism with a new programme of careful induction, involving the investigation of natural things by observation and experiment. Of course, this was to be a method for those on the forefront of knowledge to pursue, but an educational method derived from Baconian induction rapidly developed. Thus, Comenius (1592-1670) following the Baconian tradition, insisted that learning be utilitarian as well as attractive, that education must include more than memorisation, and that students must examine the natural world for themselves. In other words, for the teaching of science, Comenius' golden rule, as given in his text The great didactic, was "everything should as far as possible, be placed before the senses."(43) Although this 'rule' permeates most textual presentations of science as hobby, there is a significant distinction, however, between its use in the popularisation of physics and chemistry as a recreational pastime, and its incorporation into the expository device of participation in the presentation of the field sciences, a distinction which will be made clearer below. For this reason, the popularisation of the field sciences is analysed separately in this section, after an examination of the impact of the Baconian legacy of inductive reasoning on the presentation of experimental physics and chemistry as hobby.

a) - Physics and chemistry

From the eighteenth century onwards, largely due to the influence of popularisers such as Desaguliers, who, for example, presented the principles of Newtonian philosophy through non-mathematical exposition and demonstrat-

ion experiments, natural philosophy came to be viewed by its audiences as merely a random and casual familiarity with natural phenomena.(44) The British Association, from 1841 onwards, carried on promoting this idea of experimental natural philosophy as wholesome family entertainment, emphasising the element of showmanship, to the extent that the view has been put forward that the Association was

> "a theatre of science run by zealous missionaries intent on converting their audiences to their views."

And that,

> "As the most ostensibly evangelical scientific institution in an evangelical era, the Association depended heavily on its star performers and orators.."(45)

Thus, within the tradition of the public demonstration experiment, the emphasis was very much on the high visibility, or theatricality, of experimental natural philosophy, rather than on natural philosophy as either a socially relevant activity or as a theoretically coherent body of knowledge.

Natural history, on the other hand, never fitted in with the genre of the demonstration lecture which developed as the dominant form of exposition for natural philosophy in the late eighteenth and early nineteenth centuries, because it was a classificatory rather than an experimental science.

This tradition of the demonstration lecture as a vehicle for the popularisation of natural philosophy, had an impact on the popular science book which presented the physical sciences in the participatory genre. Such texts presented a series of experiments or tricks, each experiment being offered in the form of a cookery recipe, with an outline of necessary equipment and ingredients, and then a step by step guide to method. These texts tended,in general, to stress the entertainment value of the experiments or tricks they explained, rather than focussing on an educational

theme, or any meaningful participation at an elementary level. For example, Tom Tit's book Scientific amusements, published in 1918, was full of amusing tricks, but presented very little information of any educational value. Hence,in a section entitled "Elasticity", a trick is to be found called 'The affectionate flame', which invited the reader to

> "Blow upon a card or small screen interposed between you and a lighted candle. The candle will not be extinguished, since the blast of air is intercepted; but a curious effect will be observed. The candle flame will bend toward the screen as if it desired to reach your face."(47)

As,however, this trick or 'experiment' was not integrated into any expository narrative on the theme of air pressure, its relevance for the general reader remained somewhat enigmatic.

An explanation for the lack of educational content of this genre, may, perhaps, be found in the development of the demonstration lecture within the entrepreneurial culture of the eighteenth century (48), so that the exposition of experimental natural philosophy traditionally became associated with the dilettante recreational pursuits of the upper-classes, an association which also permeated this genre of text. Within this recreational framework, however, many such texts in the late Victorian and Edwardian eras adopted the rhetoric of Baconian inductive science for educational purposes in the presentation of each 'isolated' experiment. For example, Tissandier in his book Half hours of scientific amusement, published in English translation in 1890, educated the reader through an inductive process of experiment, hypothesis, experiment, theory. Thus, the text began with an experiment on falling bodies where, after dropping a coin and a disc of paper together, the reader was informed that "the weight of the bodies counts for nothing in their fall. It is the air only which prevents them from falling with the same velocity."(49) In order to further confirm this hypothesis, Tissandier suggested another experiment as follows:

> "Take a sheet of paper, fold it in half, and cut it so that you obtain two pieces of exactly the same size and weight. Rub one into the shape of a ball and leave the other in its former condition. Then let both fall together. The rolled-up paper will reach the ground before the other piece."(50)

As an educational method this type of presentation had its advantages, chiefly its use of clear step-by-step reasoning, nevertheless it also served to distance the reader from the actual scientific methods pursued by physicists and chemists of the period. In physics, for example, A.Schuster commented that, at an advanced level

> "In many cases the student was led [by his teachers] to believe that the main facts of nature were all known, that the chances of any great discoveries being made by experiment were vanishingly small, and that therefore the experimentalists' work consisted in deciding between rival theories, or in finding some small residual effect, which might add a more or less important detail to the theory."(51)

Thus, the inductive reasoning process featured in this genre of text, while easing the exposition of the physical sciences, also helped to distance the reader from a true appreciation of scientific method as pursued in laboratories.

In essence, the participatory genre of text in the physical sciences remained frozen in the form of the late seventeenth and early eighteenth century demonstration lecture, explaining Newtonian physics in terms familiar to Desaguliers and borrowing from the chemistry repertoires of Davy and Faraday. As such these texts do not appear to have sold well, rarely meriting a second imprint, and were increasingly marketed for children rather than adults. Indeed, by the late Victorian era, the 'scientific' lecture, at a recreational level, had generally become of no more consequence than "charades, amateur theatricals and legerdemain,"(52) pastimes which

the middle-classes felt helped build character. For as T.O'Conor Sloane commented in his book Home experiments, published in 1888,

> "A young person who can give a smooth half or three quarter's hour's talk on science, illustrating his remarks by a successful series of experiments has advanced well on the way to good oratory."(53)

Somewhat surprisingly, perhaps, this genre of text survived the social upheaval which followed the Great War and, in the twenties and thirties, its chief exponent was the populariser A.M.Low, who attempted to raise the genre from the slough of aimless dilettantism into which it had fallen, saying,in his text Popular scientific recreations , "I have in every case, purposely explained the reason for the startling or interesting effects produced."(54) Low was particularly committed to the popularisation of science as an entertaining pastime because he felt that people learnt more from an enjoyable experience and a novel sensual impression than anything else, arguing

> "This knowledge will be in many ways, superior from that obtained from standard textbooks because these experiments will be performed for 'fun' - for the pure love of science and interest in natural phenomena - as distinct from experiments made and theories learned with the object of struggling through an examination."(55)

It should, perhaps, be remarked here that Low, himself, had great difficulty passing exams, a failing which thwarted his ambitions to become part of the academic scientific research community. Undaunted, he courted the publicity of the press, and quickly established a reputation for being an inventor and 'scientific authority', called upon by the tabloid press to comment on any scientific news.(56) Giving himself the title 'professor', he was unflinching in his Baconian rhetoric about the inductive processes of science, making claims in his books such as:

> "The essence of Science, which distinguishes it from all other studies, is that experiment may precede theory. The scientist observes

> certain phenomena and attempts to build a theory that will fit the facts as he knows them rather than to fit his experiments to any assumption."(57)

Bearing in mind, however, Low's eccentric character, it is a moot point whether such statements were 'professional'rhetoric, or a true explanation of Low's own practices. One thing is clear though, Low was genuinely committed to elementary experimental exposition, as a way of familiarising the public with science. In the late thirties, as the implications of science for the next war became a prominent topic for conversation, with the average man realising that, "science is not an airy, abstract affair, but a thing of vital importance to him as an individual,"(58) one has to admire Low for his dedication to the promotion of science as a kind of friendly, domestic theatre. Indeed, it was largely his devotion to this genre of exposition which enabled it to flourish at all amongst an adult audience at this time; for the informal dilettantist charm which surrounded this genre was fading rapidly as science became increasingly institutionalised and monitored by professional scientists.

In conclusion, popularisers appear to have used the Baconian legacy of inductive reasoning and empirical observation in their popularisation of the physical sciences through the participatory genre as a straightforward educational vehicle which, from 1870-1939 served to emphasise the growing differences between academic and popular science. Because of its inability to break out of its early seventeenth and late eighteenth century mould, this genre became hopelessly outpaced by the rapid development of modern science, only managing to survive in the inter-war period because of the high social profile of the eccentric populariser A.M.Low.

b) - The field sciences.(Astronomy, natural history and geology)

Elementary texts in the participatory genre for scientific subjects which centred on field work, such as astronomy, natural history and geology, were generally intended for use in the field and were, therefore, small, light and portable, well indexed handbooks, easily used for reference purposes in outdoor conditions. Because of the stylistic restrictions imposed by the format of the handbook, writers of this genre took a pride in being terse. For example, Rev.Joseph Greene said of his handbook Insect hunter's companion ,

> "one object has been kept steadily in view,to make it thoroughly practical. Care has not been taken to employ polished or refined language, much less has anything approaching fine writing been attempted."(59)

In other words, one of the main beliefs of popularisers writing in this genre was that their science could not be presented merely by text, but had to be learnt in the field as well. For example, the astronomer E.W. Maunder said, "what I wish to urge, therefore, is that those commencing the study of astronomy should not be content with reading only."(60) It was not just enough, however, to go out and'observe facts' as advised by, for example, certain books in the scholastic genre; for there was also a strong element of the heuristic educational method in the participatory genre of exposition for the field sciences. This was typified, for example, by P.Geddes' thoughts on botany, as follows:

> "If we begin with books instead of with flowers, we shall be repelled and discouraged by the technicalities of traditional pedantry, and we shall forego all the profit - not to speak of the pleasure - of discovering the facts for ourselves."(61)

Naturally, such an educational philosophy was similar to that promoted by texts in the participatory genre of physical sciences discussed above. Where the popularisation of the field sciences was concerned, however,

the dictum that"everything should as far as possible, be placed before the senses" had a more direct relevance, since in many cases the observational basis of the field sciences put the general reader in the unique position of being able to place his senses directly before the 'facts', rather than, as in the physical sciences, relying on the medium of the lecturer or author. Somewhat ironically, authors explaining the field sciences through this participatory genre were particularly hostile to the notion of any medium placing itself between the reader's senses and the 'facts'. Such popularisers were as critical of the romantic genre of exposition as they were of the scholastic. C.Simpson, for example, in her popular geological text Rediscovering England, commented

> "You wish to see, perhaps, the Alps or the English Lake Hills through none of the beautiful stained glass that Byron and Ruskin, Turner and Wordsworth would interpose between your sight and these things 'as they are'.(62)

Thus, as part of the British empirical tradition, this participatory genre of exposition depended upon the observation of nature, inquiry and experiment, rather than upon non-empirical propositions, be they of a scholastic or of a romantic nature. Since science was presented through this genre as an intellectual and practical pursuit based on induction through the senses, the place of imagination and emotion was marginalised, along with the memorisation of abstract concepts. Therefore, the role of the reader in such texts was crucially participatory; and a key theme of this genre was that scientific progress, to a greater or lesser extent, relied on the activism of the reader. For example, the Handbook of natural history, published in 1894, and edited by I.Margesson, when discussing the study of snails, said

> "Why should one species prefer sandy downs by the seashore? ..What, again, is the instinct which leads some species, when dredged from abysmal depths of the sea, to crawl to the surface of the water when captured and placed in a jar?

"These are only examples of the many questions still awaiting solution, and towards which everyone can lend a helping hand."(63)

The importance of the reader as a potential participant in science was a genuine enough theme in most field sciences at the beginning of the period under analysis, it gradually, however, became a rhetorical device used by professionals to differentiate their 'high' science from the 'low' science pursued by beginners and amateurs. A good example of this change in emphasis is given by studying handbooks on microscopy from 1870-1900.

In the nineteenth century, it has been claimed that England led the world in the production of popular science books dealing with microscopy,(64) and that this was related to the highly developed instrument trade in this country. Books of instruction were obviously required to support sales of instruments and preparations, and the vast majority of such texts advertised named brands of microscope, along with auxiliary equipment. Microscopy really first became a craze, however, in the 1840s, after Robert Brown generated interest in it by discovering the cell nucleus.(65) This interest in microscopy was sustained in the second half of the nineteenth century by an interest in aquaria.(66) For example, Mrs. Ward's books on microscopy went through many editions between 1858 and 1890.(67) The microscope became a part of middle-class culture featured in soirees and conversaziones; indeed, the Quekett Microscopical Club (est. in 1865) had just such informal roots, for it grew out of the 'open houses' of N.B.Ward and the Queketts, held in Wellclose Square, London.(68) Aside from being a source of home entertainment, the microscope also allowed the urban dweller to become a naturalist within his own drawing room, for, as a Quekett club man pointed out in 1887, "many of us are compelled (sic) in that maze of bricks and mortar called emphatically 'town'."(69)

During the 1880s, however, a controversy developed which seems to have originated in America, between professionals and amateurs over whether a wide aperture microscope was a more worthy instrument than a small

aperture microscope.(70) The microscopist G.E.Davis, indicated the significance of this controversy in his text Practical microscopy, saying

> "Spencer's 1-inch of 50° (aperture) costs forty-five dollars, or £9; the 1-inch of 22° (aperture) in their student's series costs but ten dollars, or £2."(71)

Therefore, if the wide aperture microscope was deemed to be a better research tool, a large financial barrier was being placed between the novice and scientific research. Davis' position in this controversy was clear, when he commented

> "As light is dispersed from every point of an object to an angle of 180° , those glasses which approach infinitely nearer this latter angle must give a more correct image than those of small apertures."(72)

Davis' position was not particularly surprising, since he was using his text to remove microscopy from its status as a dilettantist pastime, saying firmly in his preface ;

> "It should be remembered that the microscope is useful from a scientific point of view, only as an aid in research, unfolding to us objects either invisible, or but faintly to be distinguished by the unassisted eye. The Author has not pandered to the tastes of mere lovers of pretty objects."(73)

By 1893, with the publication of M.I.Cross and M.J.Cole's text Modern microscopy, the professional appeared to have got the upper hand, through the aperture controversy, in distinguishing between 'high' scientific research (using a wide aperture microscope) and 'low' scientific research (using a small aperture microscope). For, Cross and Cole were using their text to instruct and guide the serious amateur, who they identified by his use of the small aperture microscope, since, they claimed that "it is doubtful whether, for the ordinary amateur, there is a real necessity for the large apertures."(74)

At the beginning of the twentieth century, this gap between 'high'

and 'low' scientific research in microscopy had widened so considerably that, by 1900, E.C.Bousfield, in his revised and rewritten edition of Rev. J.G.Wood's mid-Victorian text Common objects of the microscope, was able to state quite clearly in his introduction, that microscopy

> "..has attracted an ever-increasing host of earnest and intelligent volunteers, who have rendered yeoman service to the cause of knowledge,"

since :

> "..the number of problems calling for solution by means of the instrument in question is so vast that even the humblest worker may be of the greatest assistance."(75)

In other words, there was a vast quantity of elementary, observational work to be done which the professional had neither the time nor the inclination to pursue, and which could be 'farmed out' to the amateur, without challenging the status or the authority of the professional workers in the field. Thus, the amateur naturalist interested in microbiology,-for example, was repeatedly directed to the study of pond life by texts in the participatory genre at this time.

A similar process appears to have been going on in astronomy where the distinction between the amateur and the professional was becoming clearer, and focussed, among other things, on telescope size.(76) It too surfaced in the practical genre of text, through the work of E.W.Maunder amongst others.(77)

The only field science which seems to stand apart from this professionalising trend in the participatory genre of text is geology. For example, even as late as 1937, A.E.Trueman could quite convincingly claim that:

> "Geology is preeminently the layman's science. In it more than in any other science there is opportunity for a beginner to make original observations, to weigh up evidence, to coordinate his facts and in general to acquire a truly scientific outlook, whereas a layman can do no more in many sciences than accept ready-made conclusions, often explained by clever but dangerous analogies without

any prospect of understanding the steps by which they have been reached."(78)

The reasons why geology as a field science was largely left to the pursuits of the layman appear to have been partly that geologists were slow to react to the Origin of species in investigating evolutional paleontology, that there was a decline in conspicuous excavation, with its proneness to generate fossil hunters, and that all the big and simple finds had all been made(79); and also that there were only a relatively small number of full-time geologists until after the Second World War, and, therefore, the residual amateur support that remained in the twentieth century was required to finance their specialist journals.(80)

It would seem then, that, from the late 1880s onwards, the participatory genre of text in the field sciences, through the populariser's own enthusiasm for practical experience in his subject, and his use of the heuristic educational method, functioned, inadvertently, perhaps, as a vehicle to differentiate the work of the amateur from that of the professional. It directed the work of the amateur into observational, quantitative areas of research which, while highly educational, produced low-status knowledge. The Baconian legacy of inductive reasoning from empirical observation, proved an immensely useful device for the participatory genre, since, whether it was being used as an expository aid or as a true account of scientific method, it enabled the reader to feel part of the scientific enterprise.

The participatory genre of text in the field sciences, however, declined, along with the general decline in the widespread participation in science, as the membership figures for 'low' scientific societies fell dramatically after the Great War.(81)

5 - Science as polemic

This genre of presentation differed from the others discussed above in that its main purpose was not the popularisation of science in the traditional sense. In other words, it did not primarily intend to offer the reader the elementary exposition of scientifc theory and application. Rather, it aimed in a very obvious and open way, to educate the reader to a point of view about science. In a sense, by focussing on the ethical and social implications of science, this genre set up a social context for discussions about science, thereby shifting the emphasis away from the limited internalist scientific position which most styles of science popularisation adopted, to a more critical, externalist view. Because of this, the polemical genre presented science as a socially controversial, dynamic activity and challenged its'neutral' image of being detached from social affairs, which the majority of popular science books, in the period under discussion, promoted at one level or another. Indeed, these polemical texts used emotive language and images as they presented science as a highly topical part of general culture. Texts in this genre were usually short, comprising one essay-length argument, and much of the success of the polemic, in terms of sales and influence, depended on the fame and notoriety of the writer, since, as A.J.P.Taylor has commented, the polemic is "the Hyde Park of the written word."(82) For this reason, between 1870-1939, this genre was dominated by famed publicists like, T.H.Huxley, B.Russell and J.B.S.Haldane.

As has been pointed out in Chapter one, the present thesis focusses on the popularising work of three generations of public scientists, and the polemic genre of exposition was the most important style of communication for these popularisers as they strove to justify their scientific activities in changing social contexts.

In terms of the period under study in the present thesis, one of the first major topics for which the polemic genre was used was in answering

the antivivisectionist lobby which, in 1876, had achieved the enactment of the Cruelty to Animals Bill. This act set some limitations on the scope of physiological experimentation and infuriated a large part of the scientific community because of its implications of state interference into an area of professional expertise. Furthermore, the antivivisectionist lobby was not satisfied with the 1876 Act and wished to go further in curtailing animal experimentation. When using the medium of the popular science book, scientists who were retaliating against this lobby attempted to educate the public to the mechanist position on 'life'. In such texts the antivivisectionist was rarely mentioned, and never directly attacked, rather, the argument for mechanism was given forcefully as the only tenable position for scientific analysis. For example, H.W.Conn, in his text entitled The story of life's mechanism, published in 1899, set up the rather simplistic argument that the body is a machine because it obeys the law of the conservation of energy. In this context Conn began by defining a machine as "a piece of apparatus so designed that it can change one kind of energy into another for a definite purpose,"(83) and triumphantly concluded that,

> "the general income and outgo of the body as concerns matter and energy is such that the body must be regarded as a machine, which, like other machines simply transforms energy without creating or destroying it. To this extent, at least, animals conform to the law of conservation of energy and are veritable machines."(84)

In essays, and as the period went on, also in books, it was common to write in a more openly polemical vein, naming and attacking the opposition. In fact, this controversy over vivisection continued throughout the period 1870-1939, and became increasingly complicated by the vitalism that was so fashionable among naturalists at the turn of the century.(85) At this point, however, the example of the response to the antivivisection lobby serves to indicate that the polemic genre was used by popularisers to answer a perceived public threat to the professional control of scientific

research. Another example of this use of the polemic genre can be found in the defence of chemical research after the use of chemical weapons in the Great War made, most notoriously, by J.B.S.Haldane in his book Callinicus.(86)

The polemic genre was not always used defensively, however, but was also to be found creating a public awareness of scientific developments where some scientists felt legislative action should follow their research results. One example of this was in the sphere of public health with the late nineteenth-century lobby for vaccination. An opponent of this lobby was the aforementioned H.W.Conn, who felt that "the principle of innoculation as an aid in preventive medicine has not proved of very much value",(87) and who, consequently devoted a whole text to the utilitarian argument that bacteria were more of a help than a hindrance to man and that the occasional epidemic was a small price to pay for the general good they contributed to man.(88) A similar issue which was grist to the polemic mill was eugenics, a topic on which scientific opinion seemed largely united by the desire for a greater public awareness of developments in the science of heredity, but was divided on the need for legislative action.(89)

During the late nineteenth and early twentieth century, however, the polemic genre was also used to establish 'fringe' or pseudo sciences by appealing to the general reader for credibility, thereby cutting out the need for widespread scientific approval of a new science. A good example of this use is provided by popularisations of spiritualism. In popular science texts devoted to this subject, the author (usually a reputable scientist of another discipline but a member of the Society for Psychical Research) had to sort out verifiable scientific information concerning the psyche, from the often fraudulent information offered by mediums. Thus, the very nature of such a deviant science, being examined by a sympathetic, yet reputable, scientist in a popular text necessitated the use of the polemic genre. For, in order for the scientist to maintain

his professional reputation, he had perpetually to reiterate the controversial nature of the material he was popularising, make clear his own personal opinions, and forcefully denounce fraudulent claims. Thus, for example, the psychologist J.Arthur Hill opened his text Spiritualism and psychical research, published in 1912, as follows:

> "A certain cynical philosopher, asked by a rather irresolute lover for his advice about getting married, replied: 'Whichever you do you will repent it.' Yet the poor fellow was forced to do either one or the other. To marry or not to marry. There are only two horns to the dilemma.
>
> "It is somewhat thus with anyone who writes on a very controversial subject. He is almost forced to take sides, for he has his own opinions.."(90)

The text then proceeds in a polemical vein as Hill argues for the credibility of psychical science as a professional research area. Thus, clearly another function for the polemic genre was as a popularising tool for the professional scientist interested in promoting a new deviant science. This use of the genre, however, falls beyond the scope of the present thesis.

The dimension of the polemic genre which is of central interest to the present thesis is where it has been used by public scientists as a vehicle for encouraging or discouraging public interest in the societal implications of scientific research. This is a theme which is explored in greater detail in subsequent chapters.

6 - Dialogues and lecture transcripts.

This last type of presentation to be found in popular science books differs from the others discussed above in that both the dialogue and the lecture transcript are 'open' mediums, through which a scholastic, romantic, recreational, or polemical message can be made; and, consequently, do not constitute 'genres' of presentation in the stylistic and ideological sense used in this chapter. This being the case, where such types of popularisation are used, they are discussed in terms of the broad historical genres discussed above.

It is interesting to note, however, that the lecture transcript appears to have been a continuous element in popular science books throughout the period c.1870-c.1939, and that the dialogue, while popular in the early nineteenth century (91), declined in the late nineteenth and early twentieth century, becoming fashionable once more in the age of wireless broadcasting between the First and Second World Wars.

1 - Of course, elementary science was also presented through biographies of famous men of science, and through histories of science, as well as through works of fiction. These three methods of popularisation are not considered, however, in the present study because such genres were not primarily concerned with the exposition of science. The reader perusing the pages of such books expected, first and foremost, either to learn about a personality, or to learn about the history of science, or to follow a plot, and any scientific exposition he encountered along the way would have been coincidental to the main purpose of the book. Naturally, the fact that the exposition of science was coincidental to such genres in no way minimises their impact on the popularisation of science at this time, it simply serves to illustrate why they fall beyond the scope of the present study.

2 - J.Simon, The social origins of English education, London, 1970, pp.89-100 .

3 - D.McKie, Antoine Lavoisier, London, 1952, p.213.

4 - J.Jukes, School manual of geology, Edinburgh: A. and C.Black, 1876, preface.

5 - See chapter 3, section on the general science series and the working-class market.

6 - Op. cit. (4), pp.131-4.

7 - See chapter 3, section on the general science series and the working-class market.

8 - See chapter 3, section on the middlebrow general science series.

9 - See chapter 5, section on the Scottish impetus.

10 - G.Allen, The story of plants, London: Newnes and Co., 1899, p.87.

11 - See chapter 4, section on T.H.Huxley.

12 - For a more detailed discussion of this genre see chapter 5, section on popular science series c.1900.

13 - G.F.Chambers, The story of the weather, London: Newnes and Co., 1897, p.10.

14 - J.Munro, The story of electricity, London: Newnes and Co., 1905, p.155.

15 - M.Cloitre and T.Shinn, 'Expository practice, social, cognitive and epistemological linkage,' in, Sociology of the sciences, 1985, 9, pp. 31-61 ,p.47.

16 - In this context a 'literal' presentation of knowledge is taken to mean that there was no perceived need to translate knowledge into popular terms. In other words, there was an assumption implicit in these texts that anyone with a good general education could keep pace with the growth of knowledge without the need for popularisation.

17 - R.Phillips, A million facts, London: Ward, Lock and Tyler, 1872, p.v.

18 - Ibid., p.iv.

19 - S.O.Beeton, Beeton's illustrated dictionary of science and natural history, London: Ward, Lock and Co., 1871, p.iv.

20 - Ibid., p.iii.

21 - A.S.Galt (ed.), Cassell's popular science, London: Cassell, 1903-4, p.iii.

22 - Ibid., p.v.

23 - H.G.Wells, J.Huxley, and G.P.Wells, The science of life, popular edn., London: Cassell, 1938, p.xxii.

24 - J.A.Thomson, Biology for everyman, London: Dent, 1939, editor's note.

25 - P.Wheelwright, Metaphor and reality, Bloomington, 1961; reprinted 1971, p.38.

26 - See chapter 4, section on J.Tyndall.

27 - T.Carlyle, Sartor resartus, London: Dent, 1908, p.102.

28 - Ibid., pp.48-9.

29 - R.W.Emerson, Nature, addresses and lectures, London: Routledge and sons, 1894, p.31.

30 - Ibid., p.40.

31 - B.Seaton, 'Considering the lilies: Ruskin's 'Proserpina' and other Victorian flower books,'in Victorian studies, 1984-5, 28, pp.255-82.

32 - D.E.Allen, The naturalist in Britain, Harmondsworth, 1976, p.183.

33 - J.Ruskin, Modern painters, vol.5, 2nd. edn., London: George Allen, p.175.

34 - G.S.R.Kitson Clark, 'Romanticism and popular culture', in, J.B.Halsted (ed.), Romanticism, London, 1965, pp.

35 - For a more detailed discussion of the way this affected certain popularisers, see chapter 4, especially the section on E.Brightwen.

36 - See footnote (35).

37 - C.Flammarion, Astronomy for amateurs , London: Thomas Nelson and Sons, 1903, p.338.

38 - Rev. C.A.Hall, Romance of the rocks, London: A. and C.Black, 1912, p.67.

39 - J.Lubbock, The beauties of nature, London: Macmillan, 1895, p.65.

40 - Ibid., p.68.

41 - E.Clodd, The story of creation, London: Longmans, 1888, p.232.

42 - E.Greenly, The earth, its nature and history, London: Watts and Co., 1927, pp.1-2.

43 - Op. cit. (2), p.98.

44 - J.Morrell and A.Thackray, Gentlemen of science, Oxford, 1981, p.161.

45 - Ibid., p.161.

47 - T.Tit, Scientific amusements, London: Nelson and Sons, 1918, p.224.

48 - S.Schaffer, 'Natural philosophy and public spectacle in the eighteenth century,' History of science, 1983, 21, pp.1-43, p.5.

49 - G.Tissandier, Popular scientific recreations, London: Ward, Lock and Bowden, 1890, p.2.

50 - Ibid., p.2.

51 - A.Schuster, The progress of physics, 1875-1908, Cambridge: Cambridge University Press, 1911, p.7.

52 - T.O'Conor sloane, Home experiments, London: Sampson, Low, Marston, Searle and Rivington, 1888, p.248.

53 - Ibid., p.248.

54 - A.M.Low, Popular scientific recreations, London:Ward, Lock and Co., 1935, pp.12-13.

55 - Ibid., p.121.

56 - U.Bloom, He lit the lamp, London, 1958,p.123.

57 - Op. cit. (54), preface.

58 - A.M.Low, Science for the home, London: Nelson and Sons, 1938, p.1.

59 - J.Greene, The insect hunter's companion, London: West, Newman and Co., 1907, p.100.

60 - E.W.Maunder, Astronomy without a telescope, London: W.Thacker and Co., 1904, p.vi.

61 - P.Geddes, 'Botany', in, I.Margesson (ed.), A handbook of natural history, London: G.Philip and Son, 1894,pp.47-65,p.49.

62 - C.Simpson, Rediscovering England, London: Ernest Benn, 1930, p.22.

63 - E.R.Sykes, 'Shells', in I.Margesson, op. cit. (61), pp.31-46, p.39, (my emphasis).

64 - B.Bracegirdle, A history of microtechnique, 1830-1910, New York, 1978, p.16.

65 - D.E.Allen, The naturalist in Britain, London, 1976, p.128.

66 - L.Barber, The heyday of natural history, 1820-70, London, 1980, p.121.

67 - O.G.Harry, 'The hon. Mrs. Ward and "A windfall for the microscope" of 1856 and 1854', in, Annals of science, 1984, 41, pp.471-82.

68 - Op. cit. (65), p.93.

69 - A Quekett Club-man, My microscope, London: Roper and Drowley, 1887, p.34.

70 - G.E.Davis, Practical microscopy, London: D.Bogue, 1888, preface.

71 - Ibid., p.v.

72 - Ibid., p.123.

73 - Ibid., p.v.

74 - M.I.Cross and M.J.Cole, Modern microscopy, London: Bailliere, Tindall and Cox, 1893, p.44.

75 - Rev. J.G.Wood, Common objects of the microscope , second edn., London: Routledge, 1900, p.2.

76 - J.Lankford, 'Amateurs versus professionals: The controversy over telescope size in late Victorian science,'in, Isis, 1981, 72, pp.11-28.

77 - In this context especially, see, op. cit.,(60).

78 - A.E.Trueman, Geology and scenery, Penguin edn., 1949, first published 1937, p.10.

79 - D.E.Allen, 'The lost limb: Geology and natural history', in, . L.J.Jordanova and R.S.Porter (eds.), Images of the earth, B.S.H.S. Publications, pp. 201-6.

80 - J.G.O'Connor and A.J.Meadows, 'Specialisation and professionalisation in British geology', in, Social studies of science, 1976, 6, pp.77-89.

81 - Op. cit. (65), p.245.

82 - R.Reynolds (ed.), British pamphleteers, vol.2, London, 1952, p.7.

83 - H.W.Conn, The story of life's mechanism, London: Newnes and Co., 1899, p.31.

84 - Ibid., p.37.

85 - Op. cit. (65), pp.200-2.

86 - J.B.S.Haldane, Callinicus: A defence of chemical warfare, London: Kegan Paul, Trench, Trubner and Co., 1925.

87 - H.W.Conn, The story of germ life, London: Newnes and Co., 1897, p.189.

88 - Ibid., p.189.

89 - For a more detailed discussion of eugenics, see chapter 6.

90 - J.A.Hill, Spiritualism and psychical research, London and Edinburgh: T.C. and E.C.Jack, 1912, p.5.

91 - D.Hinton, 'Popular science in England, 1830-1870', University of Bath Ph.D. thesis, 1979, p.174.

CHAPTER 3

THE DEVELOPMENT OF THE SCIENCE SERIES IN THE LATE NINETEENTH CENTURY.

1 - Introduction

The market for serious literature in the late nineteenth century was dominated by the professional classes, but it was an expanding market because of the educational aspirations and increased literacy among the lower-middle and upper-working classes. This expansion was facilitated by the technological innovations of the period, which meant that by the 1890s printers and publishers could produce large quantities of books at comparatively low cost, with an average sized first print run for non-fiction of 2-3,000 copies.

As the marketing costs for producing books were falling, the disposable income of the "earnest minority" (1) was rising. For example, the average annual income for a lower middle-class family has been given as £110 in 1881.(2) This rise in income was accompanied, especially in the period 1874-96, by sharply falling prices, so that real income increased faster than wages and the middle and lower classes prospered.(3) At the same time the price structure of the book trade was revised downward so that, by 1890, first editions previously costing 10s. or £1 cost 5s. or 6s. and cloth-bound reprints of recent texts, hitherto priced at that figure came out at 2s.6d. or 3s.6d.(4),therefore, it would seem that despite recurring trade cycle depressions (5), the prices of books relative to wages were on a downward trend, and were well within the purchasing powers of the earnest minority by the 1890s.

At the same time that the marketing costs of producing books were being reduced, the period 1880-1900 saw the institutionalisation of the book trade, which had a dramatic impact on book prices for:

"Having enjoyed decades of free trade and commercial individualism

> the book trade was - within a few years - reorganised into a controlled multi-institutional complex - of which the main institutional pillars were the publishers, booksellers and Author's Associations, the net book regime they upheld and the legitimisation of agency services."(6)

The attack on free trade within the publishing industry was led by Frederick Macmillan, one of the new generation of publishers, who, in 1890, published the first net book which was, appropriately enough, A. Marshall's Principles of economics. The Publisher's Association, which was formed in 1891 under the leadership of C.J.Longman, John Murray and Frederick Macmillan (7), reduced the prices of books in two main ways. Firstly, in 1899, the Association introduced the net book system to fix prices at a lower level than recommended previously.(8) Secondly, in 1908, the Council of the Association agreed to the sale of books at second-hand prices after three months of publication.(9)

By the last decades of the nineteenth century, therefore, the publisher was in a position to take advantage of lower production costs and could afford to sell less expensive books, particularly if such books were produced and marketed as a series. This was because the publisher could then produce a given number of similar works in small editions at a low cost, banking on the law of averages that out of, say, fifteen titles at least one would be a bestseller (with three or four reprints) which would allow the publisher to recoup his original investment plus a small profit even if he did not sell one single copy of any other title in the series (an unlikely eventuality). Thus, the non-fiction series while unlikely, on the whole, to yield spectacular profits offered the publisher a low risk investment.(10) In this way, the series offered "a lottery in which the law of averages operates for the benefit of the publisher".(11) The series also offered other marketing advantages; for example, the publisher profited from the purchaser's possible dislike of having an incomplete

set of books, and to a certain extent books in a series advertised each other. Furthermore, it was more cost effective to advertise twenty or thirty titles in one advertisement promoting a general series title than to pay for twenty to thirty advertisements promoting single volumes. From the customer's point of view in an era of self-help, a series offered psychological reassurance through guidance towards the 'best' books. One indication of this genuine desire for guidance can be found in the great success which Lubbock's List of a hundred best books enjoyed when it was published in 1891.(12) In an era of increased specialisation the series also offered the reader access to a comprehensive type of knowledge with different specialisms being united within the series theme and title.

Thus, the series came into its own as a vehicle for popularisation in the late nineteenth century, since it satisfied both market demand and the publisher's quest for low risk investment.

2 - The middlebrow general science series.

Science had become a mildly fashionable pursuit among the educated middle-classes in the opening decades of the nineteenth century. By 1870, this audience for popularisation, for whom science was both a source of useful knowledge and of rational recreation, had expanded to include the earnest minority. MacLeod argues that this audience was particularly suited to the marketing of general science series since such series could attract both a specialist and a generalist readership during a period when science was becoming increasingly specialised.(13) The 'International Scientific Series' (hereafter I.S.S.) was certainly an example of this desire to keep the layman informed of contemporary scientific information.

In Britain the key popularising scientists used to coordinate this series were informally centred around the 'X-Club'(14) and included such celebrities as T.H.Huxley and Herbert Spencer. H.S.King, a bookseller who had recently started his own publishing house and was looking for a way to

establish a reputation, jumped at the chance to publish this series of books being planned by the American populariser of science, E.Youmans. The I.S.S. was launched in1871 as reading matter which would:

> "bring as much of each separate science as might be thought necessary for the ordinary layman within the compass of a single volume, which, while being accurate, should also be in a 'tongue understanded of the people,'"(15)

and would also be written by scientists of different nationalities.

Although much trumpeted as a popularising venture, the series had a rather conservative first edition of 1,250 copies per volume, which sold for five shillings each in Britain;(16) thereby establishing the series as one which would for the most part be within the purchasing power of the professional classes only. Furthermore, it would seem that precisely because the venture was international in scope and therefore so large and complex, some distinguished contributors gave merely collections of old magazine articles, while others were not well known to the world in general as men of scientific importance. Indeed, those , like T.H.Huxley who did contribute recent research were the exception rather than the norm, and, in fact, posed economic problems for the publishers, since the cost of providing original illustrations was well over the limit imposed by the selling of the volumes.(17)

Basically, the problem with the series, aside from its international scope, appears to have been that it was largely a collection of specialist science texts promoted as a popular science series. For example, the financial problems posed by the publication of recent research in such a series stemmed from the fact that such problems could not be solved without pushing the price up well beyond that considered justifiable for a popularising enterprise. Similarly the question as to whether the publishers were being offered old or unimportant scientific material

could have been eased by giving scientists more than nominal editorial control, but, it seems that, "the real editorship..remained with the publishers and with them alone."(18) For the publishers to retain editorial control, or to delegate to a general editor, was standard practice for 'popular' non-fiction series; but in a series such as the I.S.S., which tended to provide new and specialised knowledge, such a policy was not viable. As regards content, the majority of texts in this series would have been unintelligible to the general reader. From both the consumer's and publisher's viewpoint, the I.S.S. could not really be considered a popularising success, although it undoubtedly made a profit.

A similar verdict must be given to the 'Nature Series,' published by Macmillan from 1873, which enabled scientific features previously serialised in the periodical Nature to be presented as a series of monographs. Although slightly less expensive than volumes in the I.S.S., such texts suffered again, on the whole, from being unintelligible to the general reader.

These two series mark the end of an era when the latest scientific research was generally intelligible to the educated layman, and initiate a period which witnessed the rapid expansion of specialist science publications. By the mid to late 1880s, it was clear that the general science series which kept abreast of new knowledge, while remaining accessible to the middlebrow reader, required new insights.

In 1891, the banker and naturalist Lubbock, persuaded a reluctant Kegan Paul to launch a general science series true to the original popularising ideas of the I.S.S., but not international in scope. Despite the decline of the I.S.S. by this time,(19) the series 'Modern Science' was born. As a series it was not intended for the specialist, (20) but rather was intended to "give on each subject the information which an intelligent layman might wish to possess."(21) The cont nt of the texts suggests that this ideal was adhered to, but the series was shortlived, suggesting that it was not commercially successful.Other publishers in the middle-

brow market played safe. The Society for the Promotion of Christian Knowledge (hereafter S.P.C.K.) launched its'Romance of Science Series' in 1889, which largely consisted of written up lecture notes by popularisers who had already proved the appeal of their material by lecturing at places like the London Institution. Whittaker launched a series at this time entitled 'Whittaker's Library of Popular Science', which did not attempt to present 'new' knowledge, but simply served up elementary text-book information for adults.

The only truly innovative bid to recapture middlebrow interest in the general science series came in 1899 with the launch of the 'Contemporary Science Series' (hereafter C.S.S.). The instigator of the series was Havelock Ellis, who felt that the I.S.S. had reached "its stage of senility",(22) and that there was scope for a more modern series presenting scientific knowledge. Consequently, Ellis suggested himself as editor of such a series to D.Gordon, manager of the Walter Scott publishing company. Gordon agreed, giving Ellis a free hand in the organisation of the series.(23) Initially Ellis had planned to bring out a volume every month, but quickly found that this was not practicable, as his authors were not susceptible to editorial pressure, being largely drawn from the ranks of the major British and European intellectuals of the day. The volumes were three to four hundred pages long, selling for an average price of 3s.6d., and the authors were paid between forty pounds and fifty pounds for their work, which was approximately equivalent to the annual income of an agricultural worker of the period.(24) Gordon had insisted on a test run of twelve volumes, and depending on their reception, the series would continue Ellis was given an advance of fifty pounds. As a deliberate ploy, the series was launched with the highly controversial text The evolution of sex, by P.Geddes and J.A.Thomson (25) which caught the public's attention, and the series continued successfully thereafter, incidentally enabling Ellis to make over £250 a year from his editorial position.

The C.S.S. marks a sharp break from the content of the previous series considered in that it promoted new science and unorthodox scientific views or, as one of the contributing authors to the series said:

> "This series is intended to present in popular form an account of the progress of contemporary science, especially in those departments where our knowledge has recently been enlarged,either by the accumulation of fresh facts, or where new theories have taken the place of others hitherto accepted."(26)

Ellis's perception of science was that it was organised order, hence absolutely any subject with the correct methodological presentation could be included in his series, and titles such as The science of fairy tales were not uncommon. Ellis was most preoccupied, however, with the quickly growing social sciences such as anthropology, sociology, psychology and political economy, and this was reflected in his choice of titles which included Letourneau's Evolution of marriage, Hobson's Evolution of modern capitalism and so on.

The success of the C.S.S. would seem to question MacLeod's assertion that the end of the nineteenth century signalled a decline in the middle-brow general science series.(27) Ellis had managed to adapt the general science series to cope with changes within science and society. Under his editorship the exposition of normative mainstream science took a back seat, and newer and more challenging scientific subjects and viewpoints came to the fore, which could be more easily assimilated into bourgeois democratic culture than could the increasing specialisms of 'high' science. The problem was not, as MacLeod suggests (28), that the concept of Wissenschaft was no longer fashionable in the 1890s, since the volumes in the C.S.S. were unified by Wissenschaft. Rather the key to the C.S.S.'s success lay in its promotion of scientific subjects in such a way that popular interest could profitably and usefully be courted. For example, the best selling text in the series was Dr. Moll's Hypnotism, which reflected the

fashionable (as much as scientific) interest of the period in research concerning the psyche.

A lot of the texts in the series presented their author's position in an academic controversy, and offered the reader the flattering position of being the final court of appeal. For example, I.Taylor concluded his text The origin of the Aryans as follows:

> "The whilom (sic) tyranny of the Sanskritists is happily overpast, and it is seen that hasty philological deductions require to be systematically checked by the conclusions of prehistoric archaeology, craniology, anthropology, geology and common sense."(29)

In other words, having been presented with all the scientific evidence, the reader's common sense was deemed fit to help judge the controversy. One of the basic assumptions of the series was that the inductive scientific reasoning it offered was little more than common sense. Using accessible and topical scientific subjects the C.S.S. could sustain this belief, which was considerably attractive to middle-class culture (30) in a way in which the I.S.S. with its focus on the mainstream, and by now highly specialised, sciences, could no longer do by the 1890s. Thus, the C.S.S. was successful because by focussing on topical and controversial scientific subjects it allowed its middlebrow audience to feel an intelligent part of scientific culture, and the key to this success was the series' assumption that the layman's common sense enabled him to contribute meaningfully to popular scientific culture. In terms of its subject matter the C.S.S. was to set a precedent for general science series in the Edwardian era, which will be the subject of a later chapter.

One thing that all the series considered in this section shared, however, despite differences in content, title and approach, was a similar style of presentation, they all belonged to the scholastic genre.(31) Indeed, several volumes in both the I.S.S. and the C.S.S. became famous text-books. The texts presented information in a formal, academic manner, rather than

in an informal, popular way. The use of paragraph headings was still common during this period, and much of the language used was verbose and technical. The middlebrow general science series of the late Victorian period was the epitome of secular sobriety and secular endeavour, direct religious references being rare even in the S.P.C.K.'s series. While science was considered interesting and important, it clearly could not yet be considered fun, or a source of escapist entertainment. Sharing similar educational aspirations and believing in the new religion of scientific progress, the late Victorian middle-classes clearly expected to be informed and not amused by science. As such they were not disappointed by the middlebrow general science series of the era.

3 - The general science series and the working-class market.

So far it has been assumed that the popular science book was largely the preserve of the middle-classes with their greater educational attainment, aspirations and higher levels of income, however, by the late nineteenth century books were also marketed specifically for the working-classes, since:

> "Almost every experiment calculated to lure middle-class readers into the market - remainders, series, railway fiction or cheap periodicals - had its counterpart in a cheaper version that sold for a penny or two and was aimed at the lower-classes."(32)

For example, from the late 1860s onwards, sixpence was a common price for books bound in paper and printed in extremely small type, arranged in double columns.(33) With the technological innovations that had occurred in the late nineteenth century within the publishing industry, however, more attractive books with better type on better paper were available , for the slightly more expensive price of a shilling. At the same time, by 1900 money wage rates were 15-16% higher than they had been in 1873, and their purchasing power was approximately 43% higher, with the working-

wage ranging from approximately 15s. a week for the unskilled worker, to approximately 40s. a week for the highly skilled London craftsman.(34) Thus, the late Victorian era saw a potential increase in the number of working-class readers for whom, in the matter of books," ..nothing must be more than 2s.; and a shilling should be the general maximum."(35)

One of the most important innovations, however, for the poorer reader during the nineteenth century was the emergence of public libraries. The germ of the idea for municipal libraries seems to have come from the 5,000 to 6,000 libraries distributed throughout the U.K. and Ireland at the instigation of the Religious Tract Society. Each of these libraries contained about a hundred volumes and was placed in a church vestry, a dissenting chapel, or a schoolroom. Following this idea, William Ewart proposed a parliamentary bill, to enable town councils to levy a rate of ½d. on the pound for the purchase or erection of public library buildings, which received Royal Assent on 14 August 1850. Nevertheless, many city councils refused to levy the rates to build public libraries, and thus the flurry of library establishments between 1897 and 1913 largely occurred because of Andrew Carnegie's munificence. Before this libraries suffered from a severe lack of funds because the levy was not high enough, and they were, therefore, not very popular places because they tended to have shabby decor and could not afford to buy books. In fact libraries of this period had to rely on second-hand donations, of which a contemporary remarked,

> "Gifts of modern scientific books, or works of travel, or batches of the best current fiction are just the kind that are seldom or never made."(36)

Furthermore there was a furore, because by the 1890s several surveys indicated (37) that 65% - 90% of the books circulated in libraries were classified as fiction. The problem with this for the middle-classes was that, firstly, rate-payers seemed to be subsidising working-class entertainment; and secondly, there was a moral issue implicit in the'fiction question', which was

hotly debated (among other places) at the 1889 Library Association Symposium. For, as opponents argued, was the reading of fiction an "immoral disease", or an "uplifting and enlightening pastime"?(38)

Despite the topical 'fiction question', only 5% - 8% of the population were active borrowers in the 1880s, although as many again read inside the library.(39) Because of increased literacy, however, by the end of the century the circulation of all public libraries within the U.K. was estimated to be between thirty million and forty million volumes.(40) As libraries were concentrated in town centres, they were principally accessible to urban readers, so the main source of books for the rural working-classes in the late nineteenth century was still the pedlar.

Such pedlars mainly sold "romantic novelettes, reprints of popular and really clever stories, numbers of semi-religious essays and so on.."(41) They did also, however, occasionally sell serious literature, which largely consisted of 'out of vogue' eighteenth century poets such as Pomfret, and unintelligible scientific and philosophical classics. For example, John Passmore Edwards, the son of a Cornish carpenter, and, in later life, a millionaire newspaper proprietor, reflected in 1905 that as a boy he had bought used copies of Locke's Essay on the human understanding,and Newton's Opticks at Truro, only to find on getting them home that both works baffled him!(42)

Thus, it would seem that whether in the form of cheap, poor quality reprints, library stock or second-hand wares, by 1870 the lower-class reader largely did not have access, through books, to contemporary scientific information. During the 1870s, however, this changed, probably because publishers expected a rise in literacy (at an elementary level) after the 1870 Education Act and their expectations were fulfilled, leading to a new market for books, and science, for several reasons, became one subject, among others, ripe for promoting to this market. For, on the one hand, since the founding of the Mechanics Institutes in the 1820s un er the

aegis of utilitarianism, science had been considered by a large section of the middle-classes to be an edifying subject for the working-class reader, and, therefore it appealed to the more traditional publishing houses. On the other hand, science was fashionable among the skilled urban working-classes in the late nineteenth century, who aspired to middle-class culture, and, therefore, there was a demand for its exposition. Thus, while, as has been argued above, the middle-class reader was favouring the popularisation of the 'new' sciences such as sociology, hypnotism and spiritualism, the working-class reader was offered elementary exposition of the more mainstream sciences such as physics, chemistry and geology. To this extent Russell's comment is valid that, by the late nineteenth century,

> "the ideology of improvement for the working-class proved more powerful than self-advancement for the middle-class, in a science that was increasingly difficult and for which the cultural value was manifestly diminishing."(43)

The point has to be made, however, that it was not science per se that was diminishing in cultural value for the middle-classes, but sciences where increased specialisation, and some professionalisation, had removed them from the realms of social conversation and 'common sense'. Yet, because scientific subjects favoured by the middle-classes in the late Victorian era were largely 'new' or deviant sciences, they were not considered suitable topics for elementary exposition in text-books which were to be marketed for schools as well as for the lower-class adult reader keen to improve himself. For this reason different types of science were marketed for different audiences. One example of a publisher marketing the more mainstream sciences for lower-class consumption can be found in the development and promotion of 'Macmillan's Science Primers'.

Alexander Macmillan recognised in the late 1860s that the lucrative future of publishing in elementary science lay with the text-book because educational reform was in the air. As Macmillan, through his interest in

science, was already friendly with members of the 'X-Club', he decided to go, "not to the ordinary teacher but to the recognised masters in each branch of science ,"(44) in order to recruit authors for an elementary science series. So it was that T.H.Huxley, H.E.Roscoe, and Balfour Stewart came to edit and contribute volumes to 'Macmillan's Science Primers'. All concerned, the publishers, authors and editors, shared an optimistic belief in the impact of the 1870 Education Act on science teaching, yet in the meantime the audience for the 'Primers' was felt to be wider than that of schoolteachers and pupils, as the following review of the series by W.Tuckwell suggests,

> "Any man, ignorant even of the first principles of chemistry and physics, yet fairly dexterous and intelligent, who will patiently master the books and try each experiment for himself, is in a position to transmit their contents successfully and clearly. The officer may lecture to the soldiers of his regiment, the clergyman to the artisans of his parish, the national schoolmaster to the children of his school."(45)

Clearly then, this series of elementary science books fits into the "ideology of working-class improvement," be that improvement to take place in the army, the parish, or the school. As part of this ideology it follows that the series would not be contentious in its subject matter. This point was, in fact, made clear in a letter by T.H.Huxley, dated 18 August 1871, written to Macmillan's nephew Frederick, who joined the company that year. Huxley wrote saying,

> "Still it is a censorious world and people who would [illegible word] the province of science less orthodox than mine, might think it rather a strong measure if we included a book with the title Man and civilisation in our series.."

Continuing, Huxley suggested an

> "Elementary natural history book about man to tell of his ways and doings just as if he were a bee."(46)

Obviously, then, both editors and publishers of the series were keenly aware of a responsibility to promote science in a non-controversial manner for schools and, incidentally, for the working-class reader.

Each volume of the series had a very large first edition of 10,000 copies which sold at the price of 1s. each.(47) Presumably, the size of the edition reflected the anticipated institutional demand for such texts in the light of the 1870 Education Act, and for the first three years sales appear to have gone well enough to, "show the wonderful strides that science is making as a subject of elementary instruction in schools."(48) By 1878, however, sales appear to have declined.(49) This was probably because the market was saturated, since there was a glut of class-books in elementary science by the late 1870s. There was also a growth in elementary science books for adults who had left school at twelve.

For example, in 1873, the S.P.C.K. launched its 'Manuals of Elementary Science', which also cost a shilling per volume, and which were intelligible to anybody "beyond the age of twelve years, who has even received but a moderately good education."(50) Each text being a uniform 128 pages long (the text was probably printed on the new rotary press) presented, in the scholastic genre, short, factual accounts of botany, chemistry, geology, astronomy and so on.

In 1875, Chambers joined the economic competition against Macmillan's 'Primers' with 'Chambers Elementary Science Manuals', for which an average price was, once again, a shilling. For this venture Chambers was able to employ the general knowledge expertise of one of their editors, Andrew Findlater, who was instrumental in editing and preparing Chambers's encyclopaedia during this period. The standard preface in the texts indicated their allegiance to the ideology of working-class improvement, as it acknowledged

> "The vital importance of diffusing some knowledge of the leading principles of science among all classes of society."(51)

Such a declaration of intent would not be found in the preface of a middle-brow general science series, because it would not require a justification for appealing to a new broader audience. The texts were designed primarily for self instruction, the other purpose of the series being to "serve as text-books in schools."(52) As such, the series was extremely scholastic in presentation and provided questions for self examination which focussed on the mastery of given factual definitions.

In a similar vein, in1877, Stanford produced a series entitled 'Simple Lessons for Home Use', priced at 3d. a volume. Again, as the advertisement for this series made clear, it had an intended double audience, for

> "written in a simple and interesting manner, this series will be found admirably adapted either for use in class or as rewards for attendance and good conduct, and will, it is hoped, be the means of conveying many useful lessons to the homes and parents of the scholars."(53)

Employing an extremely large type face, presumably for the ease of its semi-literate audience, the series adopted an overtly paternalistic tone, lecturing the working-classes on both natural and domestic science. The following extract from the book Cookery is representative:

> "A labourer with fifteen shillings a week cannot live on the same things as a person with five hundred a year; and if the money often spent on tobacco, tea and beer were spent on food many a family would be healthier and happier."(54)

Clearly these types of series made economic sense from the publishers point of view, since, through one venture, it enabled them to market general science for a double audience of schoolchildren and working-class adults, of which the latter group was part of the Victorian self-help culture. How successful such series were in reaching this adult audience is not known. A contemporary commented that such books lacked working-class appeal, and suggested that:

> "If a little book containing an intelligible and non-technical description of the electric railway were offered in the villages, it would be certain to sell. But it must not be educational in tone, because common readers dislike to feel that they are being taught, and they are repelled by books which profess to show the reader how to do this or that. Technical books are unsuitable; and as for goody-goody, it is out of the question. Most of the reading rooms started in villages have failed from the introduction of goody-goody."(55)

If by "goody-goody" Jefferies was referring to paternalism then clearly some of the series mentioned above would not have been well received amongst a lower-class audience. If, however, Jefferies was referring to an evangelical religious content, then most of these series would have found favour, since, as with their middlebrow counterparts, they rarely contained a direct religious message. Yet, all general science series promoted for the lower-classes as well as for schoolchildren, would clearly have made the reader feel that he was being taught, and for that reason may not have been popular amongst adults. It was not until the 1880s that a series was launched which appears to have been particularly marketed for the urban working-classes, an audience which the popularising efforts of T.H.Huxley had marked out as sympathetic to scientific exposition if approached through the right rhetoric.(56)

Thus, in the late 1880s, Whittaker launched a series of over thirty volumes entitled "The Library of Arts, Sciences, Manufactures and Industries' which was written for "practical men". The targeted audience appears to have been the skilled artisan/engineering class. For example, in S.R. Bottone's text Electric bells, the author claimed that, "in order that the electric bell-fitter may have an intelligent conception of his work, he should make a small electric bell himself."(57) Not all the titles were of vocational application, however, for Bottone also contributed a text entitled Electrical instrument making for amateurs, in order to

encourage amateur science, "to guide the tyro in his attempts at the construction of the more useful pieces of electrical apparatus."(58)

This 'Library' attempted to reach its targeted audience by focussing on the practical and applied dimensions of science, which, through the practical genre, enabled the reader to become part of 'popular' scientific culture while retaining his own identity as a skilled craftsman. The series did not set out to teach science, or to "enter the domain of scientific speculation,"(59) but merely to assist the practical endeavours of the reader. As such it was the first general science series in this period to promote fully the idea that science was part of the culture of a manual worker, rather than being exclusively the intellectual preserve of the middle-classes.

5 - The rise of the natural history series.

The late Victorian era witnessed an increasing number of natural history series. The most obvious explanation for this was the impact Darwinism had in encouraging an interest in field naturalism as field studies grew during this period. This rise in the number of people taking to the fields was facilitated by the invention of the first prism binoculars in 1859 (60); the development of photography as a hobby, and the development of chromo-lithography, which enabled publishers to produce hand books with large, clear, colour illustrations more cheaply. Thus, by the late nineteenth century, armed with binoculars, camera and handbook, the naturalist could identify species with more accuracy.

Of course, in the Darwinian era, serious natural history was not the simple collection and identification of species that it had been earlier in the century. The true naturalist was expected to study the behaviour, feeding and breeding habits of his subjects as well as their relations with the environment and other species, so that field studies became less realistic as a recreational pursuit, requiring more time and devotion

than the dilettante natural historian could give. Because of this, at a popular level, natural history series tended to go in three different directions.

Ornithology offers the best example of two of these directions. Earlier in the century ornithology, as an extension of field sports, had tended to recruit people with a high social standing. This was reflected in 'Sotheran's Series of Works in Natural History and the Fine Arts', which offered extremely expensive books large enough on the natural history side, to enable life size colour plates of birds to be featured on every other page. As each volume cost approximately 63s. such books were clearly intended for the rich enthusiast's private library. Originally published in the 1850s, these texts were collected into a series and reprinted in 1883/4 indicating a continuing market for such books.

Also reflecting the continuing wealthy upper-class interest in natural history, Longman's published 'The Fur, Feather and Fin Series' from 1893-1906, under the editorial control of A.E.T.Watson, who was editor of the Illustrated sporting and dramatic news from 1880-1895. The focus of this series, as might be expected from its editor, was game. Each title in it was devoted to a bird, beast or fish generally included under the heading of game. Each title then examined the natural history of the animal, its interest from the point of view of sport, and then, finally, various ways of preparing and cooking it. It is likely that this series had some connection with the Fur, Fin and Feather Folk, as the writers of the sporting sections of these texts tended to be on the defensive against the new conservation trend.(61) The author of the natural history sections was invariably the Rev. H.A.Macpherson, who wrote in the old, idiosyncratic natural history style of the personal notebook. He romanticised the subject of his narrative with anthropomorphism, all traces of which had been removed by the time the subject had, under another writer, become a gastronomical delight! Thus, among the upper-class gaming fraternity, Darwinism appears

to have had little immediate impact on the 'sporting' pursuit of natural history.

At a more earnest scientific level, however, Darwinism was quicker to make an impact by encouraging the production of incredibly detailed handbooks such as L.Reeve and Co.'s 'Series of Natural History for Beginners', launched in 1866. While such texts provided current information on species of birds, animals and insects likely to be seen in the field, they did not offer any meaningful practical participation in natural history aside from observing animals behaving in the way the handbook said they would behave, and so on.

In ornithology by the 1890s, however, the more scientifically motivated amateur naturalist was being organised by professionals in his ornithological studies. During the 1880s the British Association had established a Committee on Migration to study the migratory habits of birds from the shores of Britain. The success of this fifteen year project established, among other things, the benefits of cooperative work between amateurs and professionals.(62) The ornithologist, R.B.Sharpe, who was employed by the British Museum, was part of this project, and, as editor of 'Allen's Naturalist's Library' (which ran from 1894-7) he promoted amateur research. He used this series of handbooks to encourage amateurs to study the moulting and migrating habits of birds, and to record the distribution of species in their own areas. Such a collaborative effort between the amateur and the professional naturalist, initiated a new trend in the practical genre of text (63) as well as giving a new lease of life to the serious pursuit of natural history.

The third direction for the natural history text was to try and encourage recreational pleasure in nature, aside from upper-class sport or the scientific endeavours of the amateur naturalist. A part of this recreational trend lay in the collecting-mania that continued to be fashionable during this period, which was reflected in Swan Sonnenschein's series of 'Natural

History Handbooks for Collectors'.(64) This series encouraged the collection and preservation of mosses, butterflies etc., and in many ways continued older natural history traditions despite Darwinism. By, for example, emphasising the traditional accessibility of natural history to even "the poorest person"(65) several authors in the series seemed to be reacting against the professionalisation of their subject.

Another way of encouraging a recreational pleasure in nature was to reaffirm its spiritual dimension. In this vein, for example, was the S.P.C.K.'s 'Natural History Rambles', which formed part of a stylistic genre inspired by Ruskin which was attempting to put the aesthetic back into scientific writing.(66) As such these texts abound with poetry and romantic prose, and rested on natural theological assumptions.

Until fairly recently it was generally assumed that the natural theological content in natural science books was declining by the 1860s and was never to be really popular again.(67) More recent studies, however, such as that by J.R.Moore (68) have suggested that Darwinism, far from ringing the death knell of natural theology, provoked a reaction among naturalists which led to a renaissance in natural theological literature. For example, in 1883 Henry Drummond's book Natural law in the spiritual world was published, which asserted

> "what is the search for spiritual truth in the Laws of Nature but an attempt to utter the parables which have been hid so long in the world without a preacher, and to tell men once more that the Kingdom of Heaven is like unto this and to that?"(69)

Between 1883 and 1888, this natural theology text sold 70,000 copies making it a phenomenal bestseller of the period.(70)

Science, however, was not the major cultural force of the era, and more significantly, perhaps, for natural theology, was the religious shift in emphasis away from the traditional eighteenth century focus on the exterior form of the world. For, throughout the nineteenth century, theolog-

ians of all denominations were encouraging the growth of a more evangelical type of religion, which nurtured a belief in the importance of a spiritual empathy with nature.(71) This movement was spearheaded by Frederick Temple (later to become Archbishop of Canterbury) who came to general public prominence during the controversy which the publication of Essays and reviews, sparked off in 1860. This controversy centred on biblical criticism of conservative protestant revealed religion by the group of liberal new theologians (called the Essayists), to which Temple belonged. At the time, this controversy eclipsed that of Darwin's Origin, and the new liberal theology attracted a large number of natural theological scientists such as Sedgwick and J.Henslow.(72) Thus, the reinvigorated interest in natural theology at the end of the nineteenth century should, perhaps, be seen more as the result of a progressive impulse within the Church of England, than a conservative reaction to Darwinism.

In the context of popular science books, however, this renaissance in natural theology was limited to some natural history texts during the late nineteenth century and is rarely to be found in the general science series discussed above. For while natural theological beliefs were frequently to be found in the preface or concluding remarks of texts in general science series, they were in no way allowed to shape or predetermine the scientific content of the main text, and this may well reflect the influence that agnostics such as T.H.Huxley, J.Tyndall and N.Lockyer had on the presentation of science at this time. For reasons to be discussed in the next chapter, however, the presentation of information within natural history series largely eluded their grasp, allowing series such as the S.P.C.K.'s 'Natural History Rambles' to challenge the secular values being promoted in general science series. In this context, 'Natural History Rambles' reflected the late nineteenth century evangelical presentation of science which coexisted with the secular exposition f the public scientists at this time.

6 - Conclusion.

During the late Victorian era, the technological innovations in the publishing industry, along with increased literacy, enabled three main types of popular science series to flourish. These were, the middlebrow general science series, and the general science series for the lower-classes, which reflected respectively, the growing literacy and cultural aspirations of the middle and working-classes. The third type of series was the natural history series, which, on the whole, continued to cater for a socially diverse readership, united by a group interest in a specialist hobby which tended to cut across class divisions. In this respect, the natural history series of the period differed from general science series which tended to cater for targeted social groups. The most obvious examples of this being given by the C.S.S., which appealed to its readers as enfranchised citizens, and by the 'Library of Arts, Sciences, Manufactures and Industries', which appealed to its readers as manual workers.

In general this period saw a fall from middlebrow grace for the high natural sciences, a rise in interest in the biological sciences encouraged by Darwinism, and the rise of fashionable 'new' sciences such as psychology, anthropology and sociology. Aside from Whittaker's 'library'(see above) the applied and technological sciences appear to have been viewed as separate and distinct from the 'pure' sciences, and were not usually represented in general science series of this period. Furthermore, the general science series during these decades was a largely secular vehicle, while the natural theological renaissance in the nineties seems to have been largely confined to the natural history series.

Having established these general trends in popular science series for the period 1870-1900, the next chapter analyses, in more detail, the differences between natural theological and secular attitudes towards popularisation which were developing throughout these years.

1 - R.Hoggart has characterised the tiny fraction of the working-classes who buy 'intellectual' books and 'quality' periodicals and newspapers as the "earnest minority" by which he means, "people such as those who take up voluntary trade-union activity, and those who seek adult educat n through, for instance, the classes run by the Worker's Educational A 'at- ion." For the period under consideration in the present study thi- -rc p-n- includes the artisan and engineering class, as well as the white collar worker, and members of the more traditional working-class communitie to be found in the mining and shipping industries.
See, R.Hoggart, The uses of literacy, London, 1957, chapter 11.

2 - R.Altick, The English common reader, Chicago, 1957, p.306.

3 - G.D.H.Cole and R.Postgate, The common people, 1746-1946, London, 1961, p.441.

4 - Op. cit. (2), p.307.

5 - During the period of the nineteenth century under discussion, depressions occurred in the book trade in 1873 and 1893.
J.J.Barnes, 'Depression and innovation in the British and American book trade, 1819-1939', K.E.Carpenter (ed.), Books and society in history, London, 1983, pp.231-251, p.235.

6 - J.Sutherland, 'The institutionalisation of the book trade to the 1890s' Publishing pathways series, vol.3, Oxford, 1981, pp.95-106, p.97.

7 - R.J.L.Kingsford, The publisher's association, 1896-1946, Cambridge, 1970, p.18.

8 - A contributing factor to the introduction of the net book system was its anticipated effect on a price war which was cutting profits . M.Plant, The English book trade, London, 1974, p.458.

9 - Ibid., p.425.

10 - R.Escarpit, 'The publishing dilemma', P.Davison, R.Meyersohn and E.Shils (eds.), Literary, taste, culture and mass communication, vol.12, Cambridge, 1978, pp.225-249.

11 - Ibid., p.237.

12 - For a more detailed discussion of Lubbock's interest in educating the lower-classes through books, see chapter 4, section on J.Lubbock.

13 - R.MacLeod, 'Evolutionism, internationalism and commercial enterprise in science: The International Scientific Series, 1871-1910', A.J.Meadows (ed.), Development of science publishing in Europe, Amsterdam, 1980, pp.63-95, p.64.

14 - For an explanation of the 'X-Club's' role in late Victorian public science, see chapter 4, introduction.

15 - C.K.Paul, Memories, London, 1971, p.279.

16 - Op. cit. (13), p.70.

17 - Op. cit.(15), p.280.

18 - Ibid., p.282.

19 - Op. cit.(13), p.79.

20 - Editor's introduction to, R.S.Ball, The cause of an ice age, London: Routledge and Kegan Paul, 1892.

21 - Ibid.

22 - H.Ellis, My life, London, 1940, p.170.

23 - P.Grosskurth, Havelock Ellis, New York, 1980, pp.114-5.

24 - Op. cit.(3), p.443.

25 - For further discussion of this text see chapter 6, section on P.Geddes and J.A.Thomson.

26 - I.Taylor, The origin of the Aryans, London: Walter Scott, 1889, preface.

27 - "This movement towards specialisation, towards institutional development, and towards'national efficiency', tended if anything to distract readers (and publishers) away from general series which emphasised popular scientific culture.."
Op. cit.(13), p.80.

28 - "In England, the widening separation between science and religion, literature and philosophy, now mocked the 'unified spirit' of la science totale and Wissenschaftlichkeit of the 1870s."
Ibid., p.78.

29 - Op. cit.(26), p.297.

30 - With the rise of the prosperous urban middle-classes in the late eighteenth century, there developed a middle-class culture which challenged the aristocratic standards of coquettish wit and formal elegance promoted at court. Instead, urban social life took a pride in its 'common sense' and 'emotional directness' enshrining the very characteristics which the landed gentry of the time found so very 'vulgar' and 'nouveau riche'. Consequently, to maintain that science was 'common sense' was not only to identify it as part of middle-class culture, but, for a middle-class readership of the late nineteenth century, it was also to evaluate it as a part of that culture in which they could meaningfully participate as educated individuals.

31 - See chapter 2, section on the scholastic genre.

32 - Op. cit.(5), p.237.

33 - Op. cit. (2), p.307.

34 - Op. cit.(3), pp.442-3.

35 - R.Jefferies, The life of the fields, London: Chatto and Windus, 1892, p.231.

36 - T.Kelly, History of the public libraries in Great Britain, 1845-1975, London, 1977, p.188, quotes J.D.Brown.

37 - Op. cit.(2), p.231.

38 - Op. cit.(36), p.86.

39 - Op. cit.(2), p.224.

40 - Ibid., p.227.

41 - Op. cit.(35), p.222.

42 - Op. cit.(2), p.237.

43 - C.A.Russell, Science and social change, 1700-1900, London, 1983, p.78.

44 - L.Morgan, The house of Macmillan, 1843-1943, London, 1943, p.71.

45 - W.Tuckwell, Nature, 1872, 6, p.3.

46 - T.H.Huxley to F.Macmillan, 18 August 1871, British Museum Add. MSS. 55210.

47 - Contract between Macmillan and T.H.Huxley, 9 March 1880, British Museum Add. MSS. 55210.

48 - A.Geikie to F.Macmillan, 15 June 1875, British Museum Add. MSS. 55212.

49 - A.Geikie to F.Macmillan, 19 September 1878, British Museum Add. MSS. 55212.

50 - Prof. Bentley, Botany, London: Society for the Promoti n of Christian Knowledge, 1875, preface.

51 - A.Findlater, Astronomy, London: Chambers, 1875, preface, (my emphasis).

52 - Ibid., preface.

53 - G.Phillips Bevan, Food, London: Stanford, 1877, cover advertisement.

54 - J.L.Buckmaster, Cookery, London: Stanford, 1877, pp.10-11.

55 - Op. cit.(35), p.229.

56 - For an analysis of T.H.Huxley's popularising rhetoric see chapter 4, section on T.H.Huxley.

57 - S.R.Bottone, Electric bells, London: Whittaker, 1889, preface.

58 - S.R.Bottone, Electrical instrument making for amateurs, London: Whittaker, 1888, preface.

59 - Ibid., preface.

60 - L.Barber, The heyday of natural history, 1820-70, London, 1980, p.287.

61 - The Fur, Fin and Feather Folk each took a pledge to refrain from wearing the feathers of any birds not killed for the purpose of food. D.E.Allen, The naturalist in Britain, London, 1976, p.198.

62 - Ibid., pp.219-223.

63 - See chapter 2, section on science as romance.

64 - The series was also entitled 'The Young Collector' series.

65 - W.H.Bath, Ants, bees, dragonflies, earwigs, crickets and flies, London: Swan, Sonnenschein and Co., 1888, preface.

66 - See chapter 2, section on science as romance.

67 - For example, "by the 1860s the tradition of natural theology was barren".

D.M.Knight, Natural science books in English, 1600-1900, London, 1972, p.60

68 - J.R.Moore, The post Darwinian controversies: A study of the protestant struggle to come to terms with Darwin in Great Britain and America, 1870-1900, Cambridge, 1977.

69 - H.Drummond, Natural law in the spiritual world, London: Hodder and Stoughton, 1890, p.34.

70 - R.Altick, 'Nineteenth century bestsellers', Studies in bibliography, 1986, 39, pp.235-41.

71 - T.Cosslett, Science and religion in the nineteenth century, Cambridge, 1974, p.13.

72 - Ibid., pp.12-13.

CHAPTER 4

AN EXAMINATION OF THE WORK OF SIX POPULARISERS IN THE LATE VICTORIAN ERA.

1 - Introduction

The following study of six late Victorian popularisers, Rev. J.G. Wood, Rev. G. Henslow, T.H. Huxley, J. Tyndall, J. Lubbock and Eliza Brightwen, is intended to clarify the main dimensions of the popularisation of science during the late Victorian era. Each of these figures were well known in their day as a populariser, and made a major contribution to the popularisation of science through books in terms of numbers of books published in this period. That is, however, not to claim that books were necessarily the main medium of popularisation for all these figures, and so in order not to distort unduly their efforts as popularisers, their work is considered in a broader communicative context, in which both lecturing and the writing of articles for periodicals have a role to play.

It is hoped that by analysing the popular work of these six figures, some indication will be given of the shared themes, and points of conflict, between two widespread popularising attitudes of the late Victorian era - the natural theological and the naturalistic. Each populariser has been chosen because while each fits into one of the broader categories of natural theological or naturalistic popularisation, they each made a distinctive contribution to popularisation as individuals. Consequently, an examination of their writing enables some of the complexities of popularising attitudes in this period to be explored. The work of each populariser is assessed mainly within the context of their own lives, but also as part of a society which was becoming increasingly secularised.

J.G. Wood, chronologically the first of these six popularisers, sets

the scene for the study, as he represents an extremely popular and widespread style of natural history popularisation, which had a virtual monopoly in the mid-Victorian era prior to Darwin. Later as a traditionalist in the post-Darwinian era of the nineteenth century, he stuck to a literal interpretation of Genesis, and upheld the legacy of Ray and Linnaeus with the static biological types. As such, Wood's work typified the traditional presentation of natural history with its strong natural theological background.

As a member of the Victoria Institute, the work of Rev. G. Henslow which follows indicates one of the many varied responses Christian scientists made in coming to terms with Darwinism (1), and suggests that, on the whole,Christian sections of the popular audience proved more receptive to a rejuvenated, post-Darwinian natural theology, than, in general, those in high science were disposed to accept.

The next two figures considered are, respectively, T.H.Huxley and J.Tyndall who are usually seen as two of the pioneers of the secularisation of science, dealing death blows to natural theology. As such they belong to a group of men identified as the Victorian Scientific Naturalists.(2) This group believed that Darwinian Nature could express, explain and guide life in a wholly secular culture. The philosophy of this group had three main strands: firstly, nature was considered to be resolvable into a single vast mechanism; secondly, the theory of evolution was the dynamic of this mechanism; and thirdly, they adopted the idea of conscious automatism, under which the mind can never determine the movements and interactions of the material world. The philosopher, James Ward, summarised this philosophy as art which "separates Nature from God, subordinates Spirit to Matter, and sets up unchangeable law as supreme."(3)

Although, as will be shown, both Huxley and Tyndall promoted a secular type of science popularisation, it will be argued that the subject matter of their popularisation, along with their personal predilections for certain

audiences set up two, contradictory, popularising rhetorics.

Another Victorian Scientific Naturalist, who was also a well-known populariser, was Sir John Lubbock, who was another devoted believer in the "secular religion of Progress."(4) It will be argued, however, that his amateur status lends his popular work a very different interpretation from that of his X-Club(5) peers, Huxley and Tyndall, aligning him more with the proponents of post-Darwinian natural theology than with his professionalising friends.

The final figure to be discussed will be Eliza Brightwen, a key figure in the popularisation of post-Darwinian natural theology in the 1890s. Her popularising life illustrates a connection between the evangelical response to Darwinism which linked her with Rev. G. Henslow, and the amateur enthusiasm for protectionism, which made Lubbock one of her colleagues and acquaintances.

This sample of six popularisers has been chosen for the following reasons. Firstly, it seems clear that Huxley, Tyndall and Lubbock were the most prominent public scientists of the late Victorian period, who were also active in the exposition of scientific ideas, and that is why they form half of the present sample of six popularisers considered in this chapter. Secondly, the choice of popularisers carrying on the more 'traditional' type of natural theological popularisation, while it has been more random , also seemed clear, since the focus of the thesis is books. For, the three figures chosen, Wood, Henslow, and Brightwen, are probably the most obvious contenders for an examination of this type of popularising attitude given that the bulk of P.H.Gosse's popularisation was published in the mid-Victorian period, and that other natural theological popularisers such as the ornithologist, F.O.Morris, were not only heavily involved in the anti-vivisection lobby which has been examined in detail elsewhere in a similar context as that offered by the present thesis (6), but were also not as prolific in their output of natural history exposition as the three which

have been chosen.(7)

Having established the reasons for choosing this sample of six popularisers it is intended that a study of their popularising work will give an insight into the interrelated themes of popularisation, secularisation and, to a lesser extent, professionalisation.

2 - Rev. J. G. Wood (1827-1889)

Of the six popularisers being considered, J.G.Wood was probably the most traditional in a pre-Darwinian sense. He was born in London, the eldest son of a surgeon and enjoyed a solid middle-class upbringing, being educated first at Ashbourne grammar school in Derbyshire and then at Merton College, Oxford. Wood's first employment was at Oxford's anatomical museum under Sir Henry Acland, and whilst there he began writing his first book, The illustrated natural history, published in 1851. In 1852, he was ordained deacon by Samuel Wilberforce, bishop of Oxford, and became curate of the parish of St. Thomas the Martyr, Oxford. Two years later he was ordained priest. Although Wood held clerical positions throughout most of his life, these posts did not unduly interfere with his literary career. As chaplain of St. Bartholomew's hospital from 1856-62, he only broke from writing occasionally, to give solace to the dying.(8) In 1862 he moved from the metropolis to the peaceful countryside of Woolwich, where from 1863-73 he assisted voluntarily in the neighbouring parish of Erith, delivering one or two sermons a week.(9)

Thus, although a devout Anglican priest, Wood was able to devote most of his time to natural history and its popularisation and it was his books, articles and lectures that earned him fame and money. From 1851 onwards Wood wrote approximately seventy books, the vast majority of which were popularising natural history.(10) These books fit in at various levels with the concept of an informal, personal, recreational pleasure in natural history. Wood wrote guides to both the zoo at Regent's Park and the natural

history collection at the British Museum. He wrote natural history aids to biblical study. He wrote a series of shilling pocket-books for Routledges in the 1850s, covering topics such as: the shells and animals that might be found on the seashore; animals and insects that might be found on a country walk; things to look at under a microscope, etc. He also wrote vast encyclopaedic works crammed with curious details of animal life, such as Homes without hands, published in 1865, which was obviously intended for dipping into or reference rather than to read from cover to cover. For these larger works he spent months in the British Museum Library collecting his information, which was always arranged in a rather eccentric order. He often republished part of these works as separate volumes, making his output seem even more prolific than it actually was.

On the whole, his books seem to fit in with the recreational genre of text, for he was not a great expositor, but rather delighted in describing aspects of nature to his audience. The expected participation of his audience was usually too dilettante to render his texts fully practical, and yet the narrative style is too straightforward and direct to be considered romantic. His books, rather, suggest a period when natural history was 'fashionable' fun, in which mild participation was expected.

Indeed, Wood kept abreast of the trends in natural history; his book Common objects of the seashore, published in 1857, was a commercial success because of the middle-class discovery of holidaying by the sea, and similarly his hints for an aquarium,in the same text, exploited the aquarium craze of the 1850s. By 1858, his reputation as a topical populariser was such that his Common objects of the country was a phenomenal bestseller. Priced at 1s., it sold a 100,000 copies in the first week of its publication.(11) This text, like all his others, was charmingly anecdotal and unpretentious, and was intended as a handbook to be taken on country walks. Because of its status and influence as a Victorian bestseller, it is worth considering two of its most unusual themes.

Firstly, in an era before photography had superceded hunting, and a decade before protectionism really came into its own, Wood said:

> As we do not intend to treat of the dead and dried bodies of animals, but of their active life, we return to our bat flitting in the evening dusk, and, instead of shooting him, watch his proceedings."(12)

Wood justified this unfashionable attitude towards nature by his second theme which was unusual for the period, the unorthodox, and poorly argued claim, that animals had souls, since:

> " All created things in which there is life, must live forever. There is only one life, and all living things only live as being recipients, so that as that life is immortality, all its recipients are immortal."(13)

No doubt the popularity of this book helped to sow the seeds of protectionism which were to flower at the very end of the Victorian era. At a deeper level, however, Wood's religious conviction in animal immortality suggests a reason for his contempt of modern science. In an article of 1862, he said, "There are naturalists and naturalists. Certain dreadfully scientific persons who call themselves by that name seem to consider zoology and comparative anatomy as convertible terms." He contrasted these with, "..the 'field naturalists' who delight in penetrating to the homes and haunts of creatures which they love, and spend whole days and nights in watching their habits."(14) This differentiation between the "dreadful" scientists, and the field naturalist is one which was representative of a natural theological distrust of science and naturalism in this period.(15) As a 'field naturalist', Wood worked within a natural theological framework, since "Nature to him was God, and creation was God's work."(16) This love of nature was a concept by which the anti-scientific natural historian identified himself, as against the cold, rational, and experimental biologist. This anti-scientific natural history popularisation was one of the forms, along with antivivisection polemics(17) through which disenchantment with science manifested itself.

Despite his anti-scientific attitude Wood was definitely part of a 'low' scientific culture, for in 1880 he published The field naturalist's handbook, which was intended as a practical aid for the naturalist. The text provided a monthly catalogue of all butterflies and moths which could be seen at that time of year, as well as all the plants that were in flower, and their habitats. This information was given in tabular form, and where there was a gap in Wood's knowledge, there was a gap in the tables with the plea that:

> "Should the reader be able to fill up any blank spaces by his own observations, I should feel greatly obliged if he will kindly communicate his discoveries to me as soon as possible."(18)

No specialised knowledge was,then,deemed necessary by Wood, to understand God's creation, and in this respect natural theology appears to have been related to an egalitarianism within natural history which was clearly at variance with the beliefs of experimental biologists such as Huxley (see below).

Natural theology pervades all Wood's exposition. As has been mentioned, he wrote many natural history texts as aids to biblical study. For example, in his book Birds of the bible, published in 1887, the reader discovers from textual information in the Bible, that the Chasidah is, in fact, the stork. In Wood's more secular popular natural history books, however, the religious references were deliberately kept to a minimum, according to his son(19), lest the text be classified as overly pious, and would, therefore, be unpopular. It was only when discussing the origins of life that Wood allowed himself spiritual licence to make normative biblical statements such as, "All are one family sprung from one father on earth, by the will of their one Father in Heaven."(20)

Wood thoroughly disliked the Darwinian theory of evolution, but seemed to have grudgingly acquiesced to a theory of adaptation by 1886, saying, "Never is a new organ or limb created when the same object can be attained by the modification of an already existing structure."(21) Wood never,

however, accepted the theory of evolution in so far as it concerned the development of man, and his popular books reflect this with references such as,

> "Again, contrast the skull of man..with that of the adult male gorilla. How vast, therefore is the gulf between the lowest of the human race, and the highest of the beasts."(22)

Until 1879, Wood was chiefly known, as has been indicated above, as a very popular, traditional writer on natural history. In 1879, however, Wood moved wholeheartedly into another medium, the popular lecture.(23) His agent in this enterprise was George H. Robinson (manager of the book court at the Crystal Palace) who arranged a series of lectures for the winter months. These were no ordinary lectures, however, for Wood developed the concept of the sketch-lecture. While on tour, Wood took an enormous, portable drawing frame with a black canvas stretched across it, and while lecturing he did colourful, freehand sketches with pastilles in illustration. These lectures were so popular that they lasted for ten seasons (1879-88) and took Wood to all parts of the country, where he lectured in schools, Mechanics Institutes, Lit. and Phil. Societies, as well as appearing regularly at the London Institution and Crystal Palace. He managed to draw in crowds of up to 1,400 at a time, and the high point of this second career was his invitation in 1883-4 to Boston, Massachusetts, to deliver the Lowell lectures, where he was a huge success.

In fact, lecturing was not, of course, alien to Wood, who was well practised in the art of preaching, and whose sermons shared a certain affinity with his lectures. His favourite sermons had always been the 'flower' sermons in which every member of the congregation was expected to bring an offering of flowers, which after being presented at the altar were sent to local hospitals. An abstract of one of these sermons suggests they were strongly educational in terms of natural history, in which topics such as light and colour, and the special relationship of the sun

to plant life were mentioned. Of course such sermons were far more religious in tone than Wood's lectures, and spiritual analogies abound in the former which were lacking in the more secular lectures on jellyfish and bee life. Yet a religious, natural theological dimension was present in them that unites all Wood's work, and is best summarised in his phrase "the love of Nature" (see above).

This love bears testimony to the profound respect for, and sympathy with, the natural world which flows from Wood's writings, and was an aspect of natural theology. This empathy with nature is something that the laboratory-based scientists of the late Victorian era avoided in their popularisation. It is, for example, characteristic that Wood should have been sponsored in one of his lecture tours by the R.S.P.C.A. No such links with Victorian protectionism are to be found in the work of Huxley or Tyndall.

When Wood started his career, his audience for popularisation was obviously the wealthier classes, since his first book was illustrated by 480 original woodgravings by William Harvey and was, therefore, highly priced at 18s. for the first edition. Thereafter the price went down to the (still expensive) price of 6s.(24), and 5,000 copies were sold in little more than eighteen months.(25) Furthermore, Wood's metaphorical language often referred to symbols of a refined leisured existence. For example, the nightingale was described as "this Mendelssohn among birds."(26)

Wood also wrote regularly for the middle-class readership of such magazines as The cornhill magazine, the Westminster gazette, and London society. An example of such writing occurs in an article for the latter periodical, entitled 'Turkey and oysters', in which Wood discusses the anatomy and physiology of the oyster, while explaining various ways of cooking them. As several of the recipes involve such items as a roasting fowl and champagne such articles were not intended for the consumption of the working-classes, but rather fit in with Wood's contribution through various media to the recreational pursuits of the wealthier classes.

By the 1880s, however, Wood's books were within the purchasing power of most people. For example, in 1886 his Common objects of the country was published by Routledge in a 3d. edition, bereft of engravings, and with paper covers. As his reputation slowly filtered down to the working-classes he was, in this later period, occasionally invited to speak at such working-class institutions as the Seaman's Institute at Ramsgate. Wood detested politics, however, and refused to voice an opinion on any of the social issues of his day(27), and therefore his views on education are unknown. His son, Theodore, claimed in 1909 on his behalf that, "His was the enthusiasm which fixed the enthusiasm of others; which made observers out of mechanics and naturalists out of artisans."(28) Certainly his texts had the capacity to appeal to a very wide audience,since he disdained any distancing techniques at all in his popularisation, always using popular instead of scientific names, and treating his subject in an un-systematic, anecdotal way.

Thus, as a populariser, Wood was one of the many Victorian natural theologians who participated in, and popularised an anti-scientific natural history, in which all men could be equal in their love of nature, as such he represents a viewpoint wich was in opposition to much of T.H.Huxley's popularisation.

3 - Rev. G. Henslow (1835-1925)

George Henslow was the son of the famous Rev. J. S. Henslow, the botanist and close friend and teacher of Charles Darwin at Cambridge. Henslow junior was educated at Bury St. Edmunds Grammar School, and Christ's College, Cambridge, where he obtained a first class degree in the Natural Science tripos, along with a second class in Divinity. Henslow was ordained in 1858 and earned his living variously as a curate, a grammar school headmaster and a university lecturer and examiner in botany for London University, holding the post of lecturer on botany to St. Bartholomew's Medical School from 1866 to 1890. Henslow also worked as a lecturer for

the Royal Horticultural Society. During his life, he wrote thirty-six books, all of which either dealt with the relationship between science and religion, or with popular botany.

Henslow's first publication was in 1871 with a sermon entitled Genesis and geology, which restated the old argument that geology and religion were compatible since, "The great object ever held in view by the investigations of science is the Discovery of Truth."(29) Thus, in terms of natural theology, geology "helps a considerable way towards perceiving and appreciating the gradual unfolding of God's method.."(30)

In 1875, Henslow won the Actonian prize for the best essay illustrating the Wisdom and Beneficence of the Almighty. The essay set out to prove that "the theory of evolution is not necessarily Atheistic."(31) In fact, the theory of evolution about which Henslow was writing was the Lamarckian one of adaptation, which Henslow assimilated with Christianity, by arguing that evolution was part of the 'probationary condition of man', for Henslow said, "Let us clearly understand, then, that it was the Will of God that the environments and conditions of life, should be only relatively perfect in this world."(32) Thus, whereas Darwinism with its concept of natural selection was too random in its procedures to bolster a progressive ideology, Lamarckian evolution could be assimilated in a progressive Christian orthodoxy after the Fall of Man, especially if a veil was drawn over the creation of the world and the development of man; topics which Henslow deliberately refused to mention.(33)

At the time of writing this essay, Henslow was a member of the council of the Victoria Institute which had been established in London in 1866 to promote the investigations of science, "based upon faith upon one Eternal God, who, in His wisdom created all things very good."(34) The lectures and debates of the Society were all extremely antagonistic to Darwinism. In 1869, upon considering the prevalent doctrines of creation (those of Darwin, Agassiz and Moses respectively), he concluded that "Moses wrote as the taught of God", and, therefore, his was deemed to

be the truest account of creation. As the century progressed these views were not modified and the Victoria Institute provided a solid ideological base for scientists who could not allow evolution to challenge their religious faith.

Henslow appears to have been a well-known scientific figure in London at this time, forming part of the same set as Mr. and Mrs. J. Hooker and the Brightwens (see below). In 1883, he was elected president of the Ealing Natural History and Microscopical Society, and the period from 1883 onwards marked the real beginning of his career as a populariser of science. In his inaugural address as president(35), Henslow made it clear that he felt that local natural history societies should have two functions, research and popularisation. The research interests of the society were: microscopy, meteorology, astronomy, and field naturalism.

In the pursuit of popularisation, Henslow contributed many ideas, such as informal conversaziones, public lectures, day-trips and the formation of both a museum and a library. The library was established in 1888, helped by the donation of over 50 books from Henslow, and it was built up from the transactions and reports of other societies. By 1895, however, the number of books had grown to approximately 200 and all six authors considered in this chapter were represented in it. The list of lecturers for 1884 is representative of the normal range of topics tackled by the Society (see note 36) . These lectures appear to have been chosen both to be topical and to draw on the specialist abilities of the members.

Henslow seems to have been particularly popular with the audiences at the Society's meetings because of his care in presentation which usually involved interesting visual aids. For example, the Society report of his lecture 'A half hour with the primrose' of 1885 records:

> "The Professor(37) showed specimens of nearly all the genera of which the family is cemposed (sic) including the wild auricula of the Alps and the cyclamen; and very small primroses (not ½" high)

which Sir J. Hooker found in the Kassia mountains of India."(38) Obviously the exhibition of such a variety of specimens, some of them rare, caught the attention of the audience.

Similarly, the day excursions to places such as the British Natural History Museum, and Burnham Beeches were reported to be both informative and pleasurable, appealing to a more popular membership. Henslow, however, did not simply want to make science fashionable, for as he said in his inaugural address, as President of the Ealing Microscopical Society:

> "Although something may be effected for diffusing a knowledge of science by popular lectures alone, yet the chief value of these lies in their smoothing the road to further inquiry.."(39)

Throughout his presidency, Henslow encouraged the members of the society to participate in his own research programmes. For example, in 1892 he asked the membership to select small (but not absolutely the smallest) seeds of ordinary garden annuals and sow them in rather a poor soil to see how far adaptation to environment was hereditary.

In fact there was more to Henslow's use of 'low' scientific culture through the Ealing Natural History Society than it would at first seem. For Henslow urgently required a scientific following, since in the late 1880s and early 1890s, his botanical research was concerned with a refutation of Darwinism. His results were published in two books for the International Scientific Series (hereafter I.S.S.). These texts, The origin of floral structures, and The origin of plant structures, were published respectively in 1888 and 1895, and both concluded that, "the Origin of Species is due to the joint action alone of the two great factors of Evolution - Variability and Environment - without the aid of Natural Selection."(40)

Neither of these texts were in any sense popular, but were intended for a scientific audience; they do not appear to have shaken the Darwinian opinions of the majority of the participants in high scientific culture,(41) however, for in 1897 Henslow was still arguing for adaptation as opposed

to natural selection in the periodical Natural science. This article would have been intelligible to more people than Henslow's I.S.S. texts, but the periodical in question had only a small circulation, and was mainly read by professional and amateur scientists.(42)

In 1901, however, Henslow published a popular text in G.Newnes series, the 'Library of Useful Stories', entitled The story of wild flowers. This series promoted books on various topics, but focussed chiefly on science and technology. Priced at one shilling per volume, the series provided an accessible promotion of science united by an evolutionary theme which presented Darwinism. Henslow's text in this series popularises his own theory of evolution by adaptation (for which by the beginning of the twentieth century, he was personally credited)(43), but modified his attack on Darwinism. Thus, he wrote in the preface:

> "Where then does Natural Selection come in? Nowhere at all, as far as the Origin of Varieties or Species is concerned; but it plays a most important and universal part in the Distribution of Plants.
>
> Wherever plants struggle together, or with inhospitable, inorganic environments, the many die out and the few survive, and that is the province of Natural Selection."(44)

No doubt Henslow was triumphant by this time at his meticulous proof of a theory of evolution that showed the centrality of God, and could convincingly replace Paley's Natural theology in Christian circles. For, in an address to the Christian Association of University College, London, in 1903, he concluded:

> "This universal process of self-adaptation to the environmental forces..appeals far more strongly to one's mind as undoubted evidence of a Divine, Creative Power or Mind, than Design could ever possibly do."(45)

Unfortunately for Henslow, however, the discovery of Mendelian genetics undermined his neo-Lamarckian theory of evolution, and although in 1908 he made one last attempt to salvage his scientific credibility in his

book, The heredity of acquired characteristics in plants, published by John Murray, his status as a serious scientist had considerably diminished. Among his popular audience, however, the significance of Mendelian genetics for Henslow's particular brand of post-Darwinian natural theology was largely irrelevant since much of the scientific dispute was beyond the interest of elementary readers keen to find a spiritual dimension to their appreciation of nature. Thus, fittingly, perhaps, for a scientist who had staked his career on attempting to create a viable natural theological framework for evolution, Henslow was able to spend his remaining years writing botany texts for the Society for the Promotion of Christian Knowledge and the Religious Tract Society, as well as popularising spiritualism.

These latter texts were written in a romantic style of exposition which differed markedly from Henslow's earlier works which had fitted into the dry rigours of the scholastic genre. For example, in his British wild flowers of 1910, his description of plants was more poetic than scientific in tone. Here is the beginning of his presentation of Traveller's Joy:

> "During May and June the hedges of our chalky pastures, especially in the southern counties of England, are decorated with white clusters of this flower, and when winter, with its frosts and keen blasts, has swept away both leaves and flowers this climber is still beautiful with its large tufts of feathery fruits."(46)

As part of this new romanticism, Henslow also became involved with the Nature Study movement at this time, and promoted the new ecology, both of which on a practical level could be pursued as evidence of a unity and harmony in nature which could be attributed to God. On another level, Henslow tried again to wed science and religion through his activities in spiritualism where he tried to prove scientifically the existence of a spirit world, and about which he wrote several popular books, liberally illustrated with 'spirit' photographs.

Henslow's life seems to typify the plight of the scientific clergy, who could not accept Darwinism, and indicates the increasing secularisation

of science which had occurred by the beginning of the twentieth century. Yet, as a populariser, Henslow's life illustrates the enduring religious context of popularisation in a strongly Biblical and religious culture, which offered a refuge for Henslow in his later years. Intriguingly, while Henslow never lost his faith in either God or science, he felt increasingly embittered by theology. In 1920, while 'communicating' with the spirit, Imperator, this comment popped out:

> "Those of your theologians who dwelt in the days of darkness and who have left to you an accursed heritage in their idle and foolish speculations, should have turned their minds into a more useful channel, and have been a blessing instead of a curse to mankind."(47)

Clearly, the popularisation of public scientific figures like Huxley and Tyndall had had the desired secularising effect in helping to create an "accursed heritage" for progressive Christian scientists like Henslow who tried to accomodate the contemporary belief in evolution. An examination of how these two public scientists promoted their secular views among a popular audience now follows.

4 - T.H.Huxley (1825-1895)

Huxley was born at Ealing, the son of a senior assistant master at a local private school, which Thomas attended for a few years, prior to the family moving to Coventry. From then until 1841, when he went to London University, he received no formal education. He graduated in medicine from London University in 1845, winning a gold medal for anatomy and physiology. From 1846 to 1850, Huxley sailed on the H.M.S. Rattlesnake as assistant surgeon. He devoted most of his time on the voyage to the study of hydrozoa, tunicates and mollusca, and on his return to England in 1850, he discovered that his work on Medusae had been well received. He was elected F.R.S. in 1851, was granted the Society's medal in 1852,

and found that the leading biologists in London, especially Edward Forbes, were anxious to help him.

In 1854, Huxley became lecturer in Natural History at the Royal School of Mines in Jermyn Street, and in 1855 became naturalist to the Geological Survey. Prior to 1855, Huxley had published more than thirty specialist papers, but from 1854 onwards, he devoted most of his time to lecturing, and popular exposition. Indeed, Huxley's popularising work did not begin in 1860, after his fabled clash with Bishop Wilberforce (48), since he had delivered nearly thirty popular lectures before then;rather his social profile was heightened by press attention thereafter(49), as he was repeatedly caricatured as Darwin's bulldog.

As a populariser, Huxley devoted most of his time to lecturing, appearing regularly at the Royal Institution, the London Institution, and Jermyn Street, as well as speaking throughout the country to audiences ranging from the Cambridge Y.M.C.A. to the Nottingham Working Men's Club. Over half his lectures were given specifically to working men(50), and the lecture was obviously his main medium for this semi-literate audience. Huxley evidently took great pains to tailor his lectures to the interests and levels of understanding of his various audiences, so that, for example, when lecturing at the Royal Institution on a Friday evening, he was not worried about using Latin terms, as he justifiably was when lecturing to working men. In his lectures to middle and upper-class audiences, Huxley frequently slipped in German and French words and phrases, cracked jokes which required an educated background in order to be understood, and generally played up to his more fashionable, more leisured audience, as in the following quotation from'On the border territory between the animal and vegetable kingdom', which capitalised on the popularity of Carlyle's Sartor resartus at this time (51):

> "Thus the plant is the ideal proletaire of the living world, the worker who produces; the animal, the ideal aristocrat, who mostly

occupies himself in consuming, after the manner of that noble reprentative of the line of Zahdarm, whose epitaph is written in Sartor resartus."(52)

At such lectures, Huxley frequently addressed the audience in the first person, and treated them as confidantes by discussing his latest research, and such parts of these lectures were presumably addressed more to colleagues in the audience than to the general public. In addressing wealthier, better educated audiences, then, Huxley was no longer the commanding schoolmaster of Jermyn Street, and Great Ormond Street, but appears more as a one-man show peddling his scientific wares to a critical audience. Throughout his life he held a great disdain for "middle-class dilettantism"(53) as he called it, preferring to lecture to working-class audiences, where his status was less vulnerable.

This disdain of science popularisation for the middle-classes did not, however, preclude Huxley writing prolifically for periodicals such as, Macmillan's magazine, The nineteenth century , The westminster review, The fortnightly review, The reader, etc. Such articles supplemented his income it is true, but they also betray an enthusiasm for polemical debate, which one doubts penury would have curbed.(54) A favourite victim was Gladstone, and in an ongoing controversy between the two in The nineteenth century over the interpretation of Genesis, Huxley wrote a delightful essay simply entitled:'Mr. Gladstone and genesis' which bridles with dramatic irony. Speaking of one of Gladstone's articles, Huxley introduced himself thus:

"I am a simple-minded person, wholly devoid of subtlety of intellect, so that I willingly admit that there may be depths of alternative meaning in these propositions out of all soundings attainable to my poor plummet."(55)

Fun, indeed, it must have been to be alive in the age of Victorian Scientific Naturalism if you were on Huxley's side. Such polemics seem

likely to have recruited many middle and upper-class converts to the beliefs of the young guard of science, and therefore have a place in the context of science popularisation during this period. Indeed, in 1894, Andrew Lang remarked: "In England when people say 'science' they commonly mean an article by Prof.Huxley in The nineteenth century."(56) Furthermore, these essays and many lectures have a double historical significance, for practically Huxley's entire literary output was collected and published in book form in 1894, shortly before Huxley's death. Indeed, Huxley had started presenting his work in book form himself in 1870, with the publication of Lay sermons, which was composed of a selection of his lectures. Priced at 7s.6d., this text was obviously marketed for the comparatively wealthy buyer, and its title aroused much comment.

Huxley's clerical opponents were shocked and outraged by the audacity of the title, and were reduced to gibes like:

> "..the drollest thing of all that has issued from 'modern science' is the project of promoting its doctrines by lay preaching not withstanding its'emancipation from theology'.."(57)

In fact, of course, the Huxleyan anti-clerical rhetoric belied Huxley's vision of science as the new religion, not in a positivist sense, but as enshrined in the phrase Victorian Scientific Naturalism. In a perceptive review of the time, Huxley's religious rhetoric was analysed thus:

> "Together with the title, Professor Huxley may be said to have borrowed from the pulpit not a little of its style and temper for his recent volume of miscellanies. There is something, we cannot but suppose in the possession of a vantage ground secure, for the hour at least, from contradiction, which tends to relax in the preacher, clerical or lay, the sense of responsibility whilst giving rein to the spirit of dogmatism.."(58)

Much has already been said about Huxley's desire to attack the clergy, using religious rhetoric and symbolism, in terms of the professionalisation of science in general (59), much less has been said about his affinity

with working-class audiences, and the fact that, on the whole, he was grinding an axe for the professionalisation of the biological sciences in particular, which affected his popularising techniques amongst all audiences. The following discussion of Huxley's stance as a public scientist intends to clarify some of these issues.

The review above makes it clear that in popularising science in the form of lay preaching, Huxley appeared to be using the concept of religious institutions to reinforce the dogmas of his own scientific naturalism. In a lay sermon of 1866 addressed to poorer Londoners at St. Martin's Hall, entitled 'On improving natural knowledge', Huxley thundered from his lectern:

> "I say that natural knowledge, seeking to satisfy natural wants, has found the ideas which can alone still spiritual cravings. I say that natural knowledge, in desiring to ascertain the laws of comfort, has been driven to discover those of conduct, and to lay the foundations of a new morality,"(60)

for,

> "The man of science has learned to believe in justification, not by faith, but by verification."(61)

Thus, Huxley here asserts not only that man is naturally religious, but this quotation also shows that Huxley was, as others have recognised(62), founding a new faith based on natural ethics. The audience to which he particularly promoted this viewpoint was the urban working-classes. For example, in a letter dated 1855, Huxley said:

> "I want the working-classes to understand that science and her ways are great facts for them - that physical virtue is the base of all other, and that they are to be clean and temperate and all the rest - not because fellows in black with white ties tell them so, but because they are plain and patent laws of nature which they must obey under penalties."(63)

In fact, such secular popularisation was finely attuned to the needs and aspirations of large sections of the urban working-classes in the late Victorian era. For it has been shown that the radical ideologies of the craftsman and skilled workman did not identify the working-class enemy in the middle-class of small manufacturers and professional men, as socialist ideology stressed; rather the skilled working-class emulated such middle-class figures, and perceived the enemy of working-class freedom and dignity to be the joint forces of the aristocracy and the established church.(64) Working-class secularism therefore was grounded in a tradition of opposition to established authority (65), in which a scientific education was considered a crucial tool in working-class emancipation from religious authority. For example, the working-class National Secular Society which, in the 1870s had approximately 1,000 members in London (66), trained members to answer questions such as:

> "How would you meet the argument that the long legs of the stag, the spatulate diggers of the mole, the thickening of the fur of animals in winter, etc., are marks of design?"(67)

Given this social context, it is not surprising that Huxley claimed a special affection for the skilled artisans and craftsmen that packed many of his addresses in inner city halls, eager for his exposition of evolution.(68) Huxley was keenly aware of this working-class constituent among his audiences, and E.Block ignores this context when discussing Huxley's popularisation (see fn.53).

No matter which type of audience Huxley was addressing, however, there were certain fundamental popularising concepts which he managed to convey extremely successfully and upon which his stature as a great populariser rests. These concepts will now be discussed in the context of Huxley's special interest in natural history and the biological sciences.

In the mid to late Victorian era, the field club, with its 'low' scientific membership, was flourishing (69), but the vast majority of such naturalists

devoted their time to conventional species-logging-and-describing. This situation became a problem following the publication of the Origin of species, because experimental biologists, like Huxley, who formulated and tested hypotheses, had no special status to differentiate them and their work from the conventional pursuits of natural history. A large part of Huxley's public scientific writings were intended to change this situation. Influenced by the German educational model of laboratory teaching, Huxley emphasised experimentation and the use of the microscope and the laboratory. He became famed for his use of the generalised'type' in his exposition as opposed to a confusing plethora of specific examples, and he concentrated on morphology and anatomy. For example, his series of lectures 'On our knowledge of the causes of the phenomena of organic nature', were united by an examination of anatomical 'types' and concluded:

> "It is in fact, an easy matter to prove that, so far as structure is concerned, man differs to no greater extent from the animals that are immediately below him, than these do from other members of the same order."(70)

Clearly such emphases in Huxley's popularisation contributed to an extremely lucid style of exposition, as well as helping to stress that the biological sciences were far more than a collection of natural history facts. Indeed, Huxley's reiteration of the importance of experimentation in his popular essays and addresses, also suggest his concern to give the biological sciences professional status akin to the status which chemistry and physics were already claiming through laboratory training.

As was indicated in chapter 2, however, in the section discussing the popularisation of science as hobby, the field sciences found the attainment of professional status harder to achieve than the physical sciences, because the former had a thriving 'low' scientific culture which the latter did not enjoy. For example, the popularising work of Rev. J.G.Wood, examined above, made clear the belief held in the mid to late Victorian era that natural history was part of an egalitarian 'low'scientific culture access-

ible to anyone.

As a professional scientist who wanted to create a position of social authority for the biologist, Huxley,true to his ideology of New Liberalism(71), wished to institutionalise the accessibility of the biological sciences by promoting the idea of meritocracy,which he did through his campaigns for scientific education. In this context it is significant that the only books he wrote in volume form were textbooks of the classic scholastic genre, which clearly set the reader at the very bottom of the scientific pyramid, which ascended above that reader into the heady heights of Truth. For example, in the introduction to his Lessons in elementary physiology, Huxley said:

> "The body of a man performs a great diversity of actions, some of which are quite obvious, others require more or less careful observation, and yet others can be detected only by the employment of the most delicate appliances of science."(72)

This last phrase distanced the reader, implying that it was very difficult to arrive at a complete understanding of scientific knowledge, yet encouraged him to the elementary level of "careful observation."

By articulating such beliefs in meritocracy through his lobbying for educational reform and through his writing of textbooks, Huxley was helping to establish biology as a meritocratic science, accessible, through graded educational training, to anyone, depending on how sophisticated a knowledge they wanted. The promotion of such a meritocratic scientific education was, of course, a common aim of the young guard of science including physicists like Tyndall and Lockyer because, along with their secular attacks on the clergy, it helped to create their authority and status as the new voice of science, but it was of heightened significance for Huxley as a biologist. Indeed, it was Huxley's special concern for biology that shaped the way he popularised science.

The crux of Huxley's popularising rhetoric was his belief that science was little more than common sense. In his Introductory text to'Macmillan's Science Primers', Huxley outlined this belief as follows:

"No line can be drawn between common knowledge of things, and scientific knowledge; nor between common reasoning and scientific reasoning."

To exemplify this point, Huxley continued:

"If a child acquires a new toy, he observes its character and experiments upon its properties,"

and so Huxley argued that the only difference between this and science was that,

"scientific observation is such as is at once full, precise, and free from unconscious inference."

In this way Huxley came to his well known conclusion that,

"science and common sense are not opposed, as people sometimes fancy them to be, but science is perfected common sense."(73)

Obviously such an argument was far more feasible for the biological sciences in which a large minority of enthusiasts through, for example, their affiliation to field clubs, felt themselves to be part of a meaningful scientific culture, and in which observation and induction were still important concepts (74), whereas in physics the idea that science was perfected common sense was, as will be shown through Tyndall's popularising work, already verging on the ridiculous.

There was, however, a further important distinction between the popularising work of the public scientist as biologist and that of the public scientist as physicist. On the whole, the latter had a comparatively wide circle of patrons able to promote the status-conferring practical applications of his work. The biologist, on the other hand, in an era before biology was taken seriously , had to convince the general public that his work did have socially important, status-conferring results.(75) In other words, in raising the social profile of biology, Huxley found it more profitable to single out popular audiences and convince them that biology was accessible and a worthwhile pursuit, than it was to lobby government for legislative reform in the areas of education and public health. In

this context, Huxley once remarked to Hooker that:

> "The English nation will not take science from above, so it must get it from below - we the doctor who knows what is good for it, if we cannot get it to take the pills, must administer our remedies par derriere."(76)

In this vein, Huxley used his popularising ploy that science was common sense, flattering his audiences into believing, with some degree of truth, that the biological sciences were within their comprehension. Furthermore, this gambit enabled Huxley to circumvent the lack of government support for the biological sciences (77) by instilling a little 'perfected' common sense into the public mind. For example, in 1877, in his discourse 'On elementary instruction in physiology', he said,

> "It is I think eminently desirable that the hygienist and the physician should find something in the public mind to which they can appeal, some little stock of universally acknowledged truths, which may serve as a foundation for their warnings, and predispose towards an intelligent obedience to their recommendations."(78)

Arguably, this quotation summarises Huxley's aspirations for his popularising work in the biological sciences.

In conclusion, the use Huxley made of common sense in his popularisation was, as will be developed in later chapters, to prove an immense influence on later generations of public scientists. It is important to remember, however, the particular context in which, it has been contended, he used it.

5 - John Tyndall (1820-93)

Tyndall was born at Leighlin Bridge in County Carlow, Ireland, the son of a small landowner. Tyndall attended the local school where he acquired a thorough knowledge of mathematics, which qualified him to enter as

civil assistant in 1839 to the Ordnance Survey of Ireland. In 1842 he was selected as one of the best draughtsman in his department, for employment on the English survey. On quitting the Survey, Tyndall was employed as a railway engineer for three years, and was then offered employment as a teacher of mathematics and surveying at Queenwood College. Whilst there, he met Edward Frankland, and the two decided to go and study at the University of Marburg. In 1850, Tyndall became doctor of philosophy and left Germany to return to Queenwood College as lecturer in mathematics and natural philosophy in 1851. After failing to get chairs at the University of Toronto and the University of Sydney, he was appointed professor of natural philosophy at the Royal Institution after delivering a very impressive Friday evening lecture there in 1853.(79)

Thus, from 1853 until 1887, when he retired, Tyndall had a financially secure base from which to research and popularise. Although Tyndall's salary was poor in the 1850s, so that he sought sources of finance in publishing regularly for the Reader and the Saturday review, lecturing elsewhere, and examination work, up until 1875, he paid his second laboratory assistant out of his own pocket, and even refused an increase in salary, saying that his income sufficed for his needs. Consequently, it has been argued that, Tyndall's main motivation for popularisation was never purely financial.(80)

The scientific process of discovery was, for Tyndall, divided into four stages as follows:

> "..in the prosecution of physical science, our powers of observation, memory, imagination, and inference, are all drawn upon. We observe facts and store them up; the constructive imagination broods upon these memories, tries to discern their interdependence, and then weaves them to an organic whole. The theoretic principle flushes or slowly dawns upon the mind; and then the deductive faculty interposes to carry out the principle to its logical consequences."(81)

For Tyndall, popularisation operated according to a similar process. In a lecture, the audience must be helped to observe and memorise by demonstration experiments and illustrations. The lecturer must also bring the audience's imagination into play, using metaphorical language, poetry, asking questions, and generally helping the lay audience to make the requisite connections between seemingly unrelated data. In this way scientific theory could convincingly be communicated to a variety of audiences. Tyndall rarely deviated from this formula whatever the social composition of his audience, but tailored analogies to suit their interests: construction for artisans, Goethe for the educated middle-classes, etc.

The most crucial aspect of this communication process for Tyndall was audience observation, since:

> "Facts looked at directly are vital; when they pass into words half the sap is taken out of them. You wish, for example, to get a knowledge of magnetism; well provide yourself with a good book on the subject if you can, but do not be content with what the book tells you; do not be satisfied with its descriptive wood cuts, see the operations of force for yourself."(82)

In a nutshell this explains why Tyndall was more interested in lecturing than writing, because he felt lecturing was a far more effective method of popularisation. Indeed, all his popular texts were based on his lectures. Yet, ironically, his books were incredibly popular, and reached a far wider audience than his London lectures could. For example, his text The forms of water, which launched the 'International Scientific Series' in 1871, went through twelve English editions by 1897 and, similarly, his Fragments of science for unscientific people, went through ten English editions by 1899.(83)

Tyndall was best known for his popularising efforts at the Royal Institution, delivering Friday evening discourses. At each of these lectures he managed to perform approximately twenty demonstration experiments.(84)

The fast pace of such lectures can be gauged from the following extract from a lecture on heat in 1877:

> "We now pass on to the consideration of another source of heat. You have seen charcoal burnt upon fused salt-petre, you also saw a minute ago hydrogen generated when acidulated water was poured upon zinc. In this case the zinc was burnt by the oxygen of the water, and there are bodies whose affinity for oxygen is so intense as to produce flame when thrown upon water or even upon ice."(85)

Perfectly cued, Tyndall then embarked on another experiment with potassium.

Tyndall spent a lot of time rehearsing such experiments and working out how to make the clearest educational impact through an experiment.(86) There was also, however, a large element of showmanship in such prolific demonstration experimentation, and it was not unknown for Tyndall deliberately to knock over an instrument in order to demonstrate his agility in catching it before it fell. (87) Yet, Tyndall desired his audience to understand the physics he was demonstrating, and to ensure this, each member of the audience would be given a detailed digest of the lecture in booklet form, explaining the main points, and any difficult technicalities, as they entered the lecture theatre.(88)

Aside from the centrality of the demonstration experiment in Tyndall's popularising work, the other key concept in his popularisation was the "scientific imagination", a phrase which echoes through his lectures and essays. As a physicist, he was well aware that many of the concepts he was dealing with were not tangible. For example, in his lecture on 'Matter and force', delivered in 1867, Tyndall declared,

> "..there are numerous processes in nature which entirely elude the eye of the body, and must be figured by the eye of the mind."(89)

Tyndall coaxed the scientific imagination into play amongst his popular audiences with the aid of the demonstration experiment. For example, when

lecturing upon sound at the Royal Institution in 1867, having demonstrated that sound travels in waves, using firstly solitaire balls in a wooden groove and, secondly, five small boys in a line, to show the motion of these wave lines, he concluded: "You ought to see mentally the air particles when urged outwards by the explosion of our balloon, crowding closely together, but immediately behind this condensation you ought to see the particles separated more widely apart."(90)

Tyndall used these two features of his popularisation, the demonstration experiment and the scientific imagination, to great effect. For example, in his lecture on 'Matter and force', Tyndall grew lead and silver trees in jars, showed them to his audience, and then explained:

> "The solid matter of which our lead and silver trees were formed was, in the first instance, disguised in a transparent liquid; the solid matter of which our woods and forests are composed is also, for the most part disguised in a transparent gas, which is mixed in small quantities with the air of the atmosphere. This gas is formed by the union of carbon and oxygen, and is called carbonic-acid gas. The carbonic acid of the air being subjected to an action somewhat analogous to that of the electric current in the case of our lead and silver solutions, has its carbon liberated and deposited as woody fibre.
>
> But what is it in nature that plays the part of the electric current in our experiments, tearing asunder the locked atoms of carbon, oxygen and hydrogen? The rays of the sun."(91)

Thus Tyndall has clearly used a demonstration experiment in order to provide an analogy for a difficult piece of exposition. Clearly, then, Tyndall's exemplary popularisation technique owes much to his belief that science was necessarily creative and imaginative, and that this quality should not be lost in exposition. These twinned concepts of the demonstration experiment and the scientific imagination were integral to Tyndall's lucid exposition of the physical sciences, and they marked his point of departure from Huxley in attitude towards popularisation.

In an address to students at University College, London, Tyndall had this to say:

> "The reading of the works of two men, neither of them imbued with the spirit of modern science - neither of them, indeed, friendly to that spirit - has placed me here today. These men are the English Carlyle and the American Emerson..I never should have gone through Analytical Geometry and the Calculus had it not been for those men.. all my consequent intellectual action is to be traced to this purely moral force."(92)

As suggested by this quotation, Tyndall, much more than Huxley, believed his scientific vocation to be of a spiritual quality. He pursued his researches in the spirit of Romantic mysticism and read from Emerson's works daily (93) as others of his age read their Bible. His love of Emerson, and also of Carlyle, can be traced in the use he made of these writers in his popularisation, as for example, in the following sentence, when, after showing how ice forms and melts, he said:

> "To use the language of an American poet, 'the atoms march in time', moving to the music of law, which thus renders the commonest substance in nature a miracle of beauty."(94)

As a physicist Tyndall, unlike Huxley, could not believe or convincingly popularise the notion that science was perfected common sense, rather he believed that science had more to do with imagination and spiritual insight than with the mundane rationality of common sense. An example of this belief can be found in a lecture of 1882, in which he explained that:

> "The undulatory theory of light, for example, rests upon a basis laid down by the scientific imagination - a substratum that cannot be seen,or felt, or tasted, and which can only be spiritually discerned."(95)

Tyndall was convinced that the scientist, by undertaking such mystical experiences, was a modern prophet, saying:

"Believe me, a self-renunciation which has something lofty in it, and of which the world never hears, is often enacted in the private experience of the true votary of science.. Thus the earnest prosecutor of science.. finds.. an indirect means of the highest moral culture."(96

In other words, a yawning chasm of experiences, practical as well as imaginative and spiritual, differentiated the scientist from the general public, since what separated the scientist from the lay person, aside from his spiritual insight, or scientific imagination, in Tyndall's view was experimentation, for,

"From observation we learn what Nature is willing to reveal. In experimenting we place her in the witness-box, cross-examine her and extract from her knowledge in excess of that which would, or could, be spontaneously given."(97)

Thus, the professional scientist was described as both similar to the professional solicitor, and the clergy, in expertise, with the experiment being the scientist's especial domain, through which he could ascertain the Truth. Furthermore, not everyone could conduct experiments, since "Bad experiments are jargon addressed to Nature.."(98) and are deprecated as misleading.

By suggesting that one needed a training in experimentation, Tyndall was voicing a belief, shared by Huxley, that academic qualifications were the key to professionalisation. At a popular level, however, the physical sciences had for some time been distinct from the dilettante pursuits of the layman(99), and physics from the popularisation of Newton onwards had been deemed a difficult subject to explain at an elementary level, somewhat removed from the daily intellectual culture of the general public. Because the physical sciences were traditionally difficult and did not have the strong lay participation of the field sciences, Tyndall did not need to go as far as Huxley in promoting beliefs in meritocracy in order to help professionalise his subject, rather it was more obvious for him to

build on the inaccessibility of his subject to enhance the authority of the physicist, and this was what he was doing with his references to the "scientific imagination",spiritual discernment etc. Furthermore, the physical sciences appear to have had a higher level of patronage than the biological sciences at this time.(100) Consequently, Tyndall, unlike Huxley, had no especial desire to popularise his subject among a very wide audience. Indeed, despite Tyndall's success as a lecturer to working men, such an audience was not his favourite, and after 1868, when he finished lecturing at Jermyn Street, he rarely addressed such audiences, becoming more fully involved in his research at the Royal Institution.

It was during the 1860s and 1870s that the Royal Institution reached its "high noon day of institutional prestige and popularity"(101), and Tyndall regularly addressed an audience of 500-600 people there. During this period, Tyndall also regularly contributed to the Fortnightly review, the Contemporary review, and the Nineteenth century. These quality periodicals offered another platform, aside from the Royal Institution, for scientific exposition aimed at the middle and upper-classes. Furthermore, with the Fragments priced at 16s. for two volumes, and the Forms marketed at 5s., Tyndall's main audience through the various forms of media he used was undeniably the middle and upper-classes. In this he differed markedly from Huxley, and his attitude to popularisation was consciously different from that of Huxley. In an article for the launch of Longman's magazine, in 1882, Tyndall wrote: "I should be inclined to ascribe the creation of the scientific world to inspiration, rather than to what is currently known as common sense."(102)

In conclusion, it can be seen that, although Tyndall and Huxley are commonly lumped together by historians as Victorian Scientific Naturalists, sharing secular values, and helping to professionalise science, at the level of popularisation it is clear they had quite different ideas and approaches, partly determined by their different backgrounds and person-

alities, but also determined by the popular perception of their particular disciplines in the late Victorian era.

6 - John Lubbock (1834-1913)

Lubbock was born into an aristocratic family, the eldest son of Sir John William Lubbock, third baronet of Lammas, Norfolk, who was a banker, and for many years treasurer of the Royal Society. When young Lubbock was six, the family moved to High Elms, Down, Kent, which was to be Lubbock's county home for the rest of his life. At the age of eight, Lubbock attended a private school at Abingdon, and three years later, in 1845, he went to Eton. At the age of fifteen, he was withdrawn from Eton, and started working for his father's bank, Lubbock, Forster and Co., where he remained for the rest of his life, taking over as head on his father's death in 1865. In 1870 he was elected as Liberal M.P. for Maidstone, and remained in the House of Commons until 1900, when he entered the peerage as Baron Avebury. He was in full sympathy with the Liberal Party of his day until the Home Rule bombshell of 1885, when he became a Liberal Unionist and supported the Conservative administration of Lord Salisbury. The best known act of Parliament whose passage Lubbock secured was the Bank Holidays Act of 1871 which established the August bank holiday.

As well as these two careers, in banking and politics, Lubbock had a life-long interest in natural history(103) which blossomed from childhood, through his friendship with his neighbour in the tiny village of Down, Charles Darwin. In 1858, Lubbock was elected Fellow of the Royal Society and held the office of Vice President of the Royal Society three times; he was also a member of the X-club and shared the friendship of such men as J.Hooker and Huxley. In this capacity as a man of science, Lubbock lectured regularly at the British Association, and at the Royal Institution.

As a populariser of science, Lubbock came into his own in the 1870s, by

writing texts for two 'popular' science series, the I.S.S. and the'Nature Series' . The texts for the 'Nature Series' all argue in simple, accessible terms, that insects and plants have evolved together in such a way as to make the best use of the fertilisation process. Each of these texts, On the origin and metamorphoses of insects, published in 1874, and Flowers, fruits and leaves, published in 1886, had an evolutionary argument backed up with detailed observations, and the material for them was drawn from articles submitted to Nature, and lectures given before the Royal Institution and the British Association. As such, these texts formed part of a scientific debate amongst naturalists, which in book form could offer the space for more detail, and also possibly reach a wider audience. In them Lubbock's work was presented so clearly as to be comprehensible to a non-specialist readership, and the research itself did not require expensive equipment or a laboratory as it was based on field observation.

The texts which Lubbock contributed to the I.S.S. covered essentially the same topics as those he contributed to the 'Nature Series', but they were more popular in tone. Lacking a systematic argument, these texts seem to have been intended for beginners. For example, his text On buds and stipules, published in 1899, begins:

> "..the bud is a short shoot bearing a number of young leaves closely packed together. There is generally one at the summit of of each twig and in the axil of each leaf."(104)

In general, however, the texts for both series, no matter how popular their intended audience was, were striking in the subjectivity of their presentation. In this way Lubbock's texts differed sharply from those written by Huxley for such series, for reading Lubbock's texts is like dipping into a field diary. He continually uses the first person, allowing the reader to see how he, personally, has reached his conclusions.

Lubbock's extremely popular (105) book Ants, bees and wasps, published for the I.S.S., stands testimony to this romantic trait. A representative

extract is as follows:

"..both Huber and Forel state that ants are quite deaf,"(and here Lubbock footnotes these two authors so that the reader can check up on these two references). Lubbock continues:

> "..I have never succeeded in satisfying myself that my ants, bees or wasps heard any of the sounds with which I tried them. I have over and over again tested them with the loudest and shrillest noises I could make using a penny-pipe, a dog-whistle, a violin, as well as the most piercing and startling sounds I could produce with my own voice, but all without effect. At the same time, I carefully avoided inferring from this that they are really deaf, though it certainly seems that their range of hearing is different from ours."(106)

Anybody reading this text could follow up Lubbock's sources, and conduct the experiments for himself, and this is a characteristic of all of Lubbock's popular science books, and distinguishes his popularisation from that of either Huxley, Henslow or Tyndall, for such texts place Lubbock firmly in a low scientific culture. The books discussed above were priced between 4s.6d. and 5s., establishing him mainly as a middle-class expositor.

Another of Lubbock's interests, however, aside from natural history popularisation for the middle-class layman, was the education of the working-classes, and from 1883-1898 he was Principal of the Working Men's College in Great Ormond Street, and from 1894-1902 he was Chairman of the Society for the Extension of University Teaching. In this sphere, surprisingly, Lubbock's interests as a bibliophile came to the fore, since, whereas his popularisation for all classes incorporated both lecturing and book writing, it was a love of books that Lubbock was especially concerned to promote among the working-classes, for he felt that "..the great readers of the next generation will be, not our lawyers and doctors,

shopkeepers and manufacturers, but the labourers and mechanics."(107) In fact, Lubbock's reputation suffered from making this statement in 1887 at Great Ormond Street, for he was widely teased about it, and also for his audacity in publishing a list of the Hundred Best Books that same year, despite the fact that he had never attended a university.(108) Lubbock, however, had two main justifications for making such a statement. Firstly, he believed that the pursuit of knowledge was a necessary counter-part to monotonous physical toil for the working-classes. In a speech he gave at Rotherhithe in 1891, while opening a free library, he made this belief clear, as follows:

> "Books are peculiarly necessary for the working man of our towns. If he is not to become a mere animated machine, he must generally obtain, and in some cases he can only obtain, the necessary variety and interest from the use of books."(109)

In other words, knowledge was to give the working-classes the dignity of humanity. And, in a period when labour was becoming unionised and forming its own political party, Lubbock felt that reading and nature study offered pastimes through which labour and capital could share a common culture, for in a later address he said:

> "It is impossible to remove the vast difference in wealth and luxury which has existed in all civilised nations between different classes of the community. But the truest happiness and the most real pleasures are, or might be within the reach of all. Books cost little and nature is free to all."(110)

Thus the enjoyment of both nature and reading not only spiritually uplifted a man, according to Lubbock, but it also offered the hope of social harmony, and an antidote to the divisiveness of socialism. Indeed, Lubbock presented science quite clearly as a healing balm, both for the individual and the nation. In other words, while both Huxley and Tyndall were using popularisation as a vehicle for establishing a professional

role for the scientist in society, Lubbock was emphasising the solace science could offer the weary worker in his spare time, by making claims such as, "In the troubles and sorrows of life, science does much to soothe, comfort and console."(111) Such statements established a direct link between the low level participation in science and a spiritual life. Strikingly, although Lubbock was an agnostic giving science a spiritual role in life, he did not raise a hierarchy of scientists between the layman and science, as his peers Huxley and Tyndall did. Rather, he emphasised the part everyone could play in scientific progress. In this context he said, in his Pleasures of life:

> "..periods of progress have generally been those when a nation has worked and felt together; the advance has been due not entirely to the efforts of a few great men, but of their countrymen generally; not to a single genius, but to a national effort."(112)

This idea of a unified effort in which everyone joins in, established the role of Lubbock's popularisation, which presented science as an idealised, consensual activity. In this context, it is a mistake to differentiate between Lubbock's lay-preaching and his serious scientific exposition(113), for in his books for a wider audience, which were marketed relatively inexpensively at a shilling, such as the Pleasures of life, there was perhaps little that was recognisable as exposition, but an image of science was being portrayed which equally deserves attention. The following passage, taken from Peace and happiness, establishes this image quite forcefully:

> "Science is of vital importance in our life; it is more fascinating than a novel, and anyone who neglects to follow the triumphant march of discovery, so startling in its marvellous and unexpected surprises, so inspiring in its moral influence, and its revelation of the beauties and wonders of the world in which we live, and the universe of which we form an infinitesimal - but to ourselves, at any rate, an all important - part, is deliberately rejecting one of the greatest gifts with which we have been endowed by Providence."(114)

Such an advocacy of science in resounding, devotional tones would not be found in a book for the I.S.S. or the 'Nature Series', yet amongst Lubbock's working-class audiences at Great Ormond Street, and through such books as Peace and happiness, this tone was evidently popular, and seems likely to have had two main effects.

Firstly, and most importantly for Lubbock, his popularisation must have inspired more people to go out and observe nature, albeit at a very unsophisticated level. This was a primary consideration for Lubbock in his role as father of the Nature Study movement, for at the Nature Study Exhibition in 1902, he declared:

> "No one would sit and drink in a public house, if he knew how delightful it was to sit and think in a field; no one would seek excitement in gambling and betting if he knew how much more interesting science was.."(115)

Secondly, as the image of science in texts like Peace and happiness suggests, Lubbock drew on the post-Darwinian natural theological framework, characterising nature as a moral guardian, and such a belief in the sanctity of nature probably underpinned Lubbock's protectionist work as President of the Selborne Society from 1893-1913.(116) In this sphere his popularisation can be seen to parallel closely that of Brightwen's in emphasising the romanticism of nature (see below). Yet Lubbock added to this 'religious' framework the secular concept of science as a social panacea, an harmonious, unifying pastime in which all could participate on an equal footing. This egalitarian ideal seems to have been present in his 'serious' scientific exposition for the middle-classes, in which he never elevated himself above his audience but addressed them intimately as equals. As one of the last great amateurs, part of a low scientific culture, such a popularisation technique would clearly make sense.

Thus, although a member of the X-club, Lubbock portrayed science as nothing more than a spiritually uplifting and socially unifying pastime.

For as an amateur naturalist, and a politician interested in consensus, his popularisation concerns were quite different from those of Huxley and Tyndall.

7 - Eliza Brightwen (1830-1906)

Brightwen (née Elder) was born at Banff on 30 October, 1830, and at the age of seven, after the death of her mother, she was adopted by her Presbyterian uncle, Alexander Elder, one of the founders of the publishing house of Smith, Elder and Co. Unlike all the other popularisers under discussion, she received no formal education at all. In 1855, she married a businessman, George Brightwen, and the couple lived the normal town life of the professional classes in London. Her diary (117) makes it clear that Eliza found it a little trying at times to live up to the expectations of society life, but she soldiered on with singing and sculpting lessons, and the onerous duties of being a district visitor. The Brightwens, however, were part of a scientific social 'set', often dining with the Gosses and the Hookers, and G.Brightwen's name appears on the list of members for the Victoria Institute in 1871, of which P.Gosse was vice-president.

It is thus, perhaps, no surprise then that shortly after her marriage, Eliza has an entry in her diary, as follows:

> "I began today an essay upon the dispersion of seeds, the first attempt I ever made to write upon any scientific subject, and not having much practical knowledge I had to read all I could find in our books and try to learn by finding out how very little I knew, and instead of being discouraged I resolved to make use of every opportunity when I might be in the country to pick up facts and become a careful observer of natural phenomena."(118)

Evidently, she kept this resolve for ten years later she wrote that she had been helping Rev. G.Henslow by scouring the country for flowers

to send him for his students at St. Bartholomew's Hospital Medical School, since,

> "He would tell me the classes of flowers he needed, and I must get a hundred of each kind so that each student might have one to dissect while he lectured."(119)

During these first sixteen years of her marriage, Eliza became increasingly evangelical, falling under the influence of the Rev. R.J.Knight, perpetual curate of Harrow Weald church, Middlesex. Her religious taste thus became increasingly different from that of her High Church husband and this led to marital problems, but on 8 March 1859 Eliza recorded passionately, "...I could never become a High Church woman."(120)

Her first book, published in 1871, was entitled Practical thoughts on bible study, in which she extolled the virtues to be found in close analysis of biblical texts. The following year, her biographer, Edmund Gosse, recorded that she suffered from a nervous breakdown, and,

> "For ten years she was almost wholly excluded from books, from nature, and from her friends. The death of her husband in 1883 raised her from her lethargy and suffering, and though she was liable to violent attacks of pain until the end of her life, they interfered no longer with her intellectual activity."(121)

Possibly she was institutionalised for this period of her life; her edited diaries omit these years entirely.

The Brightwens had no children, and George's death left Eliza in sole possession of a secluded estate, The Grove, Stanmore, containing woods, shrubberies, a lake and a shrine to J-J. Rousseau. For once,able to answer only to her own conscience for her activities, she was admirably equipped to become a naturalist within her own spacious grounds.

It soon became clear that Brightwen was no mere natural history collector, for as her steward and botanist, John W.Odell, remembered: "..mere collecting of specimens was not indulged in; what was arrived at was to study the life

history and character of the species captured.."(122) She was a keen amateur naturalist who, amongst other things, "with her collection of orchids verified and repeated many of the experiments of Mr. Darwin."(123)

She wrote copious notes about her observations, which she described as "word-pictures", and she was in the habit of showing these notes to her nephew,Edmund Gosse, who encouraged her to produce a text, and publish. Thus, at the age of sixty, her first natural history book appeared, entitled Wild nature won by kindness, which was, according to Gosse,

> "welcomed by the Press with unanimous approval and the Saturday review, which was giving special attention to the study of natural history, even made the little book a peg on which to hang an appeal for a revised and refreshed disposition of popular zoology."(124)

The Saturday review welcomed this text, not only as a popular work on anthropomorphic lines, but also as of worth to naturalists, concluding:

> "We hope we have said enough to induce lovers of living creatures to apply to Mrs. Brightwen's pages for themselves. Whether they are outsiders or insiders in the world of natural history, they will be sure to find in her book much that will please them, and not a little that is new to them."(125)

The Review, by featuring Brightwen's text in a main article taking up a whole printed page, not only boosted its sales, but promoted its appeal as a return to the traditional natural theological popularisation, after the secular challenge of Victorian Scientific Naturalism. This appeal emerges clearly from the beginning of Wild nature won by kindness, as follows:

> "May it especially tend to lead the young to see how this beautiful world is full of wonders of every kind, full of evidences of the Great Creator's wisdom and skill in adapting each created thing to its special purpose, and from the whole realm of nature may they be taught lessons in parables, and their hearts be led upwards to God Himself, who made all things to reflect His own perfection and glory."(126)

Indeed, by making this reference to"lessons in parables", Brightwen linked herself to the natural theological popularisation of Mrs. Gatty, whose book Parables from nature, (first published in 1855 by the Religious Tract Society) was enormously successful, to the extent that an edition was still in print in 1930!

In a similar style, Brightwen's seven natural history texts tended to concentrate on the adventures of animal characters, tame and wild, such as squirrels and robins, etc. Her 'word-pictures', as if incidentally, give a little scientific information, but the emphasis tended to be on the sentimental characterisation of animals as greedy, shy, busy, etc. Because of this unsophisticated anthropomorphism, her texts fit into the romantic genre of popularisation, challenging the ostensibly detached and neutral attitudes towards nature of writers like Tyndall and Huxley. Indeed, Brightwen's texts were often explicitly romantic, for she frequently quoted from Romantic poets to capture the mood of a season. Thus autumn is introduced by Wordsworth in her Nature rambles for students, as follows:

> "For me, who under kindlier laws belong
> To Nature's tuneful quire, this rustling day
> Through leaves yet green, and yon crystalline sky,
> Announce a season potent to renew,
> Mid frost and snow, the instinct joys of song,
> And nobler causes than listless summer knew."(127)

And when speaking of the Nautilus, for example, Brightwen said:

> "..alas, the rude hand of science has brushed away the charming poetic fancy, and we are told that the two flattened membranes which were supposed to be sails, are only used for the prosaic purpose of secreting calceous matter, in order to repair the shell when injured."(128)

From Brightwen's texts, the reader got the feeling that Nature was to be enjoyed more than analysed. She did encourage her readers to build up

home museums, books of feathers, and insect collections, but she spent far more time inspiring them to experience fully a sunset, so that they could paint a word-picture of it, equal to its magnificence, coaxing them to spend dawn outside, alone with the birds and the dew, etc. Within this context of Nature as a kind of revelation it is not surprising that Brigatwen's commentary was purely subjective, seeming to have only a vague scientific significance. For example, in the following extract about squirrels, she said:

> "So far as I can discover, these little animals of ours, being so well fed do not hibernate during the winter, for through frost and snow they come for their daily meals."(129)

This observation suggested a connexion between food supply and hibernation which was never fully elucidated, because such analytical conjecture was not part of this style of popularisation. This does not necessarily indicate, however, that Brightwen was intellectually incompetent, yet Edmund Gosse claimed that,

> "It was even noticeable that scientific literature on which occasionally she descended with her customary ardour, did more to check than to help her. It became needful to keep out of her way monographs of a technical nature dealing with branches of animal or vegetable life on which she was engaged, simply because the apparatus of pure science seemed to bewilder and depress her."(130)

This picture of an eccentric, intellectually weak, old lady does not tally, however, with Brightwen's published material. In an entry in her diary of 1892, she wrote,

> "I was delighted to receive from the library Sir John Lubbock's new book on 'seedlings'. I propose to make 'seedlings' one of the chapters in my new book on botany, though at first I was inclined to abandon the idea on seeing the exhaustive way in which Sir John Lubbock treated it, but on reading his book I found that he habitually

employed Latin terms which would be wholly beyond the comprehension of children and even of many older people."(131)

Brightwen was never a rigorous scientist, and her methods as a naturalist were eclectic to say the least, and therefore it is not surprising that she was daunted by Lubbock's exhaustive treatment of his subject. Yet, the tone of the entry suggests confidence and competency, that she understood the text, but wished to write a far simpler, popular text. This she did with the publication of Glimpses into plant life in 1887. This text was dedicated to J.D.Hooker in the following way:

"In conversation with you I have often been impressed by your conviction of the importance of inducing young people to observe the elementary facts of botany.."

In fact, Brightwen was also well acquainted with Lubbock, since she was vice-president of the Selborne Society (which she helped to establish in 1887), while Lubbock was President. The Selborne Society was part of the protectionist trend during this period, which campaigned to stop blood sports. In this capacity, for example, Brightwen was encouraged to speak at a Selborne conversazione in London in 1894 (132), on the need to forbid gamekeepers to shoot hawks and owls. In March of that year, she also spoke at Jermyn Street on behalf of the R.S.P.B., a society for which she often lectured. In this protectionist sphere Brightwen was also part of the Band of Hope, an early evangelical wing of the Nature Study movement to which Lubbock and Henslow also belonged and which has been mentioned above.

Brightwen seems, then, to have been part of a romantic reaction against the popularisation of professional scientists, a reaction to which Henslow and Lubbock also belonged in this period. Whilst never considering herself a 'scientist', Brightwen enjoyed the company of scientific men such as P.H.Gosse, Sir William Flower, Sir J.D.Hooker and Sir James Paget, who were frequent guests at her house in Stanmore. In this context, perhaps

her status as a populariser should be taken more seriously, since her popularising works were written in a sentimental style that was popular in the 1890s, and should be understood in that context (for, after all, this was a style which the historically respectable figure, Lubbock, also used during this period). Brightwen's natural theological framework provided the inspiration for her involvement with the Selborne Society, the R.S.P.B. and the Band of Hope, for her faith in good works, and her ardour for studying the word of God, divined from the bible, can be seen to parallel closely her role in the protectionist movement, and her serious studies of the book of nature. As such, no doubt she did feel alienated by the new professionals, the high priests of science, who threatened to destroy for her, and others, the direct revelatory experience of Nature with their mysterious language and laboratory rituals. Brightwen intuitively knew she could never become a 'High Science' woman.

8 - Conclusion.

The success of Eliza Brightwen as a populariser in the 1890s establishes beyond doubt the durability of natural theology as a framework for the popularisation of natural history, despite the wide acceptance of Darwinism by this time. Further, the lives of Lubbock and Henslow suggest that a framework using the romantic genre was one which a scientist unsure of his status (either through a fall in reputation as suffered by Henslow, or because he was an amateur like Lubbock) could identify with and use in popularisation. This would seem to be because, as Wood's popular work suggested, natural theology was associated with a subjective type of presentation which was vital to low scientific culture, and reassuring to those who did not have a secure, professional niche.

Another late nineteenth-century phenomenon, which seems to have provided

reassurance for popularisers who belonged to a low scientific culture, was the rise of protectionism and the Nature Study movement. Both these trends were based on a belief in the sanctity of nature and (as the later writings of Lubbock, Henslow and Brightwen indicate) romantically challenged the rational deconstruction and analysis inherent in modern science, consequently they were anathema to Tyndall and Huxley. In fact, Huxley, who was famed for his popularisation of Darwinian evolution, never ventured into the sentimental, romantic culture in which protectionism and Nature Study flourished, since his secular popularisation of natural history through books, was only presented through the secular medium of the general science series. Huxley never contributed to natural history series, which were dominated by natural theological popularisation, and which survived into the twentieth century as vehicles for the popularisation of a different set of values from those espoused by high science.

Social factors which differentiated the popular context of science popularisation from that of the mid-Victorian period were the rise of both elementary education and organised labour. From the consideration of the six popularisers discussed, it is clear that for two of them, Huxley and Lubbock, the popularisation of science amongst the working-classes was a high priority, involving political and social themes. Huxley, for example, used popularisation to help ensure that secular and liberal attitudes became part of an elementary grasp of scientific knowledge, while Lubbock promoted natural history as part of a cultural panacea helping to construct national consensus. Both these themes were to be developed dramatically in the Edwardian era to be discussed in the next two chapters. These were themes implicit in the work of two of the most famous secular popularisers of the biological sciences at this time, such themes were not so prominent in the popularising work of the physicist Tyndall. This is an important point to remember, along with the fact that Tyndall, the best known physics populariser among the late Victorian

public scientists, never claimed that science was in the realm of common sense. That was Huxley's claim, and it is a reflection of the dominance of the social and biological sciences in the public mind at this time, that this was the image of science on which popularisers tended to build in the Edwardian era.

Footnotes

1 - For a wider range of responses see J.R.Moore, The post-Darwinian controversies: A study of the protestant struggle to come to terms with Darwin in Great Britain and America, 1870-1900, Cambridge, 1979.

2 - F.M.Turner, Between science and religion, London, 1974, p.15.

3 - Quoted by Turner, ibid, p.15.

4 - R.M.Young, 'The impact of Darwin on conventional thought', in A.J. Symondson (ed.), The Victorian crisis of faith, London, 1970, p.28.

5 - There were nine members of the X-club (T.H.Huxley, J.Tyndall, J. Lubbock, J.D.Hooker, T.A.Hirst, G.Busk, H.Spencer, E.Frankland and W. Spottiswoode) which existed from 1864-93. The club met monthly, and because of the administrative power of many of the members, through offices held in the Royal Society and the British Association (and the scientific prestige of all the members), this group came to socially dominate high science during the 1870s and 1880s. The X-club was instrumental in laying the foundations of science education in Britain, and its members were known for their outspoken opposition both to the Church of England and to Gladstone. See R.MacLeod, 'The X-club - a social network of science in late Victorian England', Notes and records of the Royal Society, 24, 1969, pp.305-22.

6 - R.D.French has examined this lobby in terms of their opposition to 'scientists' such as Huxley, see R.D.French, Antivivisection and medical science in Victorian society, Princeton, 1975, pp.345-373.

7 - This has been estimated from the British Museum Catalogue, by counting the number of entries under authors' names.

8 - T.Wood, The Rev. J.G.Wood, London: Cassell, 1890, p.31.

9 - Ibid., p.33.

10 - Approximately ten of his books were about sport and exercise.

11 - F.A.Mumby, The house of Routledge, 1834-1934, London: Routledge, 1934, p.77.

12 - J.G.Wood, Common objects of the country, London: Routledge, 1886, p.13.

13 - Ibid., p.31.

14 - J.G.Wood, Out of doors, London: Longmans, 1874, p.207.

15 - Op. cit. (6), pp.371-2.

16 - Op.cit. (8), p.98.

17 - Op. cit. (6), p.372.

18 - J.G.Wood, The field naturalist's handbook, London: Cassell, 1880, preface.

19 - Op. cit. (8), p.97.

20 - J.G.Wood, The illustrated natural history, London: Routledge, 1854, p.5.

21 - J.G.Wood, The handy natural history, London: Religious Tract Society (hereafter R.T.S.), 1886, p.1.

22 - Ibid., p.14.

23 - Op. cit. (8), p.35.

24 - W.Sonnenschein, The best books, London: Sonnenschein, 1891, p.535.

25 - Op. cit. (20), p.vii.

26 - Ibid., p.285.

27 - Op. cit. (8), p.316.

28 - Ibid., p.125.

29 - G.Henslow, Genesis and geology, London: Hardwicke, 1871, pp.21-2. This sermon was preached on 5 November 1871 at St. John's Church, Marylebone.

30 - Ibid., pp.17-18.

31 - G.Henslow, The theory of evolution of living things, London: Healey, 1873, preface.

32 - Ibid., p.215.

33 - Ibid., preface.

34 - The Victoria Institute, Journal of the transactions, 1, 1866, rule 3.

35 - Ealing Microscopical Society reports, etc., 1877-1917, (non-paginated), Ealing Public Library.

36 - Ibid.: *The awakening of plant life
The earthquake in Ischia
Short review of the science of the past year
The marine aquarium
Some ethnological features of Hindustan
*The glaciers of the Alps
*Our autumn crops
Burning and explosion
Gas, and how to use it properly
An hour with a little shrimp
The laws of beautiful form

Those lectures marked with an asterisk were delivered by Henslow.

37 - Henslow was Professor of Botany to the Royal Horticultural Society, but the details of this post are unknown. There is no standard biography of Henslow.

38 - Op. cit. (35)

39 - Ibid.

40 - G.Henslow, The origin of plant structures, London: Kegan Paul, 1895, p.252.

41 - "The introduction opens with the words: 'Natural selection plays no part in the origin of species.' This dictum is not likely to be accepted by the general scientific world without very strong support."

42 - Private communication with J.Lancashire.

43 - G.Henslow, Botanical papers, Ealing Public Library, EE 54.51.

44 - G.Henslow, The story of wild flowers, London: Newnes, 1901, preface.

45 - G.Henslow, Christian apologetics, London: Murray, 1903, p.21.

46 - G.Henslow, British wild flowers, London: R.T.S., 1910, p.1.

47 - G.Henslow, The religion of the spirit world, London: Kegan Paul, 1920, p.100.

48 - "Walking back to lodgings with Hooker, Huxley remarked that this experience had changed his opinion 'as to the practical value of the art of public speaking'.."

W.Irvine, Apes, angels and Victorians, London, 1956, p.6.

49 - C.Bibby, T.H.Huxley: Scientist, humanist and educator, London, 1959, p.94.

50 - Ibid., see conspectus for details of all Huxley's major lectures.

51 - "In 1882 Carlyle's Sartor resartus... found 70,000 purchasers at 6d. a copy."

R.Altick, The English common reader, London, 1957, p.243.

52 - T.H.Huxley, Discourses: Biological and geological, London: Macmillan, 1894, pp.176-7.

For a discussion of Huxley's construction of the scientist as Carlylean anti-hero, see J.G.Paradis, T.H.Huxley: Man's place in nature, London, 1978, pp.47-73.

53 - Huxley to Dyster: "I am sick of the dilettante middle-classes." Op. cit. (49), p.97. Bibby's interpretation of Huxley's preference for lower-class audiences is widely taken as standard. For example, see W.C. Williams, 'T.H.Huxley', in C.C.Gillespie (ed.), Dictionary of scientific biography, 15 vols., New York, 1974, vol.6, p.595. Paradis also states that:

> "Huxley's belief in the bond between scientists and the working-class remained strong throughout his life. His working men's lectures, his energetic pioneering work in technical education and universities for the working-classes, suggests a deeply felt identification."

J.G.Paradis, op. cit. (52), p.32.

This view , however, has recently been challenged by E.Block, who argues that:

> "While purporting to speak to working-class audiences (witness the title of his published lectures for Working Men and Science Lectures for the People) and casual lay-readers - like those of his after-dinner speeches as well as self-improving audiences like the Y.M.C.A. and the British Association, he really assumed and targeted a largely middle-class liberal audience."

E.Block, 'T.H.Huxley's rhetoric and the popularisation of Victorian scientific ideas, 1854-74', Victorian studies, 1985-86, 29, pp.363-387, p.379.

In making this statement, however, Block underestimates the stylistic differences between lectures written for a casual/lay audience, and those

written for a middle-class liberal audience. Whilst Huxley's polemical essays about science, religion and politics were mainly addressed to this latter audience, the majority of his popularisations of scientific theory and method were initially addressed to the lower-class audiences who formed the bulk of his audience at Jermyn Street, Great Ormond Street, St. Martin's Hall etc. Arguably, it was because he had this audience in mind that his exposition was so lucid.

54 - I think that these essays portray Huxley first and foremost as a polemicist, and that to read Huxley's essays as poems (see J.H.Gardner, "A Huxley essay as 'poem'", Victorian studies, 1970-71, 14, pp.177-193) is to take them out of the polemical context in which they were written.

55 - T.H.Huxley, Science and Hebrew tradition, London: Macmillan, 1894, p.166.

56 - Op. cit. (49), p.101.

57 - Anon., Protoplasm, powheads, porwiggles, London: Longmans, 1875, p.9.

58 - Anon., The Saturday review, 1870, 30, p.269

59 - For example, op. cit. (2).

60 - T.H.Huxley, Methods and results, London: Macmillan, 1894, p.31 (my emphasis).

61 - Ibid., p.41.

62 - Op. cit. (4). See also T.Cosslett, Science and religion in the nineteenth century, Cambridge, 1984.

63 - W.F.R.Williams, 'T.H.Huxley' in, Dictionary of national biography, 30 vols., Oxford, 1959, vol.22, p.897.

64 - S.Budd, Varieties of unbelief, London, 1977, p.64.

65 - Ibid., p.81.

66 - Ibid., p.100.

67 - Ibid., p.86.

68 - Op. cit. (49), p.98.

69 - D.E.Allen, The naturalist in Britain, London, 1976, p.170.

70 - T.H.Huxley, Darwiniana, London: Macmillan, 1894, p.471.

71 - The New Liberals were liberals who attacked traditional laissez-faire individualism, replacing it with a modified individualism which encouraged a stronger element of state intervention.
See M.Freeden, The new liberalism, London, 1977.

72 - T.H.Huxley, Elementary lessons in physiology, London: Macmillan, 1881, p.1.

73 - T.H.Huxley, Introductory primer, London: Macmillan, 1880, pp.16-18.

74 - See chapter 2, section on science as hobby.

75 - W.H.Brock, 'The spectrum of science patronage' in, G.L'E.Turner(ed.), The patronage of science in the nineteenth century, Leyden, 1976, pp.173-207.

76 - Op. cit. (49), p.97.

77 - Op. cit. (75). Even the sanitary movement in the Victorian period, while it provided "career opportunities for physicians, general practitioners, chemists, civil engineers and pharmacists"(p.182) does not appear to have offered much high profile research work for the young biological sciences.

78 - T.H.Huxley, Science and education, London: Macmillan, 1894, p.294 (my emphasis).

79 - This was entitled, 'The influence of material aggregation upon the manifestations of force'.

80 - S.Forgan, 'Tyndall at the Royal Institution', in W.H.Brock (ed.), John Tyndall: Essays on a natural philosopher, Dublin, 1981, p.56.

81 - J.Tyndall, 'Elementary magnetism', in J.Tyndall, Fragments of science, 2 vols., London: Longmans, 1879, vol.1, p.405.

82 - Ibid., p.38.

83 - R.MacLeod, 'John Tyndall', in C.C.Gillespie (ed.), Dictionary of scientific biography, 15 vols., New York, 1974, vol.11, p.523.

84 - Royal Institution Archives, J.Tyndall, Notes for lectures, 3/D4-3/E5.

85 - Ibid., 3/D4.

86 - C.A.Taylor, 'Tyndall as lecture demonstrator', in W.H.Brock (ed.), op. cit. (80), p.213.

87 - D.Thompson, 'Tyndall's contribution to scientific education and the teaching of science', in W.H.Brock (ed.), op. cit. (80), p.149.

88 - Op. cit. (84), 3/D5.

89 - J.Tyndall, 'Matter and force', in J.Tyndall, op. cit. (81), vol.2, p.61.

90 - J.Tyndall, Sound, London: Longmans, 1867, p.5.

91 - Op. cit. (89), p.68.

92 - J.Tyndall, 'An address to students', (delivered at University College, London, session 1868-9), in J.Tyndall, op. cit. (81), vol.2, p.96.

93 - R.A.Haugrud, 'Tyndall's interest in Emerson', in American literature, 1970, 41, pp.507-517, p.507.

94 - Op. cit. (89), p.66.

95 - Op. cit. (84), 3/D6.

96 - J.Tyndall, 'On the study of physics', in J.Tyndall, op. cit. (81), vol.1, p.343.

97 - J.Tyndall, 'The rainbow and its congeners', in J.Tyndall, New fragments London: Longmans, 1892, p.213.

98 - Op. cit. (81), p.402.

99 - See chapter 2, section on science as hobby.

100 - Op. cit. (75).

101 - Op. cit. (80), p.60.

102 - J.Tyndall, 'Atoms, molecules and ether waves', in J.Tyndall, op. cit. (97), p.81.

103 - This section concentrates on Lubbock's work as a naturalist, for although he did also contribute to the disciplines of geology and anthropology, it was in natural history that he established a reputation as a populariser.

104 - J.Lubbock, On buds and stipules, London: Kegan Paul, 1899, p.1.

105 - The text went through seventeen editions.

106 - J.Lubbock, Ants, bees and wasps, London: Kegan Paul, 1915, (17th edn.), p.222.

107 - J.Lubbock, The pleasures of life, London: Macmillan, 1930, p.42.

108 - R.J.Pumphrey, 'The forgotten man: Sir John Lubbock, F.R.S.', Notes and records of the Royal Society, 1958, 13(1), pp.49-58.

109 - J.Lubbock, Free libraries, London: Library Association, 1891, p.5.

110 - J.Lubbock, Essays and addresses, 1900-1903, London: Macmillan, 1903, p.101.

111 - J.Lubbock, Peace and happiness, London: Macmillan, 1909, p.260.

112 - Op. cit. (107), p.237.

113 - V.Grant-Duff, The life work of Lord Avebury, London, 1924, p.54.

114 - Op. cit. (111), p.94.

115 - Op. cit. (110), p.270.

116 - For a history of the Selborne Society, see J.Ranlett, 'Checking nature's desecration: Late Victorian environmental organisations', in Victorian studies1982-3, 26, pp.197-223.

117 - E.Brightwen, The life and thoughts of a naturalist, London: Unwin,1909.

118 - Ibid., p.46.

119 - Ibid., p.78.

120 - Ibid., p.59.

121 - E.Gosse, 'Eliza Brightwen', in Dictionary of national biography, 30 vols., Oxford, 1959, vol.23, p.225.

122 - E.Gosse, 'introduction' to E.Brightwen, op. cit. (117), p.xix.

123 - Ibid., p.xx.

124 - Ibid., p.xii.

125 - The Saturday review, 1890, 70, pp.149-50.

126 - E.Brightwen, Wild nature won by kindness, London: Unwin, 1890, p.16.

127 - E.Brightwen, Nature rambles for students, London: R.T.S., 1899, p.146.

128 - Ibid., p.193.

129 - E.Brightwen, More about wild nature, London: Unwin, 1892, p.102.

130 - E.Gosse, op. cit. (122), p.xxix.

131 - Op. cit. (117), p.111. In fact Brightwen's verdict on Lubbock's volumes was something of an understatement. The text (all 1,254 pages of it) was composed of sentences such as, "The ventral suture faces the odd petal termed the vexillum in papilionaceous flowers". See J.Lubbock, A contribution to our knowledge of seedlings, London: Kegan Paul, 1892, p.383.

132 - Op. cit. (117), p.151.

CHAPTER 5

THE DEVELOPMENT, IN THE EDWARDIAN ERA, OF THE POPULARISATION OF SCIENCE THROUGH NON-FICTION SERIES.

1 - Introduction

The Edwardian era witnessed a doubling in the number of new books published annually, from 6,044 in 1901, to 12,379 in 1913.(1) This boom in the book trade may possibly be traced back to the expansion of menial clerical work during this period, since yet more people needed to be reasonably literate to earn a living thereby increasing the size of the potential book-buying public.The growth of lower-class interest in reading at this time was reflected in both church and socialist organised leisure activities, which tended to feature libraries and study classes.(2) Furthermore, developments within the book trade offered several incentives for the poorer reader to buy books during the Edwardian era. Firstly, inexpensive books began to be more attractive in appearance with sturdier board covers, and printed on better paper in a larger, more readable type. Secondly, the copyrights of nearly all the great Victorian writers were expiring, including Tennyson, Browning, Carlyle and Dickens, and, of importance for the popularisation of science, so were those of Huxley and Tyndall. In general publishing houses were flourishing under the net book agreement, and an optimism in the implications of increased literacy seems to have pervaded such establishments. This was the age when Dent launched his 'Everyman's Library' in the spirit of egalitarianism for the edification of every kind of reader, "the worker, the student, the cultured man, the child, the man and the woman."(3) This was also the first age of wireless telegraphy, aeroplanes and the mass production of cars. A time when it might be thought popular science series, featuring technological advances, would be flourishing.

In fact, however, the Edwardian era is generally perceived by historians of science as a time when the popularisation of science was in retreat, in contrast to the high profile many late Victorian scientists had given it. According to a British Association discussion paper, circulated among delegates attending a conference on the dissemination of scientific information to the public in 1946, the following conclusion was made: that the period from the 1880s to the First World War was a period when,

> "scientific research had become'bigger', more complex, and less easily disseminated by popular lectures.."(4)

Other commentators have noted that the opening decades of the twentieth century were a time when science was "socially weak", saying, for example,

> ""..its shortcomings did not lie in the quality of its top scientists. But their communication was faulty, and their influence in the nation inadequate."(5)

One obvious explanation for science being considered "socially weak" at this time was that the last generation of generalists had passed on, leaving academically trained specialists to deal with the public. Whereas, the late Victorian era had been rich in scientific people able to popularise their subjects, the Edwardian era began to see the creation of scientists whose communicative skills were of little consequence to their careers, as science became more and more specialised.

A further, less obvious consideration about the popularisation of science at this time was the rapid growth of mass communication. In 1896, Alfred Harmsworth (who became Lord Northcliffe in 1905) had published the first number of the Daily Mail, and launched the Daily Mirror in 1903. Both these newspapers established a mass market (with approximately three-quarters of a million sales daily)(6) for information and easily digestible entertainment among the lower-middle and artisan classes. Arguably, professional scientists were unsure whether they ought to manipulate such a medium, and, if they should, how they ought to go about doing so. The Edwardian journalist and populariser of science, H.G.Wells, offered an insight into

the dilemma posed by mass journalism for the scientist in his novel The food of the gods, published in 1904. At one point in the novel, Wells presents the reader with the bemused response of the scientist Bensington to the popularisation of his discovery of Herakleophorbia, a food which enabled living organisms to grow to enormous sizes. Here is Wells' summary of this popularising process:

> "..it was Punch first called the stuff 'Boomfood'..The thing became quite an obsession with Broadbeam, the Popular Humourist.
>
> An enterprising press-cutting agency sent Bensington a long article about himself from a sixpenny weekly, entitled 'A New Terror'..
>
> He was speedily quite hardened to seeing his name associated with the most incongruous ideas in the public press, and to discover in the reviews, articles written about Boomfood and himself in a tone of the utmost intimacy by people he had never heard of..
>
> It did not seem to occur to the public mind as anything more but a mere playful supposition that any more Herakleophorbia was going to escape again(7)..The sort of thing that pleased the public mind was caricatures of eminent politicians after a course of Boomfeeding, uses of the idea on hoardings, and so on ...
>
> Beyond that the public did not care to look, until very strenuous efforts were made to turn its eyes to the remoter consequences, and even then for a while its enthusiasm for action was partial. 'There's always somethin' New,' said the public - a public so glutted with novelty that it would hear of the earth being split as one splits an apple without surprise, and, 'I wonder what they'll do next.'"(8)

This excerpt suggests the extent to which popularisation had been taken out of the control of the scientist by the Edwardian era, and also hints at the contempt many scientists probably felt for the Edwardian public's superficial interest in topical issues.

The present chapter explores the changes in the presentation of science

in non-fiction series during the Edwardian era. It will be argued that the majority of such changes in this period were influenced by the arrival of both mass journalism and the professional scientist at this time.

2 - Popular science series c.1901.

A survey of popular science series which were running in the first two years of the twentieth century reveals a decline in the number of such series from the late Victorian era.(9) Around 1901, the publishing house of John Murray appears to have been at the forefront of such ventures with both the 'Progressive Science Series', and 'Murray's Home and School Library'.

The 'Progressive Science Series', was launched in 1897, under the editorial control of the biologist, F.E.Beddard. In the first nine years of its life (10) half of its volumes were devoted to biological subjects, suggesting both Beddard's special interests, and the continuing commercial viability of biology among a general readership. Priced at 6s. a volume, the series was largely beyond the pocket of all but the professional classes, and many of the texts required a high educational background. Few lower middle-class readers would, for example, have been able to get to grips with St. George Mivart's philosophical arguments in his Groundwork of science, if for no better reason than that the text abounded with untranslated Latin phrases.Some volumes in this series, however, were more accessible, with their authors displaying a gift for description. For example, here is a passage from T.G.Bonney's book Volcanoes:

> "In some vents the mud is thick as treacle, in others it is simply ink-black water. The thundering and throbbing of these boilers, the thud, thud of the hot waves chafing their barriers, the hissing and spluttering of the smaller fumaroles, and above all, the scream of a steam-whistle at the edge of a blue-slime pond produce an effect truly horrible."(11)

Clearly, such a text made entertaining reading as well as offering educational information. Other texts, such as The study of man by A.C.Haddon, wanted to encourage the reader to become an amateur participant in science, offering the budding ethnographer a list of questions to answer about the customs of the natives he might meet on his travels. Thus, although the series was comprised of uniformly large (approximately 300 pp.) red volumes, the style of presentation within the series ranged from the formality of the text-book, to the informality of a journalistic-type report in a quality newspaper. It would seem that contributors to the series were chosen for being leading authorities in their subject, rather than for their popularising skills, and were asked to give a general account of their subject which some found easier than others. Intended for a middle-brow audience, the series avoided voguish subjects like spiritualism, hypnotism etc., presumably deciding to present the more established and traditionally popular sciences like biology,geology and astronomy. As such, it seems likely that only texts which happened to be relevant to popular scientific debates, such as J.A.Thomson's text Heredity, which cashed in on the widespread eugenic interest, sold well.

In 1901, 'Murray's Home and School Library' was launched as a series of text-books featuring science, along with history and mathematics, and a host of other less well-represented subjects. The editor of the series was Laurie Magnus, whose personal specialisms were literature and history. Using a by now familiar, but increasingly anachronistic, technique, the series was advertised for both the general reader and schools. Consequently, some texts, such as J.H.Leonard's contributions on practical science, and E.M.Langley's Algebra, were written specifically for school use, and were, therefore, simply text-books. Others, such as Lubbock's History of coins and currency, and C.T.Ovenden's The face of nature were written for the general reader to further his recreational interests. Ovenden, for example, suggested that his book be used for popular lectures by a clergyman or

a layman able to gather an audience in a parish hall, and diagrams were provided from which slides suitable for a magic lantern could be made. Priced at between 1s.6d. and 2s.6d., the series offered accessible elementary instruction for the beginner, but its audience was probably largely composed of school pupils, rather than the adult general reader.

With the rise of formal elementary education, the appeal of the text-book was diminishing amongst the potential adult audience for non-fiction. Of course, for those keen to have facts and figures at their fingertips, there were reference books, such as those offered by Hutchinson's 'Concise Knowledge Library', which ran from 1897-1914. The well-indexed Natural history in this series offered quaint note-book information, reminiscent of the pre-Darwinian era, in which, under the heading,"The Wood Storks - Family Tantalidae", for example, can be found the following entry from Lieutenant Burgess' account:

> "A young bird of this species which I shot in Sind, disgorged a large quantity of small eels. The nest is composed of small sticks and is placed at the top of trees, and if there are many on the same tree, they are placed pretty close together."(12)

The Astronomy, however, was more modern in presentation, offering a series of articles on popular, topical issues. For example, five pages were devoted to an explanation of Schiaparelli's theory of Martian canals, which concluded ambivalently, "the hypothesis is seductive, but should not be hastily adopted."(13)

Most popular science series of this period are in fact beginning to reflect the rise of popular journalism, with their willingness to use the vernacular and colloquialisms. Of particular significance for the popularisation of science in books, is the consequent shift away from lecturing the reader through the scholastic genre, to a more relaxed approach, where the writer is reporting the state of a science in an interesting and topical way. A good example of this new journalistic genre is given

by the 'Library of Useful Stories', published by George Newnes, the newspaper proprietor, whose weekly, Tit-bits, made him a fortune, and helped to shape commercialised journalism for the whole of the twentieth century. The appeal of this new journalistic style, was that it gave pieces of information in small, digestible form, as'tit-bits', comprehensible to a reader with only a basic, elementary education. No doubt, it was part of Newnes' shrewd marketing ability to promote a series of short, educational texts, bristling with factual information, as 'stories'. Priced at a shilling each, the texts were undoubtedly an invaluable source of information for the persevering reader, with only a basic education behind him. The sentences are shorter than was customary in texts of the Victorian age, and allowed the reader to gradually accumulate facts about geology, evolution, electricity etc. A lot of the texts in the series of approximately fifty volumes, sported titles which indicated topical, newsworthy subjects about which the general reader might have liked to find out more information, such as, Rapid transit, Wireless telegraphy etc. Other titles suggested the perennial popularity of botany, ornithology and astronomy. The contributing authors to the series were, on the whole, fairly distinguished men of science,such as the biologist E.Clodd, the ornithologist W.P.Pycraft, the botanist G.Henslow etc., and there were no titles in the series to suggest that Newnes was willing to cash in on 'deviant' scientific topics such as Mars, spiritualism and so on. The whole enterprise appears to have been a serious endeavour to educate and inform the reader in scientific subjects, and the uncontroversial tone of the series was established by the quotation carried by all the texts in their frontispieces, which read,'"The more science advances, the more it becomes concentrated in little books" - Leibnitz'. This series clearly sought a conservative intellectual image, which held aloof from controversy, and with which the aspiring lower-class reader might well be expected to identify.

The wealthier reader was,,however, not neglected at the turn of the century, when in 1902, Hutchinson launched 'The Woburn Library of Natural History', priced at 12s.6d. a volume. Edited by the eleventh Duke of Bedford, this series made use of the aristocratic links which natural history had traditionally fostered through land ownership and game hunting. This particular Duke of Bedford was President of the Zoological Society from 1899-1936, and was well-known as a naturalist, particularly for saving Pere David's Deer from extinction, after the Boxer Riots in China, by offering them refuge in Woburn Park. The series intended to supply the beginner with an understanding of nature that was "scientifically accurate".(14) The books were so highly priced because they were printed on good quality paper, and boasted many large,coloured engravings. The texts were written in the romantic genre, being full of poetry and metaphorical descriptions. The introduction to F.E.Hulme's Wild fruits of the countryside, suggests the purpose of the texts. He started as follows:

> "Our purpose is a very simple one, to deal with the principal typical forms that one may reasonably expect to meet with during a country sojourn, and to deal with them in the simplest way - caring but little to send our readers to the dictionary in a wild quest for six-syllabled words of weird appearance, but caring much if the result of the perusal of our pages be to so far interest them as to send them to seek for themselves in the great Book of Nature."(15)

In other words, the point of the series was to instil a love of nature, and an understanding of its processes, rather than to encourage a book-bound knowledge of nature. As the reference to the "Book of Nature" suggests, this series appears to have been part of the romantic presentation of natural history which has been discussed above.(16)

3 - The plea for humane science.

As has been indicated above, the Edwardian period differed from the late Victorian era in that it was a period when professional scientists conducted their research without paying much attention to popularisation, leaving journalists to present aspects of science which they felt would appeal to their readership. In terms of the popularisation of science through books, the survey above suggests that the first years of the twentieth century largely saw a continuation of methods pursued in the late Victorian era with a few minor changes in style; consequently few of these books sold well, tending as they did, to present only the traditionally popular scientific subjects like geology, natural history etc.

As the opening decade of the twentieth century began to get into its stride, however, a new generation of popularisers came to the fore. Generally speaking such popularisers tended to be of amateur status such as H.Ellis, or/and involved in the promotion of the 'fringe' or the deviant sciences like eugenics, spiritualism, sex psychology and the Mars controversy. Arguably such popularisers were filling the gap created by the new generation of professional scientists not skilled in communication, and the growth of a mass public eager for topical and 'sensational' information.

Many of the same intellectuals that were involved in the promotion of 'fringe' or deviant sciences, were also involved with groups seeking an ethical revaluation of society. Consequently, many of the most prolific popularisers of the day belonged to left of centre groups like, the New Fellowship of Life (to which, for example, Ellis belonged), and the Humanitarian League (to which, for example, J.A.Thomson belonged). Such groups sought to:

> "replace our present competition society, with all its injustices, by a cooperative commonwealth where each man shall have the best opportunities for developing his manhood."(17)

Much of Edwardian society was moving in a left of centre direction with the tacit assumption that human intervention in social, economic

and political affairs was necessary, contributing to a consensual view of society which was left-wing in its attack on laissez-faire individualism. The impact of this shift in political emphasis on the popularisation of science will be discussed in more detail in the next chapter. At this point it is worth noting that left of centre beliefs had such a high profile in science at this time because many of the most prolific popularisers of the period held such beliefs. Such popularisers, who were sympathetic to the fashionable, ethical revaluation of society, were worried about the ethical implications of the emergence of professional, value-free science. For example, the Humanitarian League helped to sponsor lectures as a protest against what they described as:

> "the attempt of Modern Science to get rid of human feeling and to look at everything in the dry light of the intellect."(18)

The following quotation from the end of Edward Carpenter's lecture in this series, entitled "The need of a rational and humane science", summarised the humanitarian viewpoint. He said:

> "In conclusion, you begin to see doubtless that I do not believe in a science of mere formulas, which can be poured from one brain to another like water in a pot. I believe in something more organic to Humanity, which shall combine Sense, Intellect and Soul.."(19)

The Idealism implicit in the above quotation, also permeated a Back to Nature trend at this time, which helped to regenerate a sentimental interest in natural history. Reflecting this vogue the publisher Unwin collected Eliza Brightwen's natural history works together and republished them as a series, each volume of which cost 2s. In a similar romantic style, Hutchinson launched its 'Nature Library' in 1912 at 6s. a volume. This series featured an anthropomorphic presentation of natural history enhanced by numerous plates, which were incorporated into the 'tender-hearted' narrative.

Another face of this Back to Nature trend was reflected by a boom in the republishing of works by Emerson and Tolstoy which urged an ethical regeneration through a return to the 'good' rural life , in

which Nature was an ever present and moralising theme. In this vein Constable and Co., published a centenary edition of Emerson's complete works; C.W.Daniels published a 'Simple Life Series of Booklets'; and the Free Age Press launched a 'Tolstoy Series', all between 1901 and 1905.

Also symptomatic of this veneration for the simple, rural life, was Lane's series of 'Country Handbooks', which ran from 1903-1910. The editor of the series was Harry Roberts, an ethical socialist who practised medicine. The series was intended for those who wished to

> "minimise their needs, to waste as little of their lives as may be in the money-making pursuits of the market-place, and so to have the maximum of time for the pleasures of real living and independent growth."(20)

The series offered practical advice on country life in pocket size form, presumably for the urban dweller penetrating the country on foot or the newly fashionable bicycle, describing trees, flowers and birds that he would be likely to see, as well as explaining which wayside plants were safe to eat, how to tell the time by the sun, and so on. As such, the series reflected both the Edwardian craze for spending weekends in the country, pursuing a dilettante form of natural history, and the late Victorian and Edwardian social trend which sought an integration of urban and rural life.

Despite the fact that such reformist trends were creating an audience for a specific type of science popularisation; and, despite the fact that many leading popularisers of the day were part of this movement, calling for a new type of science, and were involved in 'new' sciences in which the public were interested, London-based publishers were slow in adopting a new approach to the popular science series. As has been argued in chapter 3 Ellis's flourishing'Contemporary Science Series' indicated the direction in which such series could find a receptive market. It was left to the ingenuity of the Scots , however, to promote the 'new' sciences in a truly democratic form.

4 - The Scottish impetus.

In terms of education, the Scots differed from the English in two main ways. Firstly, and most famously, the Scots nurtured an educational tradition which has been termed democratic, but which was, perhaps, more literally meritocratic in operation. The Scottish system from the early nineteenth century onwards enabled boys from all sections of society to acquire the elementary three 'R's; and a small number of boys from poorer backgrounds to go forward to more advanced study.

The second manner in which Scottish education differed from that found in England, was that because Scottish universities were open to a wide variety of students from different family and educational backgrounds, they offered a much broader, less specialised education than was offered in England and on the Continent.(21)

These Scottish educational traditions had an impact on the popularisation of science in the Edwardian era, when the Edinburgh-based publishing company of T.C. and E.C.Jack became prominent for the promotion of science through two series, 'Jack's Shilling Scientific Series', and the 'People's Books'. Both these series differed slightly from English popular science series in that, drawing on Scottish educational traditions, they saw nothing strange in offering up-to-date, topical information on a wide range of subjects to a lower-class audience through such series of educational books promoting self-help. In England, education beyond the elementary level, had traditionally been the preserve of a privileged elite, and consequently, a different, more elitist attitude prevailed in England towards the promotion of knowledge among the poorer sections of society. An attitude which assumed that, where social and political issues were concerned, it was better not to encourage debates among the lower-classes. For example, there was nothing remotely similar in England in the 1860s, to the Scottish publisher, W.R.Chambers' 'Social Science Tracts'. These were published every three months, and were edited by Chambers himself, to

"disseminate useful information among the working-classes, on subjects connected with Social, Political, and Sanitary Economy".(22) Such texts were in fact intended, in a paternalistic manner, to persuade the working-class that progress lay in cooperation rather than in confrontation. This was a Scottish theme that the Jacks, at the beginning of the twentieth century, were also keen to promote.

The Jacks launched their 'Shilling Scientific Series' in 1905. Titles in the series tended to deal with topical subjects such as Flying machines, Radium, and Spiritualism. Five texts in the series were contributed by C.W.Saleeby, and these dealt with socio-biological subjects, ranging from Heredity to Sociology. Because Saleeby contributed approximately half of all the books in the series, the series itself seems to have become a vehicle for the promotion of Saleeby's own world-view.(23) In general, the texts in this series were informal in style, and offered accessible knowledge on topical subjects. They all shared an enthusiastic optimism that, with science to guide the way, a better and brighter future was in store for mankind. With the not yet fully realised potentialities of aerodynamics, radium, eugenics, spiritualism etc., this series offered a semi-Utopian vision of the benefits science was about to produce. This unqualified optimism was, perhaps, the most characteristic component of the popularisation of science in the Edwardian era. It was to be found in the writing of H.G.Wells at this time(24), and reflected a widespread faith in this-worldly progress through man's willed intervention in evolution.

Building on the success of their 'Shilling Scientific Series', Jack launched the 'People's Books' in 1912, as a series of introductory texts with sections covering science, religion, history, social and economic issues,and literature, all priced at 6d. a copy, which continued until 1922 with the publication of 152 texts. The series intended to exploit the public's interest in topical subjects, as a self-publicising addendum

to one of the texts made clear, since:

> "Of the manufacture of reprints of the works of the great writers there has been no end. Reprints represent in the main the work of the last generation. Their value no one questions, but we live in a world that moves on, and moves rapidly, to the conquest of new knowledge. More rapidly than of yore, therefore, the old standards become antiquated, while the conditions of modern life demand at every turn some acquaintance with the most recent results of investigation."(25)

What was truly novel, however, about the 'People's Books', was not merely its concern with up-to-date knowledge, but rather its breadth of subject matter and its targeted breadth of audience, qualities which, when combined, were peculiarly Scottish. For example, at approximately the same time as the 'People's Books' were launched, the London-based publishers Williams and Norgate had launched their own non-fiction series entitled 'The Home University Library', edited by H.Fisher, Gilbert Murray and J.A.Thomson , covering similar subject areas, but with editions priced more expensively at 2s.6d. for leather bound display copies, and 1s. for cloth bound copies. With such prices Williams and Norgate were clearly not making as great an effort as the Jacks to widen the non-fiction market.

On 10 February 1912, just prior to the launch of the 'People's Books', Messrs. Williams and Norgate threatened Messrs. Jack with an injunction to revoke their planned series.(26) A few days later Robinson, one of Jack's distributors, responded to this news as follows:

> "..as to our series being an imitation of the Home University Library, I have carefully impressed the fact that the latter library is essentially for students; whereas our books are more simple and intended for the 'man in the street'."(27)

The differing titles of the two series would indeed suggest this distinction between a more advanced 'university' level audience, and the more accessible 'People's Books'. The threatened injunction was dropped. In fact, however, despite the best intentions of Messrs. Jack, the'People's Books' were not

as distinct from 'The Home University Library' in style and content as they might have been. This was because both series tended to draw on academically trained specialists for their authors, and, therefore, texts in both series shared a rather large vocabulary, tending to the use of long latinate words, which an audience with only a basic, elementary education behind them would have found a little difficult to follow. In both series, however, concessions were made to the new journalistic style, with shorter sentences, a freer use of colloquialisms, and a relaxing of the scholastic genre in evidence. Furthermore, the similarity in subject matter between the two series led to some embarrassing situations, as when the two series both released a text on Buddhism within a few months of one another, one written for the 'People's Books' by Professor T.W.Rhys Davids, and the other for 'The Home University Library' written by his wife Mrs. Rhys Davids.(28) The competition between the two series continued in the bookshops via promotion gimmicks such as bookcases.(29)

The 'People's Books' were, however, differentiated from 'The Home University Library' by their small size and inexpensive price, and, indeed, these two factors had, at first, led to a lukewarm reception for the series among booksellers who evidently felt that such texts weren't quite up to the classification of books, "being too small", having only approximately ninety pages as opposed to the 'Library's' advertised 256 pages.(30) Indeed, it is quite clear that it was only wholesale buyers such as W.H. Smith and Simpkins which allowed the 'People's Books' to break even in financial terms, for such purchasers would place orders to buy 150 volumes of each book at 4s.6d. for thirteen books less ten per cent; whereas ordinary booksellers would not order more than four volumes of each book at a time.(31) Thus, the presence of large wholesale buyers was obviously crucial in economic terms for the launching of such a series of small, inexpensive books.

On the other hand, because of the size of the books, a new distributing

outlet was open to Messrs. Jack, that of the newsagent, which helped to make the texts much more accessible to the less privileged reader. This was possible because of a new wholesale policy, by which some newsagents could be sent supplies of the books to a central office and then await orders from provincial branches; for, obviously, if the company's travellers had had to visit each individual newsagents to distribute books on a sale or return basis, the whole project would not have been economically feasible.(32)

The editor of the 'People's Books' was H.C.O'Neill, who has been credited as the man who projected as well as edited the series.(33) Prior to his position as an editor and literary advisor for T.C. and E.C.Jack, O'Neill had been a journalist working for one of the big new national papers, The daily mail, and this background of catering for a mass, literate audience obviously qualified him for the role Messrs. Jack required the editor of the 'People's Books' to fulfil. They were personally preoccupied with getting 'serious' books to the 'better sort' of working people, who, for example, attended "the better class Working Men's Institutes at which drinking was prohibited."(34)

Messrs. Jack, probably for personal reasons, linked their series with working-class temperance. Such a move was, however, shrewd in economic terms, for there does appear to have been a sociological connection between serious reading, science and temperance. This connection was emphasised in Rowntree and Sherwell's best-selling late Victorian text, The temperance problem and social reform, first published in 1899, in which part of the positive solution to alcoholism was to promote both reading rooms, and popular science lectures.(35)

This connection between sobriety and science is given further reinforcement by a recent conclusion that,

> "The Temperance Movement played an important part in the process of self-improvement and of enabling working-class people to become respectable."(36)

The avenue to respectability provided by teetotalism and 'serious' reading was a common social phenomenon in the Edwardian era, which is, perhaps, most famously recorded in D.H.Lawrence's novel Sons and lovers. Thus, at the beginning of the twentieth century, popular science appears to have been part of a method of cultural advancement for the 'better sort' of working-class people as, indeed, it had been in the late Victorian era. But, in the Edwardian era, this method of self-improvement was facilitated by the arrival of better quality, inexpensive books in newsagents. It is known, for example, that 'serious' books were only purchased from newsagents in prosperous 'get ahead' working-class districts, such as Harpurhey in Manchester where, in an early sociological survey, J.Haslam found that:

> "..compared to Ancoats, Holme and Lower Salford, that youths and young men here go more in for book-buying, for the purchase of self-educators and encyclopaedias in weekly, fortnightly and monthly parts, for the paperbacked sixpenny novels, and nature studies and general history published in instalments at sixpence and sevenpence a time."(37)

In other words, the fact that the Scottish-based publishers, Messrs. Jack published a series emphasising science, marketed for a wide audience, but did not wish the texts to be disseminated at intemperate working men's clubs is not surprising, and offers an added insight as to the marketability of popular science books among a certain, more prosperous section of the working-class, who were concerned with social advancement.

Bearing in mind this targeted breadth of audience, the series editor, O'Neill, concentrated on four main features for the series when promoting it. Firstly, it should cover the whole field of modern knowledge; secondly, each volume should be written by an authority on each particular subject; thirdly, the literary style should offer easily accessible information; and, finally, at the end of each text there must be a bibliography for further reading in the subject. These aims set out in a prospectus(38)

were satirised in Punch, 21 February 1912, as follows:

> "The best pens for the best perusers at the lowest figure. The maximum of mental pabulum for a minimum of financial outlay. Such books are those which Messrs. A.B. and C.D. Jill are issuing under the title of 'The More Than Andy Books' at a farthing each, bound in cloth. The name of the series has been carefully constructed not only to suggest extreme portability and convenience but to indicate that people need no longer wait for Mr. Andrew Carnegie to endow a free library, because at the low price of a farthing each they can get for themselves all the books they want."(39)

Thus, the two novel features caricatured by Punch were the low price (the books actually sold for 6d. each) and the projected breadth of audience. And, indeed, it was the inexpensiveness of these modern texts, combined with their non-patronising accessibility at an elementary level, which marked such a sharp break in the presentation of non-fiction series which the working-classes were encouraged by the publishers to buy. The books in the series were published in batches of a dozen, approximately twice a year; and, because of their radical departure in terms of price, topicality and width of audience it is worth examining their content in some detail.

From the perspective of the popularisation of science, one of the features of the series was its inclusion of reproductive biology as a topic for exposition. Indeed, some of the contributing authors obviously found it odd that their biological specialisms should be tackled at such an elementary level. For example here is how Gerald Leighton began his text Embryology, published in 1912:

> "What is embryology, and what is its significance or interest to the ordinary, educated man and woman? The answer to the question is the justification for the appearance of the following pages and one may regard it as a somewhat striking fact, that in a production of a series of works of which this volume is one, those responsible should have deemed it advisable to include Embryology."(40)

The text appears to have been assigned in order to prepare the gound for J.A.S.Watson's text Heredity, published the same year, which concluded in a eugenic tone, "the essential thing is that some process of artificial selection should be set on foot."(41) Indeed, the reviewers in the periodical Notes and queries, were most unhappy about the issue of eugenics being promoted by such a popular text, marketed for such a wide audience, saying:

> "We could have wished that in a popular work like this [Watson] had refrained from touching on the extremely difficult and complicated question of eugenics."(42)

Another interesting component of the science section of the 'People's Books' was the promotion of the belief that science was not a utilitarian pursuit, a point that needed to be made at a time when the significance of science itself was being increasingly eclipsed by the wonders of rapid technological advance. For example, E.W.Maunder in his book The science of the stars, published in 1912, asked:

> "What is the good of astronomy? The question is often asked, but it is the question of ignorance. The use of astronomy is the development which it has given to the intellectual powers of man."(43)

This presentation of pure science as non-utilitarian was mocked by the insensitive reviewers of Notes and queries who quipped that:

> "As if writing for the uncultivated, Maunder pauses again and again, to vindicate from the charge of foolishness the pursuit of apparently useless knowledge."(44)

The need to present pure science in this way, however, was precisely because the 'People's Books' was a series aimed at the uncultivated, in the sense that the audience was assumed not to have had the benefit of a liberal higher education.

One of the other emphases of the series was the contemporaneity of the subject matter and, of course, science by its very nature offered a wealth of decidedly modern knowledge; however, although science, possibly for that very reason, was the leading subject section of the series, other

texts in different sections offer an indication of the 'People's Books' topical scope. For example, politically the series appears to have been New Liberal/Fabian, supportive of the suffragist movement, but disdainful of the more radical suffragettes, supportive of working-class collectivism via trade unions, the Cooperative Movement, and, to a lesser extent, syndicalism, so long as such collectivism was not revolutionary and accepted the parliamentary path to social change. Such bias, however, was not presented as being in any way scientifically determined (as had been much of the social and political content of the C.S.S.). Rather, the definition of science in the 'People's Books' appears to have been limited to subjects dealing with the tangible parts of the natural and technological world, as opposed to the realm of ideology or beliefs about social issues. Thus, subjects as diverse as radiation, aeroplanes, food, sex, or pregnancy came under the heading science, but subjects such as socialism or child-rearing did not, as they would have done in the large, influential series of the late Victorian era. Under the impact of professionalisation subject demarcation was becoming narrower during this period (see chapter 1). The definition of science under which the 'People's Books' operated was presumably determined by the editor O'Neill, since the series was planned ahead, systematically, with the subjects chosen first and the authors then being found to write the required texts, for which they were paid £75 for 50-75,000 words (45) at a time when the annual average earnings of employed men and women of all ages was £80.(46)

The series was intended to promote a New Liberal viewpoint, as well as offering a wide readership the opportunity of gaining a higher level of education, and conflicting texts do not appear to have been part of editorial policy; rather the texts were supposed to complement each other in educating the people to want a consensual society, rather than the increasingly conflict-ridden one which was emerging in Edwardian Britain. Indeed, at the time that the 'People's Books' were launched, the "biggest strike Britain had ever seen,"(47) was occurring on the coalfields to secure a

national minimum wage. Thus, somewhat ironically, and to the disappointment of Messrs. Jack, sales for the 'Books' in the north of England did not go as well as planned, for, as one of the firm's travellers said:

> "It is unfortunate that the Coal Strike has come with the first publication of the 'Books' , for the masses have barely sufficient money for food to the exclusion of books and other luxuries, and we must hope for their purchase when times are better."(48)

The venture did, however, break even in financial terms, but did not prove profitable enough to keep the company afloat, for on 17 January 1916, an amalgamation took place, through which Jack became a limited company in association with Messrs. Nelson, with T.C. and E.C.Jack becoming directors of the company instead of partners as previously.(49) Nelson's decided to keep up the 'People's Books', since, as one of the directors G.M.Brown said, "the 'People's Books' have at any rate paid their way."(50) And, indeed, under Nelson's ownership, through the directorship of *John Buchan*, the series continued until 1922 although in a new, less partisan direction, with controversial topics intentionally tackled by the "detached observer".(51) A far cry, indeed, from the initial launch of the series in 1912, when it had been noticed that it did not "restrict itself to subjects scientific or historical which may be studied dispassionately."(52)

Through their series the 'People's Books', Messrs. Jack, drawing on their Scottish background, had not been afraid to tackle controversial issues for a wide readership in order to help form public opinion, thereby offering the most democratic(53) form of science popularisation through books, that Britain had witnessed for decades, since, in fact, the efforts of the Society for the Diffusion of Useful Knowledge in the 1830s and 1840s. Of particular importance was their radical departure in terms of distribution for in establishing newsagents as sales outlets, Messrs. Jack had helped to pave the way for the paperback revolution of the 1930s.

One English series that shared the 'People's Books' aim of educating the reader to a New Liberal viewpoint was the seven volume series 'Popular

Science', published between 1912 and 1913 by the Amalgamated Press. The series was one of the several Harmsworth serials, initiated and sponsored by Alfred Harmsworth (see above), and it was edited by Arthur Mee, a journalist who had worked for George Newnes (see above) contributing articles to Tit-bits, before joining the staff of the Daily mail at the request of Harmsworth who had heard, and appreciated the significance, of the system of 250,000 cross-indexed, press-cuttings which Mee had built up. Mee's organisational ability and his encyclopaedic knowledge made him an obvious editor for Harmsworth's educational serials.

'Popular Science' was presumably published in weekly or fortnightly parts to be collected into seven volumes. Each part was comprised of twelve sections as follows: 1, the universe (i.e. cosmology), 2, the earth (i.e. geology), 3, life (i.e. evolution), 4, plant life (i.e. botany), 5, animal life (i.e. zoology), 6, man (i.e.psychology), 7, health (i.e. physiology, dietetics etc.), 8, power (i.e. engineering), 9, industry (i.e. technology), 10, commerce (i.e. economics), 11, society (i.e. political theory and sociology), and finally, 12, eugenics, "the new science that would control the future and create a nobler race."(54) Thus, each part of the serial chronicled evolutionary progress, first in terms of the universe, then in terms of life itself, then through man's development, penultimately charting the progress of the industrial nations (pausing occasionally to criticise militant left-wing activity for being divisive), before finally suggesting how, in terms of social imperialism, Britain could remain 'ruler of the waves'.

Each part of the serial bears the editorial mark of Mee, a man who has been described as the "master of the forceful slogan"(55), and who appears to have added catchy section headings, in the manner of a newspaper editor, to the articles contributed by the authors of the project. The headings were not integrated into the flow of the text, and appear to have been added at Mee's editorial discretion to spice up the exposition of the contributing authors. For example, in part one of the serial in the section

on health, the following heading is to be found:

> "The healthy man who goes through danger with almost a charmed life."

This heading was culled from the following piece of exposition which it introduces :

> "Yet, though possibly dangerous microbes exist in our mouths and throats and elsewhere, and though we are ever swallowing and inhaling new doses of them, we are mostly unhurt; and the healthy man walking through all the dangers bears what is almost a charmed life. Him only the most virulent can touch."(56)

Interestingly, a large number of the credited contributing authors to this venture were Scottish, and had contributed volumes to the Jacks two main popularising series, the 'Shilling Scientific Series', and the 'People's Books'. These were authors such as C.W.Saleeby (57), Gerald Leighton, professor of pathology and bacteriology at Edinburgh University, and R.C.Macfie, a biologist with an academic position at Aberdeen University. Bearing in mind H.C.O'Neill's connection as an editor for Jacks, who had originally worked as a journalist for Harmsworth's Daily mail, there appears to have been a population of predominantly Scottish science popularisers in the Edwardian era used by a network of series editors who had a background in the new mass journalism. Exactly why this group of Scottish academics should have been so widely commissioned at this time is not clear. One tentative hypothesis could be that because of their differing educational traditions, Scottish universities did not attach as great a social stigma to mass market popularisation as did English universities.

5 - Conclusion.

During the Edwardian era, the popularisation of science through series was stylistically influenced by an increasing awareness on the part of

publishers, of the needs of an increasingly literate society. Even the most inexpensive books, which aimed at a broad audience, seemed prepared to assume a degree of maturity and egalitarianism in that audience (through the use of a less formal type of writing) than had the late Victorian series. In other words, as the formal scholastic genre, with its childhood associations of school was used less and less, inexpensive texts became less patronising, and more comparable in content and tone with the more expensive middlebrow series. London based publishers such as John Murray and George Newnes were still, however, at the beginning of the century, rather conservative in their choice of scientific topics for such series. It was, as has been argued, left to the innovating enterprise of the Edinburgh based publishers, T.C. and E.C.Jack, to establish the breadth of an interested audience in non-fiction, and this they did by tackling the more controversial sciences, as well as providing expository texts on fashionable philosophers such as Nietzsche and Bergson(58), and by presenting a coherent political position through texts on social and economic issues. In practical terms, the use this publisher made of newsagents as a sales outlet was, perhaps, the most innovating step in broadening the audience for such up-to-date non-fiction series.

The involvement of press barons like Newnes and Harmsworth in the popularisation of science at this time, along with a new trend which established mass journalists like H.C.O'Neill and A.Mee as editors for popular non-fiction series, indicates the extent to which, in the Edwardian era, entrepreneurial control of popularisation appears to have been taken out of the hands of established science publishers such as Murray and Macmillan, who through their special relationship with late Victorian public scientists had dominated the popularisation of science through books in the 1870s and 1880s .

In the main, the contributing authors to the series mentioned in this chapter, were academically trained specialists. Yet, the popularisers

who showed a flair for communication in this period tended either to be of amateur/generalist status (such as Edward Carpenter and Havelock Ellis) or they were professional scientists with an interest in the deviant or fringe sciences, such as O.Lodge, who was an enthusiast for spiritualism, or J.A.Thomson and W.C.D.Whetham, who were involved in the eugenics movement. One of the few major exceptions to this general rule was the astronomer E.W.Maunder, a professional scientist, with a skill for popularising his own subject. It could be argued, however, that he only came to the fore as a disputant in the 'fringe' controversy over Mars, which caught the public's attention at this time. Thus, it seems fair to draw the conclusion that, on the whole, high science was socially weak during this period, relying on the interest and support of the denizens from the new mass journalism to maintain its social profile. The consequent prominence of 'fringe' and deviant sciences at this time was part of this phenomenon.

All popularisers of this period, however, together with editors of non-fiction series, shared an optimism in the progressiveness of science that was semi-Utopian in scope. This belief in progressivism, differed from that which was prevalent in the late Victorian era in that it became divorced from 'scientism' in the Edwardian era. For, with increasing professionalisation and specialisation, along with the demands being made by a more democratic and secular audience, science became a more separate and distinct category within series. This reflected the perception that science was a group of 'value free' specialisms distinguished from social, economic and political topics. Consequently, science was increasingly presented as a 'value free' tool for the solution of social, economic and political problems. As the following chapter demonstrates, this gradual shift in emphasis can be seen most clearly in the popularisation of one of the most fashionable of scientific topics of the Edwardian era, eugenics.

Footnotes

1 - D.Hudson, 'Reading', in, S.Nowell-Smith (ed.), Edwardian England, 1901-1914, London, 1964, p.309.

2 - P.Thompson, The Edwardians, London, 1975, pp.206 and 251.

3 - J.M.Dent, Memoirs, London, 1928, p.123.

4 - Advancement of science, 1946-8, 4, pp.33-6, quoted in, W.H.Brock, 'Advancing science: The British Association and the professional practice of science', in, R.MacLeod and P.Collins (eds.), The parliament of science (The B.A.A.S., 1831-1981), Northwood, 1981, pp.89-118, p.109.

5 - A.R.Ubbelohde, 'Science', in, S.Nowell-Smith, Op. cit. (1), pp.213-51, p.223.

6 - D.Read, Edwardian England 1901-15, society and politics, London, 1972, p.60.

7 - Some of the food had been stored irresponsibly causing a local environmental crisis in which wasps had grown to a gigantic size.

8 - H.G.Wells, The food of the gods and how it came to earth, London: Macmillan and Co., 1904 (1920 reprint), pp.102-3.

9 - My own survey using the English catalogue of books from 1871-1906. See bibliography for list of series surveyed.

10 - The period for which I have information.

11 - T.G.Bonney, Volcanoes, London: Murray, 1899, p.55.

12 - Various authors, Hutchinson's concise natural history, London: Hutchinson, 1897, p.281.

13 - Agnes M. Clerke, A.Fowler, J.Ellard Gore, Hutchinson's concise astronomy, London: Hutchinson, 1898, p.305.

In the mid-1870s, Schiaparelli's reporting that he had seen 'canals' on Mars fanned public and amateur interest in the possibility of life on Mars; an interest which continued into the Edwardian era, arguably fuelled by controversy between amateur and professional astronomers over the control of speculative hypotheses.

See, N.S.Hetherington, 'Percival Lowell: Professional scientist or interloper?', Journal of the history of ideas, 1981, 42, pp.574-582.

W.F.Heffernan, 'Percival Lowell and the debate over extra-terrestrial life', Journal of the history of ideas, 1981, 42, pp.159-161.

14 - F.E.Hulme, Wild fruits of the countryside, London: Hutchinson, 1902, editor's preface.

15 - Ibid., p.1.

16 - See chapter 4, especially the section on Brightwen.

17 - Anon., 'Aims of the new fellowship of life', The sower, 1889, 1, p.4.

18 - Various authors, Humane science lectures, London: G.Bell and sons, 1897, preface.

19 - E.Carpenter, 'The need for a rational and humane science', Ibid., p.27.

20 - H.Roberts, The tramp's handbook, London: Lane, 1903, p.2.

21 - T.C.Smout, A century of the Scottish people, 1830-1950 , London, 1986, pp.209-30.

22 - W.R.Chambers, Political and social economy in relation to the working-class, Edinburgh: Chambers, 1864, preface.

23 - See chapter 6, section on C.W.Saleeby.

24 - W.Bellamy, 'Wells as Edwardian', in, B.Bergonzi (ed.), H.G.Wells: A collection of critical essays, New Jersey, 1976, pp.83-110.

25 - W.D.Henderson, Biology, London and Edinburgh: T.C. and E.C.Jack, 1913, addendum.

26 - Letters from Robinson to Jack, No.9, 10 February 1912, Nelson archives, University of Edinburgh.

27 - Letters from Robinson to Jack, No.10, 13 February 1912, Nelson archives University of Edinburgh.

28 - Letters from Robinson to Jack, No.10, 24 April 1912, Nelson archives, University of Edinburgh.

29 - Letters from Robinson to Jack, No.11, 20 April 1912, Nelson archives, University of Edinburgh.

30 - Letters from Robinson to Jack, No.9, 9 January 1912, Nelson archives, University of Edinburgh.

31 - Ibid., 9 January 1912, and 27 January 1912.

32 - Ibid., 6 February 1912.

33 - 'H.C.O'Neill', in ,Who was who, vol.5.

34 - Letters from Robinson to Jack, No.10, 27 March 1912, Nelson archives, University of Edinburgh, (my emphasis).

35 - J.Rowntree and A.Sherwell, The temperance problem and social reform, London: Hodder and Stoughton, 1900.

36 - W.R.Lambert, Drink and sobriety in Victorian Wales, c.1820-c.1895, Cardiff, 1983, p.253.

37 - J.Haslam, The press and the people, Manchester: City news office, 1906, p.4.

38 - Op. cit. (25) , self-advertising addendum.

39 - O.Seaman, Punch, 21 February 1912.

40 - G.Leighton, Embryology, London and Edinburgh: T.C. and E.C. Jack, 1912, p.7.

41 - J.A.S. Watson, Heredity, London and Edinburgh: T.C. and E.C.Jack, 1912, p.89.

42 - Notes and queries, 16 March 1912.

43 - E.W.Maunder, The science of the stars, London and Edinburgh: T.C. and E.C.Jack, 1912, p.41.

44 - Notes and queries, 23March, 1912.

45 - To G.M.Brown from J.Buchan, Buchan correspondence, 27 June 1916, Nelson archives, University of Edinburgh.

46 - Op. cit. (2), pp.13-14.

47 - G.D.H.Cole and R.Postgate, The common people, 1846-1946, London, 1961, p.488.

48 - Op. cit. (27), 26 March 1912.

49 - T.C. and E.C.Jack publishers 1910-1916, 17 January 1916, Sov. Coll.91, University of Edinburgh.

50 - Op. cit. (45), To J.B. from G.M.B., 11 January 1916.

51 - Ibid., To J.B. from G.M.B., 28 April 1916.

52 - Notes and queries, 14 September 1912.

53 - 'Democratic' in terms of an egalitarian approach to marketing for the widest possible readership. Of course in the classic definitions of democracy (cf. Plato,Aristotle and Rousseau) the intellectual opinion-maker does not have a valid role, and in these terms the popularisation of any subject is undemocratic.

54 - A.Mee (ed.), Popular science, vol.1, London: Amalgamated Press, 1912, p.7.

55 - H.Tyerman, 'A.H.Mee', in, Dictionary of national biography

56 - Op. cit. (54), pp.68-9.

57 - See chapter 6, section on C.W.Saleeby.

58 - The text on Bergson was the bestseller of the 'People's Books'. Letters from Robinson to Jack, No.10, 24 April 1912, Nelson archives, University of Edinburgh.

CHAPTER 6

THE POPULARISATION OF EUGENICS IN THE EDWARDIAN ERA.

1 - Introduction.

So far it has been argued that public science popularisation in the late Victorian era targeted at a middlebrow audience was concerned to contribute,via scientific exposition, to the many social and cultural debates of the era, concerning secularisation, education, professionalisation and politics, while some of the most prolific popularisers who opposed public science attitudes, kept direct references to such debates to a minimum, but made the spiritual dimension of the natural world integral to their writings. In the Edwardian era, this public science type of popularisation, relating science in a 'progressive' way to social and cultural issues and stressing its utilitarian value, came to dominate the presentation of science in general non-fiction series, as has been shown in the previous chapter, while the natural history series, on the whole, remained committed to the popularisation of a spiritual and aesthetic appreciation of nature. Furthermore, whereas in the late nineteenth century, the semi-literate lower-class reader had been marketed traditionally popular scientific subjects like geology, chemistry and so on, by the early twentieth century, series such as the'People's Books' were conveying public science images and attitudes to an audience that was much broader than the enfranchised classes of the typical late Victorian middlebrow audience.

It will be argued in the present chapter that the late Victorian public science notion that scientific education and thought had an important role to play in political and civic life, became a central tenet of popularisation in the Edwardian era. In terms of fashionable scientific topics for popularisation through books, eugenics predominated at this time,

as the previous chapter indicated, and therefore provides an obvious focus for an examination of popularising attitudes in this period. Turner has gone so far as to claim that:

> "Eugenics was the single theoretical development actively exploited by turn-of-the-century public science."(1)

After a brief history of the eugenics movement in Britain, the rest of this chapter will explore the accuracy of this claim in terms of the popularisation of six eugenicists in the Edwardian era, in the context of their relationship with the Eugenics Education Society (hereafter E.E.S.), a society which was dedicated to the popularisation of eugenic information.

2 - A brief history of the development of eugenic beliefs.

The term 'eugenics' entered the English language in 1883 with the publication of Francis Galton's book Inheritance of human faculties, where he claimed that talent was an inherited faculty passed on within families. Taken from the Greek language, Galton defined the subject in 1909 as, "the science which deals with all influences that improve the inborn qualities of a race; also with those that develop them to the utmost advantage."(2) Eugenic ideas were not associated with science, however, until the Edwardian era.

Yet, there were plenty of ideas current in late Victorian Britain conducive to Galton's ideas. For example, a staple constituent of education at this time was the classics, and most people who considered themselves to be educated would have been familiar with Plato's Republic, in which Plato's foundation myth had, as can be seen from the following quotation, many similarities to the ideas espoused by Galton:

> "..when god fashioned you, he added gold in the composition of those of you who are qualified to be Rulers (which is why their prestige is greatest); he put silver in the Auxiliaries, and iron

and bronze in the farmers and other workers..

..there is a prophecy that the State will be ruined when it has Guardians of silver or bronze."(3)

Plato's Republic,however, did not become pertinent in a practical political sense in Britain, until the Edwardian era, when the state was expanding, society was becoming centralised, and when some form of collectivism seemed part of everybody's notion of common sense.(4) Therefore, some intervention in the individual's life seemed justified as 'the best thing for society'. Until this assumption, which was in direct opposition to most Victorian thought, existed,eugenics could not thrive.

An example of the change in attitude away from laissez-faire individualism can be drawn from a comparison of eugenics with the subsidiary hereditarian ideas implicit in phrenology in the early Victorian era. It has been convincingly argued by V.L.Hilts, that "the phrenologists were the most important popularisers of hereditarian ideas before the emergence of Social Darwinism and eugenics."(5) G.Combe in his Constitution of man, for example, promised parents that their own efforts at self-improvement would be rewarded in their offspring, and J.L.Levinson published a lecture, in 1839, on the hereditary tendency to drunkenness. In all, Hilts concludes, phrenologists shared with eugenicists the conviction that the key to human progress lay in the improvement of man's biological endowment by attention to breeding, and both feared the possibility of racial degeneration. Phrenologists, however, would only go so far as to advise individuals of their moral duty as regards parenthood, they would not have dreamed of coercing individuals through legislation as many eugenicists later tried to do. Thus, phrenology illustrates that the framework of politically acceptable ideas had changed considerably from the early years of Victoria's reign to the first decade of the twentieth century. Phrenology also left a neat legacy of hereditarian ideas on which eugenics could draw. Both Galton and Spencer were influenced by phrenological ideas.

Other key intellectual predecessors for eugenics were Malthus' ideas on population control, and Darwin's theory of evolution. Both thinkers influenced Spencer and Galton. As synthesised by Spencer, however, the work of these two thinkers contributed to laissez-faire beliefs, since Spencer felt that no individual could hope to counter the great evolutionary forces shaping man and his society, since:

> "A true theory of social progress is not a cause of movement but simply oil to the movement (sic) serves simply to remove friction. The force producing the movement is the aggregate of men's instincts and sentiments, and these are not to be changed by a theory."(6)

Galton, however, viewed things slightly differently as he was more of a conservative and was less optimistic than Spencer of the inevitability of progress. Therefore, he felt that scientific principles should form the basis for social organisation in order to maintain the status quo of class differentiation. From this perspective intervention based on scientific theory was legitimate, for:

> "..we may not be able to originate, but we can guide. The processes of evolution are in constant and spontaneous activity, some towards the bad, some towards the good. Our part is to watch for opportunities to intervene by checking the former and giving free play to the latter."(7)

Thus, from its inception in British culture, eugenics was built on a belief that political intervention in societal processes, when instigated by scientific principles, was a legitimate act. Consequently, eugenics would appear to be a subject ripe for public science popularisation. Public science interest in eugenics was increased by the concerns of social imperialism.

Such concerns were fuelled by the surveys of both Booth and Rowntree in the 1880s, which had established the gigantic proportions of the problem of poverty in the inner cities of Britain. This problem was given a heighten-

ed social profile with the British loss of face in the Boer War, which suggested to many that the poorer classes were affecting the health of the Empire, since they were not physically fit enough to defend it. For the first time there was statistical evidence to show the social and physical effects of poverty, and eugenics offered one possible solution to the problem. For by discouraging the 'undeserving' poor from having children, eugenicists were convinced poverty would decrease generation by generation, and the nation as a whole would become fitter and better able to defend her'place in the sun'. In other words, the Biblical saying that the sins of the fathers would be visited upon their sons was being given hereditarian validation. At a scientific level, three theories emerged in the Edwardian era which lent eugenic beliefs credibility.

Firstly, Weismann's theory of the continuity of the germ plasm denied that acquired characters could be transmitted (and therefore environmental solutions to social problems were questionable). He also claimed that the whole burden of organic progress should be laid upon germinal variation and processes of selection. Secondly, the rediscovery in 1899 of Mendel's famous paper establishing the importance of what came to be termed dominant and recessive genes in the discontinuity of variation. Thirdly, the development of Biometry (the application to biological phenomena of precise and, for the period, sophisticated statistical techniques) suggested that variability could be measured in a given population, and therefore had the potential to show the direction of evolution, and the way in which selection was operating.(8) These three theories indicated the potential of biological knowledge to shape human society genetically.

Thus among the key factors enabling eugenics to become a major social force in the Edwardian era were: Plato's social ideals, the legacy of phrenology, collectivism, social imperialism, Weismannism, Mendelism, Biometry, and the success of Victorian public science in establishing the potential social authority of scientific principles.

The opening decade of the twentieth century witnessed a quest, among many intellectuals, for a unifying principle which would interpret and direct human progress. This search for general laws by which society could be reformed, was part of the optimistic new liberalism, typified in the political writings of the Fabians, Sidney Webb and Graham Wallas and of the liberal thinkers, Hobson and Hobhouse.(9) This search became institutionalised with the founding of the Sociological Society at the London School of Economics in 1904. This society was dominated by three thinkers, L.T. Hobhouse, who wanted sociology to synthesise the varieties of social phenomena by means of a theory of social evolution; Patrick Geddes, whose sociology started with detailed surveys of geographical origins and cultural histories of cities, leading from empirical studies to theoretical explanations; and Francis Galton, to whom social welfare meant eugenic management. These three schools of thought are more commonly known by the labels 'social work', 'civics', and 'eugenics'; and it is the latter two which are of interest to the present chapter.

As environmentalists Geddes and his followers argued that a rational civic atmosphere was bound to produce rational citizens, since the character of an organism (analagous to the state) determined the nature of its parts.(10) Geddes, however, was prepared to accomodate eugenics within this framework, and the definition Galton employed in 1909, which opens this chapter section, suggests the compatibility between the two schools. Working on Geddes' belief in the importance of both nature and nurture for the individual, the zoologist J.A.Thomson popularised a synthesis of civic and eugenic ideas in his expositions of biology. The eugenicists, however, were at variance with the civic and social work schools in that they wished to control the Sociological Society and use it to promote eugenics; instructing sociologists to collect facts that would demonstrate hereditarian laws, and then to disseminate eugenic programmes based on those facts.(11)

In 1906, L.T.Hobhouse took the first British chair in sociology at the London School of Economics; and in 1907 he became editor of the new periodical, the Sociological review. Consequently, the eugenicists split from the Sociological Society to form their own national Eugenics Education Society, the E.E.S., in 1907, and in the same year started their own periodical, the Eugenics review. Whilst the E.E.S. was proving instrumental as a pressure group in the years leading up to the Great War (to the extent that eugenic ideas formed the basis of the 1913 Mental Deficiency Act, and two other bills concerning the education of defective children and the control of inebriates, which were never passed because of the outbreak of war (12)), Galton and Pearson were busy establishing eugenics as an academic discipline.

In 1895 Pearson, as Goldsmid professor of applied mathematics and mechanics at University College, London, gave his first course on the mathematical theory of statistics to two or three postgraduates. This course became an annual event, and as the number of students taking it grew, the 'Biometric School' came into being. In 1903 the Drapers Company gave Pearson a grant which became fixed at £500 per year, allowing Pearson to establish the Biometric Laboratory at University College. In 1904 Galton gave £1,500 to the University of London for three years scientific study of eugenics, and so the Eugenics Record Office was established in Gower Street, with Edgar Schuster appointed as research fellow, and Galton as director. In 1906 Schuster resigned in order to undertake more purely biological work, and in the following year control of the office was handed by Galton to Pearson so that it might be run in contact with the Biometric Laboratory. In 1911, part of the financial legacy of Galton's will was used in accordance with his wishes to establish a Galton Laboratory and a Galton Eugenics Professorship in the University of London. Karl Pearson thus became Professor of Eugenics at University College, allowing him to resign from the Goldsmid Chair of Applied Mathematics. In October of that year Sir Herbert H.Bartlett

provided funds to build laboratories on Gower Street, which were finally completed in 1914.(13)

Thus, on the one hand the E.E.S. was thriving as a pressure group, and on the other the future looked bright for the academic research of eugenic issues. The relationship between the E.E.S. and the Biometric School was strained, however, by the Biometry/Mendelism debate.

In Britain, the Cambridge geneticist William Bateson was the key proponent of Mendelism, while Pearson was, as we have seen, the founder of Biometry. In actual fact, there was no inherent scientific incompatibility between the two theories, as J.A.Thomson made clear in his popular exposition of heredity:

> "..it is simply muddle-headedness which can find any opposition between a statistical formula applicable to averages of successive generations breeding freely and a physiological formula applicable to particular sets of cases where parents with contrasted dominant and recessive characters are crossed and their hybrid offspring are inbred."(14)

The controversy between the two theories appears to have developed largely from a personality conflict between Bateson and Pearson, and from the methodological differences between mathematics and biology.(15) Barnes and Mackenzie have found some evidence for a political dimension to the controversy, concluding:

> It can be argued that British Mendelism, was related to traditional conservative interests in British society, set in opposition to the ideas of interventionist reformers riding the tide of advancing industrialisation. The success of the Mendelian programme would both have added to the predictive resources of biologists and have discredited Darwinian gradualism and certain aspects of the intellectual tool kit of interventionist eugenic reforms."(16)

A further difference between Biometry and Mendelism was that while the

former drew on the naturalist tradition in biology with its quantitative methods, the latter used experimentation as its "primary polemical tool"(17), enabling Mendelism to become rapidly assimilated within existing biology laboratories. The importance of this controversy for the present chapter is that the E.E.S. was defiantly Mendelian and became increasingly antagonistic towards Karl Pearson, whose Biometric methods increasingly alienated him from the scientific methods of mainstream biology.

Having established this socio-political background to the science of eugenics, the popularisation of six expositors of eugenics will now be examined to see how representative of public science they were. The following sample of six popularisers was chosen because they are the writers whose names are most frequently associated with the promotion of eugenics(18) through their membership of,or relationship with,the E.E.S., and because they represent a cross-section of political attitudes. Thus, the choice was made in the hope that interesting differences will be found in the popularising techniques of the sample, and also to indicate a dimension of eugenics which has been almost totally ignored, namely its significance as a vehicle for the popularisation of an image of science.

3 - P.Geddes (1854-1932) and J.A.Thomson (1861-1933).

Patrick Geddes was born at Ballater, Aberdeenshire on 2 October 1854, the youngest son of a quartermaster in the Black Watch. He was educated at Perth Academy, then after spending a year at a bank at his father's request, he undertook an apprenticeship with T.H.Huxley at the Royal College of Mines in the 1870s. Geddes left the Royal School of Mines in 1877, and went to the Sorbonne to study zoology under Lacaze-Duthiers. Whilst in Paris he took Le Play's sociological formula "Lieu, Travail, Famille" to heart. Later this formula was to become one of the pillars of

his bio-social thought.(19) Geddes left Paris to explore Mexico, and whilst there he suffered an attack of blindness which, although it passed, ruined his career in biology by making it impossible for him to continue his work in microscopy. Geddes returned to Scotland in 1880 setting up home in Edinburgh, and from 1889-1914 he lectured at University College, Dundee during the summer sessions. This left him plenty of free time to pursue his interest in sociology which he did by creating an informal "Geddes group" in Edinburgh which met regularly at his house to discuss economic and social questions. It was at this time that Thomson, as Geddes'student in botany, struck up a friendship with his lecturer, which stemmed from Thomson's troubled conscience as to whether he should opt for science or theology as his chosen career.(20) In January 1885 Geddes founded Edinburgh's Social Union, which Thomson immediately joined, prior to completing his education at the Universities of Jena and Berlin.

Geddes' motivation behind establishing this Union can be gleaned from a lecture he gave in 1886 in Edinburgh on the labour problem. First of all, Geddes believed that the contrast between 'urban' and 'rural' perspectives on the problems of the inner city could be profitably used to find solutions for them. He felt that the rural man (or 'gardener' as Geddes usually referred to him) had the anthropological advantage of standing outside urban culture. He opened his lecture by developing the Huxleyan idea that man could be studied "as if he were a bee", by saying that as 'foreigners' scientists looked:

> "at labourer and capitalist in a quiet natural history sort of way, as species in the study of which they are indeed profoundly interested, yet which are alike sufficiently foreign, to their own life and interests and aims for them to feel wholly identified with neither".(21)

Having established the worth of an objective 'biological' insight into society, Geddes went on to claim that politics and economics were irrelevant,

that what really mattered was not legislation, but moral progress, saying:

> "What then is to be done? Are we coming back to the cheerless doctrine of let things alone? So it might seem; yet let us examine the second mischievious assumption I complained of: that in talking of redistribution, any progress in production and consumption, much less in capitalist or labourer, was not so much as mentioned - the social machine is assumed perfect."(22)

In other words, a revolution in individual morality was required in order to assure progress. Geddes concluded that the ideal of progress must be transformed "from an individual Race for Wealth into a social Crusade of Culture".(23) For Geddes believed that progress was to be assured by collectivist anarchy, using science as the arbiter of controversy.

While Geddes' anarchic vision of society developed, he and Thomson were collaborating on The evolution of sex, which was published by William and Norgate in 1889 as volume one of the 'Contemporary Science Series', edited by Ellis. Ellis, who was nearing his medical finals at the time, chose Geddes to write this book because the article which Geddes had written on reproduction for the ninth edition of the Encyclopaedia Britannica, coincided with Ellis's own thought on sex.(24) The book was a success and went through three printings and two different editions.(25) The text revealed that Geddes and Thomson rejected Spencer's individualism because, as Thomson was to comment wryly in 1906:

> "If Spencer had pursued the analogy between the human social group and the animal social group, such as that of bees or beavers, corroboration of individualism would not have been so easy, though he would doubtless have arrived at the same result."(26)

Also rejected was Kropotkin's belief in mutual aid, for:

> "the optimism which finds in animal life only 'one hymn of love' is inaccurate, like the pessimism which sees throughout nothing but selfishness."(27)

Instead Geddes and Thomson retained the useful analogy of the social organism but claimed that the dynamo of biological evolution was a synthesis of individual struggle and mutual cooperation, best expressed in mammalian reproduction with the duties of parenthood. They concluded:

> "The ideal of evolution is indeed an Eden; and although competition can never be wholly eliminated, and progress must thus approach without ever completely reaching its ideal, it is much for our pure natural history to recognise that'creation's final law' is not struggle but love."(28)

This text marks the beginning of Geddes and Thomsons' public collaboration as popularisers of biology, which was to continue for the next forty years. It has been claimed that Geddes' greatest contribution to biology was J.A.Thomson, and Geddes' biographer, Boardman, summarises the relationship between the two men as follows:

> "Scientists who knew both men intimately have said that in general Geddes had the ideas, the challenging theories, while Thomson had superior talent as a lecturer and scientist."(29)

Geddes was always marginalised in the scientific world because he was best known for his sociology at the Outlook Tower, Edinburgh; Thomson, on the other hand, rapidly established a reputation as an authoritative scientist from his position as Regius Professor of Natural History at Aberdeen University, which he held from 1899-1930, and was therefore in a stronger public position to synthesise convincingly, biology and sociology. For example, in 1907 when Geddes was becoming alarmed at the eugenicist dominance of the Sociological Society, he asked Thomson to speak on his behalf at the society. In the lecture which Thomson gave, he set himself slightly apart from the society, saying that he spoke as a scientist not a sociologist, and warned eugenicists that, " a formula borrowed from another science and applied to a new order of facts..must be rigorously tested."(30) He then devoted the lecture to assessing the relationship

between the nature and nurture of humanity, developing the idea that:

> "The useful fact to emphasise is that man, though slowly or slightly variable, is rapidly and exceedingly modifiable, and that social organisation provides a means - an external heritage - whereby the results of modifications may be practically transmissible, though not organically entailed."(31)

Siding with Geddes' 'civic' sociology, Thomson attempted to put the environmental factor back into sociology, concluding that progress "..must be not merely biological but distinctively sociological in its outlook."(32) Thus, Thomson seems to have been keen to differentiate more strongly between biology and sociology than the eugenicists in general were, for their biological perspective tended to subsume sociology.

Possibly, therefore, because Thomson was a biologist, he felt more comfortable as an activist in the E.E.S. than as an outsider within the Sociological Society; for he moved with the eugenicists away from the Sociological Society to form the E.E.S. He was clear in his own mind, however, that "..while Galton deals primarily with organisms, and Geddes with environments, these are merely scientific abstractions; in actual life organisms and their environments are inseparable."(33)

In 1911, Thomson published a very accessible book of essays entitled Darwinism and human life, in which he lucidly set out Geddes' bio-social rule for progress, as outlined in his City development of 1904, which was:

> "..to adhere to and increase those forms of selection which make for the survival of beautiful and healthful surroundings, educative and wholesome occupations, sane and progressive men and women. The first ideal has been called that of Eutopias, the second that of Eutechnics, the third that of Eugenics. They obviously correspond to the three fundamental categories of biology: Environment, Function, and Organism."(34)

All three ideals could be practically attained, Thomson argued, by "the

criticism of consumption."(35) Each individual should not buy goods that promoted bad occupations, should not live in ugly places, and should not marry undesirables. While the first two boycotts were, however, to be left to the individual's discretion, Thomson believed that the third required legislative support to stop the marriage of undesirables. F.C.S.Schiller reviewed this text for the Eugenics review, and was filled with hope that "..so high a scientific authority is willing to assist in what must in any case prove a long campaign of education."(36)

In fact, Geddes had constructed an entire historical theory to explain how his bio-social rule was the dynamo of progress.(37) In his Civics as applied sociology, Geddes outlined his theoretical four ages of man. The first age was the paleotechnic age or the Industrial Revolution, when humanity was sacrificed on the altar of economic progress. Then followed the neotechnic age, to which Geddes' generation belonged, when technology was harnessed to produce goods and lighten labour. To move to the geotechnic age, when science and technology could be used to improve the physical and material conditions of the people, Geddes believed several things had to happen. Firstly, and most importantly, all classes of society had to be united; and this was to happen through the arts and sciences.(38) William Morris was seeing to the restoration of craftsman values in art in an attempt to unite thought and action, Geddes looked forward to a similar restoration of craftsman values in science, so that proletarian experience (the experimental scientific tradition) and bourgeois culture (abstract theoretical science) could be united to secure progress. The future would be created by "uniting in individual and social evolution, workers and thinkers together and each leading by turn."(39) Thus, what was needed at present was the practical application of science, and practicality being a proletarian virtue, science was considered to be "essentially of the working-class".(40)

The idea that the working-class should have some empathy with science

had, of course, been most clearly articulated by Huxley in the late Victorian period, when he claimed that:

> "The fact is, I am, and have been, any time these thirty years, a man who works with his hands - a handicraftsman..
>
> Indeed, it has struck me that one of the grounds of that sympathy between the handicraftsmen of this country and the men of science, by which it has so often been my good fortune to profit, may, perhaps, lie here. You feel and we feel that, among the so-called learned folks, we alone are brought into contact with tangible facts in the way that you are..
>
> You know that clever talk touching joinery will not make a chair; and I know that it is about as much value in the physical sciences. Mother Nature is serenely obdurate to honeyed words, only those who understand the ways of things, and can silently and effectually handle them, get any good out of her."(41)

It would thus seem that much of Geddes' promotion of public science through his popularisation betrayed a radical development of the ideas of his teacher at the Royal School of Mines.

The key to progressive unity for Geddes was a synthesis between science which "looks mainly at the Out-world," and "the real artist who works from his inner vision."(42) To proceed from the geotechnic age to the eugenic or final eutopian age, Geddes anticipated a form of matriarchy, for:

> "This central antithesis of paleotechnic and neotechnic, thus involves the passage from the predominant mechanocentric thought and philosophy of industrial man to the originative, biocentric instinct and inspiration of domestic woman."(43)

The future of the human race, therefore, lay with the feminine instinct, and thus, Geddes and Thomson became inextricably involved with feminism.

Of course for the eugenics movement as a whole motherhood was an integral concern, Geddes and Thomson, however, felt by 1914 that they must distance

themselves somewhat both from E.E.S. conservatism as regards women's rights, and from the E.E.S.'s lack of concern with economic factors. In their text Sex, having set out the various ages through which humanity must pass, they attacked the E.E.S. for attempting to pass from the neo-technic age straight to the eugenic age without attending to either nurture or female independence, gibing that though this was illogical, it was "as the patriarchal Galton, and his well-meaning under-shepherds of the Eugenic Society would have it."(44) Despite the strong language, however, Thomson was still on the E.E.S. council in 1914.

In fact, although Geddes and Thomson still shared an ideological commitment to public science, through the promotion of their brand of socio-biology, the two were growing increasingly apart as to their political beliefs, and consequently popularisation took on different meanings for them.

Geddes believed that progress could be achieved by the voluntary action of private individuals for the public good within the framework of the local community of a city. The attraction of Geddes' civics was that it enabled the citizen to undertake practical work to shape the evolution of his community. Because of his radical beliefs, Geddes was seeking a way in which reform and development could be generated from below, through the increased knowledge and participation of ordinary citizens.(45) The key to Geddes' socio-biology was the self-direction of the individual; state coercion was anathema to him.

In order to popularise civics in Edinburgh, Geddes devoted much of his time to the Outlook Tower, which he had purchased in 1892. The Outlook Tower was to set a precedent for all cities to follow. As a civic and regional museum it was to act as a repository of knowledge of the local environment, and encourage the 'biological' interaction of organism and environment to further the evolutionary process. To this end exhibitions were set up at the Outlook Tower, which were intended to appeal to all

classes. For these exhibitions Geddes used visual materials and models, but never completed an exhibition in order to encourage participation in local environmental projects. The public were not merely expected to view the exhibitions, they were supposed to help create them. Geddes also set up a current affairs club at the Tower where the economic and social issues of the world, as reported in the press and in up-to-date publications, were collected and the data displayed in exhibitions.

As for any social reformer, education was of great importance to Geddes, and it was largely due to the pioneering efforts of Geddes and Thomson that Nature Study became part of elementary school curricula in Scotland in 1889, and in England in 1900. In fact the Nature Study movement drew its origins largely from Geddes' work at the Outlook Tower, and Nature Study was thus from its inception intended to be an ideological tool to promote Geddesian socio-biology. According to Thomson, Geddes defined Nature Study as follows:

> "Nature Study is the culture of the habit of observing and thinking for one's self, and at one's best without books or helps, in presence of the facts, and in the open air."(46)

Hence, for Geddes and Thomson, Nature Study was a way of encouraging autonomy at an early age through the self-discovery of nature. The Geddesian evolutionary belief in mutual cooperation combined with competition became a central tenet of Nature Study, enshrined in the phrase "Hunger and love solve life's problems."(47) The three basic methods of Nature Study (48) reveal the instigation of Geddes. Firstly, Nature Study was to be an inherently practical subject in which books were largely unnecessary. Geddes himself preferred to popularise by example and disliked writing his ideas down.(49) Secondly, Nature Study utilised the heuristic educational method; a method which Geddes had always used from his early days teaching botany at Edinburgh University, largely because as a man without formal qualifications, he despised the use of examinations in education, believing that,

"..the very test of efficacy in education is a decreasing need for direction of conduct by external control. Education is truly vital in the degree to which it invokes an integral personality."(50) Thirdly, the quality of vitality was essential to Nature Study for the interconnectedness of an organism's parts, and its position in the 'web of life', was central to its teachings. Such a perspective can be seen as an application of Geddes' bio-social rule(51), in which the relationships between organism, function and environment were paramount in the evolutionary process.

As such, Nature Study embodies the strengths and weaknesses of Geddes' approach to popularisation, which was for him largely a non-literary activity, relying more on visual impact, practical participation, and a kind of mystical conversion to his evolutionary beliefs. Ultimately Geddes' personality through the example of his own life, was his strongest popularising tactic, and seems to have been successful in recruiting middle-class support to his ventures in Edinburgh. His inability to write his ideas down, however, meant that as a populariser outside his own community he was largely unsuccessful, and even in the appropriate intellectual circles in London he was considered a crank.(52) In a sense, this did not bother Geddes, who could retreat behind a belligerent regionalism,for his sociological approach rested on a regional analysis of social problems, and therefore he could happily dismiss London as a place that "stunts the mind and warps it to a viewpoint of fancied superiority over the provinces."(53)

Ideologically, Geddes was still, in 1919, an anarchist awaiting "a Resorption of Government into the individual"(54) in a decentralised society. Politically, he believed in the equality of man, but as a civic sociologist he felt that the university should be the "cutting edge of progress."(55) Ultimately then he felt that an intellectual,scientifically informed, elite should guide democratic participation. In this belief he was not very far removed from Thomson, but by this time Thomson was relatively

unfettered by anarchistic visions of society.

The crux of the difference between Geddes and Thomson was that Thomson became increasingly preoccupied with his responsibilities as a professional scientist. Even by 1894, Thomson was only prepared to follow Geddes' espousal of the methods of Nature Study, which moved from the general to the particular (rather than, as in traditional biology, studying morphology before physiology), in so far as this method was pursued only at an elementary level, for he believed that "the education of the citizen is one thing, and that of the zoologist another."(56) Thus, from a professional viewpoint Nature Study was acceptable, since it provided an occupational avenue for biologists in education, but as the above quotation indicates, Thomson was unhappy with the social premises on which this 'science' rested, and wished to distinguish between'education for life' , and professional training.

It has already been pointed out that for the promotion of eugenics, Thomson was prepared to seek legislative support, and he differed from Geddes in that he was not opposed to centralised state politics. Far from attacking the state, Thomson wanted closer cooperation between the state and science, claiming that it was,

> "the duty of the State to utilise the resources of Science in the solution of practical problems;"

he continued,stating that:

> "we are filled with amazement at the abundance of expert knowledge of priceless value which is <u>not</u> being utilised."(57)

Indeed, at times in his writings, Thomson seemed to be attacking Geddes, as when he said:

> "The ultra-practical man's impatient, 'what's the use of it?' may occasionally be a sound corrective, since science, as well as art, requires to be socialised. But it often reveals an intellectual shortsightedness.

Our point has been that science will do best for the citizen if it is left to attend to its own busines."(58)

In other words, although both Geddes and Thomson believed in the leadership of experts, Thomson did not want to encourage democratic participation in science, as Geddes did. Rather as Thomson says, he wanted to 'socialise' science, making it socially acceptable and useful, but only within professional limits, and this contradicted democratic aspirations. The contradiction seemed irrefutable to Thomson, since as far as he was concerned science was "as far on one side of common sense as poetry was on the other,"(59) and therefore the ordinary citizen could not be the scientist's equal in scientific practises. Such a statement, however, contrasted strangely with another Thomson made while working with Geddes, that "Science no less than fine art, is essentially of the working-class."(60) It can only be assumed that in their collaborative enterprises Geddes took the leading intellectual role, with Thomson doing most of the writing, for the difference in Thomson's attitude between texts cannot be attributed to different audiences, or even different publishing companies, since both of the above statements come from two texts in the science section of the'Home University Library of Modern Knowledge', published in the same year.

Thomson did not share Geddes' aversion to writing, and wrote approximately thirty popular science books in which his skills as a populariser were obvious. His writing shows an easy turn of phrase, a good command of English, enthusiasm for his subject, and a wide ranging knowledge of current biological work in terms suitable for a lay audience.He used these skills to great effect in his popular exposition of heredity, which was intended as "a serious study of what has been securely established."(61) His text Heredity sold well and, despite its large size, went through three editions from 1907-1914. Thomson's tone throughout was authoritative, firmly correcting public misconceptions, pointing out that statistical

predictions can only be made as to averages within a population, not for particular individual cases where variation plays an apparently greater role; that diseases are not evolutionary tools in the sense that they strike weak and strong indifferently, and therefore their cure through medicine cannot weaken the race, and so on. The text was reasonable in tone, well argued, and in its scholastic presentation, allowed of little disagreement on the reader's part

Thomson used an adaptation of the scholastic genre in the majority of his popular science books, which, as the inclusion of his texts in the 'Contemporary Science Series' and the 'Progressive Science Series' (62) would suggest, were mainly marketed for the middle-classes, as were those he wrote in collaboration with Geddes. The adoption of a textbook type of presentation lent authority to Thomson's radical views, enabling him to package polemical viewpoints through a traditionally restrained and rational medium. For example, a typical conclusion to his popularising works can be found in his text Heredity, which concluded:

> "It will be generally admitted, however, that if we are to avoid fallacious endeavour, our ideal must include 'eutopias' and 'eutechnics' as well as 'eugenics' and that it must be not merely biological but distinctively sociological in its outlook."(63)

Throughout Thomson's popularising career, as the above quotation suggests, it was Geddes' bio-social rule which lay at the heart of his perceptions of biology. As has been indicated, such a rule can be seen as a radical development of Huxleyan public science. Ironically, however, neither Geddes nor Thomson shared Huxley's meritocratic assumptions about science, which, it has been argued, fuelled his popularisation. Rather, Geddes drew more on the egalitarian ideas implicit in post-Darwinian natural theology, which cast nature as a moral guardian equally accessible to all. As an outsider, he saw science as a uniting balm for the divisions of Edwardian society, a democratic vehicle for progress, which, in his utopian scheme,

did not require institutional coercion to sanction its ability to direct society. Thomson, on the other hand, as a professional scientist supportive of collective trends in society, saw the pursuit of high science as something separate and distinct from the low science promoted through nature study. Whilst the latter might educate for citizenship, he believed it was the former alone, with legislative support, which could solve society's problems. Thomson's attitude reflected the emergent professionalism within the biological sciences, which was not embarrassed to claim that biology was part of a body of scientific knowledge which was not merely common sense, but which gave technical expertise; expertise which he felt, with government support, was fit to lead society.

4 - C.W.Saleeby (1878-1940)

Saleeby was born in Worthing, and was educated at home, and then at the Royal High School, Edinburgh, and the University of Edinburgh, where he gained a first class honours degree in medicine. Thereafter, he was Resident Physician in the Maternity Hospital and in the Royal Infirmary, Edinburgh, and assistant to Sir Jonathan Hutchinson at the Polyclinic, London. Saleeby was, perhaps, the foremost populariser of eugenics in the Edwardian era. He was a skilled polemicist, whose writings reverberated with rhetorical flourishes and vituperative personal attacks on those who challenged his beliefs. Saleeby's popularising work veered between reporting 'scientific' results (his own and those which supported his views) and straightforward polemics. As such he was a writer who undoubtedly benefited from the presence of mass journalism in this period. He was not averse to lecturing, appearing regularly at the Royal Institution, London.

Saleeby's first major contribution to the popularisation of eugenics

through books, were the texts he contributed to the Jack's 'Shilling Scientific Series' in 1905 and 1906, before the E.E.S. was formed. These texts covered a range of subjects but were unified by Saleeby's eugenic ideals. For example, in the text on Ethics, Saleeby claimed that while caring for each individual in society when they were ill, it was necessary that "we continue to obey the indication of Nature which forbids such an individual to perpetuate his infirmity."(64) The text on Sociology concluded by praising the Sociological Society on tempting Galton out of retirement in order to join its ranks. The text on Organic evolution dealt with heredity and variation, natural selection, the transmission of acquirements etc., and concluded that, the "advocates of eugenics charm they, reason they, ever so wisely, will not succeed in achieving that for which they strive until every citizen of even mediocre intelligence is acquainted with the principles of organic evolution."(65) In attempting to address the problem of informing every citizen of eugenic theory, Saleeby, in the following text in this series, entitled Heredity, moved from the basic principles of organic evolution, to the state of their hereditarian application. It is worth noticing that in 1905, Saleeby introduced the topic of Biometry in a positive way, as follows:

> "The Biometricians are a comparatively young but very important school of biologists, whose founder is Mr. Francis Galton, Charles Darwin's first cousin, and whose foremost adherent is Professor Karl Pearson, to whom we owe the term biometry or biometrics.. .... they approach biological questions with a unique equipment in mathematics and logic."(66)

Evidently the names of Galton, Darwin and Pearson were names for the eugenicist to be proud of. Saleeby was also, in 1905, a firm supporter of nature rather than nurture, claiming that "the importance of the environment to the race is nil."(67) As for political beliefs, Saleeby at this time labelled himself a Spencerian, and said "the wisest are not either Liberal

or Conservative, but each on due occasion."(68) In other words, whilst not all progress was beneficial, evolution decreed that society could not stand still.

Consequently, following Galton, Saleeby believed that some intervention in social processes, based on scientific knowledge, was necessary. Galton had argued that such intervention should be sanctioned, not by the legislative arm of the state, but by the moral sanctions of religion, since as "eugenics strengthens the sense of social duty in so many important particulars.. the conclusions derived from its study ought to find a welcome home in every tolerant religion."(69) Saleeby seemed keen to follow this lead, for in 1907, he concluded a text on Worry by advising that the reader's fears for the future could be allayed by religious belief, and that a"passion for eugenics is well worthy of incorporation in the religion of the future."(70) Saleeby saw no conflict of values between science and religion, arguing that "science has done a great service to religion."(71 This view seems to have been connected to Saleeby's perception of evolution, as follows:

> "It is plain that though reality be, strictly speaking unknowable, yet science, which deals with its appearances, can yet infer from them somewhat of its nature. If, for instance, science can prove, as it has conclusively proved, that all phenomena are interrelated.. then we may surely make the sublime inference that there are not many realities, but one reality.."(72)

In other words, evolution indicated to Saleeby that reality was unitary, and this tended to presuppose a moving force or deity, and therefore a potentially religious purpose to reality. The science of eugenics fitted in comfortably with such an evolutionary type of religion.

Thus, like Galton, Saleeby had no qualms about using religion to further scientific ends, since for both these two the science of eugenics,and religion were united in ethical aims, encouraging "love and interest in

family and race."(73) In this respect, Saleeby was following directly on from Galton's beliefs, and, in a wider context, was continuing the popularising stances of the Victorian Scientific Naturalists, in attempting to make scientific tenets the basis of a 'civic' religion in which science informed responses to the temporal world, leaving religious belief to nurture man's spiritual dimension. Thus, Saleeby was promoting a public science image through his popularisation, even though it was a far more conservative image, at this stage in his career, than that propounded by Geddes and Thomson.

Backed by the possibility of religious sanction, Saleeby carried out the popularisation of eugenics with a proselytising zeal, "working at it by voice or pen on the average once a fortnight,"(74) in lectures and articles, firm in the conviction that "education must be displaced by selection as the supreme instrument of race-progress." Therefore, "our first task is to teach the public at large that acquired characters are not transmissible."(75) In other words, Lamarckian evolutionary theory appears to have been a part of popular culture, which eugenicists found particularly hard to change. Indeed, in 1912, Thomson still felt the need to devote space to its refutation in his Heredity.

Saleeby's major contribution to the popularisation of eugenics came in 1909 with the publication of his text, Parenthood and race culture, in which he coined the terms 'positive' and 'negative' eugenics. Amongst the attractions of positive eugenics(i.e. encouraging the interbreeding of desirables), was "the possibility of breeding such things as talent." Whilst negative eugenics(i.e.the discouragement of interbreeding amongst undesirables) would cure the problem of unemployment, which was largely caused, Saleeby felt, by hereditary disease making people unemployable, or just the sheer fact that the working-classes had too many children for whom society could provide jobs.(76) The solution to the race-problem was, claimed Saleeby, to "enhance the parental instinct,"(77) to erect

parenthood into "an act of personal and provident responsibility."(78) For socialism, or any move on the part of the state to ameliorate poverty and deprivation, was threatening the evolutionary process, since:

> "Directly the conditions become too easy, selection ceases, and it is as successful to be incompetent or lazy or vicious as to be worthy."(79)

Thus, eugenics had to rely on appeals to the duty of the individual as parent. For, the only legitimate avenue for such a personal moral appeal, affecting the private lives of individuals, appeared, to the conservative Saleeby, to be the church, since it could not be the state.

In his popular writings Thomson cited Saleeby's Parenthood and race culture favourably, but as a member of the E.E.S. he felt that Saleeby's analysis was too simplistic (80), making over-enthusiastic claims for eugenics, and neglecting many social or environmental factors.

Meanwhile Saleeby, also a member of the National Temperance League, had been developing his theory of 'racial poison', which centred on the idea that the children of drunkards were less capable of citizenship. Although Saleeby did not have much evidence on which to build this theory, he believed that "the practically complete immunity of their parenthood from alcohol is one of the great factors that explain the all but unexampled persistence of the Jews."(81) In the development of Saleeby's eugenic beliefs this theory was important in that it took environmental factors as seriously as hereditarian factors.

Saleeby's next major work was his text Woman and womanhood, published in 1912, which was at points vituperatively anti-feminist. According to Saleeby a woman's place was firmly in the home, since "just as woman is mediate between man and the future, so man is mediate between woman and the present."(82) In other words, man was the breadwinner,active in public life, while woman was the guardian of the race, secure in the domestic domain. In this context, Saleeby looked with favour at the new Women's

Department of King's College, London, for offering courses to women on Home Life. In contrast to Geddes and Thomson, Saleeby did not advocate the self-determination of women within the confines of their 'biological' determination; but rather, as an obstetrician, he seemed to use the feminine issue as a professionalising tactic for obstetrics, and the modern physiology and psychology of sex, since he believed that eugenics could not succeed without the service of such professions.(83)

By the time Woman and womanhood was published, however, Saleeby was out of favour with the E.E.S. and from 1910 was never again elected to that Society's council. Reflecting this, the text seems to mark a further shift away from Saleeby's earlier 'Spencerian'position by rejecting "the internecine conception of society which forever sets nation against nation, race against race, class against class, sex against sex, individual against individual, on the ground that the interest of one must be the injury of the other."(84) Such a statement seems to have been an oblique criticism of the E.E.S.'s preoccupation with differential fertility (the idea that the fecundity of the working-classes was heralding the demise of the middle-classes), and with social imperialism. The E.E.S. recognised these criticisms in E.Schuster's review of the book, saying, "we disagree with Dr.Saleeby concerning many of the details of the book, but recognise that in it, the true eugenic aspect of the woman's movement is clearly portrayed..", but felt that Saleeby was "too optimistic about consensus between racial rights and the rights of the individual."(85) In other words, the only part of the book of which the E.E.S. approved was the conservative attack on feminism.

With the publication, in 1914, of The progress of eugenics, Saleeby had moved radically away from his original eugenicist position as a councillor of the E.E.S., and was almost in total sympathy with the socio-biology of Geddes and Thomson. The text was dedicated to "my teacher and friend" Henri Bergson, with the message "eugenics - creative evolution become

self-conscious." Geddes had met Bergson in Paris in 1900, and both he and Thomson confessed that, "the modern movement of vitalism has our increasing sympathy," and advised their readers to read Bergson's Creative evolution(86).Possibly then, Saleeby's friendship with Bergson, as well as his acquaintance with Geddes and Thomson through the Sociological Society and the E.E.S., converted him to their more environmental interpretation of evolution. For he started this text by stating that:

> "The laws of heredity are not as Galton understood them, and they are not to be elucidated by the methods which he employed, and which Professor Karl Pearson has since elaborated, and still employs."(87)

Here then Saleeby was rejecting not only Biometry,but Galton himself. He continued:

> "Upon the competitive theory of natural selection is based a eugenic demand which practically consists in the condemnation of charity and altruism in all their forms. Thus, eugenics comes to be represented as an alternative to social reform, an enemy of love and a new buttress for the selfish and materially fortunate members of society."(88)

Further distancing himself from the E.E.S., he said:

> "they declare that environment may modify individuals, but that it has no influence upon the race. This is a cardinal assumption of eugenics as it is taught and advocated by nearly all eugenists today, and from it I expressly dissociate myself."(89)

This rejection of conservative E.E.S. belief, and the advocacy of environmental social reform by the state appears to be symptomatic of a conversion to civics, since Saleeby at one point stated categorically that:

> "Eugenics cannot succeed, as Professor Geddes pointed out long ago, unless we have also a eutopia."(90)

Thus, through the popular eugenic writings of Saleeby, between 1905 and

1914, a personal conversion can be seen away from conservatism and towards the New Liberalism of the period. Of particular interest for the present chapter is that although the political emphases of Saleeby's popularisation changed, he never questioned the legitimacy of giving science an authoritative role in directing society.

5 - W.C.D.Whetham (1867-1952)

Whetham was born in South Hampstead, London, the only son of a manufacturer. He was educated privately until he entered Trinity College, Cambridge, where he obtained first classes in both parts of the natural sciences tripos (1888-9), was Coutts Trotter student in 1889, and Clerk Maxwell scholar in 1893. He undertook research at the Cavendish Laboratory which earned him a college fellowship in 1891; he remained a fellow for the rest of his life.

In 1901 Whetham was elected F.R.S. for his electrolytic experiments, and in the following year he published a treatise on the Theory of solution which was for some time the standard textbook on the subject. Other pursuits, however, began to divert him from research, for during the Edwardian era Whetham was a leading figure of the E.E.S., and became concerned with the philosophical premises of science. Following this latter pursuit, for example, he contributed a text to the 'People's Books' entitled The foundations of science. Such texts placed him firmly in the context of the 'Cambridge school' of metaphysical thought so beloved of Oxbridge physicists from the late Victorian period onwards.(91) Such thinkers believed that science should have a much broader moral role, in contrast to the more utilitarian conception of science promoted by public scientists. Whilst such texts as The foundations of science enabled Whetham to assert a metaphysical basis to scientific thougnt, his texts on eugenics gave him the opportunity to air his conservative beliefs in a political and social

arena. As such his eugenic writings, written in collaboration with his wife Catherine, were openly polemical, offering a conservative commentary on the direction of British society.

Whetham's chief contribution to eugenics was his racial analysis of class, which claimed that:

> "It becomes more and more clear that the groups and associations formed by men are not artificial, not mere matters of chance, but correspond to real differences of innate qualities, of mental and physical characters."(92)

Class distinctions, Whetham argued, were necessary to the evolutionary process, since "to denounce class distinctions and to preach human equality is to misunderstand the circumstances under which civilisation has emerged from chaos."(93) From his conservative understanding of society, Whetham was concerned about two things. Firstly, the class differentiation in fertility rates which meant the threat of working-class stock swamping the nation, since "the stocks which are least successful or definitely unsound are increasing fastest," and consequently, "the supply of competent candidates for entry into certain professions is already falling."(94) Whetham believed the nation would decline if more attention was not paid both to positive and to negative eugenics. To aid positive eugenics Whetham suggested that, "it should become an increasing habit for the older generation where they have it, to distribute a substantial part of their property during their lifetime,"(95) in order that the propertied classes did not have fewer children because of waiting for the security of inheritance. On the other hand, Whetham's attitude to negative eugenics was quite ruthless, as evidenced in his suggestion that, "if we make the environment harder for any one class, we tend to repress its rate of reproduction, and it may be reduced rapidly in relation to the stocks which have received more favourable treatment.Its qualities and character disappear from the race."(96)

Whetham's second major concern was the democratic concept of equality, which challenged his racial theory of class. He warned that, "a disintegration of society and the breaking up of these natural class divisions seems to be a preliminary step in national decay."(97) His support for the landed aristocracy as opposed to democracy was clear cut and employed an hereditarian validation, as in the following quotation:

> "In response to the popular mandate, fortified by a belief in human equality, both in national and local affairs power has been taken from what we may term the old hereditary governing class, built up by a thousand years of social evolution."(98)

Whetham firmly believed that there should not be democratic representation of the majority, and his obvious political bias annoyed Saleeby in 1914,for in his text The progress of eugenics , he attacked Whetham thus:

> "Mr.Whetham, a physicist without training in biology or first hand knowledge of the lives, the virtues, and the vices of the poor, did service in writing upon eugenics from the standpoint of Mendelism; but it is so much the more disappointing that,with pedigrees staring him .. in the face, he should have found it possible to champion class against class, and to declare that there is a biological warrant for class prejudice.."(99)

Nevertheless,Whetham's attacks on feminism and his solution for unemployment (that those who refused a job when offered one should be sterilised) do not appear to have upset the E.E.S.(100)

Whetham was also a social imperialist, believing that the nation needed to be fit in order to survive international competition, for, "there is no finality; a nation is either gaining or losing ground, either improving or degenerating."(101) Furthermore, Whetham felt that England's lack of involvement in a serious war effort was one of the symptoms of national decay, since:

> "The long immunity of England from wars in which her national

existence has been at stake has tended to reduce the healthy sense of the duty of personal service to the community, and to obliterate the feeling of social responsiblity."(102)

Whetham was especially worried by the threat of the 'yellow peril', for:

"If the Eastern nations,while retaining their simple, less exacting standards of life and different sense of racial morality, can profit by our improvements in hygiene, take advantage of our increasing medical knowledge, and utilize the inventions which represent the life work of our men of science, our inventors and our captains of industry, they must of necessity supplant the European populations, wherever the two races come into contact with each other."(103)

Evidently, the popularisation of eugenics gave Whetham scope to voice his political opinions in a way in which the popularisation of physics clearly did not. For, by the Edwardian era, a legitimate overlap existed between sociology and biology, which allowed popularisers the freedom to speak with, allegedly, scientific authority about the direction of society.(104) That such a conservative, Cambridge physicist took advantage of this opportunity is, perhaps, suggestive of the strength of public science assumptions in the popularisation of eugenics at this time.

6 - Havelock Ellis (1859-1939)

Ellis was born at Croydon, the eldest son of a sea-captain. When he was seven, young Ellis accompanied his father on his annual nine-month voyage round the world. The rest of his childhood was spent in the Surrey suburbs of London, and he was educated at private schools in Merton and Mitcham. At the age of sixteen Ellis again went to sea with his father, and when the voyage reached Australia he settled there as a schoolteacher for four years. In 1879, he returned to England, and eventually became a medical student at St. Thomas's Hospital. The course took him eight years, from

1881-1889, and in the end he failed to secure the joint qualifications of the Colleges of Physicians and Surgeons, instead becoming a doctor with the Licence of the Society of Apothecaries. During this time he worked as editor of the 'Mermaid Series' of dramatists and the 'Contemporary Science Series' for the publishing house of Walter Scott. During the 1890s and the first decade of the twentieth century, Ellis wrote a series of six volumes entitled Studies in the psychology of sex, which were his life's contribution to science. At the same time, and there after, he earnt his living writing books for the general reader. As a member of the E.E.S., Ellis wrote many books and articles in the Edwardian era which explained and supported eugenic ideas.

In terms of popularisation, Ellis was convinced that the promotion of eugenics was allied to the progress of democracy. Comparing Britain with Russia in 1892, he claimed:

> "Not the least value of the example of Russia lies in the proof it offers that in these matters - as indeed in most others of social concern - the good intentions of a despotic government, and the enlightenment of a small minority of the population, are utterly helpless in the face of the ignorance and apathy of the mass of the population. Here as elsewhere we are concerned with the true significance of democracy."(105)

Democracy for Ellis meant the ideals of the Fellowship of New Life, which combined a belief in Fabian gradualism with individual self-cultivation.(106) The Fellowship differed from Fabianism, however, in that it held a form of collective anarchism dear, rejecting state legislative reform. Like Geddes, Ellis felt that Utopia could only be reached through the moral conversion of the individual, for:

> "It is in the developed individual conscience, guided by a new sense of responsibility, and informed by a new knowledge, that any regeneration of the race must be rooted."(107)

Thus, popularisation for Ellis meant helping the individual to develop a collective conscience,

> "through the slow growth of knowledge concerning hereditary conditions, by voluntary self-restraint, by the final disappearance of the lingering prejudice against the control of procreation, by sterilisation in special cases, by methods of pressure which need not amount to actual compulsion.."(108)

Ellis did not like the idea of legislation, since for him, eugenics heralded the Aristotelian vision of the unification of the good man and the good citizen, where individual morality and politics became fused into one conception of good, "at this final point social hygiene becomes one with the hygiene of the soul."(109) It was within the framework of these classical conceptions that Ellis believed eugenics to be capable of the status of a civic religion. With excitement he proclaimed, "today we hold in our hands more certainly than ever before the clues that were imperfectly shadowed by Plato.."(110)The education system was to be the key to change, as it had been for Plato.

In his text The new spirit, published in 1890, Ellis made clear his notion of progress, saying:

> "If democracy means a state in which every man shall be a free man, neither in economic nor intellectual nor moral subjection, two processes at least are needed to render democracy possible - on the one hand a large and many-sided education; on the other the reasonable organisation of life."(111)

This reasonable organisation of life was collectivist, since Ellis belived that progress could not be left to "the spasmodic and confused action of charities", or to "the interested action of individuals and corporat-ions."(112) On the other hand, progress was not to be entrusted to "petty moral officialdom"(113); rather progress relied on individual enlightenment to collective responsibility.

This conception of progress was to be central to Ellis's popularisation. He never wrote popular books in the sense of translating ideas from technical language to everyday discourse, rather he wrote books at a discursive level to encourage the interest of his peers in the form of the middle-class general reader. Such texts were persuasive at a polemical level, occasionally with Ellis's own research results added to give weight to the argument. For example, he concluded his Study of British genius, published in 1904, (a study somewhat dubiously based on a statistical analysis of hereditarian factors exhibited in the inclusion of names in the Dictionary of national biography), as follows:

> "We are entitled to believe that the factors of genius include the nature of the various stocks meeting together in the individual and the manner of their combination, the avocation of the parents, the circumstances attending conception, pregnancy and birth, the early environment, and all the manifold influences to which the child is subjected from infancy to birth."(114)

Clearly, despite Ellis's membership of the E.E.S.,he was not a defiant believer in heredity rather than environment, in the sense that he always appreciated the importance of environment in the determination of an individual's talents.

The motivation behind Ellis's contribution to eugenic writings for the general reader appears to have been to promote his beliefs in anarchic collectivism by stressing the importance of both hereditarianism and environmentalism, the former being associated with individualism and the latter with socialism. In his concluding chapter to The task of social hygiene(115), he made his position clear, saying:

> "In every age the question of Individualism and Socialism takes on a different form. In our own age it has become acute under the form of a conflict between the advocates of good heredity and the advocates of good environment.

As usual there is a real underlying harmony of the two demands."(116) This position was very similar to that of Thomson and Geddes; and as Ellis's choice of Thomson and Geddes' text The evolution of sex as the first publication in his 'Contemporary Science Series' suggests, Ellis was aware of Geddes' socio-biology, and the two were socially acquainted.(117)

Ellis's idealistic belief in the progress of anarchic collectivism meant that he believed war would soon be eliminated, since "the wars of modern times, have to a large extent, had commercial causes at their roots", and, therefore, "the downfall of unrestricted competition, and the organisation of industrialism, will remove this cause of war."(118) This belief in the progress of pacifism linked Ellis once again with Geddes(119)and the later writings of Saleeby, in that Ellis was no social imperialist, wishing to strengthen the race in order to prepare for international struggle. For Ellis was an avowed internationalist, believing that "the nations themselves form one family united by blood."(120) Furthermore, for this reason Ellis did not believe that differential birth rates between nations were significant, and felt that, on the whole, falling birth rates were providential, since:

> "every fall in the birth rate means a fall in the death rate, in the disease rate, in the rate of misery, an immense saving not only in money but in human happiness and social effort."(121)

These conclusions were heavily criticised by E.Schuster in his review of Ellis's tract, The problem of race regeneration, for the Eugenics review. E.E.S. beliefs on these matters were clear: the falling birth rate of the middle-classes was to be deprecated, while the 'yellow peril's' rising birth rate was a welcome spur to the eugenics cause.(122) Ellis, however, was not to be swayed from his anti-imperialist position, which was again presented to the general reader through The task of social hygiene in 1912. In this text Ellis developed his pacifist ideas, popularising them by suggesting that heroism was to be found in the pursuit of social hygiene,for

"There are departments in the higher breeding and social evolution of the race - some perhaps involving questions of life and death - where the highest courage is needed."(123)

Whilst such ideas were not part of mainstream E.E.S. thought Ellis did, however, share several beliefs with the majority of eugenicists. Firstly, he does seem to have adhered to a theory similar to that of Saleeby's racial poison when, while discussing criminality, he claimed that:

"When insanity and alcoholism are combined in the parents, a rich and awful legacy of degeneration is left to the offspring.

The action of the poison may be slow and carried on from generation to generation. The fathers eat sour grapes; the children's teeth are set on edge."(124)

Ellis also believed that making sterilisation a condition of poor law relief would "be effectively working for the abolition of pauperism."(125) In this belief he was also in step with E.E.S. policy.

The main purpose of Ellis's writings on eugenics, however, seems to have been to influence the direction of fashionable beliefs concerning eugenic policies in a collectivist and pacifist way. Having something of an amateur status, through his inability to qualify as a high status doctor, Ellis's popularisation had, as has been suggested, more to do with changing political and social attitudes, which his researches reinforced, than with the exposition of theoretical science. In this respect he differed from Saleeby and Thomson, both self-consciously professional, who, although they were also concerned to change political and social beliefs, did so from a professionally qualified position, and frequently explained hereditarian theories in their popular literature. It would seem then that Ellis did not perceive himself to be in the business of exposition because his research was of an amateur status, and was not based on the authority given by an academic training. In a sense Ellis was truly a peer of the general reader, in that he was not separated from them by a confident

knowledge of an academic specialism. Consequently, his role, as the author of popular texts on scientific topics, was to take part, as an equal, in middle-class debates concerning the direction of society, by drawing on and developing the consensual political and social attitudes of his readers. This also appears to have been the way he perceived his role as editor of the 'Contemporary Science Series'.(126)

7 - Karl Pearson (1857-1936)

Pearson was born in London, the son of William Pearson Q.C., of the Inner Temple. He was educated at University College School, then at King's College, Cambridge where he was third wrangler in the mathematical tripos of 1879, and at the universities of Heidelberg and Berlin. Pearson was called to the Inner Temple in 1882 where he studied for two years until Sir Alexander Kennedy persuaded him to abandon law for mathematics, and in 1884 he took up the post of Goldsmid professor of applied mathematics and mechanics in University College, London. The remainder of his life was spent at University College pursuing his interest in Social Darwinism.(127)

Like Ellis, Pearson believed that the reorganisation of society required above all a changed morality, but he was unequivocal that progress lay with socialism, a form of socialism that was to replace religion. He explained his position in a pamphlet of 1887 entitled The moral basis of socialism, saying:

> "Socialism arises from the recognition (1) that the sole aim of mankind is happiness in this life, and (2) that the course of evolution, and the struggle of group against group, has produced a strong social instinct in mankind, so that, directly and indirectly, the pleasure of the individual lies in forwarding the prosperity of the society of which he is a member.

The polity of the socialist is thus his morality, and his reasoned morality, may in the old sense of the word be termed his religion."(128)

Within the framework of this collectivist morality, the scientist had a special place, guiding society's course in a gradualist direction, so that while:

> "There are mighty forces at work likely to revolutionise social ideas and shake social stability. It is the duty of those, who have the leisure to investigate, to show how by gradual and continuous changes we can restrain these forces within safe channels."(129)

In this respect Pearson had much in common with the Fabians, and like them much of his political thought was associated with social imperialism, for Pearson believed that:

> "The struggle for existence involves not only the struggle of individual man against individual man, but also the struggle of individual society against individual society."(130)

Thus, Darwinism provided a rationale for social reform, since this perspective suggested that a society must be strong and centralised in order to compete against foreign rivals. Furthermore, this interpretation of the survival of the fittest justified colonialism, since it enabled Pearson to claim that:

> "It is a false view of human solidarity, a weak humanitarianism, not a true humanism, which regrets that a capable and stalwart race of white men should replace a dark-skinned tribe which can neither utilise its land for the full benefit of mankind, nor contribute its quota to the common stock of human knowledge."(131)

Thus, the political context in which Pearson's thought operated was clear: the basic moral unit was society not the individual, and working from this premise,British society needed centralisation and eugenic reform in order to strenghten her position in the world. Furthermore, reform required the new science of statistics which Pearson was pioneering, and the guidance

of academic experts trained in this science, for:

> "Witnesses, commissioners, philanthropists, social reformers, as a rule, and medical men only too frequently, sadly need that technical education, that power of reasoning about statistical data, which I think will become general when Eugenics has been made a subject of academic study, and minds specially trained to this branch of scientific study are placed at the disposal of our statesmen."(132)

Pearson's central motivation throughout the Edwardian era was furthering the professionalisation of his new science of Biometrics, which he believed would provide Britain with the expert knowledge needed to evolve into a stronger nation. It was because of this central idea that Pearson did not feel that he could be part of the E.E.S. He made his position clear in a letter to Galton in 1909, saying:

> "If our youthful efforts were mixed up in any way with the work of Havelock Ellis..or Saleeby, we should kill all chance of founding eugenics as an academic discipline..All I say is that I could not get the help we are getting from the medical profession, from pathologists or physiologists if we were supposed to be specially linked up with these names. Rightly or wrongly it would kill Eugenics as an academic study."(133)

In fact, approximately one quarter of the E.E.S. council from 1908-20 were members of the medical profession(134), and so Pearson's claim seems quite extraordinary. He personally, however, had had differences of opinion with both Ellis and Saleeby.

Ellis had published his text Man and woman in 1896, in which he claimed that, since there was more variation in men towards the abnormal (genius, criminality, insanity) men were prime movers of progress in civilisation. Pearson's biometrical studies questioned this conclusion and he publicly challenged Ellis. Ellis replied in an appendix to a later edition of the text, that Pearson was not taking environmental factors into considerat-

ion. Pearson retaliated by withdrawing his Grammar of science from the 'Contemporary Science Series'.(135) Similarly, Pearson's relationship with Saleeby, appears to have been purely one of public controversy which began with Pearson's biometric denial of the validity of Saleeby's theory of 'racial poison'(136)and hence questioned Saleeby's stance on negative eugenics. By 1912, as a result of this controversy, Saleeby, as a defiant Mendelian, rarely missed an opportunity to attack Pearson for his Biometry.

These controversies no doubt strengthened Pearson's personal dislike of two of the leading popularisers within the E.E.S., who, he felt, were making preposterous suggestions for reform without awaiting scientific evidence. In 1911, while lecturing to undergraduates at University College, London, he distanced academic eugenics from such people, saying:

> "Eugenics is the name of a new branch of science which has had so far only a few years of life. Yet, as all new things, which have reality behind them and are therefore growing, it has been quickly seized upon by innumerable 'cranks' and used as a banner to proclaim their own special 'crankeries' and push their own peculiar nostrums for the reform of society. It is needless to say that academic Eugenics has no relation at all to any idea of the State as a great matrimonial agency."(137)

Essentially, however, despite the intellectual disagreements, Pearson's reluctance to join the E.E.S. is explicable in terms of his attitude to popularisation.

Pearson felt that all citizens should have a scientific training, devoting three or four hours per week of their leisure time to the pursuit of a branch of science in which they were interested.(138) In his Grammar of science he makes his position clear, that:

> "It is the scientific habit of mind as an essential for good citizenship and not the scientist as a sound politician that I wish to emphasise."(139)

The crux of his dissatisfaction with the popularising efforts of the E.E.S., was that they were using Utopian rhetoric to promote eugenics, and:

> "If any such work gives a description of phenomena that appeals to the reader's imagination rather than to his reason, then it is bad science. The first aim of any genuine work of science, however popular, ought to be the presentation of such a classification of facts so that the reader's mind is irresistibly led to acknowledge a logical sequence - a law which appeals to the reason before it captivates the imagination. In this respect the great classics of science are often the most intelligible of books, and if so, are far better worth reading than popularisations of them written by men with less insight into scientific method."(140)

Pearson believed that those at the forefront of research should be supplying the public with information, and not relying on sensational popularisations, which distorted the true relevance of scientific work. To this end the 'Eugenic Laboratory Lecture Series' was launched in 1909 (the same year as the E.E.S.'s popular organ, the Eugenics review). This series of pamphlets priced at a shilling each were presented thus:

> "The aim of the present series of publications is to state the conclusions drawn from laborious statistical investigations and their bearing on national welfare in non-technical language suited to the general reader." (141)

One might wonder, given Pearson's commitment to the belief that scientists could guide society, why he felt popularisation to be such an important process. Clearly, however, he felt himself to be part of a democracy, hence the importance of a scientific habit of mind among citizens. Exactly how his popularisation fitted in with his belief in the leadership of experts is related to the democratic process Pearson makes clear in the following quotation:

> "The time is at hand when we shall realise that our social problems are the great academic problems - the chief problems of science, which it is utterly impossible to solve by party methods or by hustings oratory. Understand that I speak solely of finding solutions to the problems; their application to human conduct must ever depend on the will of the vote of individuals."(142)

Thus, scientists will solve social problems through research in academe; then citizens trained in the scientific method will read the scientists' popular (but neutral and rational) expositions of their research, and will then decide how to apply the new knowledge by voting. Pressure groups such as the E.E.S. have no place in this framework; furthermore, until the advent of socialism, Pearson believed that E.E.S. activity was futile, for:

> "Under socialism alone will it be possible to reap the advantages of any limit of population, because one class will not be interested in the over-production of another."(143)

Thus, Pearson's reluctance to join the E.E.S. can be seen to stem largely from his differing beliefs concerning popularisation, in particular his belief that E.E.S. propaganda was untimely because it did not wait for the verification of scientific research and the consequent reorganisation of society on socialist lines. This position could not have been further from that espoused by Saleeby in 1909, which seems to have represented the E.E.S.'s general position on popularisation, that:

> "Every individual may be a centre of eugenic opinion, and the time has assuredly come for attempting to realise this ideal, though a thousand years should pass before the facts of heredity are completely ascertained and understood. The main principles are of the simplest character, and can be readily imparted to a child."(144)

In other words, the E.E.S. were attempting to make public opinion a receptive bed for future scientific results, but in so doing they tended to assume

that eugenic beliefs were already scientific facts. Because this approach marginalised scientific research, instead of making it central, Pearson found such E.E.S. tactics despicable.

Despite the fact that one of the main reasons for establishing the E.E.S. was its role as a popularising body(145) the question of a conflict in terms of popularisation between Pearson and the E.E.S. does not seem to have been considered before. Such an explanation, however, seems more convincing than his own excuse that the E.E.S. was 'cranky', since the E.E.S. was merely an organisation in which a number of reputable professionals were involved in the promotion of a fashionable middle-class interest. The main factor which distinguished Pearson from the other popularisers considered in this chapter, however, was that eugenics was his research specialty in an academic environment. For although Thomson was a professional biologist, he was a zoologist, not a geneticist, and, similarly, the vast majority of writers popularising eugenics were writing about a subject which fell beyond their expertise. Obviously, in such circumstances, scientists with a professional reputation staked on eugenics had very good reason to keep their distance from a popularising attitude which demeaned their own research as a secondary resource for the promotion of political and social ideals.

8 - Conclusion.

From the work of the six popularisers under discussion, it can be seen that one of the main problems for the populariser of eugenics was how to make sure that progress proceeded satisfactorily. The solution to this problem was most obviously the expository dissemination of eugenic knowledge amongst the public. That alone was not enough, however, for unlike the majority of scientific popularisation, eugenics required the public to act on this information, hence the different policies advocated by the

popularisers considered in this chapter, ranging from legislative action, to the sanctions of a future religion, to the moral conversion of the individual. From this perspective it would seem that eugenics was more than "actively exploited" by public science as Turner has claimed, rather it was an expression of middle-class support for public science in the Edwardian era.

D.Mackenzie has already pointed out that eugenics seems to have focussed the interests of the professional middle-classes. He suggests that these interests would have been:

> "A tendency to'meritocracy', to an ideology of the 'expert' which would both differentiate the professionals from the mass of manual workers, emphasising the importance of mental rather than manual labour, and claim a place for expertise in partnership with, or even in command over capital and land."(146)

To a greater or lesser degree, eugenics as popularised by all six writers considered, promoted such interests. All six firmly believed that professionals should guide the state or shape society, be it in the role of enlightening the hereditarian rule of the aristocracy, as in Whetham's case, or by guiding a socialist society through the formation of democratic opinion as in Pearson's case. Liberals, such as Thomson and Saleeby tended to feel that their role was to advise the elected parliamentary leadership. Even the anarchist Geddes believed that the university was the key to progress, and Ellis, although suspicious of increased state intervention, felt that the professional should have a greater role in education. Thus, it seems clear that eugenics does indeed betray the interest of the professional middle-classes at a general level. Nowhere is this made clearer than in the popularising efforts of the writers considered in this chapter, whose writings reflect the assumption that the audiences they were catering for were prosperous, middle-class and well educated. This assumption is conveyed through the use of classical allusions, latin phrases, a difficult

latinate vocabulary, references to citizenship, and, perhaps most tellingly, a complete lack of coyness concerning negative eugenics.

Turner's argument, however, that public science did not radically challenge "the existing capitalist economic system and the military"(147) until the nineteen thirties, seems, from this examination of the popularisation of eugenics, to require some revision. For the collectivist anarchism of writers like Geddes and Ellis with their pacifist, internationalist, cooperative outlook would seem to constitute such a challenge, and was as much a part of Edwardian public science as the well-documented social imperialism of writers like Pearson and Whetham.(148)

One aspect of the professional middle-classes interest in the promotion of eugenics, however, appears to have been completely neglected by historians concerning, as it does, how the popularisation process of eugenics worked. One of the most surprising features of the popularisation of eugenics through the E.E.S., in the Edwardian era, was that it does not appear, on the whole, to have been carried out by professionals working within the fields of genetics or biometry, and the distance the biometrician Karl Pearson and the geneticist William Bateson kept from the E.E.S. may be more significant than hitherto realised. For it seems possible, from the evidence of the six writers considered in this chapter, that the majority of people popularising eugenics, though they were indeed predominantly from the professional middle-classes(149), were using eugenics to voice their social and political opinions with an alleged 'scientific' authority, precisely because it was a field in which they were not experts. Indeed, to make such blatant polemical statements in their own professional capacity would have been beyond the pale of their professional values, and would possibly have weakened their career prospects. But such professionals could use eugenics as a political vehicle without incurring such risks, and were able to do so because it was a new science with very few experts of its own. The fact that they did use the E.E.S. as a vehicle for the

promotion of their political opinions, however, meant that it rapidly became a pressure group rather than a scientific society, and therefore estranged the very experts who were most integral to its cause, experts such as Bateson and Pearson. It is in this sense that eugenics was hijacked by popularisers who promoted it as a science while demoting the social prestige of research in the relevant specialties. Thus, eugenics was not a 'deviant' science in the respect that its principles were accepted by the orthodox scientific experts, but rather it became a 'fringe' science in that these principles were promoted at the level of popularisation in such a way that scientific investigation was preempted.

In the wider context of the popularisation of science in the Edwardian era, the promotion of eugenics, along with the coverage given to technological innovation in science series discussed in the last chapter, suggests that the assumption that science was a utilitarian tool was widespread at this time. Thus, with the emphasis of the popularisation of science firmly on the ability of science to upgrade the quality of life and citizenship in this period, the Edwardian era can convincingly be described as the high noon of public science.

Footnotes.

1 - F.M.Turner, 'Public science in Britain, 1880-1919', in Isis, 1980, 71, pp.589-609, p.597.

2 - F.Galton, 'eugenics, its definition, scope and aims', in F.Galton, Essays in eugenics, London: The Eugenics Education Society,1909,pp.35-44,p.35

3 - Plato, The republic(trans. D.Lee), 2nd edn., Harmondsworth, 1974, p.182.

4 - R.Barker, Political ideas in modern Britain, London, 1978, p.49.

5 - V.L.Hilts, 'Obeying the laws of hereditary descent: Phrenological views on inheritance and eugenics', in Journal of the history of behavioural science, 1982, 18,pp.62-77.

6 - Quoted in J.D.Y.Peel, Herbert Spencer: The evolution of a sociologist, London, 1971, p.164.

7 - F.Galton, Hereditary genius, London: Macmillan, 1982, preface.

8 - D.J.Kevles, In the name of eugenics: Genetics and the uses of human heredity, New York, 1985, pp.18-19, 43, 34-6.

9 - M.Freeden, The new liberalism, London, 1978, pp.76-110.

10 - P.Geddes,'Civics as applied sociology', in H.Meller (ed.), The ideal city, Leicester, 1979, pp.65-153.

11 - R.N.Soffer, 'Why do disciplines fail? The strange case of British sociology', in English historical review, 1982, 97, pp.767-802.

12 - J.Woodhouse, 'Eugenics and the feebleminded: The parliamentary debates of 1912-14', in History of education, 1982, 11, pp.127-139.

13 - E.S.Pearson, Karl Pearson, Cambridge, 1938, pp.53-4, 76.

14 - J.A.Thomson, Heredity, 2nd.edn., London: Murray, 1912, p.372.

15 - Op. cit. (13), p.35.

16 - D.Mackenzie and B.Barnes, 'Scientific judgement: The Biometry-Mendelism controversy', in B.Barnes and S.Shapin, Natural order, London, 1979, pp. 191-211, p.205.

17 - J.Sapp, 'The struggle for authority in the field of heredity, 1900-1932: New perspectives on the rise of genetics', Journal for the history of biology, 1983, 16, pp.311-342.

18 - Op. cit. (8), see also G.R.Searle, Eugenics and politics in Britain, 1900-1914, Leyden, 1976.

19 - He used the formula almost as an algebraic equation to indicate the interrelation of place, work and folk in every aspect of life. P.Boardman, The worlds of Patrick Geddes, London, 1978, p.142.

20 - Ibid., p.69.

21 - P.Geddes, 'On the conditions of progress of the capitalist and the labourer' in The claims of labour , Edinburgh: Cooperative printing co. ltd., 1886, pp. 74-112, p.76.

22 - Ibid., p.95.

23 - Ibid., p.105.

24 - V.Brome, Havelock Ellis, London, 1979, p.61.

25 - Op. cit. (19), p.113.

26 - J.A.Thomson, Herbert Spencer, London: Dent, 1906, p.258.

27 - P.Geddes and J.A.Thomson, The evolution of sex, London: Walter Scott, 1889, p.280.

28 - Ibid., p. 312.

29 - Op. cit. (19), p.121.

30 - J.A.Thomson, 'The sociological appeal to biology', in Sociological papers, 1907, 2, pp.141-71, p.161.

31 - Ibid., p.163.

32 - Ibid., p.185.

33 - J.A.Thomson, 'Suggestions of sociology', in Saint George, 1906, 8, pp. 3-14.

34 - J.A.Thomson, Darwinism and human life, London: A.Melrose, 1911, p.228.

35 - Ibid., p.229.

36 - Eugenics review, 1911-12, 3, p.150.

37 - J.A.Thomson, The wonder of life, 6th. edn., London: A.Melrose, 1927, p.7.

38 - P.Geddes and J.A.Thomson, Evolution, London: Williams and Norgate, 1911, p.222.

39 - J.A.Thomson, Ways of living, London: Hodder and Stoughton, 1926, p.14.

40 - Op. cit. (38), p.220.

41 - T.H.Huxley, 'Technical education', in Science and education, London: Macmillan, 1895, pp.404-27, pp.406-8.

42 - P.Geddes, The world without and the world within, London: Allen, 1905, pp.23-4.

43 - P.Geddes and J.A.Thomson, Sex, London: Williams and Norgate, 1914, p.242.

44 - Ibid., p.241.

45 - H.Meller, op. cit. (10), p.29.

46 - J.A.Thomson's introduction to,J. Rennie, The aims and methods of nature study, London: University Tutorial Press ltd., 1910, p.xii.

47 - J.A.Thomson, 'Zoology', in I.Margesson (ed.), A handbook to the study of natural history, London: G.Philip and Son, 1894, p.10.

48 - Op. cit. (47), p. xv

49 - H.Meller, 'Patrick Geddes: An analysis of his theory of civics, 1880-1904', in Victorian studies, 1973, 16, pp.291-317, p.292.

50 - Ibid., p.

51 - Op. cit. (19). p.118.

52 - "Shaw, Wells, Graham Wallas etc., had, I think, a kind of affectionate respect for Geddes, but his attitude and methods were so far apart from theirs that they usually ignored him. From their quite different standpoints, they would object - among other things - to his formulae and his habit of always applying them; to his trick in going over them almost every time in making an exposition of any problem; to his folded papers and diagrams, and so on. And they had also an impatience with any thinker or teacher who quoted Comte respectfully."
Op. cit. (19), p.209.

53 - Ibid., p.209.

54 - V.Branford and P.Geddes, The coming polity, London: Williams and Norgate, 1919, p.332.

55 - Ibid., p.246.

56 - Op. cit. (47), p.15.

57 - J.A.Thomson, Introduction to science, London: Williams and Norgate, 1911, p.249.

58 - Ibid., p.247.

59 - Ibid., p.57.

60 - Op. cit. (38), p.220.

61 - Op. cit. (14), p.3.

62 - See chapters 3 and 5 respectively for a discussion of these series.

63 - Op. cit. (14), p.542.

64 - C.W.Saleeby, Ethics, London and Edinburgh: T.C. and E.C.Jack, 1905, p.73.

65 - C.W.Saleeby, Organic evolution, London and Edinburgh: T.C. and E.C. Jack, 1905, p.122.

66 - C.W.Saleeby, Heredity, London and Edinburgh: T.C. and E.C.Jack, 1905, p.39.

67 - Ibid., p.91.

68 - C.W.Saleeby, Sociology, London and Edinburgh: T.C. and E.C.Jack, 1905, p.108.

69 - F.Galton, 'Eugenics as a factor in religion', in F.Galton, Essays in eugenics, London: The E.E.S., 1909, pp.68-73, p.68.

70 - C.W.Saleeby, Worry, London: Cassell, 1907, p.292.

71 - Ibid., p.295.

72 - C.W.Saleeby, Evolution, the master key, London: Harper and bros., 1906, p.351.

73 - Op. cit. (69), p.70.

74 - C.W.Saleeby, Health, strength and happiness,London: Grant Richards, 1908, pp.415-6.

75 - Ibid., pp.415-6.

76 - C.W.Saleeby, Parenthood and race culture, London: Cassell, 1909, p.290.

77 - Ibid., p.293.

78 - C.W.Saleeby, 'Psychology of parenthood', in Eugenics review, 1909-10, 1, pp.37-47, p.45.

79 - Op. cit. (76), p.293.

80 - "these social ideals are supreme, the biological ideals are fundamental. The two must ever go hand in hand, but they are different, and they sometimes pull different ways. Hence, arise complexities which the author seems to us in some cases to ignore."
J.A.Thomson, review of Parenthood and race culture, in Eugenics review, 1909-10, 1, p.129.

81 - C.W.Saleeby, 'Racial poisons', in Eugenics review, 1910-11, 2, pp.30-52, p.5

82 - C.W.Saleeby, Woman and womanhood, London: Heinemann, 1912, p.390.

83 - Op. cit. (76), preface.

84 - Op. cit. (82), p.392.

85 - E.Schuster, review of Woman and womanhood, in Eugenics review, 1913-14, 5, p.74.

86 - Op. cit. (38), p.203.

87 - C.W.Saleeby, The progress of eugenics, London: Cassesll, 1914, p.7.

88 - Ibid., p.15.

89 - Ibid., p.16.

90 - Ibid., p.145.

91 - B.Wynne, 'Physics and psychics: Science, symbolic action and social control in late Victorian England', in B.Barnes and S.Shapin (eds.), op. cit. (16), pp.167-191, p.180.

92 - W.C.D. and C.D. Whetham, The family and the nation, London; longmans, Green and Co., 1909, pp.2-3.

93 - W.C.D. and C.D.Whetham, Heredity and society, London: Longmans, Green and Co., 1912, p.143.

94 - Op. cit. (92), p.209.

95 - Ibid., p.223.

96 - Op. cit. (93), p.127.

97 - Ibid., p.6.

98 - Ibid., p.143.

99 - Op. cit. (87), p.164.

100 - W.C.D.Whetham, 'Heredity and destitution', in Eugenics review, 1911-12, 3, pp.131-42.

101 - Op. cit. (92), p.5.

102 - Ibid., p.211.

103 - Op. cit. (93), pp.162-3.

104 - The basic difference in the popularisation of the biological, as opposed to the physical, sciences was that they were presented as part of daily experience in a way in which more experimental sciences could

not be. See chapter 2, section on science as hobby.

Furthermore, by the late Victorian period, biological theory in the form of Social Darwinism, had become part of normal political discourse, while, for various reasons, including the promotion of different sciences for different audiences (see chapters 3 and 4) the physical sciences were becoming increasingly estranged from social conversation.

105 - H.Ellis, The nationalisation of health, London: Unwin, 1892, p.223.

106 - Op. cit. (24), p.54.

107 - H.Ellis, The problem of race regeneration, London: Cassell, 1911, pp.64-5.

108 - H.Ellis, The task of social hygiene, London: Constable, 1912, p.402.

109 - Ibid., p.403.

110 - Ibid., p.405.

111 - H.Ellis, The new spirit, London: Bell, 1890, p.14.

112 - Op. cit. (105), p.6.

113 - Op. cit. (108), p.310.

114 - H.Ellis, A study of British genius, London: Hurst and Blackett, 1904, p.234.

115 - "Social hygiene" was a phrase used by Ellis to mean a type of eugenics which also involved environmental factors, and which was part of a pacifist-

socialist belief in progress.

116 - Op. cit. (108), p.399.

117 - H.Ellis, My life, London: Heinemann, 1940, p.204.

118 - Op. cit. (111),p.19.

119 - Op. cit. (19), p.189.

120 - Op. cit. (108), p.386.

121 - Op. cit. (107), p.61.

122 - E.Schuster, review of 'New tracts for the time', in Eugenics review, 1912-13, 4, p.95.

123 - Op. cit. (108), pp.347-8.

124 - H.Ellis, The criminal, London and Toronto: A.M.S.Press Inc., 1972 reprint of 1890 edn., p.98.

125 - Op. cit. (117), pp.68-9.

126 - See chapter 3, section on the middlebrow science series.

127 - B.Norton, 'Karl Pearson and statistics', in Social studies of science, 1978, 8, pp.3-35.

128 - K.Pearson, The moral basis of socialism, London: W.Reeves, 1887, p.5.

129 - K.Pearson, The ethic of freethought, London: Unwin, 1887, p.7.

130 - K.Pearson, The grammar of science, London: W.Scott, 1892, p.432.

131 - Ibid., p.438.

132 - K.Pearson, The scope and importance to the state of the science of national eugenics, London: Dulau and Co., 1909, p.11.

133 - Op. cit.(15), p.62.

134 - D.Mackenzie, 'Eugenics in Britain', in Social studies of science, 1976, 6, appendix of Farrall's data.

135 - Op. cit. (24), pp.86-7.

136 - See the 1909 series of pamphlets entitled 'Questions of the day and of the fray', London: Dulau and Co.

137 - K.Pearson, The academic aspect of the science of national eugenics, London: Dulau and Co., 1911, p.3.

138 - Op. cit. (130), p.14.

139 - Ibid., pp.9-10.

140 - Ibid., pp.12-13.

141 - K.Pearson, The problem of practical eugenics, London: Dulau and Co., 1909, introduction.

142 - Op. cit. (137), p.20.

143 - Op. cit. (143), p.25.

144 - Op. cit. (76), p.138

145 - Op. cit. (15), p.62.

146 - D.Mackenzie, 'Karl Pearson and the professional middle-classes', in Annals of science, 1979, 36, pp.125-43, p.126.

147 - Op. cit. (1), p.607.

148 - For example, op.cit. (146).

149 - Op. cit. (134), appendix of Farrall's data.

CHAPTER 7.

THE PRESENTATION OF SCIENCE IN NON-FICTION SERIES IN THE TWENTIES AND THIRTIES.

1 - Introduction.

During the First World War, the cost of the production of books rose by approximately twenty per cent (1) largely due to paper shortages. Further, from 1914-1935 production costs were more than doubled by the rising prices of materials, and by wage increases to printers and book-binders. Thus, in order to reduce costs, more and more publishing houses took to incorporating a bindery and printing plant into their publishing establishment. And so, the first half of the twentieth century, despite the setbacks of two World Wars, continued to see a steady rate of increase in the volume of book production (2), corresponding to the overall rise in literacy and standards of living during this period. From these figures it seems clear that books were very much part of everyday life for large sections of the population during the inter-war period; for example, between the two World Wars, annual library issues leapt from 60 million in 1919, to 188 million in 1939.(3) Thus, although book prices were rising during this period, so too were market demand and book production; so that the long term economic effect of the Great War on the book trade's home market appears to have been slight.Similarly, the emergence of alternative forms of communication, such as the wireless and the cinema, do not appear to have affected the market for non-fiction books in any very significant way, since both of these new forms of the media were intended primarily as vehicles for entertainment rather than for education or for information.(4)

The Great War, however, had effected some changes in the popularisation of science. Firstly, at a practical level it had hastened the institutionalisation of science, largely through the Department of Scientific and

Industrial Research (D.S.I.R.) which had been established in 1916. Such state-aided research obviously helped utilitarian scientific developments, such as wireless, aviation and the physiological importance of vitamins; 'discoveries' which were of visible, practical importance. As the historian A.Marwick has commented:

> "All of this added up to give a new scientific orientation to British society at the end of the War, just as economic developments gave an orientation towards collectivism."(5)

This emerging 'democratically' organised state of which science was a part, began to see the fruition of ideas popularised by public scientists in the late Victorian and Edwardian eras, which have been discussed in previous chapters. Thus, many popularisers were able to continue building on the public interest in the potential of science for the betterment of human life, which had been fostered before the War. Many popular science books reflect this continued confidence in the potential of science, and contained Utopian predictions for the future.

On the other hand, the War had shaken the widespread late Victorian and Edwardian belief in progress with which, as has been indicated previously, science was so widely associated. This sense of lost confidence in science was further compounded in the early twenties with the popularisation of modern physics, especially with Einstein's theory of relativity. As will be discussed more fully below and in chapter 8, the popularisation of this theory operated at a number of levels in challenging the beliefs and claims of pre-War public science, and contributed to a growing feeling of doubt about the efficacy of scientific solutions to social and political problems.

One publisher of the period commented that:

> "..there was a need for authoritative books showing as clearly as possible how, materially, the epoch-making discoveries of science, as well as the war itself, had changed the entire pre-war conception of the Universe."(6)

The ambiguity of this comment was reflected in the writing of popularisers of the twenties and thirties, who were presenting two conflicting images of science to the public. In general, they either wished to remove science from its directive role in the consideration of social issues, a role which had become commonplace in the Edwardian era, or they wished to perpetuate and strengthen that role by stressing the utilitarian benefits which science could offer. Of course, as Collins has indicated (7), neither of these stances were new; they dated, at least, from when science started to have an impact upon society, but "what was special about the period between the two world wars was the extent and the intensity of the discussion rather than its actual existence."(8)

2 - The popularisation of relativity during the inter-war period.

The twenty years between 1919 and 1939 saw certain aspects of physics coming to the fore in popularisation. During the late Victorian and Edwardian eras, physics had taken a back seat in terms of popularity with biology in the driving seat because of the great interest both in Darwinism, and, later, in genetics. With the arousal of public interest, however, in Einstein's theory of relativity, heightened by the eclipse expedition of 1919, physics, and in particular cosmology, became a dominant popularising theme between the wars. Famous scientific personalities of the period who wrote popular expositions of modern physics included Bertrand Russell, E.N.da C. Andrade, James Jeans, Eddington, and the slightly less well known, J.W.N.Sullivan.

The popularisation of modern physics was, however, dogged by two main problems. Firstly, and most obviously, Einstein's theories were so abstract that they were in danger of outrunning the possibilities of the pictorial imagination, and were, therefore, extremely problematic to popularise. Secondly, Einstein's theories seemed to challenge the public perception

of the physical sciences as subjects which dealt with constant, unchanging natural laws. For, as a professor of physics, James Rice, expressed it, in his popular work of 1927:

> "We are all aware of the revolt in philosophy against the materialism of the nineteenth century. Gradually the biological and social sciences have followed the philosophers in their search for a view of life which will recognise that man's life and activities are not the mere by-product of natural forces which go on blindly, regardless of insignificant midgets on one of the tiniest members of the immense stellar concourse. Only physical science seemed to stand out against this humanistic movement. Not so, any longer. How can it be otherwise when the aspect of every natural event is as closely related to the particular individual observing it as Relativity shows?"(9)

In other words, relativity, like Bergsonian philosophy, appeared to have challenged one of the beliefs dear to Victorian Scientific Naturalism, namely that nature operated according to unalterable and objective laws. This belief would seem to have underpinned the success of public science in creating its aura of social authority during the late Victorian and Edwardian eras, despite the fact that many popularisers of public science in the Edwardian era had actually been converted to 'vitalism'.(10) After the Great War, however, many popularisers of physics found themselves in the business of openly challenging some of the tenets of Victorian Scientific Naturalism, and denying the validity of public science.

One of the first things popularisers of physics had to get into the public's perspective was the change of attitude away from late Victorian beliefs that the physical sciences had come to an almost complete understanding of the general laws of nature (11), to the modern twentieth century perception that scientific theory was prone to change. For example, in his text The mechanism of nature, Andrade does this in the following way. First he voiced the popular criticism of physicists, that:

"Your accepted theories of one generation are abandoned in the next: how can I be sure that you are right this time?"(12)

To this he answered:

"..any particular scientific theory is a provisional tool with which we carve knowledge of the material world out of the block of Nature."(13)

Eddington chose to articulate a similar answer in his text The expanding universe, by casting himself (the scientist) as a"blundering" detective attempting to solve a crime.(14)

Having attended to this change in emphasis, popularisers of modern physics tended towards one of two main cultural interpretations of relativity and quantum physics. The first, and by far the most widespread, interpretation promoted by popularisers, was that modern physics was so difficult and beyond the comprehension of the layman, not merely at a rational level because of the mathematics involved, but because the physicist had a heightened imaginative ability which separated him from the ordinary man. For example, Sullivan wrote in his text The limitations of science, that:

"in every direction we are faced by ambiguities and contradictions. Yet this state of affairs is not depressing; it is, on the contrary, extraordinarily stimulating. For we feel that our difficulties can only be solved by man's imagination rising to the task of constructing radically new concepts."(15)

In this type of exposition, popularisers were building on earlier methods of physics popularisation which had been used, for example, by Tyndall, where he claimed that the physicist possessed mystical qualities through his imaginative powers. It was not until after the Great War, however, that this idea began to have a widespread impact on the image of science.

The idea that physicists were philosophical seers was not, however, the only cultural interpretation of modern physics. For example, the scientific texts in the 'Outline Library', launched by Newnes in 1929,

(which were all concerned with the exposition of modern physics) often presented the reader with information interpreted for him by "an enquiring layman". This layman, the journalist, Walter Grierson, frequently made cynical asides to the reader, which conveyed the impression that science was absurd. For example, one such aside went as follows:

> " The professor reminded one of Bertrand Russell's famous epigram, that mathematics is a science in which one never knows what one is talking about, and does not know if what one says is true."(16)

This type of attitude, which was unwittingly nurtured by many popularisers of modern physics, was dire from the point of view of public science and had to be countered. A more thorough exploration of these issues will be given in the following chapter.

3 - The rise of the polemic genre within general non-fiction series.

After the War, the British political status quo was challenged, first by the election of a Labour government in 1924, and then by the General Strike of 1926. Against this background of marked political changes for post-War Britain, the existence of a potentially large market for books which encouraged popular debates about the impact of science on society, appears to have been discovered by accident in 1924 after the publication of J.B.S.Haldane's essay Daedalus. In November 1923, C.K.Ogden, who was working as an editor and literary advisor for Kegan Paul, brought Haldane's essay 'Daedalus' to the attention of the publisher's readers, who suggested, somewhat disinterestedly, that it might be printed as a sixpenny pamphlet. By a twist of fate, however, one of the firm's readers was Fredric Warburg, who was so impressed by the essay that he pushed for its appearance as a book rather than a pamphlet (17), and this was done. Warburg writes:

> "There was no jacket. At half-a-crown the margin of profit per copy was above average, but no great sale was expected and the first

printing was a mere 2,000 copies. Within days of its publication, Daedalus began to sell like wildfire; impression followed impression, each of about 2,000 copies in the cautious tradition of the respectable firm which had issued it. In all, over 20,000 copies were sold, bringing in a revenue of some £1,700 of which, perhaps, £1,200 was gross profit."(18)

The text in question was a left-wing analysis of science and society, which suggested that science was bound to have a future in the West, for:

"Capitalism, though it may not always give the scientific worker a living wage, will always protect him, as being one of the geese which produce golden eggs for its table. And competitive nationalism, even if war is wholly or largely prevented, will hardly forego the national advantages accruing from scientific research."(19)

Haldane then spent the rest of the text prophesying the utilitarian, utopian future of various sciences: physics would solve the national fuel problem, chemistry would solve the world food problem, biology would create better men through ectogenesis,and psychology would cure degenerate characters through hypnotism. These prophecies excited the public imagination in a big way.(20) Haldane's enthusiastic optimism, however, did not stop there, for he went on to define science as:

"..the free activity of man's divine faculties of reason and imagination..the answer of the few to the demands of the many for wealth, comfort and victory..the subjugation of the dark and evil elements in man's soul."(21)

Haldane also argued that the world had science to thank for peace in the shape of the League of Nations, since it was the scientists "who enlarged man's power over nature until he was forced by the inexorable logic of facts to form the nucleus of an international government."(22)

Such claims apparently provoked little but cutting satire within Oxford University, the Haldane family's academic base, to the extent that J.B.S.'s

mother wrote a note to his friend Julian Huxley concerning J.B.S.'s father, John Haldane, the physiologist, as follows:

> "I find he is frightfully upset about Daedalus. Will you abstain altogether from poking fun at him on account of it? And if you can do so to keep people off the subject altogether when he is about?"(23)

Suffice to say, that in subsequent editions of the book J.B.S. publicly, and reluctantly,disassociated his father from any responsibility for the content of the text.

The amount of interest generated by the text, however, suggested the necessity of a sequel, which Ogden managed to persuade Bertrand Russell to write.(24) Russell's text was entitled Icarus, and began:

> "Icarus, having been taught to fly by his father Daedalus, was destroyed by his rashness. I fear the same fate may overtake the populations whom modern men of science have taught to fly."(25)

Thus, Russell's tone was the opposite of Haldane's and belongs during this period with the 'doubting' trend in popular science books, since for Russell science was destroying virtue, not, as Haldane claimed, perfecting it.

In commercial terms, however, it had become clear to Kegan Paul, through the impressive sales of both books (which between them sold 11,500 copies in 1924 alone (26)), that "there was a considerable market for books about the future, and we discussed the possibility of a whole series of little books and a title for it."(27) The books were subsequently published under the title 'The Today and Tomorrow Series', which ran for a little more than six years, with the appearance of over one hundred volumes, selling at 2s.6d. each, covering topics as diverse as morals, science, art and sport.

In many interesting ways, this series marked a change of direction for popular science books. Firstly, it offered a forum for openly provocative, topical ideas, aimed at the well-educated middle-classes, as suggested both by the classical titles and themes of the texts, and their price, which,

at 2s.6d. a volume for books of less than 13,000 words was relatively expensive. Secondly, the series editor, C.K.Ogden, looked for eminent authors willing to contribute, rather than picking subjects; and he was able to do this because,

> "as editor of the Cambridge Magazine, and as founder of the Heretics, Ogden knew almost everybody who was interested in either a critical or novel way in matters religious, philosophical, artistic and anthropological."(28)

Hence, the ideas for the books in the series seem to have come from the informal network of Ogden's friends, centring on the Cambridge Heretics, who, as their name suggests, were interested in controversial debates, and so,in the field of science "Ogden's instinct was to avoid what we would call today 'hard science' - descriptive books on physics or some field of straight biology."(29) And this editorial policy encouraged an interplay of ideas, and, as the texts indicate, no one particular viewpoint appears to have been promoted at the expense of others. Indeed, this was literally so as, since the series was packaged in terms of various debates, so the reader needed to be aware of the stances taken by different authors in order to appreciate fully the book they were reading. Obviously, this feature had commercial implications, since the publishers footnoted the texts, referring to other books relevant to the debate, with their own house's name and the price, clearly shown. Thus, the 'Today and Tomorrow Series' seems to herald a new era in the marketing of popular science books, in which the polemic genre provided a unifying theme for a series. Interestingly, what was only a minority view among participants in high science at this time (30), that there was a need for the public to "..consider new ideas and discuss judicially the significance of scientific discovery or applied device in relation to human progress,"(31) was in fact realised by publishers in 1924 through the marketability of books conducting such a service. Market demands had preempted the deliberations

of high science about its public image with the polemic genre emerging as a useful tool for popularising science in an up-to-date way through books.

The 'Forum Series' is added evidence of the new openly polemical dimension to the popularisation of science through series, for, published by Watts and Co., from 1926-37, the twenty-one volumes in this series each offered a short, contentious essay, such as Julian Huxley's The stream of life, published in 1926. This essay was basically a eugenic tract, which made strident claims, such as:

> "There are round about 400,000 mentally defective persons in these islands. If we could prevent them all from reproducing, the percentage of defectives would be halved in from three to five generations."(32)

And such provocative statements and ideas were characteristic of the series. It is perhaps significant that it was only during this period that volumes in a series of non-fiction books, largely focussing on science, each contained the following publisher's disclaimer: "It should be clearly understood that each writer in this series of little books is alone responsible for the opinions expressed."(33) Possibly, the reason that Watts had to adopt this disclaimer was because, as Budd has argued(34), the rationalist movement, in the form of the Rationalist Press Association, was no longer able to assume a simple identity between scientific thought and agnosticism or atheism as it had in the past, because of the rise,at this time, of the popularisation of physics as a spiritual activity. Nevertheless, clearly, whatever the reasons for the disclaimer, science as controversy had become an accepted and highly marketable form of literature during the twenties. So much so, in fact, that by 1927 the British Association made use of this particular series, by contributing the presidential addresses of the B.A. to Watts for publication in texts in the series.

From the evidence of these two series it would seem that, at this stage, the polemic genre as used in non-fiction series, provoked thought, but it

did not offer coherent solutions as series in the Edwardian era had done. In the twenties it was used as a vehicle within series to promote discussion rather than as a propagandising tool for change. Hence, it appears that the use made of controversy, by these series, as a unifying idea reflected, among other things, both the uncertainty about the role of science in society after the War, and a questioning of public science assumptions which had been widely held prior to the War, when the general non-fiction series had been used by some editors and publishers as a forceful, rather than as a deliberative, tool, committed to furthering what were perceived at the time as 'progressive' ideas,such as eugenics.

4 - Other responses by non-fiction series to the crisis of image for science.

After the collapse of the General Strike, the problems of unemployment and the depression, were, during the following years, felt to be capable of solution without a radical or revolutionary change of government. Further, by 1929, the great American boom was in full swing and Europe, reconstructed largely with the aid of American capital, seemed to be pulling itself out from under the shadow of the Great War. Unemployment in Britain was still considered to be serious, and certain areas and industries were badly depressed, but in general profits were high, and there appeared to be every possibility of carrying through important measures of social reform and of reducing unmeployment by public works and schemes of economic development and reorganisation without causing any crisis likely to lead to a collapse of the profit-making system. This calming of the social and political situation also offered a respite from controversy for the popularisation of science in books, and sales of the 'Today and Tomorrow Series' declined.(35)

In 1927, 'Benn's Sixpenny Library' was launched, which was published by Ernest Benn Ltd., and edited by William Rose. This series offered texts

of eighty pages giving inexpensive, accessible exposition of various topics (including science) by eminent authorities, in pocket-size paperbacks. The ordering of the texts within this series, however, appears to have been somewhat indiscriminate, since Benn's general scientific periodical Discovery, when reviewing the series said:

> "The Sixpenny Library lends itself very readily to systematised courses of reading, and in the scientific branch at all events a most thorough acquaintance may be formed with modern thought by arranging the titles in some simple order."(36)

The editor Rose (a classicist), however, had obviously failed to do this, and so the reviewer then proceeded to order the titles for the benefit of the reader, placing his own biography of Newton first, followed by texts on astronomy, geology, the general laws of chemistry and physics, and then, lastly, the elementary exposition of modern physics and chemistry.

These scientific titles gave factual exposition in the relaxed scholastic genre of presentation, and were expected to whet the reader's appetite for further knowledge, by "describing the wonder and beauty of a phenomenon,"(37)and then providing a graded bibliography of further reading. Yet, as the reviewer commented, "the reader should be warned, however, that he will not find many of the text-books to which he is referred quite so appetising as the carefully prepared sixpenny bait."(38) Aware of the gap in style, expression and language between the popular science book and the advanced treatise, which was widening considerably as the century progressed, this series obviously attempted, though not altogether successfully, to bridge it.

The contributing popularisers to the series were aware that the Great War had undermined public confidence in claims made prior to the War by public scientists about the necessity of finding scientific solutions to social problems. For example, one author said:

> "Scientific authority as expressed in popular books is to a very

considerable extent a matter of successful, confident bluff, and has a good deal in common with its past predecessor, theological authority."(39)

Another contributor to the series repeated this warning(40), and his message, and, indeed, the message of the series, appeared to be that the layman should refer to popular science books solely for the lucid and 'objective' exposition of scientific theory, and not for directions as to the solution of society's problems. To set the tone for his text he spent some time developing a cautionary tale of a stonebreaker who used to stop and chat with "college chaps"(41) who would 'prove' to him in simple terms that, say, the earth was round; and when the stonebreaker considered their 'proofs', he would often find some flaw in them. An example given is the way a ship disappears beyond the horizon is only a proof that the earth is not flat, if it is assumed that light travels in straight lines. This is an assumption that was often made in such popular expositions, but was rarely articulated and explained. Thus, this series appears to have tried to give popularisation back its justification for existence as an expository tool, freed from the trappings of public science. The onus of this series was clearly the exposition of established scientific information, with little or no cultural context, focussing purely on scientific detail at an elementary level. Indeed, this was done to the extent, for example, that A.Holmes in his The age of the earth, published in 1927, concluded:

"We have carefully examined the evidence in this little book - perhaps to the point of boredom - for on the decision arrived at depends any solutions of any discrepancies that may still remain."(42)

Evidently, this series consciously promoted the 'pure' exposition of theory, trying to accomodate both the democratisation of society and the increasing specialisation of science, by providing a rigorous, elementary foundation to the sciences presented. The assumption behind such a series was that any reader, irrespective of educational or cultural background, who could

afford sixpence and spare the time to learn, could become knowledgable about science. Questions about the implications of such theories, or their relevance within contemporary society, were obviously felt to be beyond the scope of the series.

Many of the science texts in this series, however, did in fact end their exposition on a note which left the reader to consider the social implications of the topic. For example, the well-known physics professor and populariser, E.N. da C.Andrade, concluded his little book, The atom, published in 1927, as follows:

> "Whether the source of energy if found, will lead to new happiness or to vast increases in population followed by ruthless war, is a question to which the answer must at present be dictated by temperament rather than reason."(43)

Such concluding remarks, however, would seem to be little more than a token gesture to the social climate, for they, along with the tone and style of the rest of the texts in the series, served to divorce 'pure' science from social responsibility.

Very similar in scope to 'Benn's Sixpenny Library' were Routledge's 'Introductions to Modern Knowledge', also priced at sixpence , which were launched in 1929. As a series Routledge's 'Introductions' were interesting in that they offered two main types of presentation, the theoretical exposition of some subjects, and the discursive explanation of the practical applications of other subjects. Within the series history fitted into the former type of presentation, while texts like Making a home fitted into the latter type. Scientific topics, on the other hand, were treated in either way. Topics like Darwinism and geology were treated by theoretical exposition at an accessible level (although somewhat surprisingly readers of this elementary series were referred to Nature for information on recent scientific discoveries), whilst newer sciences like psychology and anthropology were presented in terms of practical applications. Thus, for example,

The nursery years, was an introduction to the psychology of child development, which explained how to bring up children; while The savage as he really is, was an introduction to anthropology with a clear practical bent, as revealed by the conclusion, that:

> "Only by a true appreciation of primitive ideas, only when we know how primitive people think and why they behave as they do, can we govern them to our best advantage and their own."(44)

Thus, this series seems to have assumed that some of the older sciences were beyond the need for public justification, whilst other, newer sciences required a utilitarian excuse for their existence.

In terms of illustrating societal change from the late Victorian era to this inter-war period, probably one of the most fascinating series is 'Macmillan's Sixpenny Self-Help Library', which was also launched in 1929. For this series was aeons away from Samuel Smiles' self-help ethic. The series offered reference books, not primarily to educate the reader, but to persuade him in his capacity as a consumer to spend money on the latest technology. An obvious example of this was Mrs. Robert Noble's text Labour saving in the home, published in 1930, which exhorted the reader to buy a refrigerator, install central heating etc. etc. All texts in this series were unusual in carrying advertisements (other than for the publisher's own books(45)), and possibly the texts were in some way sponsored by companies interested in their content. For example, the British Commercial Gas Association was prominently advertised in Mrs. Noble's text; and Percy Harris's text The wireless listener's guide book, offered practical advice on which wireless sets to buy, how to improve the quality of the set (which naturally involved buying the necessary gadgets), and advertised brands of transformers, batteries, and the periodical Amateur wireless. In terms of the series' commercial slant, the most surprising text was probably F.Howard Humphris' Ultra-violet and other rays, which explained what such rays were, and their benefit to health. At the end of the text

are pages of advertisements for Vita Glass, which allegedly let in U-V rays, providing "health through your windows", and "bronzed health indoors!"(46) Evidently this series was catering for a consumer society, and offered new connotations to the phrase'self-help.'The series also offered an alternative solution for the problem of science's image during the inter-war period; it could simply be packaged and marketed as another desirable product.

5 - The continuing problem of the public image of science in the early thirties.

The summer of 1931 saw the financial collapse of Austria and Germany; during the following two years, a severe and prolonged world depression developed.In 1933 Hitler seized power in Germany, an event which jolted many scientists into a concern about the social and political world around them, and among the scientific community in Britain there was a marked growth of interest in the relations between science and society.(47) The president of the B.A. felt that its role was to offer advice when factual scientific knowledge was relevant (e.g. food policy), and to encourage research in areas of obvious social importance (e.g. nutrition). Clearly, the scientific establishment perceived its role to be that of offering an unbiased presentation of relevant information, not that of an advocate for certain policies. The problem for the popularisation of science in the early thirties, therefore, was identified as being primarily one of communication, of presenting information in a simple and accessible way.

At this time C.K.Ogden was launching his Basic English Project, which aimed to make everyday ideas communicable by using no more than 850 basic English words, with fifty special words for every special subject like general science, physics, chemistry and so on. By the mid-thirties the

project was becoming increasingly concerned with science, which linguistically had 'kept itself free from common error only at the price of cutting itself off from the common man."(48) The project claimed that :

> "One of our purposes is attacking this last view - the idea that science today is produced by experts for experts. No healthy relation-between society and science is possible in these conditions. All sorts of overstatements are made about what science is able to do, and the common reader, in East or West equally, has no apparatus for forming an opinion about their value."(49)

For this reason, the Basic English Project intended to publish a 'Basic Science Library' for the general reader, of which only five texts had been published prior to 1940. Each of these texts had a standard preface by their editor Ogden, part of which reads:

> "At a time when public opinion may have increasingly important effects on the future of science, the general reader is a person the experts would do well to take more seriously; and the current view that any newspaper story is good enough for the public may do great damage to the cause of science. With the help of Basic, science may be made simple without becoming bad science."(50)

Clearly then, the 'Basic Science Library', like 'Benn's Sixpenny Library', was another attempt to enhance the image of science by reevaluating and rejuvenating the methods of 'pure' science exposition.

The first text published in the 'Basic Science Library' was S.L.Salzedo's A basic astronomy. This text was written in the required lucid expression of Basic English. At times, however, the commitment to such a small vocabulary must have irked the reader, as, for example, in the following quotation, which read "the motion is like one of those playthings which are whipped to make them go round."(51) In other words, a spinning top!

The crucial test for this project, however, had to be whether it could make difficult science intelligible to the general reader. In this context,

the ultimate test had to be Einstein's theory of relativity. In his text on this subject for the series, A.P.Rossiter gave an encouraging run up to the theory,as follows:

> "..when the train on the rails by the side of our train is starting to go out of the station, it is a common experience to have the idea that it is <u>our</u> train which is moving, while the other is at rest. In the same way, the person moving at something nearer the velocity of light would see in the other apparatus those very changes which the other person saw in his."

So far so good, the reader would have got the general idea, but was almost immediately presented with the following sentences:

> "But with every increase of mass, inertia is greater, and acceleration less; and, again, on every one of the moving bodies, there is a contraction of distances: so that the nearer the last velocity gets to c(52), the harder it is to make any further increase. So that at c, by the time mass is'infinite', acceleration is impossible."(53)

It would seem that a difficult idea was still a difficult idea, even if it was only presented through a vocabulary of fifty technical words.

Generally speaking, by the twentieth century it was easier to talk, at an elementary level, about the increasingly theoretical body of knowledge of which science was compo sed in terms other than the scientific. Consequently, the championing of 'pure' popularisation with its emphasis on unsensational and context-free exposition does not appear to have been particularly successful in this period despite the efforts of the Basic English Project, and publishers like Benn. Meanwhile, by the early thirties, public science was beginning to regain a strong voice in popularisation through the efforts of socially concerned scientists such as Hyman Levy.

In 1934, Levy launched a series entitled 'The Library of Science and Culture'. Priced expensively at 7s.6d. per volume, the series set out to:

> "..present to the general reader a picture of the world, both of action and of thought, as science is shaping it. It will reveal how mankind has sought in science the means of satisfying its varied needs; and how, in turn, science is stimulating fresh aspirations, inspiring loftier deeds of progress, and awakening hopes of increasing mastery over the destiny of the race."(54)

Published by Watts, the series promoted a rationalist viewpoint, of which typical statements were:

> "It is no reflection on religion if civilisation should be leaving it behind as something it has outgrown, nor an exaltation of science that mankind is now embarking upon it as the next stage of human evolution."(55)

And,

> "Tradition makes the man, by circumscribing his behaviour within certain bounds; but it is equally true that man makes the traditions. And so, we can repeat with deeper insight, 'Man makes himself.'"(56)

The texts in the series offered a cultural analysis of the position of science, religion etc. within society, and always offered an optimistic rationalist conclusion. Such texts, however, never attempted to explain scientific theory and it applications, but concentrated on the more general cultural problems that science faced. This was particularly the case with J.Huxley's well-known contribution to the series Scientific research and social needs, published in 1934, and H.Levy's own text The web of thought and action, published in that same year. (57)

Although all the texts in this series were accessible in style and language, their price put them beyond the reach of the general reader, and their content was probably of limited appeal. It is perhaps unsurprising then, that they were not a spectacular commercial success, but the ideas they contained about the presentation of science to the general public were to influence popularisation in the later thirties.

6 - The Penguin revolution.

By 1935 secondary education was widespread; higher education had grown and spread middlebrow culture outside the environs of the universities through extra-mural programmes and movements, such as the Worker's Educational Association; and the public library movement appears, with hindsight, to have strengthened the impulse towards book ownership. All this contributed to a public hunger for books that were not overly didactic on the one hand, but that were not, on the other hand, too lowbrow, and which were cheap enough, with cheerful enough covers, to be put on bookshelves at home.

Allen Lane, the publisher, had for some time been brooding over the idea of launching a series of paperbacks which would suit this new market, but when he actually voiced his idea in public to the book trade he got a very negative resonse. The two main arguments against launching such a series were: that the scheme would either fail because the book buying public was not large enough to support by regular purchase the long runs which alone would make a series of this kind economically viable, or, that if the scheme were a success it would ruin the book trade. (58) Despite this unenthusiastic reception to his brainchild, Lane pressed on with the scheme. He decided that the break-even point for such a series was the sale of between 17,000 and 18,000 copies per title. He planned to print only 20,000 copies so that no author could hope to earn more than his advance - not even those who were initially paid £25 - unless his book went into a second Penguin edition, a possibility which seemed unlikely. Those obtaining an advance of £50 would not earn a penny more unless their books sold 48,000 copies, an eventuality which even Allen's most optimistic forecasts did not sustain, although incredibly, the majority of Penguins were to sell that many copies within three or four months of publication.(59) In fact, it was only the Woolworth consignment, initially for 63,500 copies of the assorted first titles, that enabled the Penguins to be

launched. As with the more earnest 'People's Books' a generation earlier, it was only the opening up of sales outlets beyond the normal booksellers which enabled the series to flourish. Penguins were sold in department stalls, tobacconists, tea shops, anywhere in fact where the public could be persuaded to impulse-buy such inexpensive books. Allen Lane had made the book, for the first time in its long history, one of the mass media.

Following this success, Lane launched the non-fiction'Pelican Series' in 1937, carefully choosing distinguished scholars, who were also well-known by the public as popularisers, and who would therefore not intimidate this vast new book-buying readership. Significantly Julian Huxley and James Jeans were two of the first authors approached to have, in traditional Penguin policy, texts previously published in hard-back sold by Lane in a paperback edition.(60) Indeed, science stood first in the category of book proclaimed as within Pelican territory. Sir Peter Chalmers-Mitchell was chosen as the science editor for the series, because as Secretary to the Zoological Society from 1903-35, he was respected by the academic community, yet had proven talents both as an administrator and as a communicator; he was also highly esteemed by the convivial Lane for his ability to make the best Dry Martini in London!(61) The remaining three of the four Pelican editors, Krishna Menon, H.L.Beales and W.E.Williams were proselytising left-wing radicals, and therefore committed Pelicans to a predominantly Leftish viewpoint. During the thirties, however, such a political stance showed shrewd marketing sense. Victor Gollancz, with his Left Book Club, had established through his membership lists, that there was a constant market of at least 50,000 people for socialist books.(62) The intellectually aspirant sixpenny book-buyer in the late thirties, drawn mainly from the younger and poorer sections of society, favoured left-wing views; consequently, few of Lane's Pelicans sold less than 40,000 copies within a year. The impact such texts had on public thought must have been immense. G.D.H.Cole and R.Postgate concluded, that:

"members of the working and middle classes who had never bought books before were buying vast quantities of the best and newest literature, including social, historical, and scientific works mostly by Left-wing experts."(63)

In fact, however, the scientific section of Pelicans was not left-wing, which probably reflected the conservative editorial control of Chalmers-Mitchell. The majority of scientific texts in the series dealt with the physical sciences, and relied on tried and trusted popular texts by Jeans, Eddington and J.W.N.Sullivan. Prior to the War, there were also a couple of texts comprising Julian Huxley's collected essays, and also a reprint of J.H.Fabre's Social life in the insect world. As most of Lane's Pelicans were reprints of successful texts, his contribution to the popularisation of science through books, lay not so much in influencing the content or style of popular science texts, but in establishing a mass market for them.

7 - The rise of the radicals' influence on the popularisation of science through books.

While the mass marketing of books had established that middlebrow public opinion, by the late thirties, tended towards a left-wing viewpoint, the B.A. had, in 1938, founded a Division for the Social and International Relations of Science, which was established as a liberal forum for 'objective' discussion. (64) It quickly became dominated by radical left-wing scientists such as J.B.S.Haldane, Lancelot Hogben and Hyman Levy.

Such left-wing activists had, by the late thirties, become increasingly enamoured of some aspects of the role that science played in the Soviet Union. The idea that research could be centrally planned to help solve social and economic problems seemed eminently sensible to a large number of scientists at this time, who felt that science could and should be given a more prominent role in society. Of particular significance to the

to the present study, however, was the Soviet attitude towards popularisation. Within Russia, the popularisation of science had always been a more overtly political act than in Britain. Under the reign of Tsar Alexander the second, for example, it was particularly taken u p and promoted by populists dedicated to the emancipation of the Russian serfs.(65) After the revolution of 1917 and the Bolshevik seizure of power, it was Stalin who made science a central tenet of policy, using it to unite the nation behind the slogan 'socialism within one country'. Because the mass of the Russian population was still ill-educated by the thirties, the traditional, didactic methods of exposition were not appropriate for Stalin's needs. Hence, popularisation rapidly developed in a different way from Britain, as scientists were required to take their knowledge to the proletariat in factories, workshops and Palaces of Culture, and discuss how it could be used to solve social, technical and economic problems. In polemic vein, the Moscow Daily News of 1932 reported that, such meetings were not:

> "adulterated 'popular' science - no mild evening of 'adult education' in which benevolent professors unbend and condescendingly, hand working men some easy titbits of geology and astronomy. Of such is the 'adult educational movement' of capitalist lands."(66)

In fact, however, as has been shown by the present study, such an assessment of the types of popularisation which had been going on in Britain was inaccurate, although, ironically, it was exactly this type of 'pure' popularisation which some scientists and publishers were supporting in Britain at this time. What particularly impressed British observers about Russia, however, were the strong links between scientists and industrial workers, and the platform given to scientific experts to urge scientific solutions to social and economic problems. The perceived centrality of the role of science in the apparent successes of the Russian social experiment acted as a catalyst for British popularisers keen to promote their

own brands of public science. Having faltered for a decade, because of the impact of the Great War, and because of the initiative taken by conservative popularisers of physics, Russia offered a spur to public scientific activity in Britain.

Richard Gregory had, through Nature, been arguing for the continuation of the type of popularisation favoured by public science with its emphasis on the "exoteric" (i.e. the social context of science), since 1920 when he made a plea for the B.A. to pay attention to subjects "of vital interest to the community".(67) It was not until the late thirties, however, when left of centre views were fashionable, and when a group of radical popularisers rose to prominence through the Social Relations of Science Movement, and looked for inspiration to the U.S.S.R., that such ideas actually started affecting popularisation in Britain.(68) It was against this background of a new radical approach to popularisation, and of a mass book-buying market receptive to left-wing views, that L.Hogben launched his successful series 'Primers for the Age of Plenty' in 1936.

The series was motivated by a desire to answer social questions and to assess changing human needs. Each text in the series aimed to be topical and to emphasise the social history of the subject being presented. Published by George Allen and Unwin, and with each large volume priced relatively expensively at 12s.6d.,the first text in the series Mathematics for the million was a phenomenal success, going through seven impressions in the first six months of its publication. This text written by Hogben, took the reader step by step through the socio-historical evolution of basic mathematics , building up to the most topical chapter, the conclusion, which dealt with statistics. The second text in the series, also written by Hogben was Science for the citizen, published in 1938. This text did not merely offer basic exposition in a novel, historical way (as the Mathematics had done) but was much more an agenda for action, with large sections of the book devoted to hunger and disease and the conquest of behavioural

problems within society.(69) The other texts in the series dealt with learning the rudiments of language, and with the history behind topical social problems such as colonialism, the employment of women etc. The series intended to be, above all, a guide to intelligent citizenship.

Inspired by the Soviet 'success' with popularisation, the British popularisers of the day adopted this new socio-historical approach to the exposition of science which became increasingly topical and polemical, not merely discussing problems, but urging socialist solutions. In the days of mounting insecurity in Europe, it suited the most prolific popularisers of the period to adopt this 'socialist' model of popularisation, which attempted to integrate scientific knowledge into the social and political life of the country. By campaigning for the institution of air raid precautions, and by debunking Hitler's 'scientific' proofs for anti-semitism (70), public scientists experienced a brief but exhilarating hey-day of influence which was to end abruptly with the Hitler-Stalin pact of 1939. In fact, the S.R.S. movement's efforts to revolutionise popularisation were not as demoocratic in scope as its rhetoric might suggest, since many of its writers were consciously building on the meritocratic scientific structure promoted by the Victorian Scientific Naturalists.(71)

8 - Conclusion.

After the Great War, public science attitudes were challenged by a lack of conviction in the belief that progress was inevitable, by fears concerning the application of scientific developments for war, and by the way modern physics was popularised to distance science from both progress and its social implications. Consequently, a general disquiet surrounded the belief that

public science could guarantee progress, and this was reflected in the presentation of science in the twenties and thirties through general non-fiction series, which tended either to promote open-ended discussions about science, or to champion a 'pure' type of popularisation, which served to distance science from its cultural context. Not until the late thirties did public science regain its confidence in the face of growing Nazi strength, when,encouraged by the example of the Soviet Union, and the growing audience for socialist commentary within Britain, radical popularisers, associated with the S.R.S. movement,came to the fore.

The following chapter will explore how two of the most famous popularisers of modern physics at this time, used their popularisation to challenge public science assumptions, and how public scientists responded, through their exposition, to this challenge.

Footnotes.

1 - R.J.L.Kingsford, The publisher's association, 1896-1946, Cambridge, 1970, p.60.

2 - M.Plant, The English book trade, London, 1974, p.464.

3 - Ibid., p.468.

4 - See A.Briggs, The golden age of wireless, London, 1965.

There are very few sources which explore the interaction between various forms of media in Britain in the twenties and thirties. By the thirties, however, there was undoubtedly some interaction between wireless broadcasting and the publication of books. For example, J.Huxley had several of his birdwatching broadcasts published in book form, and his book, which launched Levy's 'Library of Science and Culture', entitled Scientific research and social needs was adapted from a series of radio broadcasts of the same name. Similarly, one of James Jeans' famous books, The stars in their courses was also adapted from a series of radio broadcasts. All of these texts will be discussed in chapter 8.

The impact such broadcasts had on their audience is largely unknown, apart from one pioneering study among schoolboys which found that broadcasts stimulated reading. For example, many boys who had listened to the radio dramatisation 'Life of Pasteur', had gone on to read Vallery-Radot's Life of Pasteur, as well as various handbooks of medicine.

See J.Mersand, 'Radio makes readers', in Literary taste, culture and mass communication, 1978, 12, p.280.

5 - A.Marwick, The deluge: British society and the First World War, London, 1965, p.236.

6 - F.A.Mumby, The house of Routledge, London: Routledge, 1934, p.205.

7 - P.Collins, 'The British Association as public apologist for science, 1919-1946', in P.Collins and R.MacLeod (eds.), The parliament of science, Northwood, 1981, pp.211-237.

8 - Ibid., p.229.

9 - J.Rice, Relativity, London: Benn, 1927, pp.77-8.

10 - In fact, Geddes, Thomson, Saleeby and Whetham all appear to have been influenced by Bergson in the Edwardian era, and evidently felt that a belief in 'creative evolution', legitimated intervention in society along'scientific'principles. Whether, of course, the public would have been quite so willing to accept their leadership if it had been widely inferred that the scientific method could be as subjective as the creation of poetry, is somewhat doubtful!

11 - See chapter 2, section on science as hobby.

12 - E.N. da C.Andrade, The mechanism of nature, London: G.Bells and Sons, 1930, p.4.

13 - Ibid., p.7.

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CHAPTER 8

AN EXAMINATION OF THE WORK OF SIX POPULARISERS DURING THE INTER-WAR PERIOD.

1 - Introduction.

As indicated in the previous chapter, after the Great War popularisers of science had to acknowledge a growing mistrust of science. Relativity had shaken the 'positivist', progressive aspects of science so successfully popularised by the Victorian Scientific Naturalists, and consequently, the public's'faith'in science was challenged by the news that scientific 'truths' were really only working hypotheses. Furthermore, the public could no longer find solace in the belief promoted by T.H.Huxley that science was only 'refined' or 'organised' common sense, since in the case of modern physics this was palpably not so. With the deepening economic depression, the rise of Fascism and Nazism (and news of the use of mustard gas in Ethiopia bringing back disturbing images of the Great War), one of the main challenges of popularisation in the 1930s was the attempt to rescue science from ill-repute as being both socially harmful and elitist in its incomprehensibility. To this end the Social Relations of Science (hereafter S.R.S.) movement had an important impact on popularisation, dedicated as it was, through it's politically diverse supporters, to developing "a systematic analysis of science and society that would provide answers to the vital questions of the day."(1) Consequently, it proved to be the focus for the popularising activity of public science at this time.

The S.R.S. movement is formally recognised as having begun in 1931, when, on the one hand, Bukharin addressed the International Congress of the History of Science at the Science Museum on South Kensington in July, and on the other, the issue of the social relations of science was given a special emphasis at the B.A.A.S. annual meeting in September. The sig-

nificance of Bukharin's address outlining the social functions of science and calling for an alliance of mental and manual workers, was that it catalysed the political activity of radical scientists (2), while the presidential address of General Jan Christiaan Smuts at the B.A.A.S. conference indicated the growing awareness among mainstream scientists of the need for the coordination of science with wider societal change.(3)

The S.R.S. movement was never monolithic or cohesive and involved no more than a few members of the scientific community; it was also,as Werskey has indicated, initially divided between its politically 'moderate' and socialist factions.(4) Prior to 1938 the political 'moderates' concentrated most of their attention on the B.A.A.S. and the British Science Guild, and their case was championed by Macmillan's periodical Nature, edited by R.Gregory. This wing of the movement was keen on promoting the piecemeal application of scientific knowledge to specific social problems, and aimed at a closer cooperation between government and science by working through the existing parliamentary system. The socialists tended to work through the Association of Scientific Workers, the Cambridge Scientists' anti-war group, and the Labour and Communist parties. They saw the reconstruction of science and the reconstruction of society as interdependent tasks. Science they wished to rationalise and redirect, away from war especially; and society they wished to reorganise in accordance with supposedly scientific principles and in ways that would support further scientific progress. In general, they thought no one more qualified for the task of scientifically reorganising society than themselves. The socialists, on the whole, believed Russia to be carrying out the social reorganisation of science and derided the concept of 'pure' science; while the political 'moderates' upheld a belief in 'pure' science and distrusted both Germany and Russia. In 1938 a mutual abhorrence of fascism united the two factions who worked together through the B.A.A.S.'s newly created Division for the Social and International Relations of Science. This division marked the formal organisation and

institutionalisation of the S.R.S. movement.(5)

The S.R.S. movement, however, was not the only group within the scientific community particularly concerned with popularising science between the Wars. Collins has identified three such distinct groupings in this period.(6) One grouping, labelled the 'scientific rationalists', appears to correspond to Werskey's politically 'moderate' grouping in the S.R.S. movement, including as it does, men such as R.Gregory and J.Huxley who felt that the application of scientific methodology (a largely undefined term) to social and political problems would lead to man's salvation. This grouping wished to popularise the methods and principles of science as applicable to national and industrial affairs. The second major grouping identified by Collins, is the socialist wing of the S.R.S. movement, identified by Werskey as the "visible college", including radical scientists such as H.Levy and L.Hogben, who wished to promote the view that science could only be progressive after a fundamental socialist change in the structure of society. The third main grouping identified by Collins is that of the B.A.A.S., who felt that popularisation should stimulate public interest in the intellectual achievements of pure science and the practical achievements of applied science. This last grouping was not represented in Werskey's study, but must be considered in a discussion of inter-war popularisation.

For this reason, the present chapter begins with an analysis of the popularisation of Eddington and Jeans, both of whom perpetuated this 'pure' type of popularisation, thereby challenging the assumptions of public science. Their style of popularisation was extremely successful, and the ideas they promoted were anathema to public scientists. Indeed, it will be argued that, at the popularising level, the S.R.S. movement was a reaction to the dominance of the metaphysical physicists. Consequently, after discussing the popularisation of Eddington and Jeans, the respective development as popularisers of Levy, Hogben, Haldane and Huxley will be examined.

2 - A.S.Eddington(1882-1944)

Eddington was born into a Quaker family living in Kendal, his father being headmaster of the Stramongate School there run by Quakers. Two years after his birth, young Eddington's father died of typhoid and the family moved to Weston-super-Mare. At first Eddington was educated at home, then at a small prep. school, and from 1893-8 as a day-boy at Brynmelyn School in Weston. In 1898 he won a Somerset County Council scholarship of the annual value of £60 for three years. This enabled him to enter Owen's College, Manchester at the precocious age of sixteen. Whilst there he concentrated on physics under the direction of Professor Schuster. In 1901, he won a scholarship worth £75 a year in Natural Science at Trinity College, Cambridge which he took up. In 1907 he became a fellow of Trinity and lived at Cambridge for the rest of his life, researching among other things the radiative equilibrium of the stars, and the recession of the galaxies. In terms of popularisation, however, his name was most often linked with the exposition of relativity.

Eddington was one of the first British physicists to understand Einstein's theory of relativity and to grasp its implications. Hence, at the request of the Physical Society of London, Eddington prepared his Report on the relativity theory of gravitation, which was published in 1918 by the Fleetway Press Ltd. According to Eddington's biographer A.V.Douglas, this was the first complete account of relativity to appear in the English language (7), and a second edition was called for eighteen months later. By 1920 when the second edition was published, the deflection of light by a gravitational field had been confirmed (within wide limits of probable error) by the Greenwich and Royal Society expeditions to Principe and Sobral for observation of the total solar eclipse of 29 May 1919. This eclipse expedition received considerable publicity, and the names of Einstein, de Sitter, Weyl and Eddington became familiar to many readers of the quality daily press.(8) Capitalising both on his powers of exposition

and on his new found fame, Eddington published a far less mathematical explanation of relativity in 1920. Entitled Space, time and gravitation, this book was issued by the Cambridge University Press, and launched Eddington on his supplementary career as a semi-popular expositor of science. In fact, however, as much of Eddington's reputation as a populariser seems to have stemmed from his commitment to the popularisation of relativity among fellow physicists as from his works for a general audience. In particular, his text The mathematical theory of relativity, published in 1923, is the expository work most venerated by biographers and scientists as a piece of 'classical exposition' (9) and is unintelligible to those without an advanced mathematical education.

The majority of Eddington's expository texts, which were marketed for a general audience, are best described as semi-popular in that whilst some passages were clearly intended for the general reader, others were written for the scientifically trained. In his preface to The expanding universe, first published in 1932, Eddington made his position clear, saying:

> "The book is not intended solely as an..exposition, and I have not hesitated to plunge into matters of extreme difficulty when it seemed necessary for an adequate discussion of the problem."(10)

In all, this approach must have made for rather frustrating reading on the part of the general reader who could be coaxed with an accessible analogy one minute, and confronted with unexplained algebraic equations the next. When, however, Eddington was clearly addressing his more popular audience through his semi-popular books, he was able to produce some interesting ideas to reassure them that an outline of modern physics was not beyond their grasp. For example, here is a popular passage from Space, time and gravitation:

> "Let us compare two well-known books, which might be described as elementary treatises on relativity, Alice in wonderland and Gull-

iver's travels. Alice was continually changing size, sometimes growing, sometimes to the point of vanishing altogether. Gulliver remained the same size, but on one occasion he encountered a race of men of minute size with everything in proportion, and on another voyage a land where everything was gigantic. It does not require much reflection to see that both authors are describing the same phenomenon - a relative change of scale of observer and observed."(11)

Eddington often built on a presupposition that his audience was familiar with such classic works of fiction, and he often used quotations from Shakespeare, or ideas from Shakespeare's plays, to ease the flow of exposition by adopting such well-known fictional themes to aid his analogies. Such use of poetry and fiction was not new, of course, and had been a favourite popularising device of natural historians using the romantic genre in the late nineteenth century.(12) After the Great War, however, it found greater favour with popularising physicists attempting to convey highly abstract ideas to a wide audience.

Eddington did write one truly popular book entitled Stars and atoms, published in 1927, which was based on a lecture he gave at an evening discourse for the meeting of the B.A.A.S. in 1926. The style of this text differed markedly from that of his other books in that it used short sentences, non-technical language and possessed an informal, humourous delivery. Indeed, jokes abounded, such as:

"there is always one safe weather forecast on the sun; cyclone or anti-cyclone, the temperature will be very warm - about 6,000° in fact."(13)

Eddington also made a lot of use of photographs in this text, whereas the majority of his books contained only diagrams and tables. He used the photographs to familiarise the audience with unfamiliar atoms and electrons which he repeatedly referred to, as "homely objects..which can be photographed."(14) The importance of concrete, material examples, illustrations

* There is no reference (15)

and analogies for a popular audience was the bane of popularising physicists in the inter-war period, but it was a willingness to provide them that helped to establish this commercially successful populariser. Thus, Eddington in this, his most accessible text, frequently used metaphor, thereby, for example, transforming stellar atoms into "rude savages" (16), and giving terrestrial atoms "crinolines" of electrons.(17)

What is particularly interesting about the more commercially popular physicists in the inter-war period is the similarity in their popularising technique to that of the late Victorian natural historians who used the romantic genre of exposition. At first glance the similarity would seem to begin and end with the shared features of metaphor, analogy, poetry and fiction. In fact, however, the popular writings of Eddington and Jeans have an added affinity with the popularisation of late nineteenth century natural history in the romantic genre, namely the belief in a transcendental Creator. For example, in The nature of the physical world, published in 1928, Eddington claimed that: "the idea of a universal Mind or Logos would be, I think, a fairly plausible inference from the present state of scientific theory.."(18) He distanced himself, however, from Jeans' affirmation that this Mind was God (see below) by adding that, "science cannot tell whether the world spirit is good or evil.."(19) For whilst Eddington was prepared to assert, that "the nature of all reality is spiritual,"(20) he was not prepared to go as far as Jeans, saying:

> "I do not think that with any legitimate usage of the word it can be said that the external world of physics is the only world that really exists."(21)

Whereas, as can be seen below, Jeans deduced spiritual truth from mathematical symbolism, Eddington's intuitive apprehension of spiritual truth transcended such symbolism. In his Swarthmore lecture (22) of 1929 Eddington made his feelings about the compatibility of his Quakerism with his scientific beliefs clear, saying:

"Rejection of creed is not inconsistent with being possessed by a living belief. We have no creed in science, but we are not lukewarm in our beliefs. The belief is not that all the knowledge of the universe that we hold so enthusiatically will survive in the letter; but a sureness that we are on the road. If our so-called facts are changing shadows, they are shadows cast by the light of constant truth. So too in religion we are repelled by that confident theological doctrine which has settled for all generations just how the spiritual world is worked; but we need not turn aside from the measure of light that comes into our experience showing us a way through the unseen world."(23)

In other words, both scientific and Quaker belief were united for Eddington by his faith that they both shared the central tenet of open-minded questioning in their respective quests for truth. Clearly, Eddington could see the link between the Quaker way of life, built around the communion and silent devotion of the Meeting, thus training the spirit to value a sympathetic solitude, and his intuitional approach to scientific problems, which he described as mystical, saying:

"What I may attempt is to dispel the feeling that in using the eye of the body or the eye of the soul, and incorporating what is thereby revealed in our conception of reality, we are doing something irrational and disobeying the leading of truth which as scientist we are pledged to serve."(24)

Although spirituality was integral to Eddington's life and work, and he, like Jeans, was using a non-rationalist genre of exposition to stress the spiritual side of science, the exposition of modern physics was unlike the popularisation of natural history in the late Victorian era which had used a similar type of genre, in that it was dealing with unfamiliar and unobservable phenomena and, therefore, there was a danger in associating such phenomena too closely with daily religious experience, since the

majority of Christians would then not be able to understand the scientific theory which 'supported' their faith, and might, therefore, feel alienated. Thus, neither Jeans nor Eddington, were in the business of creating a modern natural theology based on physics, since the professionalisation and specialisation of science had made such an attempt impossible, as modern theoretical science was not accessible to everyman. Furthermore, the plight of natural theology after the Darwinian 'revolution' suggested the weakness of allying religious belief too closely with contemporary scientific theory. For these reasons Jeans retreated into an Idealist elitism (see below) but for the Quaker Eddington such a position was not tenable.

When Eddington first set about popularising modern physics, he was concerned to explain the theory of relativity to the ordinary man, and he was confident that this could be achieved. In the Romanes lecture of 1922, Eddington had this to say:

> "There is a strange delusion that the fourth dimension must be something wholly beyond the conception of the ordinary man, and that only the mathematician can be initiated into its mysteries. It is true that the mathematician has the advantage of understanding the technical machinery for solving the problems which may arise in studying the world of four dimensions; but as regards the conception of the four dimensions of the world <u>his point of view is the same as that of anybody else</u>. Is it supposed that by intense thought he throws himself into some state of trance in which he perceives some hitherto unsuspected direction stretching away at right angles to length, breadth and thickness? That would not be much use. The world of four dimensions of which we are now speaking, is perfectly familiar to everybody. It is obvious to everyone - even to the mathematician - that the world of solid and permanent OBJECTS has three dimensions and no more..which..may be analysed into right-and-left, backwards-

and-forwards, up-and-down. But it is no less obvious to everyone that the world of EVENTS is of four dimensions which include sooner-and-later."(25)

At this early stage in his popularising career, Eddington was using many of the techniques bequeathed by late Victorian and Edwardian public science; for example, by using the rhetoric that science is just part of everyday experience, is just refined common sense, he was presenting an attitude that would have been familiar to his audience. The notion that science could be mystical was rejected through the humourous reference to mathematicians throwing themselves into trances. As early as 1920, however, Eddington was aware of the weakness of this type of popularising rhetoric for modern physics, as is evidenced in the preface to Space, time and gravitation, where he said:

"As the language of a poet rings with a truth that eludes the clumsy explanations of his commentators, so the geometry of relativity in its perfect harmony expresses a truth of form and type in nature, which my bowdlerised version misses."(26)

Consequently, Eddington's popularising career was devoted to promoting the idea that science was not common sense. His best-known popularising technique for communicating this belief was his example of the two tables, the first table being the common sense table, and the second table being the scientific table. Using this example in the introduction to his The nature of the physical world, first published in 1928, Eddington said:

"I need not tell you that modern physics has by delicate test and remorseless logic assured me that my second scientific table is the only one which is really there - wherever 'there' may be. On the other hand, I need not tell you that modern physics will never succeed in exorcising that first table - strange compound of external nature, mental imagery, and inherited prejudice - which lies visible to my eyes and tangible to my grasp."(27)

One theory recently put forward which might possibly explain part of the reason why popularising physicists chose to actively promote the claim that science was no longer part of common sense, is articulated by Biezunski, where he argues that:

> "In spite of the support of the major physicists of the twenties, the majority of their colleagues considered relativity too removed from their previous knowledge to become motivated enough to spend time studying it. The issue of incomprehensibility was a key and was used as an argument against the theories in the public arena, since because they did not see any profit in studying thses strange ideas, it was important for them, in order to keep their special positions as scientists, to maintain the gap relative to the layman's knowledge."(28)

In other words, Biezunski is arguing that the rhetoric of incomprehensibility was used to further distance the public from theories which the majority of physicists did not wish to study, in order to maintain the socio-epistemological order. Indeed, much of Eddington's consequent popularisation would fit into this interpretation, with statements like:

> "It is true that the whole scientific inquiry starts from the familiar world and in the end it must return to the familiar world; but the part of the journey which the physicist has charge is in foreign territory."(29)

This would appear to be a strong territorial statement telling the general public to stay out.

Where mysticism is concerned, however, as in the writings of Eddington and Jeans, there is an added religious motivation to mystification. For example, in his text New pathways in science, published in 1934, Eddington was at great pains to promote the idea that the scientific story of what is happening around the reader was surreal by introducing"Einstein's observer", a man who,

> "has one eye (his only sense organ) which is colour blind.

> He can distinguish only two shades of light and darkness so that the world to him is like a picture in black and white. The sensitive part of his retina is so limited that he can see in only one direction at a time.
>
> The point is that all our knowledge of the external world as it is conceived today in physics can be demonstrated to him. If we cannot convince him we have no right to assert it."(30)

Having established this rather grim, purely rational, scientific perspective, Eddington continued:

> "So long as physics in tinkering with the familiar world was able to retain those aspects which appeal to the aesthetic side of our nature, it might with some show of reason make claim to cover the whole of experience; and those who claimed that there was another, religious aspect of our existence had to fight for their claim. But now that its picture omits so much that is obviously significant, there is no suggestion that it is the whole truth about experience."(31)

Clearly, Eddington felt that modern physics had successfully managed to unhitch the popularisation of science from the secular rationalism which had so dominated popularisation in the late Victorian and Edwardian eras. His argument throughout his popular books seems to have been that religion and science, though offering different perspectives, were compatible, and that one needed both for a full appreciation of the world.

There is also a political dimension to the divorce of science from daily experience which popularising physicists managed to stage in the twenties and early thirties, and this was also suggested by Eddington in New pathways in science, where he said:

> "The tyranny of the engineer has been superseded by the tyranny of the mathematician. At least this is a view very widely taken. But alongside this there is a growing realisation that the mathematician is a less oppressive master than the engineer, for he does not claim

any insight deeper than his own symbols."(32)

This idea that public science or "classical" science of the late Victorian and Edwardian eras had been harmful to society was more forcefully put by E.F.Bozman in his introduction to the Everyman edition of The nature of the world, in which he suggested that:

> "Perhaps it led directly to the Great War and to the rigid forms of government which have succeeded the War. Just when it seemed to be all-powerful, all-pervading, Einstein, Eddington and others, by examining the function of the observer in scientific observations, exposed its limitations and solved the nightmare."(33)

For Eddington, as a Liberal (34) and a pacifist, this political dimension to the popularisation of modern physics would undoubtedly have appealed to him, since his major contribution to the rhetorics of popularisation was to offer a twentieth century separation of science from social values, which put the onus of ethical judgement back into the religious domain. His position was made clear in The philosophy of physical science, published in 1939, which concluded:

> "The problem of knowledge is an outer shell underneath which lies another philosophical problem - the problem of values. It cannot be pretended that the understanding and experience gained in the pursuit of scientific epistemology is of much avail here; but that is no reason for trying to persuade ourselves that the problem does not exist. A scientist should recognise in his philosophy - as he already recognises in his propaganda - that for the ultimate justification of his activity it is necessary to look, away from knowledge itself, to a striving in man's nature, not to be justified by science or reason, for it is itself the justification of science, of reason, of art, of conduct."(35)

For Eddington that justification was his Quaker faith. Because, however, Eddington did not believe that science was the key to either happiness

or progress (unlike his contemporaries in the S.R.S. movement) popularisation did not pose a great philosophical problem for him, since the general reader might have an interest in science and that was all well and good, but there was no necessity for him to understand science as members of the S.R.S. movement claimed. Rather, Eddington believed that the ordinary man should have access to science (hence his semi-popular books) but it did not really matter if he could not follow modern physics or felt alienated by it.

The best summary of Eddington's attitude to popularisation was given in the conclusion to The expanding universe, where he said:

> "Science has its showrooms and its workshops. The public today, I think rightly, is not content to wander around the showrooms where the tested products are exhibited; the demand is to see what is going on in the workshops. You are welcome to enter; but do not judge what you see by the standards of the showroom."(36)

In other words, Eddington was prepared to present modern physics in a semi-popular way, that is, give a taste of what was happening in the workshop (through the passages which were largely unintelligible to the general reader) and also to offer popular accounts of the general outline of modern theory in a glossy 'showroom' way. Popularisation then meant showing the reader backstage, but as Eddington was not a public scientist, whether the public understood or felt alienated by what they saw was not his concern, since he believed that political, moral and social decisions lay beyond the scope of science anyway.

In fact, because Eddington was careful never to suggest that modern physics was inextricably linked with religious faith (unlike Jeans), his popular rhetoric was harder for the S.R.S. movement to attack, and was more dangerous to their cause, than were the monist statements made by Jeans.

3 - James Jeans (1877-1946).

Jeans was born in Southport, the only son of a parliamentary journalist. He attended Merchant Taylors' School, and proceeded as mathematical entrance scholar, to Trinity College, Cambridge, where in 1898 he was bracketed second wrangler. He also studied practical physics for one year at the Cavendish Laboratory, and in 1900 gained a first class in part ii of the mathematical tripos, an Isaac Newton studentship in astronomy and optics, and in 1901 a Smith's Prize. In that year he became a fellow of his college.

He had to leave Cambridge in 1902 to enter sanatoria for treatment of tuberculosis of the joints which was completely cured. While there he wrote his Dynamical theory of gases, which was published in 1904. In 1906 he was elected Fellow of the Royal Society. From 1904-1912, he taught mathematics at Cambridge and Princeton Universities. From 1912-18 he and his wealthy American wife lived in London, moving to Dorking in 1919. For the following ten years Jeans was one of the two honorary secretaries of the Royal Society, and continued his career as a mathematician in the sphere of astronomy working on, among other things, the partition of energy, rotating fluid masses, star clusters and the equilibrium of the stars. In 1929, however, he made a conscious decision to earn his living as a populariser, being aware that at the age of fifty-two his powers as a mathematician could only decline.(37) Jeans' biographer, E.A.Milne, claims that Jeans was able to make this transition because S.C.Roberts, the secretary of Cambridge University Press (hereafter C.U.P.), was made aware of Jeans' gifts as a general writer by the closing chapter of his technical work, Astronomy and cosmogony, published in 1928. Subsequently Jeans was commissioned by the C.U.P. to write his first popular book The universe around us, published in 1929. The book was a success selling 11,300 copies in three months.

In fact, however, Jeans' popularising career had begun in a less academically auspicious way with the publication of his text Eos, for Ogden's

controversial 'Today and Tomorrow Series' in 1928.(38) This text was a considerable success, revitalising the sales of science texts within the series (39) and, presumably, it was after noting Jeans'commercial potential that the C.U.P. was prepared, through the mediation of S.C.Roberts, to become involved with his popular books. For, from 1929 onwards, with the publication of The universe around us, Jeans remained with the C.U.P.

The C.U.P. seem to have been particularly adept at sustaining Fleet Street interest in Jeans' pronouncements. For example, it had 10,000 copies of Jeans' Rede Lecture printed and bound as The mysterious universe a few weeks before the lecture was given, and review copies were sent to all major newspapers. Consequently, The Times devoted a leading article and a centrespread to the lecture the day after it was delivered.(40) Jeans' contention that God was a mathematician(41) struck gold in terms of sales; 1,000 copies of The mysterious universe were sold every day for a month after it was published in 1930, and the periodical press was overwhelmed with correspondence about it.(42) After the outstanding success of this book, Jeans was in demand as a lecturer both to learned societies and to popular audiences, and also as a broadcaster. The stars in their courses, published in 1931, was, as has already been mentioned, based upon wireless talks, while Through space and time, published in 1934, was based upon the Christmas lectures given at the Royal Institution in 1933. Jeans was dubbed 'the Edgar Wallace of Astronomy', and it was a Fleet Street joke to ask: 'Have you read the midday Jeans?'

One of the keys to Jeans' success as a populariser was undoubtedly his bardic charm on paper, the ideas and images,which his accessible metaphors induce, are still today quite striking. This charm is conveyed in the following quotation which was intended to help the reader place the position of the sun in relation to globular clusters. Jeans began:

> "Let us butter our bun. Let us cut it into two halves, top and bottom, spread a good thick layer of butter between the two halves,

and then put them back into position again. Then the butter represents the stars, and the currants the globular clusters. The sun is not, as Sir William Herschel thought, near the middle of the bun; it is true that there is as much of the bun above it as below it, so that it comes in the middle of the layer of butter, but it is nearly half way out from the centre to the rim."(43)

As can be seen, Jeans was skilled in relating astronomical concepts to familiar everyday objects, in much the same way as T.H.Huxley had been skilled, two generations earlier, when explaining evolution. There is, however, an impudent quality present in Jeans' exposition, which is lacking from that of his more earnest predecessor.

Jeans also employed another stylistic device which made the reading of his texts enormously satisfying; he stirred up the reader's anxiety and then offered a cathartic solution. At first Jeans continually intimidated the reader with the astronomical sizes to which he often referred, so that often the message of astronomy would seem to be "one of melancholy grandeur and oppressive vastness"(44),as man,

"taking possession of his tiny speck of dust in space, surveys with astonishment the strange universe in which his life is cast, and looks wonderingly and perhaps anxiously and fearfully into the future."45)

Then, like a revivalist preacher, who, after terrifying his audiences with visions of hell, offers them heaven, Jeans finally reassured the reader that the sheer enormity of the universe should not worry him any more than the future, since:

"We discover that the universe shews(sic) evidence of a designing or controlling power that has something in common with our own individual minds - not, so far as we have discovered, emotion, morality, or aesthetic appreciation, but the tendency to think in the way which, for want of a better word, we describe as mathematical,(46)

for "..from the intrinsic evidence of his creation, the Great Architect of the Universe now begins to appear as a pure mathematician."(47) Thus, the reader need have no fear as long as he was prepared to believe that God had ordered the universe according to mathematical principles, since, Jeans argued, the universe was clearly under control even if, as he seemed prepared to admit in the above quotation, that control had no part of "emotion, morality, or aesthetic appreciation." Jeans tended to clarify this position by using Plato, as in the following quotation, where he said:

> "The essential fact is simply that all the pictures which science now draws of nature, and which alone seem capable of according with observational fact, are mathematical pictures.
>
> To speak in terms of Plato's well-known simile, we are still imprisoned in our cave, with our backs to the light, and can only watch the shadows on the wall. At present the only task immediately before science is to study these shadows, to clarify them and explain them in the simplest possible way."(48)

From this premise of an ideal reality, Jeans claimed that:

> "If we could translate our knowledge from the language of phenomena into the language of reality, the word 'mathematical' would, I think, have some sort of translation in the latter language; it would not drop away as having represented a mere form of apprehending phenomena. And if this is so, it would seem to suggest that reality must have something of a mental nature about it."(49)

And,

> "It follows from all this that if we want the ultimate truth about the universe or its constituents, we must go to the mathematician."(50)

The implication of this Idealism for the general reader was that the mathematician alone had access to reality, and that a non-mathematician

could not make sense of his world and (implicitly) should not try to do so. This metaphysical approach made science both mystifying and alienating for the general reader, but undoubtedly seemed reasonable in the face of modern physics, for, as Jeans so helpfully put it, when contrasting Victorian and modern science:

> "Out of the impressions registered through their senses, they had built an inferential world of objects which they believed to be real, and effected by events of much the same kind as occurred in their everyday experience. They described this as the 'common sense' view of science; and defined science as organised common sense.
>
> Then new refinements of experimental technique brought new observational knowledge, which shewed(sic) that the workings of nature could not be explained in terms of the familiar concepts of everyday life. New and unfamiliar concepts were found to be necessary; the age of common sense science had passed."(51)

In other words, whereas the presentation of science favoured by the biologist T.H.Huxley, offered a science potentially accessible to anyone concerned to discover the 'facts'; modern physics seemed by its abstraction to have finally and irretrievably removed science from the observations and impressions of everyday life. A view which Tyndall had also been anxious to promote in that'old-fashioned'Victorian era!

Jeans relished this 'modern' Idealist vision of science, seeing it as a vast improvement because it restored man back to the centrality of the universe which he commanded prior to the acceptance of Galilean and Newtonian natural philosophy. For, as Jeans pointed out:

> "Until early in the present century scientific knowledge was continually compelling man to lower his estimate of his importance and of his position in the universe."(52)

But now we see that,

> "humanity may not have been mistaken in thinking itself free to

choose between good and evil, to decide its direction and development, and within limits to carve out its own future."(53)

In actual fact what Jeans meant was that theoretical physicists were, by virtue of his Idealist philosophy, in a position to shape the world, since,

" the physicist no longer sees nature as something entirely distinct from himself. Sometimes it is what he himself creates, or selects, or abstracts; sometimes it is what he destroys."(54)

This shaping of the world simply meant, however, that physicists should continue to undertake 'pure' research, since such work would bring them nearer to ultimate reality; it did not mean the active scientific planning promoted by the S.R.S. movement. Indeed, Jeans made his position clear vis a vis this movement while makirg his presidential address at the B.A.A.S. annual conference at Aberdeen in 1934, where he is reported to have said:

"while the Association has taken social welfare so largely into its field of vision, it should not be forgotten that the Association has another trust, that of purely scientific research and we would be betraying that trust if we ever lost sight of that."(55)

Furthermore, because, according to Jeans' philosophy, science was still only studying the shadows of the real world,it had no authority to organise scciety, for:

"Our main contention can hardly be that the science of today has a pronouncement to make, perhaps it ought rather to be that science should leave off making pronouncements: the river of knowledge has too often turned back on itself."(56)

Consequently, Jeans' attitude to the S.R.S. movement was perhaps best summed up by the rhetorical flourish near the end of his Presidential address at the above conference, where he asked:

> Shall we not risk the fate of the over-ambitious scientist Icarus, rather than resign ourselves without an effort to the fate which has befallen the bees and ants?"(57)

In other words, no matter where 'pure' research led, its pursuit was more worthy than the planning and organisation of a Realist society.

This laissez-faire popularising attitude, which Jeans and Eddington shared, although for each of them it was born of different political and religious values, it will be argued, significantly effected the other popularisers considered in this chapter, who lumped Eddington and Jeans together, labelling them the 'Physical Idealists'.

4 - The S.R.S. movement

In opposition to the Idealists considered in sections 2 and 3 of this chapter, who are 'representative' of Collins' B.A.A.S. popularising stance, the following four popularisers to be considered in this chapter were part of the S.R.S. movement as outlined in the introduction. Although these four popularisers did not compose a formal group they were informally acquainted, having contact with each other through a shared education (Haldane and Huxley were friends at Eton and, also, later at Oxford), involvement in political associations (Haldane, Levy and Hogben were members of the 1917 Club (58)), and scientific research (Huxley, Haldane and Hogben, together with F.A.Crew, were instrumental in developing experimental biology in the field of genetics). These four scientists were friends with a high popularising profile, whose public science writings will be examined in the following order: Firstly, Hyman Levy will be considered because, as a mathematician , he made the greatest effort through his writings to counter the Physical Idealists, then the popularisation of Lancelot Hogben will be examined, since he carried on from Levy in challenging the Physical Idealists. Next, J.B.S.Haldane's writings will be analysed

to assess whether, as a populariser who flourished throughout the twenties and thirties, his style was altered by the S.R.S. movement. Finally, after considering these socialist popularisers, the public science writings of Julian Huxley will be examined to see the responses of this high profile, politically 'moderate', public scientist to the social and political developments of the twenties and thirties.

5 - Hyman Levy (1889-1975)

Levy was born into a poor Jewish emigré family, living in Edinburgh. With the support of one of his schoolteachers, Levy won a bursary to Heriot's School in Edinburgh, and from there gained a place at Edinburgh University, graduating in 1911 with a First Class Honours degree in mathematics and physics. He continued his education at the University of Göttingen in Germany by working on hydro and aerodynamics. He returned to Britain in 1914 because of the outbreak of War. In 1916 he was seconded to the aerodynamics department of the National Physical Laboratory where he stayed until 1920, when he was appointed lecturer in mathematics at Imperial College. By the 1930s, the period in which he made his main contribution to the history of popularisation, he was professor of mathematics at the Royal College of Science, and was an active member of the Communist Party.

Levy's first major popular contribution to the S.R.S. movement came in 1931 with the publication of his text, The universe of science, which was a response to the popular texts by the Idealist physicists. Levy made this emphasis clear in the introduction to the text, as follows:

> "The assertion of contemporary scientists, who state that the universe is a fickle collection of indeterminate happenings, and a great thought in the Mind of its Architect, a pure mathematician, serves merely to divert the activity of the scientific brain from

its concentration on the contradictions and confusions of the all too real world to a state of passive and unreal contemplation..

Speculation divorced from the needs of man, in the sense that it cannot be put to the test of action, remains mere isolated word spinning, a pleasant game for theorists, but if indulged in at a period of critical change a dangerous and reactionary game."(59)

Levy began to challenge the view promoted by Eddington and Jeans that science was no longer common sense by talking about mundane everyday objects, including Eddington's favourite object, the table. When talking about a table, Levy refused to juxtapose a scientifically defined table against the everyday perception of a table as Eddington had done. Rather he superimposed the scientific view onto the layman's view by using the concept of change, saying:

"If we were to examine the table by the aid of highly refined instruments, we should find that, far from the table remaining permanent and unchanged while we have been reading this, all sorts of extraordinary things have been happening to it. It has given up moisture to the air or absorbed some from it. If we are really careful about what we say, it is not honestly the same table. It is a different table, very like the other, but still different, or, if it is the same table, it is a changed sameness."(60)

As the above quotation indicates, one of the keys to Levy's criticism of Eddington and Jeans' position was bound up with the concept of change, a concept that was crucial to public science, implying as it does, the potential for progress. At the popularising level, the public scientist had to be convinced of the educability of man, since his whole political srategy for staging the cultural preeminence of science relied on some kind of widespread general knowledge of contemporary science among the general public. To popularisers unconcerned with, and in some cases, antagonistic to, public science, such as Jeans and Eddington, man's educabil-

ity in an egalitarian sense was irrelevant. It is in terms of this debate between 'pure' popularisation and public science that the concept of common sense became crucial to the socialist members of the S.R.S. movement in the inter-war period. For this reason, Levy based his book The universe of science on the premise that: "The universe is our datum, it is given, it exists, it is the everyday world of common sense and common experience."(61) To construct this approach to science Levy relied on the concept of "isolates". He claimed that science was like common sense, in that it searched for systems that could be isolated from their setting without disturbing their structure and the process they presented. He gave the following example:

> "Here is a child. Almost as soon as the term child has been applied to it we have effected the isolation, for, in thought, at any rate, we have dismissed its history, its family relationships, its home and its country. We have isolated it by clarifying it in this case, by merging it tentatively with other objects under the general heading child."(62)

Each "isolate", Levy explained, is unique in its mode of functioning, otherwise science would not have isolated it. Building on this concept of the "isolate", Levy moved the reader on to a consideration of modern physics, with its theoretical entities, arguing that such entities as particles, atoms and electrons were simply "isolates" of a similar type to the example of the child. In other words, Levy had attempted to relate the common sense universe of the general to the scientific universe of the particular.

In fact, what appears partly to have distinguished the views of the popularisers considered in this chapter who were associated with the S.R.S. movement, from those associated with 'pure' popularisation, was that the former viewed themselves as experimental scientists, while the latter considered themselves to be theoreticians. Levy, for one, was very aware

of this difference, actually stating in his book The universe of science, that:

> "the implied claim [in Eddington and Jeans'] popularisation is that the mathematician's picture of the universe is also that of the scientist, a claim that has been allowed to stand without challenge, principally because of the dominance that the mathematician has established in our generation over the experimentalist."(63)

To counter this dominance, Levy made experimentation central to his rebuttal of Physical Idealism, saying that his own claim that science was still in the realm of common sense basically rested on an "experimental justification." He continued, saying:

> "We have viewed science as a breaking down process, a chipping off of pieces, and an examination of how small a piece may be chipped off in order yet to be able to state with sufficient precision what is happening in detail to the universe. A mathematical technique which faithfully described the process of the experimenter would follow this analytic process and show how from the larger isolate the lesser isolate was derived."(64)

This, however, Levy claimed was precisely what the Physical Idealists did not do; they moved from the electrons up to a consideration of the universe. In other words, Levy's argument was, that because these physicists did not interact with the 'real' world they were happy to claim that science was not common sense, a claim which Levy felt an experimental scientist could not make, and a claim which was foreign to the 'scientific method'.

It will be noticed that in this Marxist answer to Idealism for the British general reader the key concepts were "common sense and "experimentation" which were positively valued. These concepts were taken up and used by fellow socialist scientists in the thirties, as will be shown below. Levy, however, was aware that to claim that science was simply common sense was not a sophisticated enough, or even credible, explanation in an era

dominated by the complexities of modern physics. Furthermore, such a claim would undermine the professional status of the scientist as expert, a status that was never questioned by left-wing scientists of this period. Hence, Levy amended his position, as follows:

> "In one sense there is nothing, there can be nothing in science that violates common sense. The fact is that all new knowledge violates the common sense of the ignorant, but it has not become knowledge without being subjected to the common sense of the initiated.. Science begins and ends with common sense. Its knowledge is essentially democratic.."(65)

This "common sense of the initiated" Levy was at pains to point out, was not dealing with Absolutes, but with scientific laws which only stated what seemed extremely likely to happen, such laws, the Marxist Levy would have the reader believe, lean more towards determinism than towards free will. What is more, they certainly did not point to "the discovery of something 'spiritual' at the core of scientific theory."(66) Rather these laws were "not superimposed on the universe by some external agency", but were "exposed in the being and action of its parts."(67) They were "pieces of advice", which offered "a method of helping us to decide what to do with the world."(68) This belief really lay at the heart of the difference between the socialists of the S.R.S. movement and the Idealists, at the popular level. For Eddington and Jeans, as has been shown, refused to get involved with any discussion of the social and political implications of scientific research in their popular texts. This faith in 'pure' research was dismissed by Levy as irrational, saying that:

> "Individual scientists are of course inquisitive and interested in the world, just like other people, but this does not in itself give science a greater importance than stamp-collecting or cookery."(69)

It was social usefulness, according to Levy, that gave science its cultural preeminence. Furthermore, Levy was uncomfortably aware that:

> "The traditional picture of the scientist as a bespectacled individual so immersed in his laboratory that he is unconscious of the havoc his work is producing in the outside world is not entirely a caricature."(70)

He attempted to challenge this picture of the scientist in The universe of science, by building on his concept of "isolates". For example, he ended the text with the plea that:

> "In so far as the products of science are misused, the responsibility of at least protesting lies on the shoulder of every individu l scientist..It cannot be avoided by shutting tight the study doors to worship in silence - 'Science for its own Sake' - as an Absolute Principle of Isolation."(71)

Clearly, for Levy, the enemy of science was capitalist society, whereas for Jeans, the enemy was man's moral apathy.(72) Levy was thus anxious to create an active philosophy, to spread a Marxist understanding of the problem as a prelude to action. Within this context, pejorative words alluded to thought without action, such as 'dreaming', 'speculation', etc. In this scheme of things, theoretical physics and pure mathematics were open for attack, whereas the experimental and applied sciences were obviously considered potentially progressive because they combined thought and activity. Levy summarised this position, as follows: "The men of action are becoming conscious of the bar that stands in the way of progress. The dreamers have found refuge in the skies."(73) Hence, praxis was what distinguished the rational scientist from the irrational in Levy's framework, and science was praxis for Levy, since in science "theory is tested in practice."(74)

For Levy, as for other popularisers to be considered in this chapter, Marxism and science were so closely related that the two could not be separated; goaded on by the Soviet 'experiment' they began to forcefully voice this belief. Levy, however, was aware that reasoning was not enough to convince the public of the justice of Marxism, since to do so would be

to presume that "man in his present stage of evolution, can be satisfied by science alone or by cold reason."(75) Levy continued,saying:

> "it may not be difficult to demonstrate that belief in the unluckiness of the number thirteen has no foundation, but how are you going to prevent people from acting on a belief that thirteen is unlucky? How are you going to make them sit down thirteen at table?"(76)

The solution according to Levy, was to "permeate social life with the spirit of critical foresight."(77)

Aside from writing books, articles and broadcasting for the B.B.C. Brains Trust, Levy also attempted to "permeate social life" with the'Library of Science and Culture', a series of books he edited for the Rationalist Press Association, which was designed to "present to the general reader a picture of the world, both of action and of thought, as science is shaping it."(78) In fact the S.R.S. movement was welcomed by the R.P.A. because it challenged the connections between science and religion which Eddington and Jeans had so successfully established. Consequently it was willing to publish material by the S.R.S. movement,although it refused to formally ally itself with the movement, and would not champion 'scientific humanism' as advocated by J.Huxley, who worked for the Association.(79)

Many of the texts in the 'Library of Science and Culture' were based on a kind of Socratic principle (Levy claiming that the majority of its readers would have had a classical education(80)), in which wide ranging conversations amongst a variety of people, printed in dialogue form, were intended to form the reader's opinions as to possible solutions to social problems. Since Levy was playing Socrates, the solutions in such texts were naturally always Marxist. The first text in this series was based on a series of wireless broadcasts focussing on Julian Huxley which will be discussed below. Levy's own personal contribution to the series was entitled The web of thought and action, and was published in 1934. In it Levy presented a dozen conversations with various experts about their attitudes

towards science. In essence, no doubt, this was intended as a rather basic sociological survey. One of the most interesting conversations, for the present study, was with a person Levy termed an "expert man in the street", a Mr. E.W.Hall. Mr. ("I think that international financiers are at the bottom of it all.") Hall worked on experimental wireless apparatus with one of the large electrical companies, and was probably chosen for his left-wing views. The following part of the conversation is worth quoting in full, since it gives a rare glimpse of Mr. Everyman responding to a populariser (in this case, Levy himself), and suggests, as Levy intended it to, the scale of the problem faced by socialist popularisers:

> H.L. "It is asserted that space and time are not really distinct entities, but a far-dimensional continuum; that the universe is not of fixed or even of approximately fixed size, but is continually expanding at an incredible pace; that the universe is gradually passing to a state of heat uniformity which must mean the death of everything. And interpreting this, some scientific writers have asserted that all this exposes hitherto unexpected mysticism in the universe, and that it must have had a creator with a striking resemblance to a pure mathematician. What sort of effect, if any, does this have on the layman?"
>
> E.W.H. "He accepts it, of course, but without any idea of understanding it, especially if the writer is an expert; but it doesn't mean much to him really. He just classes it as another one of these mysteries that he thinks science is continually discovering. I don't think he worries twopence about it.."(81)

Building on such responses, Levy concluded that thinkers should emerge from the study and enter the "social laboratory"(82), where politics was practised and history was made. This text points to Levy's role in popularisation, which was to attack the dominance of the Physical Idealists before an educated audience.

It was not until the end of the thirties that Levy produced an expository text of his own, which was a large, uninspiring tome of 736 pages entitled Modern science, which began: "If science means anything it entails clearing the atmosphere by reducing it to reason and finally it and common sense to a common denominator."(83) In fact, this ideal was more nearly met by Levy's close friend and colleague Lancelot Hogben in his expository texts. Levy had among other things, however, been instrumental in clarifying the popularisation problems of the inter-war period for left-wing scientists.

6 - Lancelot Hogben (1895-1975)

Hogben was born in Portsmouth, the son of a Plymouth Brethren evangelist. With the closure of his father's mission in 1905 the family moved to London, where Hogben attended Tottenham County School, winning an open scholarship to study medicine at Trinity College, Cambridge in 1912. After gaining his degree in 1915, Hogben was imprisoned as a conscientious objector for several months. Upon his release from Wormwood Scrubs, he lived in London, where he earnt his living as a journalist, and married the feminist mathematician, Enid Charles. From 1919 to 1929 Hogben held (in chronological order) academic positions as a biologist at Birkbeck College and Imperial College, London, Edinburgh University, McGill University in Montreal, Canada, and the University of Cape Town in South Africa. In 1929, he returned to England at the request of Sir William Beveridge to take up the first chair in social biology at the London School of Economics, where he remained until 1937. Being an enigmatic political soul, however, who remained aloof from party politics, he did not find the aggressive partisan stances of the school to his liking, and moved with relief to Aberdeen University in 1937 as Regius Professor of natural history.

Like Levy, Hogben had cut his popularising teeth explaining current scientific problems in popular radical terms to the left-wing audiences

of the Plebs League during the First World War and early twenties. His commitment to the socialist promotion of science was strong, but it was not until the thirties that he came to prominence as a populariser, with the publication of his first popular book, Mathematics for the million. The text was completed in 1934 but Victor Gollancz, the first publisher to whom Hogben offered it, refused it, saying "mathematics is a worst seller."(84) After this rejection, and because Hogben did not want his name associated with the text in case its publication jeopardised his election to the Royal Society, the text lay in a drawer for two years. After Ho ben had become a Fellow of the Royal Society in 1936, the book was published in England by Allen and Unwin. It was an enormous success with tens of thousands of copies being sold in the thirties alone, running through eleven impressions and two editions prior to 1940.

In many ways the text appears to have been a direct response to the writings of Eddington and Jeans. For example, Hogben refers to Jeans in an opening paragraph, saying that there is a "distinguished astronomer who pauses, while he entertains us with astonishing calculations about the distance of the stars to award M. le grand Architecte an honorary degree in mathematics."(85) Hogben continued, distinguishing between descriptive language, the language of "sort", and mathematical language, the language of "size", saying:

> "Civilised societies in the twentieth century have democratised the reading and writing of sort language. Consequently the plain man can understand scientific discoveries if they do not involve complicated measurements. He knows something about evolution. The priestly accounts of the creation have fallen into discredit. So mysticism has to take refuge in the atom. The atom is a safe place, not because it is small, but because you have to do complicated measurements and use underground channels to find your way there. These underground channels are concealed from the eye of the people because the plain man has not been taught to read and write size language.

..The time has now come for another Reformation. People must learn to read and write the language of measurement so that they can understand the open bible of modern science."(86)

Having been brought up by evangelist parents, it was perhaps not surprising that Hogben should use the analogy of Catholicism to vilify the Physical Idealists. His text was intended as a primer, teaching basic Newtonian concepts, and Hogben did not get involved in any attempt to explain modern physics. His theory of popularisation seems to have been that if modern science could be made accessible by familiarising the public with mathematical concepts, the 'fallacies'of Idealism would be obvious. With this in mind, he sought to lampoon Plato, using provocative headings, such as "Plato took measurement out of geometry and put magic in its place."(7) This attack on Platonism was clearly made with an eye on the popularising technique of Jeans, who frequently cited Plato in his writings. Hogben vehemently objected to Jeans' popularising attitude as being both mystifying and trivialising. Taking Jeans' at time frivolous exposition to heart, the puritan Hogben warned his readers that:

"If mathematics is a game, there is no reason why people should play it if they do not want to. With football it belongs to those amusements without which life would be endurable. The view, which we shall explore is that mathematics is the language of size and that it is an essential part of the equipment of an intelligent citizen to understand this language."(88)

Following this supposition, Hogben's presentation of mathematics was novel in that it set natural science in a socio-historical context. Hogben explained his technique at the beginning of his text, as follows:

"The customary way of writing a book about mathematics is to show how each step follows logically from the one before without telling you what use there will be in taking it. This book is written to show you how each step follows historically from the step before,

and what use it will be to you or someone else if it is taken."(89) This method of presenting popular science in a socio-historical context was part of a trend in the thirties, which Hogben acknowledged in his Conway Memorial Lecture(90) of 1939, praising the work in this field of Joseph Needham, Julian Huxley and Professor Andrade.(91)Here is an example of its use in Hogben's text:

> "Neolithic man was also learning to keep track of his meals and hours of labour by the length of the sun's shadow cast by poles or stone monuments, which he erected to observe it. This growing awareness of time..quickened as a more stable agricultural and pastoral economy was established.."(92)

This method portrayed science as part of socio-economic culture, not as something 'pure' and aloof from society, as in the popular writings of Eddington and Jeans.

Following Levy, Hogben was aware of the left-wing need for praxis in the popularisation of science, and attempted to incorporate thought and action in the learning processes of his popular texts. For example, when he explained how the ancients worked out their calendars with theodolites, he also explained how the reader could make his own theodolite, with a metal rod, a blackboard protractor, a plumbline, and a wooden support. This could then be used "to find the latitude and longitude of your house, or make an ordnance survey of your neighbourhood."(93) Thus, the reader was actively involved in the text, putting mathematical principles to practical uses. Hogben also integrated some aspects of the heuristic educational method into his text, so that the mathematical exercises at the end of each chapter were called "Discoveries to Make", and involved the reader in putting his new knowledge to the test of experimentation, taking nothing on trust. An example of such a "discovery" being:

> "If you can find a convenient space, peg out the Egyptian rope triangle and the surveyor's triangle. The link referred to is 7.9

inches long. Satisfy yourself that these are both ways of setting out a right angle."(94)

This text was probably such a success because it combined the reassuring format of a textbook with exercises, with the interest of following an historical plot (the Marxist interpretation of the development of mathematics), along with a concern to show how an understanding of mathematics could help the reader shape the world around him by evaluating statistical evidence. In the 'socially aware' climate of the thirties, which has been mentioned in the previous chapter, such a format clearly struck a commercial chord.

Like Levy, Hogben was concerned to convince the general reader that scien , even mathematics with its foreign language of size, was accessible, and part of common sense experience, and, like Levy, he identified Eddington and Jeans in the public domain as enemies of science. Probably the most vulnerable point of Eddington and Jeans' popular books, in terms of conducting a popular debate about the accessibility, or non-accessibility, of science, was the attacking and ridiculing of T.H.Huxley for presenting science as common sense. Huxley, however, throughout his own lifetime, and throughout the first half of the twentieth century,enjoyed considerable veneration for his skills as a populariser.(95) Consequently, Hogben responded to this attack, and, as a public scientist himself, was quite willing to champion Huxley, and to establish an iconography of Victorian popularisers as 'democratic' heroes. For example, in the foreword to the second edition (96) of his popular science text Science for the citizen, first published in 1938, Hogben said:

"In the Victorian age big men of science like Faraday, T.H.Huxley and Tyndall did not think it beneath their dignity to write about simple truths with the conviction that they could instruct their audiences.. The new fashion is to select from the periphery of mathematicized hypotheses some half assimilated speculation as a preface

to homilies and apologetics crude enough to induce a cold sweat in a really sophisticated theologian who knows his job. The clue to the state of mind that produces them is contempt for the common man. The key to the elegant literature which the pen of Faraday and Huxley produced is their firm faith in the educability of mankind.

Because I share that faith I have not asked the reader to take any reasoning on trust."(97)

Indeed, Hogben's admiration for Huxley as a public scientist seems to have been far more than rhetorical, for, as he made clear in a later essay, the S.R.S. movement had far more than a commitment to popularisation in common with Victorian Scientific Naturalism. Hogben commented:

"The demand for instruction in the natural sciences as an essential constituent of a curriculum of humanistic studies is not a new theme. It is necessarily the need of any powerful social group or community whose prosperity depends on the application and extension of scientific knowledge. Huxley was its prophet.."(98)

Hogben's Science for the citizen, based on the same expository model as Mathematics for the million, was written because, while at the London School of Economics, Beveridge asked Hogben to lecture once a week to civil service examination candidates, since the Civil Service Commissioners had prescribed a paper on general science. Hogben enjoyed the opportunity of building up a course in natural science for students trained in other disciplines, and wrote his lecture notes up for publication on the train journeys between London and Devon, where he had a cottage. Bearing in mind this original audience, which was traditionally antagonistic towards science, Hogben can perhaps be excused certain polemical flourishes, such as:

"This is not the age of pamphleteers. It is the age of the engineers. The spark gap is mightier than the pen. Democracy will not be salvaged by the men who can talk fluently, debate forcefully, and quote aptly."(99)

Rather, according to Hogben, the natural scientist was the obvious saviour of democracy because he was trained to act on his thoughts, rather than being merely trained to phrase such thoughts stylishly, as Hogben alleged a training in the humanities aimed to do. As with Levy, so with Hogben, experimentation was to be the key to progress.

Essentially all three generations of public scientists which have been the focus of this study, had been using popularisation to battle for cultural hegemony against the humanities. In the thirties, however, the emphasis changed sharply, moving away from the promotion of recreational science, since, as Hogben was aware:

> "Increasing specialisation and expanding outlets of vocational choice for individuals with a native inclination or aptitude for scientific studies must progressively limit the appeal of science as an active hobby."(100)

Thus, Karl Pearson's ideal of the role of science in a democracy, examined above, was now outdated in the eyes of the thirties public scientists, who used their faith in Soviet planning to construct a new model for popularisation, rooted in socio-historical contexts and stressing utility. Whilst, of course, utility was by no means a new concept for popularisation (and, indeed a crude use of the socio-historical context of science had been made by Geddes and Thomson in the Edwardian era, see above), the difference in the inter-war period was provided by the increasing complexity of science. The novice could no longer participate at any meaningful level in science, and yet democratic ideals stressed meaningful involvement. The solution to this problem for the S.R.S. movement was to abandon any attempt to explain the theories of modern science, and to move on to an exposition of the potential impact of such modern science on society. Hogben was at the forefront of this change of emphasis, through his work for the British Institute of Adult Education. He summarised his attitude as follows:

> "The Adult Education Movement has no need for biology courses of

the kind which exist in the universities. What it needs are courses on malnutrition, public health policy, the revolution of agricultural technique made possible by recent technological discoveries. It has no need for courses of chemistry and physics on the university model. It needs courses on how an intelligent government would bring new chemical industries to the depressed areas and how it could mobilise new sources of power."(101)

This attitude was part of Hogben's creed of scientific humanism, which he expressed at the end of Science for the citizen, as follows:

"The social contract of scientific humanism is the recognition that the sufficient basis for rational cooperation between citizens is a scientific investigation of the common needs of mankind, a scientific inventory of resources available for satisfying them, and a realistic survey of how social institutions contribute to, or militate against, the use of such resources for the satisfaction of human needs. The new social contract demands a new orientation of educational values and new qualifications for civic responsibility."(102)

The task of popularisation in all this was for the scientist to inform the public of what use his scientific activity could be, so that they could then act on this information to ensure that the potential applications of such science would be implemented for the good of society. In Hogben's words:

"To get the fullest advantages of the benefits which science can provide, the citizen must see that those who enjoy making scientific discoveries are encoraged to do so. To get the fullest opportunites for doing the kind of work which is worthwhile to themselves scientific workers must participate in their responsibilities as citizens. Among other things this includes refraining from the arrogant pretence that their own prejudices are a sufficient justification for the support which they need."(103)

In other words, the argument for 'pure' science was not only irresponsible, it was also petulant!

In fact, it seems to have been Hogben's polemical presentation of science in his text Science for the citizen, which sustained the reader's interest. For example, under the section in the text headed 'The body as machine', polemical statements were common, such as:

> "In newly ploughed fields of knowledge, self-evident principles spring up perenially. The work of Home, of Boussingault and of Liebig was the signal for a fresh crop of weeds."(104)

Such statements mingled with straightforward text-book diagrams and pieces of exposition like:

> "While it is working the engine must be supplied with oxygen, which it gets from the air itself. It is also discharging carbon-dioxide and water vapour together with a certain amount of soot due to incomplete combustion. Its activity is therefore accompanied by a process essentially like respiration."(105)

Essentially, Science for the citizen, like Mathematics for the million, is probably best summarised as an openly polemical textbook. Hogben jumbled up various genre techniques outlined in chapter two, using the scholastic, the polemical, and the practical and recreational, each contributing to the creation of scientifically enlightened citizenship. The whole focus for fostering lay interest in science had shifted from the science itself to the development of society in general. This was, after all, the logical extension of the public science tradition as traced in the present study.

The only genre in which Hogben did not dabble, was the romantic, the genre used by Jeans and Eddington, a genre consistently ignored by public science in the thirties, because its main purpose was to infuse science with a spiritual dimension. The role of Hogben's'primers', on the contrary, was to instil a sense of praxis or rational scientific consciousness in the public mind in order to further the positive democratic response to science

that such socialists desired in order to realise their claims for the scientific reorganisation of society.

7 - J.B.S.Haldane (1892-1964)

J.B.S.Haldane was brought up in Oxford, where his father held the position of professor of physiology. Young Haldane was educated at the Dragon prep. school, Oxford, then at Eton, finally gaining a First Class Honours in both Mathematics and Classics from New College, Oxford. From 1915, he served as an officer of the Black Watch Regiment until his release from the army in 1918. Thereafter, he was selected as the first Dunn Reader in biochemistry at Cambridge, until, in 1926 he became head of the Genetics Department at the John Innes Horticultural Institution, and research professor in physiology at the Royal Institution. In 1933, he became Professor of Genetics at University College, London.

In terms of popularisation, Haldane came to public prominence with the commercial success of his book Daedalus, published in 1923, which was mentioned in the previous chapter. In this early text, Haldane distinguished science from theology, saying:

> "But it is most significant that, although Daedalus was responsible for the death of Zeus' son Minos, he was neither smitten by a thunderbolt, chained to a rock, nor pursued by furies. Still less did any of the rather numerous visitors to Hades discover him either in Elysium or in Tartarus.
>
> He was the first to demonstrate that the scientific worker is not concerned with gods."(106)

Having taken such a position on the supernatural early in his popularising career, Haldane did not change it significantly in the period considered. Indeed, of all the public scientists considered in this chapter he seems to have been least concerned with the Physical Idealists and rarely mentioned

physics, tending to dismiss it as a subject that was "inevitably technical."(107) As an atheist, Haldane held the natural world to be "neutral and indifferent to human ideals"(108), and believed that "humanity or any other aggregate of such a kind, may very well take the place of god in an ethical system, but is not a god in any intelligible sense of that term."(109 In other words, like the other socialists considered, Haldane believed that a scientifically organised society could be ethical, but unlike the others, his main target for criticism when discussing religion was not Idealist physics, but the rather old-fashioned anti-Darwinian school. For example, in 1932, in his book The causes of evolution, Haldane said,

> "We have now to ask whether God made the tapeworm. And it is questionable whether an affirmative answer fits in either with what we know about the process of evolution or what many of us believe about the moral perfection of God."(110)

Furthermore, in his text Science and the supernatural, written in the form of a dialogue of letters between him and the Catholic priest Arnold Lunn, Haldane frequently shifted the argument away from modern physics to biology. This failure to acknowledge more contemporary metaphysical issues in science, probably stemmed in part from the fact that Haldane's central professional concern was biology, and, therefore, he was more interested in the implications of his own specialty, genetics. In this field, he strongly refuted the suggestion (made for example by Aldous Huxley in his novel Brave new world, published in 1932) that a scientifically organised society would become horrifically mechanist. This was, of course, something that was also contended by the Physical Idealists. Haldane, however, maintained that as long as biologists and not engineers ran society this could not happen, because, he argued, "treasure your exceptions. That represents the biological point of view, whereas the engineer's point of view is 'Scrap your exceptions'."(111) Therefore, Haldane claimed, despite decades of eugenic rhetoric to the contrary, that a biologist would never forget

that each individual was unique.

For Haldane, as with other socialist scientists considered in this chapter, experimentation was integral to his public science. For example, as the quotation above indicates, he regularly alluded to the ethical code implicit in experimentation under which the scientist attempted to prove his conclusions to be wrong. This was one of the reasons why, in the twenties, he, like Pearson before him, believed novice participation in science to be important, for he claimed that:

> "The objection to most amateur science lies not in the foolishness of its experiments, but in the inability of the experimenters to be satisfied with negative results.. Amateur scientists commonly fail because they set out to prove something rather than to arrive at the truth, whatever it may be. They do not realise that a good half of most research work consists in an attempt to prove yourself wrong. Intellectual honesty is discouraged by politics, religion and even courtesy. It is the hardest but the most essential of the habits which the scientist, whether professional or amateur must form. And if he can spread the habit among his fellow men it may prove to be a contribution to the good life compared to which the applications of science to engineering and medicine are comparatively unimportant."(112)

By the thirties, however, there was no mention of such low-level scientific activity in Haldane's writing, for by this time his exposition was chiefly polemical in genre.

In fact, Haldane's popularising writings can be broken down into three main types. The type for which he was perhaps most famous was the Utopian flight of fancy, of which Daedalus was probably the best known and best selling. In it, among other things, Haldane claimed that ectogenesis (the gestation of the foetus outside of the womb) would be a normal occurrence by the 1950s, and placing himself in that imaginary future, he reported:

"The small proportion of men and women who are selected as ancestors for the next generation are so undoubtedly superior to the average that the advance in each generation in any single respect, from the increased output of first-class music to the decreased convictions for theft is very startling..

I can see the election placards of 300 years hence..'vote for Macpherson and a prehensile tail for your great-grandchildren'."(113)

Hogben, in particular, was impressed by Haldane's confidence in foreseeing future scientific achievements, and felt such visions were a necessary popularising ploy for socialist scientists, saying:

"Professor Haldane's Daedalus is more relevant to a rational choice between possible forms of social organisation than any generalisations which 'economic analysis' derives by the application of logic to verbal definitions of its subject matter. Collectivists will not realise the strength of their own case till they equip themselves with a little information about the resources which a rationally planned society could make use of."(114)

Haldane was indeed very good at playing around with visionary ideas, one of the most useful (in Hogben's sense above) being that international cooperation should not be built on a negative end, such as not starting a war, but on the positive aim of conducting a world war against disease(115). This Utopian type of popularisation was a fairly continuous element in Haldane's popular writings creating a thought-provoking style which was entertaining to read.

In the late twenties and early thirties Haldane did, however, write some elementary exposition in the scholastic genre, such as his text Animal biology, for which he was co-author with J.S.Huxley. This work was intended to appeal to readers who wanted "something more solid and more continuous than is the bulk of popular scientific literature."(116) Much of this text betrayed an emulation of the popular exposition of T.H.Huxley

especially the use made of the frog as an introductory type.

By the mid to late thirties, however, Haldane's popularising work centred on contributions to ongoing political debates, involving him in writing pamphlets for the British Science Guild, in which he made ostensibly neutral statements like the following:

> "It is at any rate clear that the 2s. per week allowed for the child of the unemployed man for all purposes is inadequate.. It is not for the biologist to suggest how this situation be remedied. But if it is not remedied then the research of the last few years on dietetics has been largely useless, and there appears to be little point in continuing it."(117)

Four years later,in 1938, after his public commitment to communism(118), Haldane became a more forceful polemicist, writing articles for left-wing vehicles of communication, such as the Daily worker. His articles for this paper were written to outline the shortcomings of capitalism while presenting current scientific knowledge in relation to everyday life. Here is an example of this type of popularising polemic:

> "It is a law of Nature that if we drink water contaminated with typhoid bacteria we are likely to get typhoid.. But the moment we understand this law it becomes untrue, because we can add 'but not if we boil or chlorinate the water before we drink it.'
>
> In the same way we suffer every ten or eleven years from an economic depression causing widespread unemployment. Yes, but not if we understand the economic laws which cause these cycles, and act on our knowledge. There was no slump in the Soviet Union in 1931, and there is no sign of a coming slump there today."(119)

Evidently, by 1938, Haldane believed that it was right for the 'enlightened' biologist to suggest how social and political situations be remedied. Indeed, in many ways, Haldane's articles for the Daily worker can be characterised as Marxist homilies, pointing out scientific 'truths' which could

contribute to the good life.

Thus, although there is a continuity of optimistic belief in public science throughout Haldane's popularising efforts of the twenties and thirties; his 'conversion' to Marxism acted as a catalyst in developing his polemical skills and marked a move away from both scholastic exposition and a commitment to recreational science. In this way Haldane's popularising career during this period gives some indication of the impact of the S.R.S. movement, and the Soviet 'experiment' on public science at this time. An even starker example of this impact is given by a consideration of J.S.Huxley's popular writings below.

8 - J.S.Huxley (1887-1975)

Julian Huxley was born in London, the son of Leonard Huxley, and the grandson of T.H.Huxley. He was educated first at Eton, and then at Balliol College, Oxford where he gained a first class honours degree in natural science (zoology) in 1909. After graduating he spent a year working in Dr. Dohrn's biological laboratory in Naples and then returned to England to lecture in zoology at Balliol. In 1913, Huxley obtained a research post in genetics at the Rice Institute, Texas, where he remained until 1917 when he joined the British Army as an intelligence officer. At the end of the War he took up the position of senior demonstrator in zoology at New College, Oxford, moving to King's College, London in 1925 to become professor of zoology. In 1927, he resigned as professor in order to devote more time to writing and research, since this was the period when he was collaborating with H.G. and G.P. Wells on the writing of the popular science book, The science of life.

Huxley's popularising career began by chance in 1920, when his work on the induction of metamorphosis in the axolotl by feeding it thyroid gland, was published in a paper in Nature, which reported:

"In conclusion the opinion was expressed that in the course of time it would be possible to extend the duration of man's life very appreciably."(120)

This claim did not go unnoticed by the national press, and the Daily mail announced that:"Young Huxley has discovered the elixir of life".(121) The publicity was regarded by some of his colleagues as likely to damage his reputation in the scientific world, and he thought it right to correct the exaggerated stories that were being published. He was granted an interview with the Times, where he repeated his claims in a less sensationalised manner, saying:

"that numerous other examples showed that the apparent irreversibility of the life cycle was only apparent, and that the ordinary type of life cycle had been adopted as the most convenient, but not as the only possible method of grappling with existence."(122)

Huxley was launched on a popularising career.

In 1926, he prefaced his popular text Essays in popular science as follows:

"One of the duties of scientific men not necessarily all of them, but certainly some of them taken as a group is to make available to the lay public the facts and theories of their science, and especially to try to recreate something of the mental background that is engendered by those facts and those theories."(123)

The reason for this duty according to Huxley, was because, as society was becoming democratised, scientists were in danger of becoming "an isolated caste in a half-hostile environment."(124) Popularisation would bring scientists out of isolation and make a contribution to an amicable public environmemt for science. Furthermore, in a democracy,as Huxley was aware, adequate funding relied on public good will. At this stage in his popularising career, Huxley, as the above quotation indicates, saw popularisation, in the 'pure' sense as the exposition of 'facts' and 'theories'. He did,

however, show an early inclination towards public science, because of his liberal faith in progress. Such progress was a scientific law for Huxley, as he demonstrated in his essay 'Progress, Biological and Other'. This demonstration involved a comparison with physical laws, as follows:

> "The gas laws state that the pressure of a gas kept at constant volume increases in a particular way with increase of temperature.
>
> In a gas whose temperature is raised, many particles will, at any given moment, be travelling more slowly than the average rate, when it was cooler, many even which (sic) had been travelling fast may now be travelling slowly."

Huxley continued, saying:

> "In biological evolution, some organisms degenerate, some remain stationary, but the average of certain properties, and more especially their upper level, increases."(125)

This belief in an'objective' scientifically deducible law of progress helped lend an optimistic hue to scientific activity, whilst at the same time implying that such progress was 'neutral', and that, for both these reasons, there was no need to be concerned about the social impact of science on society. Consequently, the motivation for his 'pure' type of popularisation was quite different from that of Eddington and Jeans, discussed above. Huxley's optimistic faith in the beneficial progress of science for society stemmed from a belief in humanism as a guiding force. In the thirties, he was to become aware that humanism was not necessarily society's guiding force, and he therefore sought to make it so. He was never to change radically his political position beyond this, and thus seems representative of the popularising group identified by Collins as the scientific rationalists.

Whilst being at one with his grandfather's attacks on theology, J.S. Huxley wished, like his grandfather, to retain the ethical benefits of religion in a 'scientific' society. In a text entitled Religion without revelation, published in 1927, Huxley stated this position clearly:

> "The great bulk of the religious spirit with all its potentialities for promoting human unity, for providing busy man with peace and refreshment, for helping humanity in its task of controlling evolution (which is only a more accurate way of saying bringing to pass the Kingdom of God upon earth), for stressing the permanent satisfactions and highest values in the welter of daily existence, is locked up in a theological strong-box, hidden away from half humanity in a fairy-story land."(126)

Thus, one of the problems with religion in the conventional sense was, for Huxley, the rigours of theology. The only way of creating heaven on earth was, therefore, to destroy conventional religion and replace it with scientifically based religious spirit, since "the idea of God is.. a convenient symbolism for grasping under a single head the multifarious activities of the universe in their relation to man."(127) Thus, for Huxley, scientific humanism was equivalent to God, since:

> ".. in the religious sphere, was it not Jesus who laid down once and for all that the kingdom of heaven is within us? As, if we abandon the idea of external certitude for scientific law, we need not worry about doing so for our scheme of values."(128)

Huxley argued that:

> "A Humanism that is also scientific sees man endowed with infinite powers of control."(129)

In other words, like the socialists considered in this chapter, Huxley believed that a scientifically planned society was inherently ethical. Huxley, however, did not place so much faith in rationalism as Levy, Hogben and Haldane. He saw science as a necessarily large component of society, but not as the sole component, saying:

> "In my phrase, scientific humanism, I have chosen to emphasise science as against all the other human activities for a simple reason - that at the moment science is in danger of setting itself up as an

external code or framework as did revealed religion in the past; and only by putting it in its rightful place in the humanist scheme shall we avoid this dangerous dualism."(130)

This scientific humanism was to lie at the core of Huxley's philosophy throughout the period under consideration, and descended more directly from T.H.Huxley's liberal brand of public science than did that of the socialist popularisers considered. Like many of the other popularisers associated with the S.R.S. movement, however, the above quotation appears to suggest that Huxley was spurred into action as a public scientist by the popularisation of modern physics.

Prior to the early thirties, when the S.R.S. movement got under way, Huxley's popularisation consisted of general essays about science, and exposition in the scholastic genre. Of particular importance in the latter category was The science of life, a work which took several years to write in collaboration with H.G. and G.P. Wells, and which was first published in eight volumes in 1931. The text offered a mechanist presentation of life, which began:

"We shall find first that the human body is a machine amenable to the same chemical and physical laws as most of the machines man makes himself for his own ends."(131)

In this vein, the text continued offering accessible exposition of biological topics.

Another of Huxley's better known popularising ventures at this time, was his wireless talks on birdwatching, commissioned by the B.B.C. in 1930. A book was published that year based on the transcripts of those talks. During this period Huxley was part of a popularising trend for promoting novice participation in science to further professional knowledge.(132)Huxley acknowledged the success of such popularisation in his preface to the text, in the following way:

"I may perhaps say that in answer to a specific request I made

over the ether for more information concerning the sparrow attracting propensities of crocuses, I received over a hundred letters.. they seemed to show the opportunity of doing cooperative natural history research of real value over the wireless."(133)

Huxley concluded these talks by suggesting how bird lovers could help protect birds by putting up bird boxes and supporting the R.S.P.B. etc. Until the S.R.S. movement helped shape popularisation, such novice partici a-tion in research and the encouragement of activity in non-professional societies was, as can be seen from the writings Pearson and Haldane, generally considered the democratic model of popularisation.

In 1932, however, Huxley was part of a group of scientists who visited the Soviet Union, and he published his impressions in A scientist among the Soviets that same year. Huxley started the text by trying to lay aside his cultural preconceptions in order to breathe in the Russian atmosphere. Like many other British visitors to Russia at this time, he was clearly impressed by the revolutionary attempt to organise a large country on planned 'rational' lines, saying: "Whatever a man's political or moral or religious opinions may be about Russia, he cannot escape one conclusion - that Russia is engaged upon an enormous experiment."(134) Clearly seduced by the enormous importance of science in Soviet society, he continued:

".. the Five Year Plan is only a symptom. It heralds the birth of a new kind of society, a society which is coherently planned, and has not, like Topsy and the out-of-hand individualisms that constitute our Western nations, 'jest growed'."(135)

A related aspect of this planning was popularisation, and the prominence of Soviet science popularisation had a great impact on Huxley, who reported:

"In the biological sphere the scientific spirit is just as important as in the physical and mechanical. Here too propaganda is very busy. I have spoken of the admirable posters connected with maternal and child welfare. Veterinary science too is much boosted; for instance,

in the Park of Culture and Rest, exhibitions of the highly realistic posters and diagrams about the improvement and the diseases of livestock is almost (though definitely not quite) as prominent as that concerning machinery."(136)

As has been indicated in the previous chapter, the Soviet 'experiment' was one of the factors which catalysed public scientific activity in Britain, and Huxley was undoubtedly influenced by it. In his text An introduction to science, published that same year, and co-written with the physicist E.N. da C.Andrade, Huxley concluded:

"The next step is to study economic and social change and find out how to control it deliberately instead of letting it control our life by just happening. And for that science is needed: without science and the scientific spirit, we shall just drift along; with their aid man may be able to learn how to control his own destiny."(137)

Huxley, however, rapidly became aware of the shortcomings of Soviet planning, particularly where liberal freedoms were concerned. For example, in 1934, in his text If I were dictator, where he once more outlined his scientific humanism, he said:

"Fascism and Communism are attempts to build up.. a social religion. But just as many of the early attempts to build up God-religion were crude and in many respects repulsive, so the early attempts at social religion can scarcely help being crude and repulsive in many of their aspects."(138)

At the same time, however, as a scientific humanist, Huxley was arguing for a similar social religion based on science, saying:

".. the physical and biological sciences, in discovering the unity of matter and energy, have provided a real basis for what up till now have been only theological speculations."(139)

The practical, organisational side of this philosophy was clarified in a popularising exercise of 1933 when Hyman Levy and Huxley broadcast

a series of talks to see "how far science today is helping to cater for the needs of the people of this country."(140) These broadcasts were published in book form in 1934, and constituted the first volume of Levy's 'Library of Science and Culture'.

Much has been made of these transcripts by the historian, G.Werskey, who claims that they mark Huxley's "conversion to a Marxist perspective;" a veritable "pilgrim's progress".(141) Studied in the context of Huxley's public science writings in the twenties and early thirties, however, this conclusion seems questionable. Huxley did indeed come to question the idea of 'pure' science during his visits to different research establishments, as Levy suggested he might. But Huxley's conclusion as to the social relevance of science was as follows:

> ".. the bulk of research in progress in this country is organised from the production end - that is to say, it is organised and planned with a view to improving efficiency in technical processes and reducing cost to the producer or to the state. There ought to be much more research organised from the consumption end - directed towards the needs of the individual citizen as an individual and as a citizen."(142)

This conclusion emphasised Huxley's liberalism in which the individual and the citizen were distinct and 'separate' entities. Furthermore, his conclusion was also liberal in its advocacy of capitalism modified to consumer needs. Huxley's last words on the subject (which are triumphantly reproduced by Werskey) were as follows:

> "The chief moral of this book, it seems to me, is that science is not the disembodied sort of activity that some people would make out, engaged on the abstract task of pursuing universal truth, but a social function intimately linked up with human history and human destiny."(143)

In fact, such a conclusion does not compromise Huxley's scientific humanism in the slightest, since the crux of his philosophy had always been progress -

ive social evolution, the dynamic of which was science. Furthermore, by the late thirties, Huxley was more than ever sceptical of Marxism, because he was receiving regular correspondence from the scientist H.J.Muller in Russia, and, therefore, knew of the Stalinist purges before many other British scientists.(144)

Thus, in conclusion it would seem that, although Huxley was closely associated with the more radical popularisers and followed the trend away from exposition in the scholastic genre and the encouragement of novice participation, to the thirties public science model of popularisation which stressed utility, national planning, and a socio-historical presentation; his central philosophy remained that of liberalism. As such,Huxley's reformist type of public science followed more closely in the footsteps of his illustrious grandfather than did that of the more radical popularisers discussed above, despite the latters' avowed respect for T.H.Huxley.

9 - Conclusion.

From this study of six prolific popularisers drawn from the three main popularising groupings as identified by Collins, it can be seen that the physicists, Eddington and Jeans, set the agenda for popularisation in the inter-war period by promoting a 'pure' type of popularisation as against public science. It was in reaction to this, at the popularising level, that Levy devoted so much time to rebutting Idealism and putting forward alternative Marxist beliefs about science. Once Levy had established a radical public science response to Idealism, it was Hogben who was more successful in writing best-selling popular science books, which focussed on a socio-historical presentation and made praxis the key to the learning process. J.B.S.Haldane's popularising career, spanning the twenties as well as the thirties, indicates the marked change in emphasis which public science adopted in the inter-war period, moving away from whimsical Utopian essays

and the exposition of science as hobby, to a far more polemical, socio-economic centred type of science popularisation. As a scientific rationalist, Huxley's popularising career in the inter-war period, also marked this change in direction for public science. For public scientists, whatever their political complexion, seemed to have been united by the belief that 'democratically' valid scientific leadership could be retained through popularisation, if attention was focussed on the social implications of science, and away from the complexities of modern scientific theory.

Of course, in a sense, such a conclusion left modern physics firmly in the hands of 'pure' popularisation, since the social implications of relativity and quantum mechanics at first seemed too remote to consider, and were later swathed in military secrecy. On the other hand, the public scientists, from the first, seemed aware that modern physics was beyond their purview. Levy, for example, had gone to great lengths to suggest, somewhat defensively, that experimental science was the only 'real' science, implying that Eddington and Jeans were philosophers, not scientists. This was patently untrue, but seems to have formed a rhetoric strong enough to console public scientists. For although many of them, particularly Haldane and Huxley, as their writing indicates, were acutely aware of the distinction between the biological and the physical sciences, they chose to promote their own biological knowledge and ignore physics.

Thus, in a way, the inter-war period can be viewed as a time when the tensions inherent in public science between physicists and biologists (glimpsed earlier in the writings of Tyndall and Huxley) came to the fore, resulting in the disciplinary divisions between 'hard' and 'soft' science being reinforced by a separation in their popularisation techniques.

Footnotes

1 - R.E.Filner, 'The roots of political activism in British science', in Bulletin of the atomic scientists, 1976, 32, pp.25-30. p.25.

2 - G.Werskey, The visible college, London, 1978, p.138.

3 - W.McGucken, Scientists, society and the state: The social relations of science movement, 1931-47, Ohio, 1984, p.27.

4 - Op. cit. (2). See also, G.Werskey, 'British scientists and "outsider" politics, 1931-45', in Science studies, 1971, 1, pp.67-83.

5 - Op. cit., (3), p.148.

6 - P.Collins, 'The British Association as public apologist for science, 1919-1946', in R.MacLeod and P.Collins (eds.), The parliament of science, Middlesex, 1981, pp.211-237.

7 - A.V.Douglas, The life of A.S.Eddington, London, 1956, p.39.

8 - Ibid., p.42.

9 - For example, ibid., p.51.

10 - A.S.Eddington, The expanding universe, Harmondsworth, 1940, preface.

11 - A.S.Eddington, Space, time and gravitation, Cambridge: Cambridge University Press, 1923, p.32.

12 - See chapter 3.

13 - A.S.Eddington, Stars and atoms, Oxford: Clarendon Press, 1927, p.11.

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16 - Op. cit. (13), p.22.

17 - Ibid., p.16.

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19 - Ibid., p.324.

20 - A.S.Eddington, New pathways in science, Cambridge: Cambridge University Press, 1934, p.319.

21 - Ibid., p.26.

22 - The Swarthmore lectureship was established in Philadelphia by the Woodbrooke Extension Committee to provide for:

> "an annual lecture on some subject relating to the message and work of the Society of Friends."

23 - A.S.Eddington, Science and the unseen world, London: Allen and Unwin, 1929, pp.55-6.

24 - Ibid., p.31.

25 - A.S.Eddington, The theory of relativity and its influence on scientific thought, Oxford: Clarendon Press, 1922, p.15, my emphasis.

26 - Op. cit. (10), preface.

27 - Op. cit. (18), p.8.

28 - M.Biezunski, 'Popularisation and scientific controversy, the case of the theory of relativity in France', in Sociology of the sciences, 1985, 9, pp.184-189, p.188.

29 - Op. cit. (20), p.8.

30 - Ibid., p.13.

31 - Ibid., p.315.

32 - Ibid., p.323.

33 - Op. cit. (18), p.ix.

34 - Op. cit. (6), p.13.

35 - A.S.Eddington, The philosophy of physical science, Cambridge: Cambridge University Press, 1939, p.222.

36 - Op. cit. (10), p.118.

37 - E.A.Milne, Sir James Jeans, Cambridge, 1952, p.73.

38 - Kegan Paul, Trench, Trubner and Co. archives, 1923-32, University College, London.

39 - Ibid. From 1928-32 Eos sold 12,000 copies.

40 - In fact the leading article ridiculed Jeans' lecture and was rather dismissive, concluding:

> "It is indeed a mysterious universe that we inhabit, and not the least mysterious are those strange beings thrown up from the primeval slime and now turning their telescopes on the fretted vaults of heaven."

The Times, November 5 1930, p.10.

41 - J.Jeans, The mysterious universe, Cambridge: Cambridge University Press, 1930. p.134.

42 - Op. cit. (37), p.72.

43 - J.Jeans, The stars in their courses, Cambridge: Cambridge University Press, 1931, p.110.

44 - J.Jeans, The universe around us, Cambridge: Cambridge University Press, 1929, p.342.

45 - Op. cit. (43), p.2.

46 - Op. cit. (41), p.149.

47 - Ibid., p.134.

48 - Ibid., p.127.

49 - J.Jeans, The new background of science, Cambridge: Cambridge University Press, 1933, p.296.

50 - J.Jeans, 'Man and the universe', in J.Jeans et al, Scientific progress, London: Allen and Unwin, 1935, pp.11-39, p.31.

51 - Op. cit. (49), p.42.

52 - Op. cit. (50), p. 37.

53 - Ibid., p.38.

54 - Op. cit. (49), p.2.

55 - Op. cit. (3), p.30.

56 - Op. cit. (39), p.150.

57 - J.Jeans, 'The new world picture of modern physics', in the British Association report for 1934, pp1-19, p.18.

58 - The 1917 Club was a Soho establishment where left-wing thinkers met, united , among other things, by their affiliation to the Labour Party, trade unions such as the N.U.S.W., or their interest in worker's education.

59 - H.Levy, The universe of science, London: Watts, 1931, pp.vii-viii.

60 - Ibid., p.19.

61 - Ibid., p.20.

62 - Ibid., p.45.

63 - Ibid., p.29.

64 - Ibid., pp.73-4.

65 - Ibid., pp.208-9, my emphasis.

66 - H.Levy, 'What is science?', in M.Adams (ed.), Science in the changing world, London: Allen and Unwin, 1932, pp.33-109, p.73.

67 - H.Levy, Science in an irrational society, London: Watts, 1934, pp.9-10.

68 - H.Levy, Thinking, London: Newnes, 1936, p.114.

69 - Ibid., p.111.

70 - Op. cit. (66), p.38.

71 - Op. cit. (59), p.240.

72 - "The tragedy does not lie in man's scientific control over Nature but in his absence of moral control over himself."
Op. cit. (57), p.16.

73 - Op. cit. (67), p.69.

74 - H.Levy, A philosophy for a modern man, London: Gollancz, 1938, p.267.

75 - Op. cit. (66), p.103.

76 - Ibid., p.105.

77 - Ibid., p.106.

78 - H.Levy, The web of thought and action, London: Watts, 1934, frontispiece.

79 - See below, section on J.Huxley, and also S.Budd, Varieties of unbelief: Atheists and agnostics in English society, 1850-1960, London, 1977, pp.168-9.

80 - Op. cit. (2), p.171.

81 - Op. cit. (78), p.15.

82 - Ibid., p.238.

83 - H.Levy, Modern science, London: Hamilton, 1939, preface.

84 - G.P.Wells, 'Lancelot Hogben', in Biographical memoirs of the fellows of the Royal Society, 1978, 24, pp.183-221, p.200.

85 - L.Hogben, Mathematics for the million, London: Allen and Unwin, 1936, p.14.

86 - Ibid., pp.14-15.

87 - Ibid., p.23.

88 - Ibid., p.27.

89 - Ibid., p.35.

90 - This lecture was given annually at Conway Hall, Red Lion Square, W.C.1, for the South Place Ethical Society, which studied and disseminated ethical principles and cultivated a rational religious sentiment.

91 - L.Hogben, The retreat from reason, London: Watts, 1936, p.47.

92 - Op. cit. (85), p.40.

93 - Ibid., p.54.

94 - Ibid., p.67.

95 - See for example:

L.Huxley, Life and letters of T.H.Huxley, 2 vols., New York, 1901.

E.Clodd, T.H.Huxley, London, 1905.

J.R.S.Davis, T.H.Huxley, London, 1907.

P.C.Mitchell, T.H.Huxley, 2nd edn., London, 1912.

96 - The second edition was published in 1939.

97 - L.Hogben, Science for the citizen, London: Allen and Unwin, 1938, p.11.

98 - L.Hogben, 'Naturalistic studies in the education of the citizen', in L.Hogben, Dangerous thoughts, London: Allen and Unwin, 1939, pp.104-20, p.104

99 - Op. cit. (97), p.1089.

100 - Op. cit. (98), p.109.

101 - L.Hogben, Education for an age of plenty, London: British Institute of Adult Education, 1937, p.15.

102 - Op. cit. (97), p.1089.

103 - Ibid., p.736.

104 - Ibid., p.901.

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106 - J.B.S.Haldane, Daedalus, London: K.P.T.T. and Co., 1923, p.48.

107 - Ibid., p.11.

108 - J.B.S.Haldane, Callinicus, London: K.P.T.T. and Co., 1925, p.82.

109 - J.B.S.Haldane, 'God-makers', in J.B.S.Haldane, Fact and faith, London: Watts, 1934, pp.66-85, p.81.

110 - J.B.S.Haldane, The causes of evolution, London:,Longmans, 1932, p.159.

111 - J.B.S.Haldane, 'The biologist and society', in M.Adams (ed.), Science in the changing world, London: Allen and Unwin, 1935, pp.253-68, p.261.

112 - J.B.S.Haldane, 'Scientific research for amateurs', in J.B.S.Haldane, Possible worlds, London: Chatto and Windus, 1928, pp.162-76, p.174.

113 - Op. cit. (106), pp.65-6.

114 - Op. cit. (91), p.47.

115 - Op. cit.,(111), p.259.

116 - J.B.S.Haldane and J.S.Huxley, Animal biology, Oxford: Clarendon Press, 1927, preface.

117 - J.B.S.Haldane, Human biology and politics, British Science Guild, 1934, p.17, my emphasis.

118 - The Marxist philosophy of the sciences was published in 1938. He did not, however, become a full member of the Communist Party until 1942.

119 - J.B.S.Haldane, 'The disorder of nature', in J.B.S.Haldane, Science and everyday life, London: Lawrence and Wishart, 1939, pp.104-8, p.107.

120 - Nature, 1920-1, 106, p.678.

121 - J.R.Barker, 'Julian Sorrell Huxley', in Biographical memoirs of the fellows of the Royal Society, 1976, 22, pp.207-38, p.211.

122 - The Times, 22 January 1921, p.10.

123 - J.Huxley, Essays in popular science, London: Chatto and Windus, 1926, preface

124 - Ibid., preface.

125 - J.Huxley, 'The inheritance of acquired characters', in ibid., pp.29-37, p.32.

126 - J.Huxley, Religion without revelation, London: Chatto and Windus, 1926, p.377, my emphasis.

127 - J.Huxley, 'T.H.Huxley and religion', in op. cit. (123), pp.137-63, p.158.

128 - J.Huxley, What dare I think , London: Chatto and Windus, 1931, p.163.

129 - Ibid., p150.

130 - Ibid., pp.176-7.

131 - J.Huxley, G.P. and H.G.Wells, The science of life, London: Cassell, 1938, p.1.

132 - See chapter 2, section on science as hobby.

133 - J.Huxley, Bird-watching and bird behaviour, London: Chatto and Windus, 1930, preface.

134 - J.Huxley, A scientist among the soviets, London: Chatto and Windus, 1932, p.48.

135 - Ibid., p.51.

136 - Ibid., pp.74-5.

137 - E.N. da C.Andrade and J.Huxley, An introduction to science, Oxford: Blackwell, 1932, p.334.

138 - J.Huxley, If I were dictator, London: Methuen, 1934, p.121.

139 - J.Huxley, 'Religion and science: Old wine in new bottles', in J.Huxley, Essays of a biologist, London: Chatto and Windus, 1934, pp.235-304, p.303.

140 - J.Huxley, Scientific research and social needs, London: Watts, 1934, p.14.

141 - Op. cit. (2), pp.242-3.

142 - Op. cit. (140), p.256, my emphasis.

143 - Ibid., p.279.

144 - It has been argued that he kept this knowledge to himself so that he would not be dismissed as a fascist by the scientific left, and thus curtail any influence he might have over progressive science.

D.B.Paul, 'A war on two fronts: J.B.S.Haldane and the response to Lysenko in Britain', in Journal of the history of biology, 1983, 16, pp.1-37, pp. 15-16.

CHAPTER 9

1 - Historical deductions.

One of the primary objectives of this thesis was to determine to what extent public scientists were able to promote the idea, through popularisation, that science was crucial to social, political and ethical developments from c.1870-c.1939; and to what extent the promotion of public science was checked at a popularising level by rival viewpoints. To this end chapters 3 and 4 suggested that, in the late Victorian era, many general science series were dominated by public scientists through their various roles as editors and contributing authors to such series, and through their friendship with Frederick Macmillan. Their dominance in this sphere would seem to have been great to the extent that even the Christian Knowledge Society and the Society for the Promotion of Christian Knowledge did not, through their general science series, challenge the Victorian Scientific Naturalists' didactic presentation of science as 'secular' knowledge. Late Victorian public science, however, as revealed through the popularisation of Huxley and Tyndall, while keen to secularise scientific knowledge and to promote meritocratic assumptions about the pursuit of science, did not directly suggest, even at a polemical level, how science was to be used in the civic sphere. Rather, it seems to have been more concerned to stress 'professionalising' interests, such as science education, and the autonomy of scientific expertise. This is perhaps most clearly demonstrated by the way in which the romantic writings of Lubbock, a public scientist without scientific qualifications or professional scientific status, seemed to find more ideological positions in common with evangelical popularisers who also used a romantic genre of presentation. Consequently, he stressed the role of nature as moral guardian, supported protectionism, and the promotion of subjective analysis. Indeed, in the context of science popularisation, it was largely through the romantic presentation of natural

history at this time, that natural theology flourished, challenging the naturalistic propositions made by public science.

In the Edwardian era, as indicated in chapters 5 and 6, public science attitudes reached a high noon of currency. Aided by collectivising trends in politics, the public fascination with new technology and the emergence of the new journalistic genre, a large number of series examined for this period reveal public science assumptions about scientific knowledge, particularly the belief that science promised social and political progress. As has been argued, the apotheosis of these assumptions is to be found in the polemical popularisation of eugenics at this time, when popularisers of a wide range of political complexions supported such beliefs.

After the destruction of the Great War, however, chapters 7 and 8 illustrated the way in which public science ideas were questioned. Progress no longer seemed inevitable, and a pluralist viewpoint became fashionable at a variety of levels in popularisation, from the use of polemical debate as an organisational feature in general non-fiction series in the twenties, to the didactic exposition of such series in the thirties, and the romantic popularisation of Eddington and Jeans, both of which promoted science as a pursuit separated from other activities such as politics. Public science was also challenged by the way in which modern physics was popularised to stress, among other things, that scientific knowledge was provisional rather than certain. In an age when science was being blamed in some quarters for social and economic problems this was an obvious defensive reaction, as was the popularisation of the idea that science was 'pure', an idea that was formally promoted by the British Association.(1) Public scientists, on the other hand, because of their political and social beliefs were keen to perpetuate the idea that science was certain, experimentally proven, knowledge. They also promoted the idea, through a socio-historical form of popularisation using a variety of genres, that the direction of science was culturally determined, and that, therefore, social problems

could be solved by reorganising society. Because of the growth of a large left-wing readership in the late thirties, the latter viewpoint appears to have gained ground in the years leading up to the outbreak of the Second World War.

The proviso was made at the outset of this thesis that much more could be deduced about the presentation of science than about the reception of that presentation. Nevertheless, certain features of the changing audiences for science books can be outlined. Firstly, in the late Victorian era, the popularisation of science through books tended to operate at two levels for two distinct audiences. On the one hand, there were series which clearly targeted the enfranchised classes, who wished to participate in debates on social issues in which science was felt to have an authoritative role, such as the social position of women, the problem of criminality, and so on. Such 'exposition' helped to keep science a major part of general middle-class culture at a time when scientific research was rapidly becoming differentiated from daily discourse. On the other hand, 'traditionally' popular scientific topics such as geology, natural history, astronomy, and to a lesser degree, physics and chemistry, were promoted at a didactic level for audiences with a less structured education, and a marginalised political role. In the Edwardian era, however, a greater number of series promoting science were targeted at a lower-middle and upper-working class audience, who were assumed not to have had a liberal education, yet who were believed to want information about science, the arts, philosophy, and society, of the sort that the established middle-classes had been reading in the late Victorian period. The early twentieth century, therefore, can be viewed as a time when the new mass journalism had found a broad audience for science popularisation, among other things, by adopting a more 'democratic' approach to knowledge. After the Great War, however, although the majority of non-fiction series addressed themselves to a broad book-reading audience largely undifferentiated by education or wealth; yet, ironically,

in a period which began to see the impact of the 'paperback revolution', and when left-wing opinions were fashionable, a significant proportion of popularisation, as evidenced in the writings of Eddington and Levy, would seem to have been written for an elite, very widely read audience.

2 - Theories tested.

These historical deductions about the images of science presented through popular science books, and the particular audiences they addressed, were drawn from an application of Gramsci's formulation of hegemony. For, at the beginning of this thesis, the claim was made that this concept offered a better theoretical point of departure for a study of popularisation than that offered by Whitley. This was because Whitley's theory offered an internalist perspective on the relations between the pursuit of scientific research and popularisation, whereas the present study wished to find some of the main images of science presented through popular science books, and, in particular, to trace the concept of public science as presented through this medium.

In other words, models of popularisation such as Whitley's are not helpful if the focus of the analysis is the ideological package which is part of the presentation of scientific information, rather than the scientific information itself.(2) Of course, it may be argued that such packaging is external and irrelevant to the structure of scientific ideas and the validity of scientific theories. Nevertheless, the ideological content of popularised science is a highly relevant focus for studies in popularisation because it is an important part of the public's perception of science. Indeed, Whitley himself concedes that:

> "The more heterogenous audiences are, the more simplified and apodictic popularisation is likely to be..[so that]..scientists and other popularisers will tend to emphasise general overall purposes and consequences of their work so as to appeal to all groups."(3)

One of the problems, however, with internalist models such as Whitley's is that it means that the dynamics of popularisation have to be found in the interaction of scientific fields and their publics, with little attention being paid to the wider 'external' issues and points of conflict on which such simplified and discursive popularisation draws. As this thesis has indicated, however, the Gramscian theory of hegemony embraces such issues in a way which is more pertinent to studies interested in the popularisation of elementary science as part of a broad cultural exchange of ideas and beliefs. Therefore, it is, as this thesis has demonstrated, an extremely useful theory for studies in popularisation which wish to make a clean break from the idea that popularisation is a process which begins with the scientist as a keeper of esoteric knowledge. For a start, it legitimises a new approach to the history of popular culture which questions this conception of the popularisation process.

This is because Gramsci argues that popular culture is a mosaic of "scattered and fragmentary bits of information"(4),in which one can find concepts which have"spread beyond the confines of intellectual groups"(5) to form the conflicting points of view which any one individual holds to be 'common sense'. Gramsci thus validates the historical observation of such fragmented concepts through the study of a particular medium or type of artefact. Consequently, if an understanding is sought of some of the images of science which the general public is receiving during certain periods of time, then it is a realistic historical project to focus on the ideas being presented by identifiable, intellectual groups through their popularisation of science through popular science books.This firmly places popularisation in a much wider cultural context which serves as the point of departure for a study of the popularisation process, offering a viable theoretical alternative to internalist studies which make the science itself the central focus. Furthermore, if popular culture is hypothesised as fragmentary, then it is valid to study some of the incoherent fragments, rather than, in classic Marxist terms,

trying to build up a causal historical narrative, which will tend to analyse the relations between commercial, intellectual, industrial and governmental interests, rather than focussing on the popularising material itself.(6) In these terms,this study has made apparent the suitability of the Gramscian theory of hegemony for analyses of popularisation. For, it enables a fresh interpretation of historical issues to be made by looking at these issues from the perspective of the content of a published medium. Such a perspective does give an unusual set of impressions about a period, an issue, or a person, but in Gramscian terms it produces some valid pieces of the mosaic of popular culture.

The treatment of the popularisation of eugenics in chapter 6 is a good illustration of the way this approach works. For example, previous studies of eugenics have tended either to view the issue from the perspective of the personality of a key scientist such as Karl Pearson (7), or from that of the socio-economic background of the E.E.S. (8), or both (9), with the general conclusion being drawn that eugenics revealed an omnipolitical faith in social imperialism. In fact, however, by applying the Gramscian concepts of hegemony and popular culture and studying the published popularising material of eugenicists, eugenics begins to look more like a coherent expression of a widespread faith in public science, in which fragmented and contradictory beliefs, including pacifist internationalism as well as social imperialism, are subsumed within an ideology of public science. It is for this reason that the argument has been made in chapters 5 and 6 that the Edwardian era was the high noon of public science, for from a Gramscian perspective public science appeared poised to become a dominant ideology in the years leading up to the Great War.

Related to the validity of the pieces of cultural mosaic revealed through the application of Gramsci's theory of hegemony, is Gramsci's use of the term 'intellectual', which alludes to any spokesperson for a class and/or social force. (10) Using this definition, membership of the 'scientific

community' can be broadly given to any populariser on whom the status of scientific authority is bestowed by various media, institutions and organisations. This concept generally approximates to Sheets-Pyenson's use of 'low' science, which was adopted in chapter 1 of the present thesis. In retrospect, however, Gramsci's definition of an intellectual would seem to offer a more appropriate analytical tool for an externalist examination of popularisation. For example, in the context of this study, publishing houses had an instrumental role to play in upholding claims to scientific status in the popular arena, by choosing which authors to commission, and which subjects to classify as science. Consequently, a wider conception of 'scientifically' valid knowledge comes in to play, which is arguably more in tune with popular perceptions in particular historical periods, than criteria based directly or indirectly on the internal academic or 'high' science gatekeepers of the time.(11) In the late Victorian and Edwardian periods, for example, the'Contemporary Science Series' promoted a conception of scientific knowledge which encompassed social and political opinions concerning feminism, sexuality etc. which would not have been recognised as scientific knowledge by many practitioners of science, but which was presented as such knowledge under the editorial control of Havelock Ellis. To label this conception of scientific knowledge 'low' science may be useful for internalist models of popularisation, but unduly interferes with the observation of images of science in popular culture from an externalist perspective.

Within this broad 'popular' conception of the scientific community which Gramsci's model of popular culture offers, it is easier in terms of popularisation issues to rebut the myth of this community as monolithic and homogenous. For example, although Whitley makes this rebuttal when setting up his model of popularisation he has trouble sustaining it, because the heterogeneity of this group then largely rests on the disciplinary differences between scientific fields, differences which are not usually very apparent at a popular level. Indeed, Whitley seems to be claiming a general consensual

attitude among scientists as to the function of popularisation, which, he claims, is to"communicate certainty to non-specialists", and to sustain the belief in the "universal validity and social utility" of science.(12) Because, however, Gramsci's theory of hegemony enables external factors such as religion, politics and media influence to offer the 'scientific community' a heterogeneous status, a more sophisticated appraisal of Whitley's alleged promotion of scientific domination and expansion through popularisation can be made, as this thesis has demonstrated, by applying Gramscian concepts to published popularising material.

This can be seen, for example, when studying some of the main popularising issues of the inter-war period which were explored in chapters 7 and 8. For, whilst Whitley's model of popularisation might indicate the different ways in which, say, Jeans as a physicist and Hogben as a biologist communicated science as certain knowledge to non-specialists, it would not have clarified the way in which these differences related to the respective cultural beliefs of the two popularisers. Consequently, without the Gramscian theory of hegemony an extremely important social dimension to the complexity of the promotion of scientific expansion and domination through popularisation would have been lost.

Aside from the particular use made of Gramsci's theory of hegemony in this thesis, it is also worth stressing in this conclusion the particular relevance of externalist studies of popularisation in terms of the problem of how elementary science is communicated. For example, Whitley's main contribution to an analysis of the style of communication adopted by popularisers is to state that:

> "The more removed the context of research is from the context of reception in terms of language, intellectual prestige and skill levels, the easier it is for scientists to present their work as certain, decontextualised from the conditions of its production, and authoritative."(13)

This statement is undoubtedly true, but, as this thesis has shown, the motivation for members of the scientific community to popularise is far more complex than this statement would suggest. Moreover, Whitley does not even consider the various reasons why people might wish to have access to popularised science, other than for vocational purposes. And this is another weakness inherent in internalist models of popularisation, since external factors such as social stratification are an important consideration in this sphere,as the work of Altick and Hoggart has indicated (14), and as this thesis has verified in the context of audiences for popular science books. Further, as even the largely morphological use of genres by the present writer has indicated, scientific information can be sought for reference, as a recreational pursuit, or as a serious hobby, for a good read, or for the fun of following an argument for argument's sake; and science does not have to be presented as certain and decontextualised to fulfil many of these purposes.

Finally, it would seem from this discussion that externalist approaches are highly pertinent to any analysis of science popularisation, and more use should, therefore, be made of them. Further, Gramsci's theory of hegemony is particularly appropriate for such studies, bringing, as it does, fresh insights and new perspectives to the history of science.

3 - The contemporary relevance of the study.

The insights which have been drawn from this 'externalist' study of three 'periods' of time, are pertinent to the issues surrounding popularisation today.For, one of the most striking products of this study is the extent to which ideological beliefs play a role in the images of science which the scientific community present to the public. It may of course be argued that this is 'interference' which will always happen in a communicative process which relies on discursive, metaphorical explanations of 'pure' science. That it is, in effect, a weakness inherent in popularisation. On the other

hand, it may simply be that the popularisation process exaggerates the ideological beliefs which are part of the pursuit of science as an activity which is culturally interactive. Whichever view is taken, however, this analysis has serious implications for the recent campaign to promote the public understanding of science spearheaded by the Royal Society.(15) For the campaign promotes the idea that the exposition of knowledge can help resolve social differences about health or diet, manufacturing methods, or issues such as nuclear power and 'acid' rain, on the rationale that such differences stem from lack of information, ignorance or the misapplication of the appropriate rules. As H.Collins has recently suggested, however, the promotion of 'public understanding' in terms of factual statements about controversial issues would not help, since 'experts' themselves disagree about this type of issue, indicating that knowledge in itself is no arbiter.(16) Furthermore,it would seem, from studying the popularisation of public science during a span of time when a range of sciences were of public interest, both controversial and 'ordinary'(17), that the creation of public understanding is never a straightforward and neutral process of factual dissemination. Rather, because any exposition is value-laden, carrying the populariser's political and social opinions and beliefs, it will, therefore, appeal to some sections of society but not to others. Thus, the concept of 'public understanding' being promoted by the Royal Society would seem to be doomed to failure as a panacea for a scientific community bothered by underfunding and a lack of political sympathy. For, as this thesis has indicated, popularisation is part of an hegemonic process which tends, if anything, to accentuate basic ideological conflicts within society.

Footnotes.

1 - P.Collins, 'The British Association as public apologist for science, 1919-1946', in, R.MacLeod and P.Collins, The parliament of science, Northwood, 1981, pp.215-6.

2 - In fact, a relatively high proportion of studies in popularisation deal with the relations between the scientific research community and popularisation. For example, over half the essays in Sociology of the sciences yearbook, 1985, 9, which is devoted to the forms and functions of popularisation consider this relationship.

3 - R.Whitley, 'Knowledge producers and knowledge acquirers: Popularisation as a relation between scientific fields and their publics', in, Sociology of the sciences yearbook, 1985, 9, pp.3-28, p.17.

4 - A.Gramsci, Selections from the prison notebooks, London, 1971, p.425.

5 - Ibid., p.423.

6 - For example, see K.Bayertz, 'Spreading the spirit of science: Social determinants of the popularisation of science in nineteenth-century Germany', in, Sociology of the sciences yearbook, 1985, 9, pp.209-29.

7 - B.J.Norton, 'Biology and philosophy: The methodological foundations of biometry', in, Journal of the history of biology, 1975, 8, pp.85-93.

8 - G.R.Searle, Eugenics and politics in Britain, 1900-1914, Leyden, 1976.

9 - D.Mackenzie, 'Karl Pearson and the professional middle-class'in, Annals of science, 1979, 36, pp.125-43.

10 - Op. cit. (4), pp.5-23.

11 - For example, see S.Sheets-Pyenson, Low scientific culture in London and Paris, 1820-1875, University of Pennsylvania Ph.D. thesis, 1976, pp.14-17.

12 - Op. cit. (3), pp.24-5.

13 - Ibid., p.13.

14 - R.Altick, The English common reader, London, 1957.
R.Hoggart, The uses of literacy, London, 1957.

15 - See Royal Society publications, such as:
W.Bodmer, The public understanding of science, London, 1986. Also the annual publication, Science and public affairs, 1986 - .

16 - H.Collins, 'Certainty and the public understanding of science: Science on television', in, Social studies of science, 1987, 17, pp.689-715, p.691.

17 - Collins takes "ordinary consensual science" to mean science in which no decisions concerning competing technical claims have to be made.
Ibid., p.691.

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Abbreviations:

K.P.T.T. and Co. - Kegan Paul, Trench, Trubner and Co.

S.P.C.K. - Society for the Promotion of Christian Knowledge.

C.K.S. - Christian Knowledge Society.

R.T.S. - Religious Tract Society.

PRIMARY SOURCES

(A) Archival sources

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Ealing Microscopical Society reports etc., 1877-1917 (Ealing Public Library).

G.Henslow botanical papers (Ealing Public Library).

John Tyndall papers (Royal Institution Library).

John Lubbock papers (British Museum manuscript collection).

Nelson archive (University of Edinburgh).

T.C. and E.C. Jack papers (University of Edinburgh).

Routledge and Kegan Paul archive (University College, London).

Other enquiries for archive sources proved unsuccessful, see chapter one, note (33).

(B) Critical bibliography of Series of Books, in chronological order.

1) L.REEVE AND CO.'S SERIES OF NATURAL HISTORY FOR BEGINNERS (1866+)

Publisher: L.Reeve and Co.

Editor(s): Unknown.

Price: 10s.6d.

Format: 8vo.

Stylistic features: Handbooks, with many black and white engraved illustrations.

Contributors: There are no standard biographies for any of the contributors.

Audience: Reasonably wealthy natural history enthusiast.

Examples of texts in series:

E.C.Rye, Beetles, 1866.
E.F.Staveley, Spiders, 1866.
H.T.Stainton, British butterflies and moths, 1867.
E.F.Staveley, British insects, 1871.
C.P.Hobkirk, A synopsis of British mosses, 1884.

Number of published titles: 13 vols. by 1900.

2) INTERNATIONAL SCIENTIFIC SERIES (1871-1911)

Publisher: H.S.King until 1876 when Kegan Paul assumed publishing responsibility.

Editor(s): E.Youmans until c.1880 when Alfred Trench assumed editorial control.

Price: 5s.

Format: 8vo.

Stylistic features: Information presented through 'scholarly' monographs.

Contributors: The majority of authors were high status practitioners of science. British contributions in the 1870s and 80s were dominated by the 'young guard' of science.

Audience: Participants in 'low' and 'high' scientific culture, and the well-educated middle-class general reader.

Examples of texts in series:

J.Tyndall, Forms of water, 1871.
B.Stewart, The conservation of energy, 1872.
H.Spencer, The study of sociology, 1873.
N.Lockyer, Studies in spectrum analysis, 1878.
T.H.Huxley, The crayfish, 1880.

Number of published titles: 98 vols.

3) MACMILLAN'S SCIENCE PRIMERS (1872+)

Publisher: Macmillan.

Editor(s): T.H.Huxley, H.E.Roscoe and B.Stewart.

Price: 1s.

Format: 18mo.

Stylistic features: Text-books using the heuristic educational method.

Contributors: Largely the 'young guard' of science.

Audience: Schoolchildren, and various working-class audiences.

Examples of texts in series:

A.Geikie, Geology, 1872.
N.Lockyer, Astronomy, 1872.
H.E.Roscoe, Chemistry, 1872.
B.Stewart, Physics, 1872.
T.H.Huxley, Introductory, 1880.

Number of published titles: 11 vols. by 1900.

4) NATURE SERIES (1873+)

Publisher: Macmillan.

Editor(s): Probably N.Lockyer, as he was editor of the parent publication Nature at this time.

Price: (Av.) 3s.6d.

Format: 8vo.

Stylistic features: Information presented through 'scholarly' monographs.

Contributors: Participants in 'high' science, who had written articles on similar topics for the periodical Nature.

Audience: Participants in 'low' and 'high' scientific culture, and the well-educated middle-class general reader.

Examples of texts in series:

G.Forbes, The transit of Venus, 1873.
N.Lockyer, The spectroscope and its application, 1873.
J.Lubbock, On British wild flowers, 1873.
W.Spottiswoode, The polarisation of light, 1874.
A.M.Mayer and C.Barnard, Light, 1878.

Number of published titles: 26 vols. by 1900.

5) MANUALS OF ELEMENTARY SCIENCE (1873+)

Publisher: Christian Knowledge Society.

Editor(s): Unknown.

Price: 1s.

Format: 16^{o}

Stylistic features: Text-books in the traditional, didactic style.

Contributors: Figures with a 'high' scientific status, who were also practising Christians.

Audience: Schoolchildren, and various working-class audiences.

Examples of texts in series:

A.J.Bernays, Chemistry, 1874.
T.G.Bonney, Geology, 1874.
B.H.Bentley, Botany, 1875.
W.H.M.Christie, Astronomy, 1875.

Number of published titles: 5 vols. by 1900.

6) CHAMBERS' ELEMENTARY SCIENCE MANUALS (1875-85)

Publisher: Chambers.

Editor(s): A.Findlater.

Price: (Av.) 1s.

Format: 8vo.

Stylistic features: Text-books in the traditional, didactic style.

Contributors: No standard biographies for most of the contributors.

Audience: Schoolchildren, and various working-class audiences.

Examples of texts in series:

A.Crum Brown, Chemistry, 1875.
A.Findlater, Astronomy, 1875.
A.Findlater, Language, 1875.
J.Cook, Sound, 1877.

Number of published titles: 11 vols.

7) SIMPLE LESSONS FOR HOME USE (1877)

Publisher: E.Stanford.

Editor(s): Unknown.

Price: 3d.

Format: 18mo.

Stylistic features: Text-books employing a paternalistic, didactic style.

Contributors: Authors for the science texts were scientific practitioners, well-known as popularisers.

Audience: Schoolchildren and their working-class parents.

Examples of texts in series:

G.Phillips Bevan, Food, 1877.
J.L.Buckmaster, Cookery, 1877.
G.Henslow, Flowers, 1877.
R.J.Mann, The weather, 1877.
R.A.Proctor, Astronomy, 1877.

Number of published titles: 14 vols.

8) NATURAL HISTORY RAMBLES (1879+)

Publisher: Society for the Promotion of Christian Knowledge.

Editor(s): Unknown.

Price: 2s.6d.

Format: 8vo.

Stylistic features: Romanticised descriptions and anecdotes concerning the flora and fauna likely to be encountered on country walks.

Contributors: 'Low' level participants in natural history, whose enthusiasm was fuelled by natural theology.

Audience: Evangelical readership.

Examples of texts in series:

M.C.Cooke, The woodlands, 1879.
P.M.Duncan, The seashore, 1879.
C.O.Groom Napier, Lakes and rivers, 1879.
D.T.Ansted, In search of minerals, 1880.
M.C.Cooke, Ponds and ditches, 1880.

Number of published titles: 8 vols. by 1900.

9) SOTHERAN'S SERIES OF WORKS IN NATURAL HISTORY AND THE FINE ARTS (1883-4)

Publisher: Sotheran.

Editor(s): Unknown.

Price: (Av.) 63s.

Format: Folio.

Stylistic features: A collection of reference works, lavishly illustrated with colour engravings.

Contributors: Early to mid-Victorian authors acknowledged as authorities in their field.

Audience: Wealthy collectors.

Examples of texts in series:

F.Luthmer, Ornamental jewellery of the Renaissance, 1883.
J.Gould, Birds of Asia, 1884.
J.Gould, Birds of New Guinea and the adjacent islands, 1884.

Number of published titles: 13 vols.

10) KNOWLEDGE LIBRARY (1884-8)

Publisher: Longmans.

Editor(s): R.A.Proctor.

Price: 6s.

Format: 8vo.

Stylistic features: Collections of articles reprinted from the periodical Knowledge.

Contributors: Largely Proctor himself.

Audience: Participants in 'low' scientific culture, and the middle-class general reader.

Texts in series:

G.Allen(ed.), Nature studies, 1884.
R.A.Proctor, Light science for leisure hours, 3 vols., 1884-8.

Number of published titles: 4 vols.

11) NATURAL HISTORY HANDBOOKS FOR COLLECTORS (subtitled, and better known as, YOUNG COLLECTOR SERIES) (1885+)

Publisher: Swan Sonnenschein and Co.

Editor(s): Unknown.

Price: 1s.

Format: 8vo.

Stylistic features: Handbooks giving information related to the fashion for natural history collections.

Contributors: 'High' level participants in natural history.

Audience: 'Low' level participants in natural history, young adults.

Examples of texts in series:

J.E.Bagnall, Handbook of mosses, 1886.
E.A.Butler, Pond life, 1886.
W.H.Bath, Ants, bees, dragonflies..., 1888.
C.Hopley, Reptiles, 1888.

Number of published titles: 28 vols. by 1900.

12) WHITTAKER'S LIBRARY OF ARTS, SCIENCES, MANUFACTURES AND INDUSTRIES (1888+)

Publisher: Whittaker.

Editor(s): Unknown.

Price: (av.) 3s.

Format: 8vo.

Stylistic features: Didactic texts, encouraging a practical understanding of applied science.

Contributors: There are no standard biographies for any of the contributors.

Audience: Skilled artisan and engineering classes.

Examples of texts in series:

S.R.Bottone, Electrical instrument making, 1888.
S.R.Bottone, Electric bells, 1889.
S.F.Walker, Electricity in our homes and workshops, 1889.
Anon., Practical ironfounding, 1889.

Number of published titles: 5 vols. by 1900.

13) CONTEMPORARY SCIENCE SERIES (1889-1914)

Publisher: Walter Scott.

Editor(s): H.Ellis.

Price: (Av.) 3s.6d.

Format: 8vo.

Stylistic features: New, topical 'scientific' theories presented through 'scholarly' monographs.

Contributors: Well-known British and European scholars.

Audience: Well-educated middle-classes.

Examples of texts in series:

P.Geddes and J.A.Thomson, The evolution of sex, 1889.
A.Moll, Hypnotism, 1890.
J.M.Letourneau, The evolution of marriage, 1891.
J.A.Hobson, The evolution of modern capitalism, 1894.

Number of published titles: 37 vols. by 1900.

14) ROMANCE OF SCIENCE SERIES (1889+)

Publisher: Society for the Promotion of Christian Knowledge.

Editor(s): Unknown.

Price: (Av.) 2s.6d.

Format: 8vo.

Stylistic features: Written up popular lecture notes.

Contributors: Participants in 'high' science, who were well-known as popularisers, and who were not part of the 'young guard' of science.

Audience: Middle-class general reader.

Examples of texts in series:

R.S.Ball, Time and tide, 1889.
C.M.Tidy, The story of a tinder-box, 1889.
A.H.Green, The birth and growth of worlds, 1890.
J.Perry, Spinning tops, 1890.

Number of published titles: 9 vols. by 1900.

15) WHITTAKER'S LIBRARY OF POPULAR SCIENCE (1891+)

Publisher: Whittaker.

Editor(s): Unknown.

Price: (Av.) 3s.6d.

Format: 8vo.

Stylistic features: Presentation of knowledge through text-books.

Contributors: Amateur enthusiasts pursuing professional careers in law, trade or engineering.

Audience: Those wishing to learn some elementary science in a formal, structured way.

Examples of texts in series:

G.F.Chambers, Pictorial astronomy, 1891.
G.Massee, Plant world, 1891.
H.T.Wood, Light, 1891.
F.H.Hatch, Mineralogy, 1892.
S.R.Bottone, Electricity and magnetism, 1893.

Number of published titles: 5 vols. by 1900.

16) MODERN SCIENCE (1891+)

Publisher: Kegan Paul.

Editor: J.Lubbock.

Price: 2s.6d.

Format: 8vo.

Stylistic features: Factual exposition of scientific theories, probably based on popular lecture notes.

Contributors: Participants in 'high' science.

Audience: Middle-class general reader.

Examples of texts in series:

W.H.Flower, The horse, 1891.
G.L.Gomme, Ethnology in folk-lore, 1891.
R.S.Ball, The cause of an ice age, 1892.
H.M.Ward, The oak, 1892.
R.T.Glazebrook, Laws and properties of matter, 1893.

Number of published titles: 5 vols. by 1900.

17) FUR, FEATHER AND FIN SERIES (1893+)

Publisher: Longmans.

Editor(s): A.E.T.Watson.

Price: 5s.

Format: 8vo.

Stylistic features: Each text was divided into three sections, dealing respectively with the natural history, hunting techniques and cookery methods relevant to individual types of game.

Contributors: The amateur enthusiast, H.A.MacPherson wrote all the natural history sections.

Audience: The gaming fraternity.

Examples of texts in series:

H.A.MacPherson et al, The partridge, 1893.
" , The pheasant, 1893.
" , The grouse, 1894.
" , The hare, 1896.

Number of published titles: 9 vols. by 1900.

18) ALLEN'S NATURALIST'S LIBRARY (1894-7)

Publisher: Allen.

Editor(s): R.B.Sharpe.

Price: 6s.

Format: 8vo.

Stylistic features: Handbooks for use in the field.

Contributors: 'High' level participants in natural history.

Audience: 'Low' level participants in natural history.

Examples of texts in series:

R.B.Sharpe, Birds of Great Britain, 2 vols., 1894.
R.Lydekker, British mammalia, 1895.
W.R.O.Grant, Game birds, 2 vols., 1895, 97.

Number of published titles: 8 vols.

19) HUTCHINSON'S CONCISE KNOWLEDGE LIBRARY (1897+)

Publisher: Hutchinson.

Editor(s): Unknown.

Price: 5s.

Format: 8vo.

Stylistic features: Reference works.

Contributors: Participants in 'high' level science.

Audience: Participants in 'low' scientific culture.

Examples of texts in series:

R.Lydekker, Hutchinson's concise natural history, 1897.
A.M.Clerke et al, Hutchinson's concise astronomy, 1898.

Number of published titles: 3 vols. by 1900.

20) PROGRESSIVE SCIENCE SERIES (1897+)

Publisher: Murray.

Editor(s): F.E.Beddard.

Price: 6s.

Format: 8vo.

Stylistic features: Presentation ranged from the scholastic to a journalistic type of synopsis of the subject.

Contributors: High status practitioners of science.

Audience: Well-educated middle-class general reader.

Examples of texts in series:

A.C.Haddon, The study of man, 1898.
St. George Mivart, Groundwork of science, 1898.
T.G.Bonney, Volcanoes, 1899.
J.A.Thomson, Heredity, 1908.

Number of published titles: 12 vols. by 1900.

21) LIBRARY OF USEFUL STORIES (1897+)

Publisher: Newnes.

Editor(s): Unknown.

Price: 1s.

Format: 8vo.

Stylistic features: Presentation ranged from the scholastic to a journalistic type of synopsis of the subject.

Contributors: Authors of science texts ranged from the amateur enthusiast to the professional academic.

Audience: Lower middle-classes.

Examples of texts in series:

G.F.Chambers, The stars, 1897.
M.M.Pattison Muir, The wanderings of atoms, 1898.
H.W.Conn, Germ life, 1899.
G.Henslow, Wild flowers, 1901.

Number of published titles: 51 vols. by 1905.

22) MURRAY'S HOME AND SCHOOL LIBRARY (1901-13)

Publisher: Murray.

Editor(s): Laurie Magnus.

Price: (Av.) 2s.

Format: 8vo.

Stylistic features: Presentation ranged from text-books to subjective exposition of natural history.

Contributors: Amateur enthusiasts, and members of the teaching profession.

Audience: Schoolchildren, and general reader.

Examples of texts in series:

E.M.Langley, Algebra, 1901.
J.H.Leonard, Practical science, 1901.
J.Lubbock, History of coins and currency, 1901.
C.T.Ovenden, The face of nature, 1902.

Number of published titles: 20 vols.

23) WOBURN LIBRARY OF NATURAL HISTORY (1902+)

Publisher: Hutchinson.

Editor: Duke of Bedford.(H.A.Russell)

Price: 12s.6d.

Format: 8vo.

Stylistic features: Romanticised presentation of flora and fauna, using coloured engravings.

Contributors: F.E.Hulme was an amateur enthusiast who earnt his living by writing about nature and architecture.

Audience: The books were probably bought for display and dilettante recreation.

Examples of texts in series:

F.E.Hulme, Wild fruits of the countryside, 1902.
F.E.Hulme, Butterflies and moths of the countryside, 1903.

Number of published titles: Unknown.

24) COUNTRY HANDBOOKS (1903-10)

Publisher: John Lane.

Editor(s): H.Roberts.

Price: 3s.

Format: 8vo.

Stylistic features: Handbooks offering practical information about country pursuits and skills.

Contributors: Amateur enthusiasts.

Audience: Urban middle-classes.

Examples of texts in series:

H.Roberts, The tramp's handbook, 1903.
E.S.Shrubsole, The fisherman's handbook, 1904.
A.I.Shand, The gun room, 1905.
T.F.Dale, The stable handbook, 1907.

Number of published titles: 15 vols.

25) JACK'S SHILLING SCIENTIFIC SERIES (1905+)

Publisher: T.C. and E.C. Jack.

Editor(s): Unknown.

Price: 1s.

Format: 8vo.

Stylistic features: Presentation ranged from journalistic type synopsis to polemics.

Contributors: All authors had a public reputation for expertise in their topics, whether of amateur or professional status. C.W.Saleeby wrote 5 of the books in the series.

Audience: Largely lower middle-classes.

Examples of texts in series:

G.Bacon, Balloons, airships and flying machines, 1905.
C.W.Saleeby, Heredity, 1905.
C.W.Saleeby, Organic evolution, 1905.
W.Hampson, Radium, 1905.

Number of published titles: 12 vols. by 1906.

26) HOME UNIVERSITY LIBRARY OF MODERN KNOWLEDGE (1911+)

Publisher: Williams and Norgate.

Editor(s): H.Fisher, G.Murray and J.A.Thomson.

Price: (Av.) 2s.

Format: 12mo.

Stylistic features: Ranged from text-books to journalistic type synopsis.

Contributors: Science texts were written by scientists with academic positions. The leading contributor was J.A.Thomson, who was also the science editor.

Audience: Middle-class general reader.

Examples of texts in series:

P.Geddes and J.A.Thomson, Evolution, 1911.
A.R.Hinks, Astronomy, 1911.
A.N.Whitehead, Introduction to mathematics, 1911.
A.M.Carr Saunders, Eugenics, 1926.

Number of published titles: 139 vols. by 1914.

27) PEOPLE'S BOOKS (1912-22)

Publisher: T.C. and E.C. Jack.

Editor(s): H.C.O'Neill.

Price: 6d.

Format: 12mo.

Stylistic features: Ranged from text-books to journalistic type synopsis.

Contributors: Science texts were written by scientists with academic pos positions, of whom many were drawn from Scottish universities.

Audience: Largely the lower middle-classes.

Examples of texts in series:

N.R.Campbell, The principles of electricity, 1912.
G.Leighton, Embryology, 1912.
E.W.Maunder, The science of the stars, 1912.
W.C.D.Whetham, The foundations of science, 1912.

Number of published titles: 152 vols.

28) POPULAR SCIENCE (1912-13)

Publisher: Amalgamated Press.

Editor(s): A.Mee.

Price: 6d.

Format: 8° weekly parts which were collected into 8vo. bound volumes.

Stylistic features: Ranged from the synopsis to the polemic. All the copy was kept 'punchy' through Mee's editorial control.

Contributors: Scientists with academic positions, many of whom were drawn from Scottish universities and who also contributed to the 'People's Books'.

Audience: Largely lower middle-classes.

Number of published vols: 7 ('Popular Science' was a Harmondsworth serial).

29) HUTCHINSON'S NATURE LIBRARY (1912+)

Publisher: Hutchinson.

Editor(s): Unknown.

Price: 6s.

Format: 8vo.

Stylistic features: Well illustrated, romanticised narrations of animal life.

Contributors: Amateur enthusiasts.

Audience: Unsophisticated, recreational readership.

Examples of texts in series:

W.P.Pycraft, The infancy of animals, 1912.
F.Finn, Bird behaviour, 1919.
E.Step, Insect artisans and their work, 1919.

Number of published titles: 5 vols. by 1919.

30) TODAY AND TOMORROW SERIES (1924+)

Publisher: Kegan Paul, Trench, Trubner and Co.

Editor(s): C.K.Ogden.

Price: 2s.6d.

Format: 8vo.

Stylistic features: Polemical essays.

Contributors: Mainly authors educated at Oxford and Cambridge, who were acquaintances of Ogden.

Audience: Middle-class general reader.

Examples of texts in series:

J.B.S.Haldane, Daedalus, 1923.
B.Russell, Icarus, 1924.
J.W.N.Sullivan, Gallio, 1927.

Number of published titles: 85 vols. by 1932.

31) FORUM SERIES (1926+)

Publisher: Watts and Co.

Editor(s): Unknown.

Price: 1s.

Format: 8vo.

Stylistic features: Polemical essays.

Contributors: Well-known scientific figures.

Audience: Middle-class general reader.

Examples of texts in series:

J.S.Huxley, The stream of life, 1926.
W.Bragg, Craftsmanship and science, 1928.
L.Darwin, What is eugenics?, 1928.
A.Keith, Darwinism and what it implies, 1928.

Number of published titles: 10 vols. by 1928.

32) BENN'S SIXPENNY LIBRARY (1927+)

Publisher: E.Benn.

Editor(s): W.Rose.

Price: 6d.

Format: 8vo.

Stylistic features: 'Pure' factual exposition.

Contributors: Scholars and writers, the majority being academically qualified in their subject.

Audience: General reader.

Examples of texts in series:

E.N. da C.Andrade, The atom, 1927.
G.Forbes, The earth, the sun and the moon, 1927.
A.Holmes, The age of the earth, 1927.
E.MacBride, Evolution, 1928.

Number of published titles: 46 vols. by 1928.

33) SIXPENNY SELF-HELP LIBRARY (1929-30)

Publisher: Macmillan.

Editor(s): T.H.Campbell Howes.

Price: 6d.

Format: 8vo.

Stylistic features: Exposition of practical applications of knowledge.

Contributors: 'Experts' in their field, having professional status.

Audience: General reader.

Examples of texts in series:

P.Harris, The wireless listener's guidebook, 1929.
Mrs.R.Noble, Labour saving in the home, 1929.
F.Howard Humphris, Ultra violet and other rays, 1930.

Number of published titles: 10 vols.

34) INTRODUCTIONS TO MODERN KNOWLEDGE (1929+)

Publisher: Routledge.

Editor(s): F.B.Kirkman.

Price: 6d.

Format: 8vo.

Stylistic features: Presentation ranged from 'pure' theoretical exposition to discursive explanations of the practical utility of the subject.

Contributors: Authors of the science texts were academically qualified in their subject.

Audience: General reader.

Examples of texts in series:

N.Baynes, Europe throughout the ages, 1929.
J.H.Driberg, The savage as he really is, 1929.
L.H.Dudley Buxton, From monkey to man, 1929.
S.Isaacs, The nursery years, 1929.

Number of published titles: 19 vols. by 1930.

35) OUTLINE LIBRARY (1929+)

Publisher: Newnes.

Editor(s): Unknown.

Price: 2s.6d.

Format: 8vo.

Stylistic features: Irreverent exposition of topical philosophical issues.

Contributors: Many of the texts were written by Walter Grierson, sometimes using the pseudonym 'The Listener', or 'The Skeptical Layman'. He was a journalist who worked for The Times.

Audience: Middle-class general reader.

Examples of texts in series:

J.A.Thomson, What the world is made of, 1929.
W.Grierson, The conclusions of modern science, 1930.
The Listener, Talks with the professor, 1930.
J.W.N.Sullivan, Present-day astronomy, 1930.

Number of published volumes: 9 vols. by 1930.

36) BASIC SCIENCE LIBRARY (1934+)

Publisher: Kegan Paul, Trench, Trubner and Co.

Editor(s): C.K.Ogden.

Price: 2s.6d.

Format: 18mo.

Stylistic features: 'Pure' exposition of scientific theories in Basic English.

Contributors: Friends and acquaintances of C.K.Ogden with scientific knowledge.

Audience: General reader.

Examples of texts in series:

S.L.Salzedo, A basic astronomy, 1934.
P.M.Rossiter, Basic for geology, 1937.

Number of published titles: 5 vols. by 1940.

37) LIBRARY OF SCIENCE AND CULTURE (1934+)

Publisher: Watts and Co.

Editor(s): H.Levy.

Price: 7s.6d.

Format: 8vo.

Stylistic features: Conversational and/or philosophical discussion of cultural issues surrounding science.

Contributors: Authors qualified in a science specialism, with a general interest in cultural issues.

Audience: Well-educated middle-class reader.

Examples of texts in series:

J.Huxley, Scientific research and social needs, 1934.
H.Levy, The web of thought and action, 1934.
D.Forsyth, Psychology and religion, 1935.
W.Gordon Childe, Man makes himself, 1936.

Number of published titles: 5 vols. by 1936.

38) PRIMERS FOR THE AGE OF PLENTY (1936+)

Publisher: Allen and Unwin.

Editor(s): L.Hogben.

Price: 12s.6d.

Format: 9" by 6".

Stylistic features: Text-book presentation incorporating a variety of styles.

Contributors: L.Hogben wrote the science texts.

Audience: General reader.

Examples of texts in series:

L.Hogben, Mathematics for the million, 1936.
L.Hogben, Science for the citizen, 1938.

Number of published titles: 4 vols. by 1940.

39) PELICANS (1937+) (Those with a scientific content).

Publisher: Allen Lane.

Editor(s): The science editor was Sir Peter Chalmers Mitchell.

Price: 6d.

Format: 8vo.

Stylistic features: Republication in paperback of previously successful popular science books.

Contributors: Popularisers previously successful in print, like J.H.Jeans and J.S.Huxley.

Audience: Lower middle-classes.

Examples of texts in series:

J.H.Jeans, The mysterious universe, 1937.
J.S.Huxley, Essays of a biologist, 1937.

Number of published titles: 15 science vols. by 1940.

(C) Books and periodicals studied as primary sources.

Unless otherwise stated, place of publication is London. If a book is part of a series this will be indicated in brackets at the end of the entry.

Adams, J., Educational theories, Benn, 1928. (Benn's Sixpenny Library).

Adams, M.(ed.), Science in a changing world, Allen and Unwin, 1933.

Allen, G., Nature studies, Wyman and Sons, 1884. (Knowledge Library).

Allen, G., The story of the plants, Newnes, 1899. (Library of Useful Stories).

Andrade, E.N. da C., The atom, Benn, 1927, (Benn's Sixpenny Library).

Andrade, E.N. da C., The mechanism of nature, G.Bell and Sons, 1930.

Andrade, E.N. da C., Simple science, 3rd edn., Oxford, Blackwell, 1936; first published 1934.

Angell, J., Animal physiology, Collins, 1874. (Collins' Science Series).

Angell, J., Magnetism and electricity, Collins, 1875. (Collins' Science Series).

Anon., Half-hours underground, Nisbet and Co., 1900. (The Half-Hour Library).

Anon., Man's helpers, Bell, 1911. (Animal Life Readers).

Anon., Medicine for the million. A medical handbook containing all the information required for ordinary purposes, Simpkin, Marshall, Hamilton, Kent and Co., 1906.

Anon., Practical ironfounding, Whittaker, 1889. (Whittaker's Library of Arts, Sciences, Manufactures and Industries).

Ansted, D.T., In search of minerals, S.P.C.K., 1880. (Natural History Rambles).

Ash, E.L., Pond life, London and Einburgh, Jack, 1913. (People's Books).

Ayling, J., The retreat from parenthood, K.P.T.T. and Co., 1930.

Bacon, G., Balloons, airships and flying, London and Edinburgh, Jack, 1905. (Shilling Scientific Series).

Bagnall, J.E., Handbook of mosses, Sonnenschein, 1886. (Young Collector Series).

Ball, R.S., The story of the heavens, Cassell, 1885.

Ball, R.S., Time and tide, a romance of the moon, S.P.C.K., 1889. (Romance of Science Series).

Ball, R.S., The cause of an ice age, 2nd edn., Routledge and Kegan Paul, 1892 1892; first published 1891. (Modern Science Series).

Ball, R.S., In the high heavens, 3rd edn., Pitman, 1907; first published 1893.

Ball, R.S., A popular guide to the heavens, 4th edn., G.Philip and Son, 1925; first published in 1905.

Baly, E.C.C., Inorganic chemistry, London and Edinburgh, Jack, 1912. (People's Books).

Barrett, W.F., Psychical research, Williams and Norgate, 1911. (Home University Library of Modern Knowledge).

Barry, W., The papacy and modern times, Williams and Norgate, 1911. (Home University Library of Modern Knowledge).

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