The landed estate as patron of scientific innovation: Horticulture at Woburn Abbey, 1802-1839

Thesis

How to cite:

For guidance on citations see FAQs.

© 1983 The Author

https://creativecommons.org/licenses/by-nc-nd/4.0/

Version: Version of Record

Link(s) to article on publisher’s website:
http://dx.doi.org/doi:10.21954/ou.ro.0000de25

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online’s data policy on reuse of materials please consult the policies page.

oro.open.ac.uk
The landed estate as patron of scientific

A thesis submitted to the Open University, Faculty
of Arts, Department of History of Science and
Technology, for the degree of Doctor of Philosophy.

by


January 1983

Authors no: HDG 60153
Date of submission: JAN 1983
Date of award: 11-4-83
BEST COPY

AVAILABLE

Variable print quality
## Contents

Abstract
Dedication
Statement of originality
Availability for consultation
Acknowledgements
Note on abbreviations

### Chapter One - Horticultural science, 1790-1840

1.1 Horticulture defined
1.2 Experimental horticulture
1.3 Some major developments of scientific gardening, 1790-1840

### Chapter Two - The social framework of horticultural science

2.1 Aristocratic interest
2.2 Agricultural communication channels
2.3 Horticultural botany
2.4 The horticultural interest of some general scientific societies
2.5 The emergence of specialist horticultural societies
2.6 Self improvement and useful horticulture
2.7 Horticulture, colonies and overseas trade

### Chapter Three - Experimentation and innovation at Woburn Abbey, 1802 to 1824

3.1 The sixth Duke of Bedford and Woburn Abbey
3.2 Robert Salmon and aboricultural science
3.3 George Sinclair, scientific gardener
3.4 George Sinclair's horticultural chemistry
3.5 George Sinclair's botanical science
   3.5.1 Research on grasses
   3.5.2 Research on heaths

Chapter Four - Investigation and experimentation at Woburn Abbey, 1825 to 1839

4.1 James Forbes and aboricultural science
4.2 The Duke's flower, greenhouse and fruit collections
4.3 The Woburn glass-houses

Chapter Five - Woburn's network of communication and the scope of its influence

5.1 Correspondents
5.2 The local and national impact of the research at Woburn
5.3 The sixth Duke's social and political influence

Chapter Six - Conclusion

Bibliography
Abstract

This thesis is concerned with the horticultural activities that took place in the early nineteenth century at Woburn Abbey, the stately home of John Russell, sixth Duke of Bedford (1766-1839). During the sixth Duke's reign the work undertaken at Woburn involved more than simply raising fruits and vegetables for the table and landscaping the grounds, creating different kinds of garden and cultivating trees, shrubs and flowers in order to provide pleasant vistas. Bedford was an important patron of scientific horticulture and the Abbey was a centre for innovative and experimental gardening. Under the Duke's direction investigations were carried out into various aspects of horticultural science. These enquiries contributed significantly to English scientific gardening during the first half of the nineteenth century.

I shall detail the sixth Duke's patronage of science, discuss his motives and consider the scientific work he inaugurated at Woburn in relation to the wider institutional context of horticulture. Nearly all of the horticultural investigations at the Abbey were conducted by the head gardeners. The different tasks they carried out will be examined. It was their skill and effort which ensured that the Duke's ideas were put into operation. They helped to create and maintain Woburn Abbey's reputation for horticultural excellence, innovation and experiment. There will also be an evaluation of the Duke's
schemes at the Abbey. Besides looking at their effect locally, their influence nationally will be appraised.

The sixth Duke of Bedford's great predilection for gardening, the role played by his estate in the development of horticultural science at this time and his efforts to foster the growth of horticulture outside the confines of his stately home make Woburn a particularly useful point from which to explore some of the technical and social aspects of this scantily documented branch of nineteenth-century science.
Dedication

This thesis is dedicated to the memory of my father, who introduced me to the countryside and to gardening, and to my mother, for her love.
Acknowledgements

I would like to thank Professor Colin Russell and his Department for granting me an Open University Studentship. Without this award I would not have been able to undertake research into the history of early nineteenth-century horticultural science.

Lord Tavistock kindly gave me permission to use the papers relating to the sixth Duke of Bedford, George Sinclair, James Forbes and Woburn Abbey. The staff of the following assisted my researches and gave advice: Bedford County Record Office, Bedford Estate Office; British Library Reading Room and Department of Manuscripts, British Museum (Natural History) Department of Botany, Chelsea Physic Garden, County Hall Library Bedford, Devon Record Office, University of Durham Department of Paleography and Diplomatic, Greater London Record Office, Institute of Historical Research (University of London), Library of the Linnean Society, National Library of Scotland, National Register of Archives (Scotland), Public Record Office Kew, Public Record Office of Northern Ireland, Institute of Agricultural History and Museum of Rural Life University of Reading, Library of the Royal Botanic Gardens Kew, Lindley Library of the Royal Horticultural Society, Library of the Royal Institution, Library of the Royal Society, Library of the Royal Society of Arts, University College of London Library and the Library of the Wellcome Institute for the History of Medicine.

Gavin Bridson of the Linnean Society, Mrs M. Draper of the
Bedford Estate Office, Dr John Harvey, Guy Meynell, Robert Napthine of County Hall Library Bedford, Dr Charles Nelson of the Department of Agriculture National Botanic Gardens Dublin and Mr Robert Thorne of the Department of Architecture and Civic Design Greater London Council were particularly helpful. Dr G.E. Fussell was kind, hospitable and supplied encouragement. Irene Smith, the Archivist of the Library of the Royal Botanic Gardens Kew, was marvellously warm and supportive. Lavinia Wellicome, Librarian/Curator at Woburn Abbey, gave much assistance and showed great understanding. Mr James Collett-White at the Bedford County Record Office supplied an infectious enthusiasm.

Mrs Pat Dixon interpreted my handwriting, typed the script and provided cheer. Lastly, and most importantly, my supervisors Dr Gerrylynn Roberts and Dr Vance Hall unfailingly provided encouragement and constructive criticism. When there were changes in their domestic and working life they both carried out their duties with good humour. Without Dr Hall's faith in the idea this thesis would not have received support. Dr Roberts, single handed, guided the chapters through their final stages.
Note on abbreviations

The following abbreviations, arranged alphabetically, are used in the footnotes:

Adam Corr. Correspondence and papers of W.G. Adam 1816-1839.
Adam Pps. Papers of W. Adam 1804-1816.
Agric. Hist. Rev. The Agricultural History Review.
B.C.R.O. Bedford County Record Office.
B.M.N.H. British Museum of Natural History.
Fmr's. Mag. The British Farmers Magazine.
B.V. Bedford Estate Vouchers.
Crocker Pps. Papers of Edward Crocker.
Flor. Cab. The Floricultural Cabinet.
Gdnr's And For's. Rec. The Gardener's and Forester's Record.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.L.R.O.</td>
<td>Greater London Record Office.</td>
</tr>
<tr>
<td>Haedy Corr.</td>
<td>Correspondence of Christopher Haedy.</td>
</tr>
<tr>
<td>Hort. Reg.</td>
<td>The Horticultural Register.</td>
</tr>
<tr>
<td>H.V.</td>
<td>Household vouchers of Woburn Abbey.</td>
</tr>
<tr>
<td>Irish Corr.</td>
<td>Copy of letters written when the sixth Duke of Bedford was Lord Lieutenant of Ireland, March 30 1806 to April 20 1807; Vols. A-D.</td>
</tr>
<tr>
<td>Irish Fm. and Gard. Mag.</td>
<td>The Irish Farmer's and Gardener's Magazine and Register of Rural Affairs.</td>
</tr>
<tr>
<td>Lib. Linn. Soc.</td>
<td>The Library of the Linnean Society.</td>
</tr>
<tr>
<td>P.R.O., Belfast.</td>
<td>Public Records Office, Northern Ireland.</td>
</tr>
<tr>
<td>R.I.A.</td>
<td>Archives of the Royal Institution.</td>
</tr>
</tbody>
</table>
R.V. Russell Vouchers.
Salmon Pps. Papers of Robert Salmon.
Trans. Linn. Soc. Transactions of the Linnean Society.
Trans. R. Soc. Arts. Transactions of the Royal Society of Arts, Manufactures and Commerce.
Chapter One - Horticultural Science, 1790-1840

In order to place the activities at Woburn Abbey in context it is necessary to survey the development of horticultural science generally during the first forty years of the nineteenth century. Moreover, to make clear what the sixth Duke and his contemporaries regarded as horticultural experiment I shall consider certain terms in common usage. To begin, I want to make a distinction between horticulture and agriculture and to indicate some of the main branches of early nineteenth-century gardening.

1.1 Horticulture defined

The first edition of Encyclopaedia Britannica, published in 1771, defined gardening as, '... a branch of agriculture, containing the cultivation of gardens'. 1 Patrick Neill (1776-1851), the horticultural commentator, Secretary of the Caledonian Horticultural Society and Vice-President of the Botanic Society of Edinburgh, in his survey of British horticulture drawn up for the Edinburgh Encyclopaedia and published independently in 1817, wrote of it as an entirely separate entity. He regarded gardening as, '... the management of a garden, whether intended for the production of fruit, of culinary vegetables or of flowers'. 2 In a later work, published in 1838, Neill described horticulture as:


'... That branch of rural economy which consists in the formation and culture of gardens. Its results are culinary vegetables, fruits and flowers. On one side it is allied to agriculture, from which, however, it is distinguished by the nature of its products and by the smaller extent and greater complexity of its operations; on the other side, in its processes of embellishment, it approaches the arts of the Landscape Artist and the Forester; from which, however, it also retires in the comparative minuteness of its details.'

Clearly, horticulture was intensive cultivation on a relatively small scale and the gardener was required to carry out a fair number of activities and to pay great attention to detail.

Farming, on the other hand, was much more extensive. Between 1771 and 1838 gardening came to be regarded as a distinct activity and was no longer viewed as a sub-branch of agriculture. By the first quarter of the nineteenth century its own definite sub-branches had emerged. John Claudius Loudon (1783-1843), horticultural authority, author, editor and observer, in his standard work, An encyclopaedia of gardening, (1822) treated floriculture, pomology and aboriculture as notable divisions. Loudon also devoted sections in his encyclopaedia to the discussion of landscape gardening and to glass-house culture. Thus, it can be seen that gardening in the early nineteenth century embraced the cultivation of flowers, fruit, vegetables, shrubs and trees, either out of doors or under glass, and the design and laying out of gardens. The care of lawns should also be included in this list. Horticulture by the second quarter


of the century had become an important subject in its own right. In certain areas, particularly near or within easy reach of large towns, it was an important commercial activity. For some contemporaries, most notably Sir John Sinclair (1754-1835), President of the Board of Agriculture, it was almost equal in importance as an occupation to farming.

Many writers at this time regarded the terms 'gardening' and 'horticulture' as interchangeable. A number of horticulture's practitioners, influential journalists and compilers of text books considered it as a science-based endeavour. A few actually believed the subject was a distinct branch of the sciences. One of the first both to call horticulture specifically a science and to write extensively about gardening as a scientific activity was Loudon. His impressively comprehensive, An encyclopaedia of gardening contained a large section devoted to, 'Gardening as a science'.

Charles Macintosh (1794-1864), respected gardening writer and horticulturist to the Duke of Buccleugh at Dalkeith Palace, Scotland, remarked with a certain amount of justification and with untypical exaggeration in 1828 that, 'horticulture has within these few years, made more rapid advances towards perfection, than perhaps any other science'.


John Lindley (1799-1865), Assistant Secretary of the Horticultural Society of London and Professor of Botany at University College, in his, An outline of the first principles of horticulture (1832) used, '... the science of horticulture ...' to explain the rationale behind certain practical operations. Lindley continued to develop this theme and in 1840 produced a book, '... aimed at the intelligent gardener and the scientific amateur ...' in which the main operations of gardening were explained, '... upon physiological principles'. Although for Lindley plant physiology and taxonomy were the bedrock of horticultural science, he also believed that chemistry was of vital importance and that electricity was significant.

The comments made by contemporaries about the knowledge that was needed for gardeners to be able to carry out their work competently can be useful indicators of the development of horticulture as a science. Towards the end of the eighteenth century Walter Nicol (d. 1811), head gardener at Wemy's Castle, Fife shire, Secretary of the Caledonian Horticultural Society and writer of sound gardening books, instructed his apprentices in, amongst other things, botany, writing, arithmetic, geometry.


11. Ibid., p. VII.
and mensuration. Patrick Neill wrote in his survey of British horticulture that he believed a gardener should have an understanding of chemistry and of vegetable physiology. In 1836 student-gardeners of the Horticultural Society of London, most probably at the instigation of John Lindley, had to pass an examination at the end of their course if they wanted to be recommended for employment. Successful candidates were awarded graded certificates. The syllabus covered English, mathematics, geography, botany and plant physiology. As far as I can ascertain, chemistry was not treated as a distinct subject at the Horticultural Society of London. But, it does seem possible that some knowledge of chemistry was required for the section of the course devoted to the physiology of plants. Lindley, at this time, was an influential officer of the Society and also its examiner. Some of his books on botany utilised the results of chemical investigations and, as I have mentioned earlier, he regarded chemistry as a subject which could be of value to horticulture.

The foregoing indicates how complex horticulture was becoming by 1840 and how well-informed gardeners were expected to be. The more skilful horticulturists and textbook writers were using

13. Ibid., p. 181.
15. For example, see Lindley, (n. 9) and (n. 10), p. VII.
knowledge from many scientific subject areas. In a book designed to instruct young gardeners, published just after the end of our period, Loudon made it clear that he required trainees to be proficient in the following: arithmetic, bookkeeping, geometry, mensuration, practical trigonometry, mechanics, hydrostatics, hydraulics, land surveying, levelling, planning, mapping, architectural drawing, isometrical projection (three dimensional drawings) and perspective, the geography of natural history, geology, meteorology, chemistry and physiology. He demanded such extensive learning because gardeners on estates sometimes became foresters, bailiffs and stewards and he wanted to make sure they could meet the various requirements of these different positions.

Historians of science have detailed a number of developments that occurred in certain of the areas listed in Loudon's extremely comprehensive and ambitious syllabus. It appears that meteorology, climatology and plant geography were evolving as scientific subjects. Geology had become a distinct discipline. There was a re-vitalised interest in plant taxonomy, morphology and physiology, efforts were made to diffuse analytical mathematics, there were attempts to utilise chemistry in the examination of plants, soils and manures.


17. Ibid., p. 1.
and great emphasis was placed on careful observation, rigorous collection of data and accurate measurement. These historians have also indicated that contemporaries realised that in order to understand their own chosen subject fully, it was necessary to capitalise on knowledge gained in related areas. Thus, Loudon's checklist is as much a reflection on the growth that had occurred in British science generally at this time as it was a comment on what progressive scientific horticulturists regarded as a more than satisfactory state of affairs.

1.2 Experimental horticulture

So that the scientific work at Woburn Abbey can be evaluated, it is necessary to have some idea of what the sixth Duke of Bedford meant by 'experiment' when he promoted various courses of action.

When the Duke applied the term to horticulture he used it in a very general sense. As well as demonstrating that this term embraced a wide range of activities I also want to indicate some of the skills that were needed to carry out such work. For example, when the Duke wanted to test the efficacy of various manures for farm and garden crops at the Abbey, the experimental work consisted of growing plants on small equal-sized strips of land, applying measured dressings of manure, recording the vigour of the plants during the stages of growth and weighing the harvest. Controls were used and the soil underwent a chemical analysis before planting. Such methods needed care and precision and involved a knowledge of mathematics and chemistry. This contrasts markedly with an experiment undertaken by James Forbes (1773-1861), one of the Woburn head gardeners, which was not so rigorous or as systematic. The Duke required his gardener to find a way of prolonging the season of hardy fruit. Left to his own devices, Forbes undertook some experimental work which involved conducting comparative trials of various materials in order to find the covering that would most effectively slow down the ripening of fruit intended to be served as dessert at the Duke's dinner table. The results

19. Edmund Cartwright, 'An experimental essay on salt as a manure, and as a condiment mixed with the food of animals', Communications to the Board of Agriculture on subjects relative to the husbandry and internal improvement of the country, 4, (1805), pp. 370-381.

were not quantified. In this instance observation was important but a grasp of chemistry and mathematics was not really needed.

For the Committee of the Horticultural Society of London, experimental work in their fruit garden meant growing all known varieties and carefully compiling a dossier of botanical characteristics. Standardisation of nomenclature was their aim. When the sixth Duke of Bedford wanted to publish accurate and well executed catalogues of his collections of grasses, heathers, willows, pines and cacti his head gardeners undertook experimental work similar to that carried out by the Superintendent of the Horticultural Society of London's fruit garden. In this way the necessary botanical data was accumulated. To fulfil these tasks the Duke's gardeners and those employed by the Horticultural Society of London needed an expertise in botany, good powers of observation and the ability to conduct their work in a systematic manner.

The term 'experiment', therefore, was synonymous with 'enquiry', 'investigation' and 'trial'. The work carried out was short or long term, simple or complex and could be organised rigorously or conducted in a less exact manner. Moreover, what constituted an experiment varied with the aim of a particular investigation.

1.3 Some major developments of scientific gardening, 1790-1840

Support for experimental horticulture in these years came from a number of organisations and societies such as the Board of Agriculture (f.1793), the Bath and West Society (f.1777) the Dublin Society (f.1733), the Horticultural Society of London (f.1804), the Caledonian Horticultural Society (f.1809), the Linnean Society (f.1788), the Royal Botanic Society of London (f.1839), the Royal Society (f.1660), The Royal Institution (f.1799), the Society of Arts (f.1754), the Society for the Diffusion of Useful Knowledge (f.1826), the East India Company (f.1600), and in the early 1840s, the Royal Agricultural Society (f.1833).

These groups, as a rule, promoted scientific horticulture and shaped its direction by funding investigations and experiments, by issuing awards and premiums, by disseminating knowledge through their meetings and publications and, in some cases, through the compiling of syllabuses and the setting of examinations. They encouraged systematic enquiry, careful observation and stressed the importance of recording results and of accumulating reliable data. Although a wide range of horticultural activity was promoted, the following were of concern to many - several were of interest to almost all: grasses, aboriculture, the raising of improved varieties of plants and the importation of new ones, pests and diseases, the utilisation of chemistry and horticultural botany.22

22. This information was derived from an examination of their journals, pamphlets and the like, published between 1800 and 1840.
A principle area of scientific gardening at this time was botanical horticulture. It was characterised by an increasing preoccupation with accumulating knowledge of the external features of plants and by a growing interest in internal plant physiology. There was a great zeal for classifying plants during the late eighteenth and early nineteenth century and accurate results depended on the careful examination and precise description of their external features. This classificatory zeal was a result of the writings of Carl Linnaeus (1707-1778), Professor of Botany at the University of Uppsala, Antoine-Laurent De Jussieu (1748-1836), Professor of Botany at the Museum National de' Histoire Naturelle in Paris, Augustin Pyramus De Candolle (1778-1841), Professor of Natural History at the Academy of Geneva and Robert Brown (1773-1858), Librarian of the Linnean Society. Linnaeus had a powerful impact in England between 1770 and 1820 and in the 1820s and 1830s the work of De Jussieu, De Candolle and Brown became increasingly influential. As a result, great efforts were made to communicate descriptions of external characteristics and to provide reliable illustrative material. Curtis' Botanical Magazine, founded in 1787, catered for this pre-occupation. The magazine became an important and respected scientific publication in which plants were carefully depicted.

23. For biographical details see the D.S.B.
and their botanical characteristics were accurately noted. Several institutions and societies which were interested in horticulture produced publications that contained drawings and descriptions of plants. It was not uncommon for horticultural and botanical writers to produce books which illustrated and discussed one particular species. General textbooks, as a rule, took pains to include both descriptive data and engravings. The audience for these publications were botanists, head gardeners, landowners, curators of botanic gardens, nurserymen and other scientific types.

Such developments reflect the powerful impression which the literature of these taxonomists had made. A corollary of this was the search for new or unusual varieties of plants. Discoveries enabled the various systems of plant classification to be extended. The acquisition of fresh finds aroused much interest and Curtis' Botanical Magazine gave prominent attentions to the more interesting specimens. Besides being valued for their scientific importance, such plants were much sought by collectors for their rarity and

24. The magazine was established by William Curtis (1746-1799) who had been a demonstrator at the Chelsea Physic Garden and who founded a botanic garden at Lambeth, London. A principal aim was to present scientific information about plants that were being brought into cultivation. Favoured specimens were illustrated by coloured engravings.

25. There were two major systems. The sexual system of Carl Linnaeus was based on the number and arrangement of a plants reproductive organs. Antoine-Laurent De Jussieu was a key figure in developing the natural system. Here, classification depended upon the consideration of a great many factors.
curiosity value and by those whose interests lay in commercial exploitation.

Besides these efforts to add to the knowledge of external plant physiology there were important enquiries being made which focussed attention on the internal structure of plants. A notable contributor was Thomas Andrew Knight (1759-1838), President of the Horticultural Society of London from 1811 to 1838 and landed gentleman. Many of his experiments and investigations examined the role and function of the internal vessels of trees and flowers. His findings were frequently quoted by contemporaries and were often used in discussions and arguments connected with various aspects of horticultural theory and practice. John Lindley was exaggerating his case when he wrote that Knight was, '... the best horticultural physiologist the world has ever seen'. But his judgement that Knight's experiments were conducted with a skill which few could emulate seems a fair one.

Apart from Knight, there were others who undertook valuable

26. For details of much of Knight's experimental work, see his papers in George Bentham and John Lindley (ed.), A selection from the physiological and horticultural papers, published in the Transactions of the Royal and Horticultural Societies by the late Thomas Andrew Knight, Esq., President of the Horticultural Society of London, etc., etc., to which is prefixed a sketch of his life, (London, Longman, Orme, Brown, Green and Longman, 1841).  

27. Lindley, The theory of horticulture, (n. 10), pp. X-XI.
enquiries into the vital functions of plants. Joseph Priestley (1733-1804), chemist, teacher, natural philosopher and theologian carried our investigations on natural gases which helped to lead to the beginnings of the discovery of photosynthesis. 28 Humphry Davy (1728-1829), Professor of Chemistry at The Royal Institution and Professor to the Board of Agriculture in what in reality was agricultural chemistry, provided a useful service to plant physiology. Apart from drawing attention to the subject and its areas of uncertainty, his popular book, Elements of agricultural chemistry, 29 supplied a convenient summary of the experimental work of many botanists and horticulturists and particularly emphasised the findings of T.A. Knight. The appendix of the third edition of 1821 was augmented by six pages of notes written by Knight. 30 Robert Brown's botanical enquiries produced seminal results. Brown's important investigation of the development of pollen grains and the ovule in the coniferae and cycadeae formed the background to his discovery of the nucleus of the vegetable cell. His examination of the structure of the inflorescence and seeds


of a variety of plants produced serviceable data.\[31\] Incidentally, Brown's work here also helped to improve methods of classification.

Another major feature of British horticultural science in the years between 1790 and 1840 was the interest shown in, and the encouragement given to, the production of improved varieties of plants. A number of the institutions mentioned earlier offered premiums to individuals to raise better kinds of flowers, fruit and vegetables. Some even acquired experimental plots of land and financed their own enquiries.\[32\] Besides institutional support, individual efforts were important. The contributions of T. A. Knight\[33\] and the Rev. William Herbert,\[34\] (1778-1847), Anglican minister, botanist and horticulturist, deserve attention. Both took considerable pains to produce new and vigorous varieties of flowers and vegetables by cross-fertilisation and Knight made a particular effort to improve the stock of several kinds of hard and soft fruit.

A further notable development at this time was the utilisation of chemistry. Between 1780 and 1820 a number of writers indicated

31. See the D.N.B. and the D.S.B. for further information.

32. The Bath and West Society had land for experimental work at Weston near Bath whilst the Board of Agriculture had several acres in London for investigation. The Society of Apothecaries, the Royal Dublin Society and the Horticultural Society of London had their own gardens where enquiries could be undertaken.

33. for particulars, see the D.N.B.

34. See the D.N.B. for details.
in their articles, short treatises and lengthy texts that
cchemistry could be of great assistance to the farmer and
gardener. Its relevance continued to be emphasised
throughout the 1820s and early 1830s. The belief that
cchemistry could be of value to agriculturalists and horticulturists
was rarely challenged in the very early years of the nineteenth
century. Many of the ideas and arguments that were marshalled
to explain how this subject could contribute to agricultural
and horticultural improvement relied more on theoretical
assumptions than on what was actually possible practically.
In reality, contemporaries used a knowledge of chemistry to
help them analyse plants, soils and manures and for a time
believed that their results were of some utility. One of the
most influential popularisers and practitioners of chemical
analysis was Sir Humphry Davy. Some account must also be taken,

35. Richard Kirwan, What are the manures most advantageously
applied to the various sorts of soils and what are the causes
of their beneficial effect in each particular instance,
(Dublin, George Bonham, 1794); Earl of Dundonald, A treatise
showing the intimate connection that subsists between
agriculture and chemistry, (London, Private printing, 1795);
William Henry, A general view of the nature and objects of
chemistry and its application to arts and manufacturers,
(Manchester, J. Johnson, 1799); Frederick Accum, A system of
theoretical and practical chemistry, (London, Private printing,
1803, 2 vols.); Humphry Davy, 'On the analysis of soils, as
connected with their improvement', Communications to the
Board of Agriculture on subjects relative to the husbandry and
internal improvement of the country, 4, (1805), pp. 302-318.

36. W.M. Toulmin, Rational amusement: being a series of
curious and instructive experiments in chemistry,
(Calcutta, Private printing, 1822); Anonymous, 'Outlines of horticultural
George John Towers, The domestic gardener's manual, (London,
Whittaker; Treacher and Company, 1830); William Grissenthwaite,
A new theory of agriculture, (London, Hamilton and Adams, 1830,
however, of those chemical manufacturers who, perceiving an
opportunity for personal gain, provided the chemicals and apparatus
that enabled those who were interested to undertake this kind of
work.

Fourthly, important changes occurred in the early nineteenth
century in the design and heating of glass-houses. During
this period the first free standing houses were built, iron
was increasingly used as a construction material and steam
and then hot water heating gradually replaced the ubiquitous
furnace and hot air flue system. 37 J.C. Loudon's wrought
iron sash bar, 38 perfected by about 1817, and the efforts of
firms specialising in greenhouse construction enabled
substantial changes to be made in the shape of glass-houses.
Sir George Stewart Mackenzie (1780-1848), writer on
horticulture and agriculture and Convener of the Caledonian
Horticultural Society's General Committee for Prizes, and T.A.
Knight were amongst the first to argue, publicly and influentially,
for the necessity for radical changes in design. 39 The commercial
exploitation of Loudon's wrought iron sash bar led to 'ridge and
furrow' glazing and allowed domed and semi-domed structures to be

37. Paul Smith, The evolution of the glass-house in England -
An illustrated history from early times to 1830, M.Sc.

38. Loudon produced this bar in 1816. Used in conjunction with
a cast iron framework it enabled large curvilinear, arched
and dome shaped glass-houses to be built. See Loudon, (n. 4),
p. 357.

39. Sir George Stuart MacKenzie, 'On the form which the glass of
a forcing-house ought to have, in order to receive the greatest
possible quantity of rays from the sun,' Trans. Hortel. Soc.,
London, 2, (1817), pp. 171-177; T. A. Knight, 'Suggestions
for the improvement of Sir George Stuart MacKenzie's plans
for forcing-houses', Ibid., p. 351.
built in the 1820s and 1830s. Both Loudon and Knight saw these improvements as being part of the struggle to control nature.40 These were the forerunners of the Crystal Palace which was designed in 1851 by Sir Joseph Paxton (1801–1865), head gardener to the sixth Duke of Devonshire and horticultural author and editor. Such developments in heating, in the use of construction materials and in design enabled gardeners to carry out their work more efficiently and effectively. They widened the scope of the cultivation of foreign plants.

Finally, the decades between 1780 and 1840 witnessed a substantial growth in horticultural literature. Compared with the previous century, the number of texts covering scientific and practical aspects of gardening in the nineteenth century increased very dramatically.41 The journals of the institutions, societies and organisations interested in developing horticulture contained illustrations of plants and botanical descriptions as well as reports of the results of investigations. Between 1785 and 1800 two magazines were founded, Curtis' Botanical Magazine and the Botanists Repository. They were the only horticultural journals in existence. In the next half century at least thirty five more were established, though not all of them were long term.


survivors. One of the most informative of these was the Gardener's Magazine, founded in 1826 by J.C. Loudon. This volume of literature indicates there was a substantial demand for information. Clearly, these periodicals played an important role in diffusing knowledge of practical and scientific gardening.

Some comment needs to be made about the role of commercial interests in contributing to the growth of scientific horticulture. Two historians of science, W. H. Brock and R. Porter, have quite rightly suggested that commercial factors need to be taken into account if we are to understand more fully the developments which occurred in natural history in the eighteenth and early nineteenth century. There is evidence in support of this from the field of horticulture. Indeed, commercial interests could initiate experimental and investigatory work and often helped to diffuse knowledge, push particular ideas and products, meet and develop market demand and create and maintain fashions and crazes. The seed firm of T. Gibbs and Company carried out hybridisation

42. These figures were compiled after examining the journals and periodicals on the open shelves at the Library of the Royal Botanic Garden, Kew and from an examination of the catalogues in the British Library. The estimates are meant to be rough guides only.

experiments and made a special study of grasses.\textsuperscript{44} C. and G. Loddiges, the London nurserymen, developed an automatic watering system for glass-houses, popularised the cultivation of orchids, produced botanical catalogues and sponsored plant hunting expeditions.\textsuperscript{45} The booksellers Ridgway and Company exhibited a willingness to publish works of botanical and horticultural science. W. and D. Bailey, entrepreneurial iron manufactures, developed Loudon's wrought iron sash bar.\textsuperscript{46} Frederick Accum (1768-1838), chemical operator, lecturer and consulting chemist, supplied equipment to those who were carrying out chemical analyses of plants, soils and manures and developed special 'portable laboratories'.\textsuperscript{47} Cuthbert William Johnson (1799-1878), farming and gardening writer, co-founder of the Farmer's Almanac and Calendar and part owner of a salt-manufactory at Heybridge in Essex, vigorously publicised the benefits of salt as a manure, using experimental evidence to back up his claims.\textsuperscript{48} Undoubtedly, such considerations need to be taken into account when examining the development of gardening

\textsuperscript{44} See the letters from George Sinclair to Thomas Gibbs, written between 1809 and 1822, B.E.O., G.S.T. Collection, number 9.

\textsuperscript{45} Smith, (n. 37), pp. 144-148.

\textsuperscript{46} Ibid., pp. 148-150.

\textsuperscript{47} Accum, (n. 35), Vol. 1, p. XXX and Vol. 2, p. XXVII.

\textsuperscript{48} Johnson wrote extensively on the use of salt as a manure making use of much experimental evidence to prove that careful applications increased the yield of certain crops. Probably, his most popular book which went through many editions was, An essay on the uses of salt for agricultural purposes and in horticulture, (London, W. Simpkin and R. Marshal, 1821, Second edition).
science between 1780 and 1840. It is probable that commercial factors played a part in maintaining the interest shown in horticulture by various scientific societies and organisations. They most likely helped foster the developments in horticultural science that have been discussed earlier.
Chapter Two - The social framework of horticultural science

The role of societies, organisations and individuals in supporting agricultural improvement and in encouraging its evolution along scientific lines in the late eighteenth and early nineteenth century has been explored by several historians. A number of factors were involved. Although it is a complex matter to account for this encouragement of scientific farming it is possible that population growth may have been of some significance. The whole question of population expansion and its consequences, however, is still a controversial issue. Without firm evidence, therefore, it is only possible to suggest such a connection.

During the years between 1790 and 1840 this was also true for gardening, for broadly similar reasons. Horticultural improvement and investigation was fostered by various scientific societies and institutions, by organisations, by a major trading company, by bodies which wanted to improve the conditions of the labouring class, by botanic gardens, by landocrats, and by entrepreneurs who had obtained their wealth from commerce and industry. The efforts of T. A. Knight, who was a country gentleman, also need to be taken into account. Their patronage contributed to the development of scientific gardening.

Much of this chapter is concerned with the promotion of horticultural

science by organisations and institutions. A great deal of emphasis will be given to those which received the support of the sixth Duke of Bedford, namely: the Bath and West of England Society (President 1802-1805), the Board of Agriculture, the Horticultural Society of London (a subscriber to the experimental garden), the Labourer's Friend Society (a Vice-President), the Linnean Society, the Royal Institution (a member of the Mechanics Committee), the Society of Arts (one of the Vice-Presidents) and the Society for the Diffusion of Useful Knowledge (a governor and life subscriber). The Duke, in fact, belonged to many societies. He was also a member of the Royal Asiatic Society, the Botanic Society of Edinburgh, the Farming Society of Ireland, the Highland Society of Scotland and the Zoological Society of London. Even though this list is not exhaustive, it illustrates the sixth Duke's willingness to encourage scientific bodies and institutions and indicates the extent of his support.

As I shall explain, the commitment of societies, institutions, organisations and individuals to horticultural investigation encompassed a wide variety of motives and gave rise to many different activities. At present, I merely want to note some of their major interests. Plant physiology was of great concern to the long established Royal Society in the early nineteenth century. The Bath and West Society and the newly created Caledonian Horticultural Society and the Horticultural Society of London were anxious to encourage improvements in the
cultivation of fruit trees. The latter strongly advocated the production of hard and soft fruits by the technique of cross fertilisation. The Linnean Society devoted itself to the detailed botanical description and classification of plants, especially those that had been newly discovered in Britain and in other countries. Investigations and experiments that had a relevance to both agriculture and horticulture were supported by the Board of Agriculture, the Bath and West Society and the Royal Society of Arts. The Royal Institution was involved in the application of the technique of chemical analysis to farming and gardening. Botanic gardens mainly served the needs of medicine, agriculture and horticulture. Some contributed to the education of medical students and, like the Horticultural Society of London, to the training of gardeners. Experimental work was undertaken at the Chelsea Physic Garden, the Brompton Botanic Garden, the London Botanic Garden, Kew Gardens and the botanic garden at Myrtle Street, Liverpool. The East India Company, along with the Royal Society of Arts, the Horticultural Society of London and Kew Gardens, attempted to develop the botanical riches of the colonial empire. Investigations in botany and horticulture were financed by the Company. The Labourer's Friend Society and the Society for the Diffusion of Useful Knowledge wanted to see the poorer sections of society efficiently cultivating gardens and allotments. Both organisations diffused practical and scientific horticultural information. Landed aristocrats, bankers and industrialists who involved themselves in horticultural activities were, by and large, interested
in the collection and systematic arrangement of plants and in the technological improvement of their greenhouses. T. A. Knight, the Herefordshire squire, was known in the 1800s for his investigations in plant physiology, although he carried out a variety of experimental work.

I have divided this wide-ranging support for scientific gardening into the following major sections: aristocratic involvement, agricultural communication channels, horticultural botany, general scientific societies, specialist horticultural societies, self improvement and useful horticulture, and trade and empire. These sections should not be regarded as rigid compartments. Several organisations could fit comfortably under more than one heading and, arguably, the number of headings could be expanded. The work of certain individuals has been discussed in relation to societies and organisations but little attention has been given to their efforts outside this institutional context. My intention is that the following structure should be regarded simply as a manageable frame of reference.

2.1 Aristocratic interest

The pursuit of horticulture by the landocracy in the first half of the nineteenth century has been noted in recent years by several historians, although somewhat cursorily. Contemporary reports and observations mention the names of certain of these enthusiastic landocrats, and indicate the number of gardens

that they maintained and utilised. Writing in 1829, J.C. Loudon severely castigated George IV for the poor state of many of the Royal gardens but believed, 'So long, indeed, as we have noblemen as the Dukes of Bedford, Northumberland, Portland, Buccleugh and Devonshire ... we need not fear the example of a British King ...'.

P. Neill included a survey of private gardens in his informative and reliable, *An account of British horticulture* (1817). Many that he singled out for praise belonged, not surprisingly, to the aristocracy. James Mangles (1786-1867), gardening writer and former naval commander, included an extremely comprehensive list of the principal gardens of England in a very useful appendix to his book, *The floral calendar* (1839). This addition is instructive when used as a 'social' and trades directory.

Out of the two hundred and sixty nine gardens mentioned in this survey, well over a third belonged to the peerage and of the thirty nine gardens singled out for special merit, over half were owned by this group. James Forbes wrote in his *Hortus Woburnensis*, published in 1833, that the taste for gardening had at this time pervaded all ranks of society and pointed out the nobility's preoccupation with glass-house plants. Forbes, along with other professional gardeners, attempted to tap this expanding market by publishing gardening texts which were specially designed to cater for the predilections and needs of the landed horticulturist.

Members of the landocracy concerned themselves personally with their gardens for a number of reasons. Many, as F.M.L.

Thompson has accurately observed, derived intellectual and aesthetic pleasure from their lawns, varieties of trees, herbaceous borders, displays of annuals, greenhouse plants and the parkland surrounding them. Possibly, landed aristocrats fostered horticultural activities because they saw it as their duty to look after and utilise the land and to encourage beauty. It was part of the aristocratic lifestyle to entertain grandly. Well managed gardens and landscaped wooded areas not only showed off the family seat to good advantage but also provided a setting for the entertainment and amusement of guests.

Prestige was to be gained from maintaining gardens in a state of splendour and rivalling other estates in the acquisition of rare and unusual specimens. Extensive collections of well-cared for exotic plants obtained from many parts of the world ensured an estate's reputation for horticultural excellence. The taste for growing anything that was unique or strange was widespread. This caused consternation amongst some professional horticulturists. Joseph Paxton disapproved of this, regarding it as mere frivolity; and

8. Ibid., pp. 96-97.
he argued in 1838 that once the novelty value had worn off, plants were thrown out of large establishments without their ornamental qualities being fully appreciated or even realised. No doubt a great number of the landocracy were not as serious-minded as Paxton would have liked, although for some notable landowners this was not a frivolity. Rather, it was a serious approach to horticulture which had important consequences. Exotic or out of season fruits from the kitchen garden hot-houses were also a means of conferring prestige on country house owners. Fruit could be sent as impressive gifts to relatives and dinner guests could be fed with carefully nurtured pineapples, peaches, apricots, grapes and cherries from the forcing ranges.

Though aristocratic landowners set trends they were also followers of fashion and it is likely that the desire to be regarded as stylish and progressive encouraged an interest in landscaping and garden design. A taste for Chinese gardens with their temples and ornamental and flowering plants was fostered by landscapists. Amongst the most influential were Sir William Chambers, active during the latter half of the eighteenth century, and Humphry Repton


and John B. Papworth, who worked in the early part of the nineteenth. The Chinese element was especially strong in the gardens owned by the Prince Regent, the Dukes of Bedford, Devonshire, Marlborough, Northumberland and Portland, the Marquises of Buckingham and Stafford, the Earl of Essex and Lord Grenville. The taste for Chinese plants (and also for plants from the Americas) was encouraged by the efforts of collectors working under the patronage of individuals and of institutions (such as the Horticultural Society of London and the East India Company). For a small number of aristocrats, this interest in gardening went much deeper. They showed a willingness to patronise investigations and experiments in the scientific aspects of horticulture. We will now turn to these few and examine the sort of work they sponsored.

The Marquis of Blandford (1766-1840), who became the fifth Duke of Marlborough in 1817, was extraordinarily devoted to horticultural botany. Between 1798 and 1817 he used the grounds of his estate at Whiteknights Park, Reading, to develop this interest. He virtually turned them into a botanic garden, importing a great many flowering shrubs, rare


13. Siren, Ibid., pp. 30, 74-75, 84-88; Mangles, (n.5), See his comments on the gardens of these aristocrats on pp. 104-110.
trees and exotic plants into the Park and its plant houses in an effort to add to the varieties in cultivation and to extend horticultural knowledge. The Marquis was eager to introduce and develop many varieties of dahlia and specialised in the cultivation of aquatic plants which were reared in specially constructed tanks in his hot-houses.

He established a Linnean Garden at Whiteknights, in which herbaceous plants were arranged according to the classificatory system of Linnaeus, and was a patron of other scientific gardens.

The work he promoted was regarded as an important contribution to science. Some of his collections appeared in Curtis' Botanical Magazine and in Sir J.E. Smith's Exotic botany. The latter became a standard reference on rare and unusual foreign plants.


16. Anonymous, A catalogue of the Brompton Botanic Garden, (London, W. Bulmer and Company, 1803). See the list of subscribers, the subscribers terms, the original design and the catalogue itself.

17. Many of the details of new plants published in the magazine during the 1810s, 1820s and 1830s were reprinted by other horticultural journals.

plants. Smith (1759-1828), President of the Linnean Society, was a popular teacher and a recognised scholar of botany and horticulture.

The second Duke of Northumberland (1742-1817) employed a skilful horticulturist at Syon Park, Middlesex, to maintain his horticultural collections. Occasionally, botanical descriptions and specimens of new foreign plants were sent from Syon to the Linnean Society for publication. 19 The third Duke (1785-1847), also invested extensively in horticultural improvements and instructed his gardener to complete a botanic catalogue of all the plants contained in the gardens. 20 The sixth Duke of Devonshire (1790-1858) was an ardent devotee of horticulture and botany. 21 Botanical and cultural details of new plants and fruit grown at Chatsworth House, Derbyshire (the family seat), were sent to the Gardener's Magazine. The sixth Duke encouraged the diffusion of horticultural knowledge by distributing his surplus stock of new varieties to other enthusiasts. 22


At Welbeck Abbey in Nottinghamshire, the third and fourth Dukes of Portland were interested in pomology, the science of fruit growing. The third Duke (1733-1809) subscribed to the Brompton Botanic Garden, London, and was an avid collector of grapes and pineapples. His head gardener, William Speechly (c1733-1819), published treatises on their management which combined science and technology with practice. The fourth Duke (d. 1854) encouraged his gardener to improve the list of grapes which William Speechly had compiled by providing reliable descriptions of those which had not been fully and confidently detailed. The results appeared in the *Transactions of the Horticultural Society of London* in 1832. The fourth Duke was keen to support investigations into the physiological aspects of horticultural botany. He wanted to ascertain the causes of failure in some of his early forced grapes and his gardener conducted careful and thorough physiological experiments. The gardener believed his findings contradicted some of the accepted theories of the movement of sap and fully discussed the issue in the *Gardener's Magazine*. Another


A gardener at Welbeck was instructed by the Duke to carry out similar experiments on vines. The idea was to improve their cropping power.

The third Earl of Dartmouth (1753-1810), who became the first President of the Horticultural Society of London, was another zealous horticulturist. The Earl maintained an extensive garden on his estate at Sandwell House, Staffordshire. By providing details of a number of the plants in his collection he contributed to the publication of Sir J.E. Smith's and J. Sowerby's *English Botany* (1790-1814, 35 vols.) which became a highly regarded work of reference on botanical taxonomy.

Collections of trees, especially pines and willows, were features of the estates of the nobility. The pinetums (an accumulation of pine trees, botanically arranged) of the Dukes of Bedford and Devonshire, the Marquis of Blandford and Lord Greville enjoyed a reputation amongst landocrats and writers of botany and horticulture for being varied and extensive. Lord Greville (1759-1834) was a pioneer here and established a five acre pinetum at Dropmore House, Buckinghamshire, in the mid-1790s. Greville raised many new varieties from seed.

27. Desmond, (n. 20), p. 381.
and a catalogue of his collection appeared in the *Gardener's Magazine* of 1828 giving the botanical details of fifty two varieties.\(^{28}\) However, the shoddily produced, uncoloured engravings which accompanied the list could not have been of value to those who were anxious to identify the different species. An additional list of nineteen new varieties, which included plants from abroad as well as those bred in England, was printed in the journal five years later.

The Duke of Devonshire established an arboretum (a botanical collection of different types of trees) at Chatsworth and a catalogue of the various species along with botanical information was also published in the *Gardener's Magazine* in 1835.\(^{29}\)

Besides trees and shrubs, grasses attracted the attention of the nobility. This was particularly true of the Dukes of Bedford, Buccleugh (Dalkeith Palace, Midlothian) and the Earl of Hardwicke (Wimpole Hall, Cambridgeshire).\(^{30}\) As a rule, such keen aristocrats set up systematically arranged grass

---

\(^{28}\) William Baillie, 'Some account of the flower gardens and the Pinetum at Dropmore, the seat of Lord Greville', *Gdnr's. Mag.*, 2, (1828), pp. 265-268.


gardens on their estates. These plots were the focus of quite detailed investigations undertaken to find out which grasses were most suitable for use in pastures. Such enquiries provided information which was useful to botany and horticulture.

Many of the great landowners that I have mentioned sponsored, some even initiated, the evolution glass-houses. The Dukes of Bedford, Devonshire and Northumberland and the Earls of Egremont and Hardwicke financed trials of the recently developed hot water heating apparatus. Accounts of the type of equipment used in the greenhouses of these estates together with comments on their performance, appeared in the Gardener's Magazine in the late 1820s and throughout the 1830s. In an issue of 1831, for example, the apparatus employed in the forcing pits at Syon House was reported whilst in an edition of 1832 the system in use in the pineapple stoves of the third Earl of Egremont's (1751-1837) Petworth Park estate in Sussex, was detailed. 31

The involvement of a small sector of the landed aristocracy in agricultural improvement and their willingness to consider scientific techniques of farming has been convincingly demonstrated. So has their entrepreneurial role in the development of mines, iron works, mills, canals, ports and urban building land. 32

31. J.C. Loudon, 'Syon House', Gdnr's. Mag., 7, (1831), p. 366; Mr Cottram, 'Observations made on the performance of a hot-water apparatus in a pinery at the Earl of Egremont's, Petworth, Sussex, during the severe weather in January last by Mr Harrison, the gardener there', Gdnr's. Mag., 8, (1832), pp. 147-148.

Possibly, such initiative can be regarded as an aspect of the 'spirit of enquiry' (an awareness of the possibilities of change, development and growth) observed, and given this label, by contemporaries in the late eighteenth and early nineteenth century and whose scope I have sketchily outlined. To this can be added their patronage of horticultural science. The examples given above of those landocrats who were willing to use their estates for horticultural innovation and enquiry show that only a handful were involved. Their impact, however, was greater than their size might at first suggest. The most active of this small group, as we have seen, were the Dukes of Bedford, Buccleugh, Devonshire, Marlborough (Marquis of Blandford) Northumberland and Portland, the Earls of Dartmouth, Egremont and Hardwicke and Lord Greville. Apart from their patronage of horticulture it is unclear, as yet, what else they might have had in common. Three out of the six Dukes were Whigs and three were Torys. Of the whole group (of nine) at least five had affiliations with the Whig party. A similar proportion, but not the same individuals, were connected with Cambridge University and over half of the group supported parliamentary reform in the early 1830s. The Duke of Marlborough took little interest in politics, however, yet he was a very important patron of scientific horticulture in the early nineteenth century. Generally, the landed interest supported the corn laws although in 1828 five out of the nine voted against the new Corn Bill. This does not necessarily mean they disagreed with agricultural protection in principle; they might have wanted to retain

33. Thompson, (n.2), p. 154. Thompson was applying this term to landowners and the managers of their estates, although he also had in mind entrepreneurs from the world of banking, trade and industry (and the like).
the existing bill. Some peers, though, presented petitions to Parliament opposing the proposed legislation on the grounds that it would cause hardship to certain sections of the community and the Earl of Hardwicke was strongly against the introduction of the bill into Ireland because he believed it would have a detrimental affect on the poorer classes.34

All the landocrats that I have discussed belonged to three at least of the following seven organisations and societies and a high proportion were members of five (two thirds belonged to six): the Horticultural Society of London, the Board of Agriculture, the Bath and West of England Society, the Linnean Society, the Royal Society, the Society of Arts and the Royal Institution. It is not always accurate to infer more than a casual interest in a subject from membership lists of societies during the period. However, the very fact that the individuals mentioned invested in horticultural improvements and investigations on their estates makes the motives for their membership of these particular organisations seem genuinely scientific. To the improvers amongst the nobility that have been introduced already could be added, I believe, the Duke of Sutherland, the Earls of Mountnorris, Spencer and Winchilsea and Sir Abraham Hume. Undoubtedly, the roll call could be

extended to include those who were not so strongly involved. We shall now turn to these institutions and organisations and examine their encouragement of scientific horticulture.

2.2 Agricultural communication channels.

Some of the institutions and organisations that dealt mainly with farming matters also concerned themselves with horticulture. This is particularly true of the Dublin Society, and two bodies which, though not established as purely agricultural societies, became gradually involved in farming during the late eighteenth century: the Bath and West of England Society and the Highland Society of Scotland. The Board of Agriculture showed similar interest. It differed from the above, being partly a voluntary association and partly a piece of administrative machinery funded by the Government. Although the patronage of enquiry and experiment by the Board and these Societies is important, their real significance lies in the role they played in changing attitudes and in shaping the development of agricultural and horticultural science. Whether the experiments and investigations they initiated produced actual results is of lesser importance. One aim of examining these enquiries is to see how they fitted in with the expectations of science held by the patrons of agriculture and horticulture. A further objective is to consider how this investigative work supported their conceptions of agricultural and horticultural science.

The journals of these bodies provided an opportunity in the
very early years of the nineteenth century for the detailing and encouragement of issues germane to scientific horticulture. There were very few horticultural periodicals at this time. Curtis' Botanical Magazine, a publisher's venture, covered horticultural botany but it was not a forum for discussion, being devoted entirely to botanical illustration and description. Other publishers ventures, The British Magazine and the Commercial and Agricultural Magazine, which in 1802 became the Agricultural Magazine, though they emphasised farming concerns and not gardening matters, occasionally dealt with topics of value to the horticulturist (pests and diseases, vegetables, propagation and manures). The first horticultural journal produced by a society was the Transactions of the Horticultural Society of London, (1807). This publication provided a vehicle for the exchange of ideas. It remained unopposed until the appearance of three additional periodicals in the years between 1814 and 1818. These were a journal published by a society, the Memoirs of the Caledonian Horticultural Society, (1814), which adapted the same style as the Transactions of the Horticultural Society of London, and two commercial undertakings, the Botanical Register, (1815) and the Botanical Cabinet, (1818). Before papers were allowed to be printed in the Horticultural Society of London's Transactions they had to be judged by the Council as being worthy of publication. They also had to be read at one of the sittings of the Society. Presumably, articles for the Memoirs of the Caledonian Horticultural Society went through the same kind of selection procedure.
No doubt control over what appeared in the *Botanical Register* and the *Botanical Cabinet* was exercised by those who edited these journals. It was only in the 1820s and 1830s that there was a marked expansion in horticultural magazines. Until this increase, the publications of agricultural society's were an important channel for the dissemination of horticultural science and practice.

The Board of Agriculture, created at a time of social discontent and during a period when farming could bring substantial profit, was founded to encourage the landowning classes to adopt enclosure and other agricultural improvement. It was supported by a modest government grant (though it lacked the privilege of franking) and functioned for twenty nine years as a promoter of improved farming and of agricultural and, to a lesser degree, horticultural science. Sir John Sinclair, a major controlling influence, regarded the activities of the Board as being part of a general movement to make Britain, '... the garden of Europe'. Sinclair was very interested in horticulture, having written works on practical and

35. Berman, (n. 1), p. 3.

experimental gardening independent of the Board. 37

Through his efforts the Board sponsored horticultural projects. One scheme was a volume, penned by Sinclair, aiming to disseminate practical and scientific information on the factors assisting and retarding the vegetation of plants. Sinclair wanted to add to what was already known about these factors so he included in his book a questionnaire dealing with the agents that were necessary for plant growth. Nurserymen, gardeners and farmers were invited to send him their ideas, observations and the results of any enquiries they had undertaken. 38 Thus for Sinclair, one way of advancing horticultural and agricultural science was to concentrate on a particular problem area, gather a variety of relevant observational and experimental results and then use this data to make a reasoned judgement. Another project planned by Sinclair was the compilation of a voluminous work on agriculture which was to include sections on horticulture written by some of the most respected gardeners of the day.

With the accession of Lord Somerville as President, in 1798,

37. Sir John Sinclair, The code of agriculture including observations on gardens, orchards, woods and plantations, (London, Sherwood, Neeley and Jones, 1817); Sir John Sinclair, An account of some experiments to promote the improvement of fruit trees by peeling the bark; with a description of the instruments calculated for that purpose, and engravings of them, (London, W. Bulmer and Company, 1820).

38. Sir John Sinclair, Hints on vegetation and questions regarding the nature and principles thereof addressed to farmers, nurserymen and gardeners, (London, Board of Agriculture, 1796).
the work was abandoned. In an address to the Board during his second Presidency, Sinclair explained that one of its major aims had been to improve the strains of plants by encouraging the cultivation of the best kinds and by crossing different sorts to raise new varieties. He referred to the scientific horticulture of Thomas Andrew Knight in order to explain what could be achieved through such efforts. 40

Sinclair's successor Lord John Somerville (1765-1819), agricultural improver and innovator, believed that if the Board of Agriculture was to encourage effectively improved and experimental farming it needed the assistance of landowners who had some knowledge of agricultural science. Somerville wanted them to set an example to husbandmen. He hoped these landowners would put the Board's schemes into operation on their estates. 41 Lord John practised what he preached. He allocated twenty eight acres of his own land for experiments on the chemical analysis of soils and on ways to improve the yield of crops and suggested the Board should establish an experimental farm. The investigations


40. Sir John Sinclair, Address to the Board of Agriculture, on Tuesday the 22 April 1806, (London, Board of Agriculture, 1806), p. 8.

41. Lord John Somerville, The system followed during the last two years by the Board of Agriculture, (London, W. Miller, 1800), p. 4.
patronised by Lord Somerville had a relevance to both agriculture and horticulture. Moreover, for certain issues and problem areas there was a close connection between agricultural and horticultural science and developments in one of these areas could be picked up and utilised by practitioners in the other. Agriculturists could turn their hand to horticultural activities and gardeners could carry out agricultural investigations. The usefulness of the Board's investigations for farmers and gardeners is illustrated by the enquiries of Humphry Davy. As Maurice Beman has shown, Davy's work at the Board of Agriculture and at the Royal Institution very early in the nineteenth century was similar, and the Board initially utilised the Royal Institution defacto as its own laboratory. The aims and philosophies of these two societies were closely linked and up to about 1810 there was an interlocking directorate. Fourteen of the nineteen governors of the Royal Institution belonged to the Board of Agriculture and eight of them were among the most outstanding agricultural improvers of the day. This directorate defined the scope of Davy's investigatory work, although Davy was not slow to reinforce their belief in the value of scientific enquiry. Davy analysed soils and manures for the Board, gave a series of lectures on

42. Beman, (n.1), pp. 55-56.
vegetable substances and their connection between chemistry and vegetable physiology and, later, gave a number of lectures on agricultural chemistry. All these series of talks contained ideas that promised to have practical value for the farmer and gardener. Davy, as previously mentioned, made great use of the researches in vegetable physiology of the horticulturist Thomas Andrew Knight and both men maintained a friendly, scientific correspondence. In 1810 Davy wrote to Knight, 'In considering the physiology of the subject I shall have little to do but to second your labours, for you have created almost all the science we have on the subject'.

Rosalind Mitchison has correctly and graphically described how the Board showed a, '... surprising omnivorousness ... in selecting subjects for enquiry. Premiums in the form of monetary payments and medals were awarded to those who had satisfactorily conducted investigations along lines specified by the Board and accounts of successful applicant's work

43. Ibid.
44. See the letters written between 1808 and 1810 in, Eighteen copies of letters from H. Davy to T.A. Knight, 55-73, 1808-1828, R.I.A., 26D/2 (i) Letters 1-3, 26D/2(ii) Letters 4-7, 26D/2 (iv), 26D/2 (v), 26D/2(vii) and 26D/2 (viii).
45. Letter dated 30 April 1809, 26D/2(ii) Letters 4-7, Ibid.
46. Rosalind Mitchison, 'The old Board of Agriculture (1793-1822)', The English Historical Review, 74, Number 290, (1959), p. 44.
appeared in an occasional publication, Communications to the Board of Agriculture. In the Communications, published between 1797 and 1819, a great deal of interest was shown in manures. The Board encouraged the evaluation of various substances which could be used to promote vegetation by insisting on careful comparative trials and later specifying they had to be verified by chemical experiment (which most likely entailed a chemical analysis of the actual manures and of the soil of the trial plots). It also published an appendix to a general report in 1796 which contained essays on such topics as plant nutrition, the renovation of soils and the efficacy of various substances used as manures. 

Premiums were offered to those who based the cultivation of trees and the pruning of fir timber on scientific principles. Others could gain a premium if they improved the culture of such farm and garden crops as beans, peas, carrots, cabbage, turnips, chicory and potatoes. To be considered for an award, investigators had to explain how these crops exhausted or ameliorated the soil, how their seeds were affected by steeping, how their growth was affected by different manures, how their pests could be eliminated and how their diseases were caused.

47. Communications to the Board of Agriculture on subjects relative to the husbandry and internal improvement of the country, (London, George Nicol 1797-1813, 7 Vols.). Communications to the Board of Agriculture on the subjects relative to the husbandry and internal improvement of the country, New Series, 1, (1819).

48. Additional appendix to the outlines of the fifteenth chapter on the proposed general report from the Board of Agriculture on the subject of manures, (London, Board of Agriculture, 1796).
and could be cured. 49

Like the publications of the Board of Agriculture, the Transactions of the Dublin Society, the Letters and Papers of the Bath and West and the Transactions of the Highland Society of Scotland provided channels for the communication of applied horticultural science. The issues which they covered and the problems which they were interested in were broadly similar. These societies (as the Board did) issued prizes and medals to encourage investigation and to foster improvements in the techniques of cultivation. 50

The Dublin Society, also like the Board, invested in the chemical analysis of manures and soils and engaged William Higgins, formerly of Oxford University, as its first professor of chemistry and mineralogy. 51 The Society similarly aimed to unite science with practice. However, it differed from the Board of Agriculture and the societies mentioned above, by establishing a botanic garden (at Glasnevin) and by appointing a Professor of Botany. This was Walter

49. Premiums offered by the Board of Agriculture, (London, Board of Agriculture, 1804).


Wade (d.1825), physician and botanist. At the Board of Agriculture such an appointment was not made and it was left to Humphry Davy to undertake botanical enquiries. The gardens at Glasnevin exhibited plants useful to agriculture and industry and contained greenhouses and ornamental specimens. The plots and borders were systematically arranged according to the Linnean system of classification and every plant or new acquisition was labelled with its scientific and common name and Linnean class. There was also a permanent exhibition demonstrating the numerous ways of propagating plants, shrubs and trees. The Society published a botanic catalogue, systematically arranged, of the contents of the garden. In these ways the Society contributed to the development of agricultural and horticultural science and provided practical guidance and useful knowledge for landowners, botanists, farmers and gardeners. It was quite vigorous in promoting horticultural botany. Premiums were awarded to candidates who produced the best answers to specific questions on botany in public examinations set by the Society (although I have not been able to find out anything about the nature of these examinations or the value they had for the examinee). Experimental work in vegetable


54. See the list of premiums in the Trans. Dub. Soc., in 2, Part 1, (1800) and 2, (1803).
physiology was fostered. Ninian Niven (1799-1879), the garden's curator, began investigations in 1835 into the functions of the internal layers of trees. At Liverpool in 1838 he presented his findings to the British Association for the Advancement of Science.55

The aims of the Bath and West of England Society were, 'To promote the good of the community by encouraging industry and ingenuity, to excite a spirit of enquiry, to bring specialism and theory to the test of accurate experimentation ...'.56 Some of the Society's members were interested in botany and horticulture and its first secretary, Nehemiah Grew, owned a considerable nursery at Lawrence Hill near Bristol.57 The Society was anxious to develop the science and practice of pomology, no doubt because of the great amount of fruit growing in Gloucestershire, Wiltshire and Somersetshire. Their Letters and Papers covering the late eighteenth and early nineteenth centuries contain premium-winning articles dealing with apple and pear cultivation.58 Particular emphasis was laid on accumulating an accurate set of

55. Ninian Niven, 'Details of experiments on vegetable physiology and observations thereon', Gard's. Mag., 14, (1838), p. 162.
57. Ibid., pp. 18, 44.
58. See the list of premiums in, Letters and papers on agriculture, planting etc., selected from the correspondence of the Bath and West of England Society, for the encouragement and agriculture, arts, manufactures and commerce, 8, (1798), Rules and orders, (n. 50).
characteristics of various apples and on the production of new varieties or improved strains of apples and pears by cross-fertilisation and by using grafts. A separate section for experimental horticulture was created, probably very early in the nineteenth century. There were five claimants in 1802. Unfortunately, the booklet published by the Society listing the awards does not describe the nature of this work.\textsuperscript{59} This category seems to have survived for only a short while. The Bath and West also offered premiums for ways of eradicating pests and diseases, for the best method of cultivating vegetables and for ascertaining the constituents of soils by experimental means. An award was advertised in 1838 for heating glass-houses efficiently.\textsuperscript{60} A chemical laboratory was founded in 1806 and lectures on the analysis of soils and minerals were given by Dr Clement Archer. Experimental work continued into the 1820s under Dr Wilkinson. In 1819, as a result of investigations, Wilkinson recommended the use of salt as an aid to soil fertility.\textsuperscript{61}

Clearly, certain aspects of horticulture, particularly if they were closely allied to agricultural concerns, were of interest to the Bath and West, the Dublin Society and the Board of Agriculture. They encouraged experimentation in

\textsuperscript{59} Rules and orders, Ibid.
\textsuperscript{60} Hudson, \textit{The Bath and West}, (n. 56), pp. 12-13, 46, 85.
\textsuperscript{61} Ibid., pp. 57, 73.
farming and gardening and were a force influencing the development of horticultural science. Their periodicals diffused ideas and contained information that was of interest to the horticulturist. Moreover, as Kenneth Hudson has shown, there was an expansion in regional and local agricultural societies between 1780 and 1820. It is highly probable that some, if not a great many, of these societies issued papers. Given that this was so, it is plausible to suggest that such material could also have acted as channels of communication for horticultural information.

2.3 Horticultural botany

The Linnean Society was one of the most important bodies, possibly the most significant society, concerned with horticultural botany in early nineteenth-century England. Other principal promoters were botanic gardens. There were many of these gardens in the first third of the nineteenth century, some owned by the monarch, some by universities, several by societies, some privately and others by public corporations. To note all of them would be unnecessarily tedious so I am going to mention just five that may be regarded as reasonably representative of their genre: Kew Gardens, the Chelsea Physic Garden, the London Botanic Garden and the establishments at Brompton and Liverpool.


63. The Linnean Society paid very little attention to practical gardening. Another important body was The Royal Botanic Society of London, which was formed in 1838 and granted its Royal Charter in 1839. The Society made a valuable contribution to horticultural science in its early years but this work lies outside our period.
The botanist Sir J.E. Smith formally founded the Linnean Society, an offshoot of the ailing Society for Promoting Natural History. Although it encouraged the classification of plants according to the system advocated by Linnaeus there was no specific 'Linnean' programme. In reality it was, '... a society for the cultivation of the science of natural history in all its branches and more especially of the natural history of Great Britain and Ireland ...', and was, '... desirous to promote every kind of improvement in the Arts and Science ...'. The major purpose of the Society was to develop botany and zoology and its promotion of horticultural science was part of this desire to encourage improvement generally. Sir J.E. Smith, President between 1788 and 1828, was strongly involved in horticulture. He grew at his garden in Norwich many of the plants that he studied and maintained contacts with British and foreign gardeners. Several members of the Society, for example, Sir Joseph Banks, the Dukes of Bedford, Buccleugh, Marlborough, Northumberland and Portland, the Earls of Dartmouth, Derby, Hardwicke and Mountnorris and Sir Abraham Hume, as I have already indicated, were patrons of horticulture. A number of gardeners were admitted as associate members of the Society and some of them worked on the estates of the landed aristocracy. A few of the above


66. For details see the D.S.B.
landocrats employed head gardeners who belonged to the Society.

The main contributions of the Linnean Society to the development of scientific horticulture were the inclusion of scientific articles in its Transactions and the maintenance of an extensive collection of dried plants. The Transactions, begun in 1791, provided a respected and formal medium for the regular publication of scientific discoveries. The articles, as a rule, contained much technical terminology. They were likely to appeal to the academically minded. Usually, those contributions relevant to gardening covered aspects of horticultural botany. In comparison, the Transactions of the Horticultural Society of London included papers on practical gardening and the pieces in the Gardener's Magazine, founded in 1826 by J.C. Loudon, tended to use less technical language. As I have stated earlier, the Horticultural Society's Transactions, the first specialist horticultural journal which dealt with experimental and innovative gardening, did not appear until 1807. The Linnean Transactions, like the publications of the Board of Agriculture and the various agricultural societies, therefore, acted as an important channel for the communication of scientific horticultural knowledge, albeit of an academic nature.

I now want to indicate the aspects of horticultural botany the Society was interested in and to note the lines of enquiry it was willing to encourage during the years between 1800 and 1840.

67. Allen, (n. 64), p. 47.
Newly discovered, rare very unusual plants from Britain, Australia, India, the Indies, Egypt, Indo-China, Japan, the Americas and the Arctic appeared in the Transactions. Each specimen was thoroughly and scientifically described, although illustrations were not normally provided. Much of the descriptive work was undertaken by Sir J.E. Smith. Similar interest was shown in new varieties that had been raised from seed and occasionally a lengthy monograph was written about a particularly intriguing species. Apart from providing botanical biographies of plants, the Society published material on internal plant physiology and anatomy. Papers appeared on the structure of pollen, seeds and stamens and other articles dealt with the origin of buds, the mechanics of germination, the formation of the epidermis, the development of seminal germs, the phenomena of variagation and the deoxidisation of leaves. Pieces dealing with classification and nomenclature were encouraged. The value of the systems of Linnaeus and Jussieu was discussed and debated and, periodically, attempts were made to classify plants that had proved difficult to arrange. Scientific names were given to those recently discovered plants that had been botanically described and the meaning of technical terms was considered. Very occasionally, there were articles on pests and diseases. The characteristics of aphis, wireworms and the insects that attacked pine trees were outlined, various remedies were recommended and blights were written about.  

68. This is based on an examination of the Trans. Linn. Soc., 1-18, (1791-1841).
The serious scientific nature of the Society was reflected in the foundation of a library housing works of reference, in the introduction of compulsory subscriptions allowing new publications to be purchased and in the appointment of able and respected botanists to the post of clerk/librarian. To assist members to carry out their botanical and horticultural investigations and to be of service to science the Society began a herbarium (a collection of dried plants) which it endeavoured to extend over the years by judicious purchases. It also welcomed the donation of collections. Thus, an effort was made to build up the necessary facilities to enable plants to be accurately identified and classified.

An illustration of the Linnean Society's interest in horticulture and its sympathy towards the problems experienced by an emergent society trying to promote scientific gardening can be seen in the assistance which it gave to the Horticultural Society of London. In 1805 the Horticultural Society was allowed to use a room in the apartments of the Linnean Society, at a modest rent, in order to hold meetings. The Horticultural Society engaged the clerk of the Linnean Society during the same year to give assistance to its own clerks. Between 1813 and 1817 the London Horticultural Society was permitted to keep a library in the Council Room of the Linnean Society.


d0. Gage, Ibid., pp. 124-125.
The limit was reached in 1817, however, when the botanists refused the horticulturists the use of a room for storing fruit which had been raised by cross-fertilisation. 71

A further indication of the Linnean Society's interest in horticultural matters was the role it played in the transformation of the Royal Gardens at Kew into a public botanic garden furthering botanical and horticultural science and education.

In the late 1830s the fate of the gardens at Kew was being seriously debated and the Government, mindful of the criticism that the gardens were no longer as efficient as they had once been, considered whether they should be discontinued. The Linnean Society fully supported the suggestion of John Lindley, who was appointed by the Treasury to report on the gardens, that Kew should be, '... made worthy of the country and converted into a powerful means of promoting national science ...'. 72

In a memorial drawn up by the Linnean and Horticultural Societies and the University of London, the Government was urged to adopt Lindley's proposal, which was eventually put into practice in 1841.

Another group, the Worshipful Society of Apothecaries, was

71. Ibid., p. 24; Fletcher, (n.2), pp. 42, 55.

72. John Lindley, Report upon the present condition of the botanical garden at Kew, with recommendations for its future administration, R.B.G.K., Kewensia, Reports and Documents 1784-1884, p. 4.

also willing to foster scientific horticulture.

Apprentice apothecaries had to show a proficiency in the recognition of fresh plants that had medicinal value and so a piece of ground was needed where specimens could be grown. During 1673 the Society established a botanic garden at Chelsea, London, in order to serve the needs of its profession. The gardens achieved great eminence in the eighteenth century partly through the efforts of one of its keepers, Philip Miller (169-1771), who became one of the most expert practical and scientific gardeners of his day. By the early nineteenth century the Physic Garden was still important to the Society but it had lost its great prestige.

Throughout the 1800s the Society continued to use the garden, as its founders had done, as a depot for the accumulation of specimens that could be used in medicine and to familiarise students with a wide variety of British and foreign plants. Another object of the Society was to demonstrate how dried and living materials could be systematically arranged. Furthermore, it participated in the distribution of economic and ornamental plants, although this was regarded as being of secondary importance. To ensure these goals were accomplished.


the Society was careful to engage as keepers gardeners who were knowledgeable in botany and who were capable of introducing improvements and of following developments in scientific horticulture. William Anderson (1766-1846) was appointed keeper in 1814 and was responsible for improving the grounds and the facilities. Anderson developed the stock of plants in the garden, bringing in many new varieties and sowing thousands of seeds, and modified the heating system in the glass-houses to give greater efficiency.76 At the request of the Society of Apothecaries, Anderson in 1815 turned part of the garden into an experimental plot and placed it at the service of the Horticultural Society of London. The Apothecaries promised that their gardener would, if requested, conduct experiments in horticultural science.77

At this time the apothecaries in England wanted to see professional standards firmly established by Parliamentary legislation and their campaigns of agitation culminated in the Apothecaries Act of 1815. This Act laid down a five year apprenticeship and specified that students had regularly to attend lectures and pass an examination.78 In 1816 the

76. Ibid., pp. 120, 127-128.
77. Ibid., pp. 122-123.
Society of Apothecaries added botany to their compulsory subjects. This enabled practical and scientific aspects of horticulture to be introduced into the syllabus because the Act of 1815 had not laid down a rigid curriculum. Apprentices were now provided with instruction in horticultural skills as it was felt these would be useful. During the 1820s, under the stimulus given by the Act of 1815, the Society widened the scope of its instruction in botanical and horticultural science. After 1821 the Demonstrator of Plants, in monthly meetings with students, had to talk about the principles of vegetative life, outline the structure of plants, discuss aspects of physiology, classify plants according to Jussieu as well as Linnaeus, comment on their natural climate, describe the alterations in plants caused by cultivation and state their food value. In addition, in 1829, a natural and chemical analysis of vegetative matter was included in the course and prizes were awarded for the best examination papers.

In the same year the garden was thrown open to the professors and students of the city's schools of medicine. Consequently, the numbers using the garden to study botanical and horticultural science increased and in response to this extra load the salary

80. Ibid., pp. 167-168.
of the Demonstrator was raised, a professor of botany was appointed and meetings now became weekly and not monthly.\cite{footnote1}

In 1835 John Lindley was appointed its Professor of Botany. Lindley had become an important and influential figure in the horticultural world and his reputation ensured that the garden and its teaching continued to enjoy prestige. To improve the garden's educational facilities Lindley totally revised the arrangement of specimens. This was accomplished in 1839. He also compiled a thorough and systematically ordered catalogue of all the trees, shrubs and plants held by the Society.\cite{footnote2} Lindley, therefore, ensured that the link between medicine and horticulture was firmly maintained.

The Chelsea Physic Garden was founded and cultivated to cater for the needs of medicine whereas the grounds at Kew House, Richmond, Surrey were formed both for the aesthetic pleasure of the Dowager Princess Augusta and for her scientific enlightenment. Later, the scientific function of Kew became paramount. In the 1750s the Dowager Princess, assisted by the third Earl of Bute (1713-1792), formed nine acres of her leased estate into a botanic garden. With the Princess' death in 1772 the property passed to her son, George III, and Kew became one of several royal gardens. The King's botanical

\cite{footnote1} Ibid., pp. 180-186.

\cite{footnote2} Ibid., pp. 196-197, 202.
and horticultural adviser was Sir Joseph Banks (1743-1820), who became Kew's unofficial director. Under Banks' guidance the botanic gardens became extremely important and the work carried out there contributed markedly to the development of horticultural science.

Banks had a very wide interest in scientific matters and was an important figure, being President of the Royal Society and a member of a number of influential societies. Sir Joseph was actively involved in fostering scientific horticulture. He helped to found the Horticultural Society of London in 1804. contributed technical papers to its Transactions and wanted to make Kew Gardens a scientific centre. At Kew his aims were, firstly, to cultivate a wide range of plants from all parts of the world so that botanists and horticulturists could learn their scientific details and, secondly, to participate in the exchange of information and plants with individuals, societies and other botanic gardens to enable scientific knowledge to be diffused. Banks wanted Kew to serve the economic needs of Britain and her empire as well. This aspect will be discussed in the section on horticulture and


84. Sir Joseph Banks was a member of the following: the Society of Arts, the Board of Agriculture, the Royal Institution, the Horticultural Society of London and the Linnean Society. He was also a subscriber to botanic gardens and took an interest in the affairs of the East India Company.
overseas trade. The achievement of these aims owed something, as W.B. Turrill has pointedly commented, to the generous manner in which Banks gave his time, energy and money.\(^5\)

Under George III's patronage and Sir Joseph's direction, collectors were sent from Kew, armed with letters of introduction, to South Africa, India, China, the West Indies, the Americas and Australia and were instructed to bring back economically useful, botanically and horticulturally unusual and aesthetically pleasing plants. The success of these missions can be gauged by the publication in 1789 of the three volume *Hortus Kewensis* by the head gardener, William Aiton (1731-1793). This was a catalogue listing over five and a half thousand specimens cultivated at Kew and was arranged according to the system of Linnaeus. It became a scientific work of reference and was extended by Aiton's son and successor, William Townsend Aiton (1766-1849), who published a second edition in five volumes between 1810-1813. The revised work listed over eleven thousand plants.\(^6\) Francis Bauer (1758-1840), botanical artist at Kew, produced a book of botanical engravings of some of the exotic plants that grew in the gardens. This, too, became a standard. It was not just the work of the Kew collectors that contributed to the extensive nature of these volumes. The inwards accounts (plants and seeds received) and record books of the garden show that horticulturists, botanists and curators in other countries sent much material


\(^6\) Fletcher, (n. 2), pp. 29-30.
Besides disseminating science through the various editions of the *Hortus Kewensis*, Banks was successful in ensuring the distribution of an enormous number of seeds, cuttings and living and dried plants throughout Britain, Europe, the Indies, Australia and India. W. T. Aiton propagated the *Lilium tigrinum* sent to Kew from China in 1804 by one of the collectors, and by 1812 had distributed over ten thousand bulbs. In keeping with Banks' desire to spread a knowledge of botanical and horticultural science, the gardens were open to the public. Those who were interested could obtain a plant's scientific name from its attached label. For specimens raised from seed the native soil was noted, too, whilst for imported plants details of the year of introduction and the donor were provided.

With Banks' death the gardens lost an indefatigable patron and between 1820 and 1840 never quite maintained their earlier glory. Several historians of Kew, however, have

87. See the *Inwards Book*, for the years 1805-1809, 1809-1818, 1819-1824 and 1837-1843 and the *Record Books* for the periods 1804-1826 and 1828-1847, R.B.G.K., *Kewensia*.


90. J.D. Hooker, *Miscellaneous notes on the history of Kew Gardens*, (1878). This is held in the *Kewensia Collection*, R.B.G.K.

tended to exaggerate its decline in these years. Although the number of plant collectors was curtailed and although there were no scientific publications from any of its horticultural staff, Kew still remained one of the premier botanic gardens in this country. Throughout the 1820s and 1830s it enjoyed a reputation for its aboretum, pinetum, grass garden, bulbs, alpines, ferns and stove and greenhouse collections.

John Smith (1798-1888), the scientific botanist and gardener employed under W.T. Aiton, was responsible for keeping the gardens in a very creditable state and helped to ensure that they functioned as Banks had intended. Smith continued regularly to correspond and exchange plants with the botanic gardens of Britain, Europe, the West Indies and the colonial gardens in India and Africa.

Kew is an illustration of the very marked expansion in the foundation of botanic gardens that occurred in Great Britain between 1760 and 1840. To show the sort of work less extensive and less illustrious gardens could carry out in the early nineteenth century I want to look briefly at three further examples of this phenomenon: Liverpool Botanic Garden, the London Botanic Garden and Brompton Botanic Garden. They


94. See the Inwards Books and Record Books, (n.87); Outward Book, (n.88); John Smith, A record of a few special events and matters relative to the Royal Botanic Garden at Kew, n.d., R.B.G.K., Kewensia.
all had a relatively small acreage and were founded independent of any society. The first two became well known for their botanical and horticultural activities but little is known about the latter.

The Curator of the Brompton Botanic Garden was John Salisbury and its subscribers included keen horticulturists such as Sir Joseph Banks, the Duke of Portland and the Marquis of Blandford. Its aims were to promote the sciences of botany, agriculture and medicine and it attempted to achieve these objectives by arranging and cultivating the garden in a scientific manner. Subscribers had a right to inspect the labelled and systematically organised plants and use the facilities of the library for study. The publication of a catalogue of the specimens in cultivation helped to make the garden's contribution to these sciences less parochial.

The botanist and smallholder William Curtis aided by the patronage, encouragement and assistance of the nobility, the Society of Apothecaries, doctors of medicine and nurserymen, established the London Botanic Garden in 1779 (near the site of the present Festival Hall). To maintain his stock of plants in good condition Curtis had to ensure skilful horticulture was practised. As D.E. Allen has pointed out,

95. Anon, A catalogue, (n.16).
Curtis capitalised on the skills he acquired as Demonstrator of Plants at the Chelsea Physic Garden and used his garden as a teaching establishment, providing courses and botanical excursions for those studying medicine. Very probably, horticultural botany formed part of the instruction he gave.

A second important function of the garden, noted in an earlier work by G. E. Fussell, was to serve the needs of agriculture. Curtis spent fourteen years investigating pasture grasses and offered packets of mixed seed which he believed would produce a good sward. Fussell, however, has overlooked the fact that Curtis was also conducting horticultural investigations in order to find out the best seeds for making lawns.

On Curtis' death the garden was continued by his partner William Salisbury (d. 1823), a former pupil, who moved to a new site at Sloane Street early in the century. Salisbury, like his business associate, contributed to the development of botanical and horticultural science. He improved the gardens' facilities for scientific study by sending plants and seeds to subscribers, by building up a technical library and by displaying plants that were of value to agriculture, medicine, rural economy and industry. Improvements were made to the ranges of glass-houses and quarters

96. Allen, (n. 64), pp. 105-106.
97. G. E. Fussell, 'Pure strains of grass seed', *Agriculture*, 57, Number 2, (1951), passim.
illustrating the classificatory systems of Linnaeus and Jussieu were established. He also sold collections of dried grasses. It seems likely these were purchased by societies or individuals who were building up herbariums. Salisbury continued the lectures and field excursions started by Curtis and anticipated a period of expansion with the passing of the Apothecaries Act of 1815. Possibly his courses, like those at the Chelsea Physic Gardens, now gave a greater emphasis to the study of horticultural science.

The idea of founding a botanic garden at Liverpool was encouraged and made a reality by the efforts of William Roscoe (1753-1831), a patron and practitioner of the arts and sciences and a keen botanist and horticulturist. Roscoe (chief subscriber) and the other local providers of capital established the garden in 1803 for both practical and scientific reasons. They believed that if the comfort of life was to be maintained it was essential to utilise botanical knowledge to assist the development of gardening, agriculture and medicine. It was also believed that it was important to keep on acquiring living specimens not only to observe their different characteristics but also to safeguard them from extinction; the idea was to preserve


vegetation for the benefit of science. Roscoe and his subscribers envisaged that the gardens would act as a sanctuary for the protection of plant life. It was hoped that the results obtained from observing the discriminatory features of plants would assist the development of botanical classification and thus ultimately of botanical science itself. 102

In reality, the gardens catered more for the needs of botany and horticulture than for the requirements of agriculture and medicine. My impression is that this came about because Roscoe, strongly devoted to botanical and horticultural affairs, exerted a substantial influence. That Roscoe clearly regarded the project as a venture in botanical and horticultural science is seen by the appointment of the knowledgeable and respectable botanical gardener John Shepherd (1764-1836) as curator, by the technology used in the garden and by the facilities that were provided. For example, Shepherd cultivated an enormous number of foreign plants in a specially constructed conservatory which had five compartments, each maintaining a different temperature, raised tender and rare aquatics in special aquariums and looked after a collection of half hardy herbaceous plants reared under a series of frames. There was also a systematically arranged grass plot, which indicates the garden attempted to serve agricultural needs. 103 Under Shepherd's care the

102. Ibid., Vol.2, p. 255.

103. John Shepherd, A catalogue of the plants in the botanic garden at Liverpool, (Liverpool, Private printing, 1805), pp. IV-V.
gardens became renowned for their collection of ferns and for the investigative work that was carried out on these plants. Shepherd successfully conducted experiments to raise ferns from spores, which at the time was a difficult operation, and instructions were sent, together with spores, to nurseries in other parts of the country.  

Shepherd also corresponded with private collectors and other botanic gardens and exchanged plants. In common with many other establishments, a botanic catalogue of the collection was issued and, with its sections on ferns, made a useful addition to existing botanical and horticultural literature. A library containing works of natural history and an apartment for a herbarium was built in order to aid identification and classification. Roscoe, in a move to improve the facilities and enhance the garden's scientific importance, donated his collection of three thousand dried South Sea Island plants.

These few examples show the wide range of interest in horticultural botany - it was fostered by a variety of specialist bodies from the prestigious Linnean Society to the local Brompton Botanic Garden. All the societies and gardens examined in this section either gave encouragement to, or participated in, the collection, identification, description and classification of newly discovered plants. Some also conducted experiments, became involved in the


physiological aspects of horticultural botany and most likely provided specimens to aid the investigatory work of others. In fulfilling all of these functions they contributed to the development of gardening science. These activities were carried out for a variety of reasons. The Linnean Society aimed to extend and develop scientific knowledge connected with natural history. Kew Gardens and the Liverpool Botanic Garden owed much to the philosophical and practical ideals of Sir Joseph Banks and William Roscoe respectively. The Chelsea Physic Garden was founded to serve the needs of medicine. This, too, was one of the aims of the London Botanic Garden and the Brompton Garden, which also tried to be of service to agriculture. These two establishments were run as commercial enterprises and set out to tap the various demands for botanical and horticultural knowledge. I have omitted any reference to those botanic gardens founded by wealthy individuals in the grounds of their home and those established by borough councils during the 1830s and 1840s. Quite probably, they acted as a showcase for rare specimens and unusual imports, provided an environment for experimental work and were a means of assisting the development of descriptive botany and plant classification. However, a great deal more investigative work is required before their role in nineteenth-century horticultural science can be confidently appraised.

2.4 The horticultural interest of some general scientific societies

The following surveys briefly the concern of the Royal Society
of Arts, the Royal Institution and the Royal Society with various aspects of scientific horticulture. The sixth Duke of Bedford was a member of the first two. The articles concerning horticulture published in the Philosophical Transactions of the Royal Society were, like those of the Linnean Society's Transactions, of a technical nature. In both of these publications, the papers covered a wide range of topics, although the Royal Society tended to print contributions that dealt with the internal functions of plants. The Royal Institution and the Royal Society of Arts, similar to the Board of Agriculture and the agricultural societies mentioned in an earlier section, usually published articles that combined science with practice. The Royal Institution was keen for horticulturists to utilise chemical analysis whereas the Society of Arts was very anxious to promote aboricultural improvements and develop techniques to improve the viability of seeds.

The Royal Society of London for the Improving of Natural Knowledge received its Royal Charter in 1663. During its early years some of its members fostered the development of botanical and horticultural knowledge by sending back accounts of rare plants on their travels abroad, by making sure that the Society established botanical correspondents and collectors in Britain and in other countries and by ensuring that the specimens which were received were arranged and catalogued. 106 Several

historians have argued that this early vigour contrasts sharply with a later period of comparative lethargy and have singled out the years between 1780 and 1820, a time when Sir Joseph Banks was President, as being a period when the Society was particularly torpid. ¹⁰⁷ Many of its historians have explained that there was little interest in botany during these years and have pointed out that not one single paper on a botanical topic appeared in the Philosophical Transactions. They have stated that the Linnean Society had practically absorbed all the communications connected with this science. ¹⁰⁸

This was far from being the case. The Linnean Society did not enjoy a monopoly because the Transactions of the Horticultural Society of London also contained papers on botanical topics. More importantly, though, I want to suggest that between 1790 and 1820 the Royal Society gave great encouragement to botanical and horticultural science and that its journal was much more important than the Linnean Society's Transactions in fostering the development of plant physiology. The alphabetical index of the matter contained in the Philosophical Transactions for the years 1781 to 1820 reveal articles on


the pests of garden plants, on the culture of various vegetables, on substances that were used as manure, on a number of flowers, on grafting trees and on the plants of different countries. The papers on anatomy and physiology covered such topics as the reproductive organs of plants, the functions of leaves, the effects of gravity on the growth of plants and the purpose of the various layers beneath the bark of trees. 109

The index strikingly discloses the fact that twenty two papers on horticultural science were written by T.A. Knight and of these, fifteen dealt with aspects of vegetable physiology. 110 Not all of Knight's papers read before the Royal Society found their way into the Philosophical Transactions. It is difficult to say how many were heard as there is no comprehensive catalogue of his writings. Thus, the Royal Society was a vehicle for publicising Knight's investigations in horticultural science.

Its encouragement of his work was the result of a chance meeting. In drawing up a list of landowners who would be willing to answer a Board of Agriculture questionnaire, Sir Joseph Banks had come into contact with Knight who was carrying out investigations in vegetable physiology at Elton in Shropshire. On realising the importance of this


work Banks persuaded Knight to publish his findings, gave encouragement and advice and read all Knight's papers to the Royal Society. He was able to give such patronage and prominence to Knight's work for several reasons. Firstly, although Banks was interested in chemistry and physics he was passionately concerned with botany and horticulture, and was eager to innovate and investigate. He even copied some of Knight's experiments. Secondly, Banks was a powerful personality and exerted a strong Presidential grip on the Society, a grip which D.S.L. Cardwell has not unfairly described as tyrannical (although it was a well meaning despotism).

The following is a sample of some of the issues that Knight reported on in his papers: the cause of debility in fruit trees, the ascent and descent of sap, the formation of roots, bark and buds, the behaviour of detached leaves, the direction taken by roots, shoots and tendrils and the origin and function of various vessels within the trunks of trees. None of these papers were reprinted or appeared in a modified form in the Transactions of either the Linnean Society or the Horticultural Society. Knight's work in vegetable physiology was regarded by contemporaries as

111. Ibid., pp. 10-11.


highly important and was praised by such eminent men as Humphry Davy, John Lindley and John Claudius Loudon. In 1806 Knight was awarded the Copley Medal by the Royal Society for his scientific contribution to botany and horticulture. The Society, therefore, far from neglecting botany in the years between 1795 and 1820, made a unique contribution by disseminating the results of Knight's pioneering work in vegetable physiology. With Bank's death in 1820 the Philosophical Transactions no longer contained articles on botanical and horticultural science and for the next twenty years only three papers appeared on these topics. Even though articles on physics and chemistry began to dominate the Transactions the Society did not entirely lose its interest in botany. During this period it awarded the Copley Medal to A.P. De Candolle in 1833 and to Robert Brown in 1837 for their work in plant physiology. The original objectives of the Royal Institution were to improve the living standards of the poor and create social harmony. It intended to accomplish this by spreading a knowledge of new and useful improvements and by demonstrating


how discoveries in science could have a practical application. Historians discussing the first fifteen years of its development have largely concentrated on the encouragement it gave to agricultural improvement, on the appointment of Humphry Davy and on Davy's work on agricultural chemistry. Maurice Berman, in the most recent history of the Royal Institution, has explained how very early on it began to lose its philanthropic outlook and that in the early 1800s its proprietors began to expect the work that it encouraged and initiated to bring pecuniary rewards. Berman's analysis concentrates on the landowning members who were keen to use science to improve farming and on the work and achievements of Davy and of his successor Michael Faraday, but of course, horticultural science and technology were also highly relevant.

Humphry Davy's investigations in vegetable physiology at the Royal Institution, which promised to have some bearing on the practical aspects of farming and gardening, have been discussed in connection with the Board of Agriculture. Here, I want to concentrate on the public lectures and articles dealing with botany and horticulture that appeared in the journals issued by the Institution between 1799 and 1831. Right at the outset

117. Berman, (n. 1), 1-2, 6-7.
it interested itself in the science and technology of gardening. Through improvements and developments in horticulture, the yield of crops could be increased and a more varied diet could be provided for the population as a whole. By encouraging the progress of scientific gardening the Society was striving to realise its original philanthropic aims. The Society proposed to give public lectures on various aspects of vegetation and provide talks on the effects produced by manures, together with instructions for their composition and their application to different soils. It was planned to exhibit models of hot-houses and to demonstrate several improvements in their design. 120 Although the Institution did not appoint a professor of botany, as it had done for chemistry, it did employ Sir J.E. Smith to organise a series of lectures which were delivered once a year until 1825. In 1829 Professor W.T. Brande of the Institution gave a course on botany which was attended by thirteen gardeners employed by the Horticultural Society of London and in the mid 1830s Professor John Lindley was requested to give a series of botanical talks. 121 It is quite clear that although much of the work of the Royal Institution was concerned with chemistry and physics, botany and its related sciences were provided for.


121. Mins. for 10th and 28th April 1829 and 24 March 1830, Vol. 9, 1828-1830 and for 7 December 1833 and 22 January 1835, Vol. 10, 1830-1837, Lib., R.H.S.
The Institution first published a *Journal* in 1802 and in this and volume two of 1803, were a number of articles concerning plants which had industrial uses and two papers on vegetable physiology. Between 1817 and 1831 several issues of a single journal were produced annually, covering topics connected with science, art and literature. After 1831 the *Journal* was discontinued. Articles dealing with a wide variety of topics on botanical and horticultural science appeared frequently, a great number occurring between 1827 and 1831. Sometimes over 50% of an issue was devoted to such articles. Authors included Cuthbert W. Johnson, Thomas Andrew Knight, John Lindley, P.J. Redoutte (1759-1841), a notable botanical draughtsman, and Joseph Sabine (1770-1837), Secretary and one of the Vice-Presidents of the Horticultural Society of London and a contributor to its *Transactions*. Pieces on plant physiology predominated and emphasis was placed on providing the results of chemical analysis of seeds, vegetables and flowers. Techniques in practical horticulture were discussed, books on horticultural chemistry and botany were reviewed, botanical details of newly discovered plants were given, the techniques of botanical illustration were considered and, occasionally, further information was provided about recently imported and cultivated species. There were also articles which outlined the vegetation found in other countries, which debated the systems of plant classification, which provided advice on the cause and cure of pests and diseases and which recommended the use of certain substances as manures.

A wider range of topics were covered compared to the Transactions of the Linnean Society. The pieces which combined science and practice which were printed in the Journal of the Institution were similar to those appearing in the Transactions of the Horticultural Society of London. Of the periodicals issued by the organisations and societies that have been mentioned so far, the Journal of the Royal Institution contained the greatest number of papers that dealt with the application of chemistry to horticulture. It can be seen that throughout the 1820s and during the early 1830s the Institution supported botanical and horticultural science, sometimes strongly.

The aim of the Society for the Encouragement of Arts, Manufactures and Commerce, was to promote improvements in all these branches by fostering scientific and technological progress. A Victorian analyst of the Society noted that although the patronage of agriculture was not specified in the plans of its founders it did, nevertheless, encourage improved farming. This was also the case for horticulture between 1790 and 1840.

To stimulate agricultural experiment and innovation and, indeed, to further improvement in all the areas which occupied the attention of the Society, medals and premiums were offered

to those who undertook prescribed investigations and provided satisfactory accounts of their work. The awards which could be offered and the conditions which had to be met before they could be granted were printed in its journal, *Transactions of the Royal Society of Arts*, and were organised under seven major headings; for example, agriculture, chemistry and manufactures. The very wide range of issues and problem areas which the Society wanted investigating in order to promote the development of agriculture has been fully documented by two historians of the Society. Although gardening was not directly mentioned until the mid 1820s, when it was allocated a sub-heading under agriculture, the major sections on farming, chemistry, the colonies, trade and manufactures contained topics which were pertinent and valuable to horticulturists. In this way, as we shall see, the Society patronised a variety of horticultural investigations and in doing so fostered horticultural science.

The Society was anxious to promote the development of aboriculture and premiums were offered for experiments carried out to find the best methods of raising trees, ascertaining the most suitable soil for different species, establishing a scientific basis for the techniques of pruning and estimating the growth rate of fir timber. Awards were also offered for investigations into the cure of pests of fruit trees, vegetables and flowers and the cause and treatment

---

of their diseases. The Society encouraged enquiries into the use of steam and hot water for heating plant houses and awarded a premium to someone who had developed a glass case for growing ferns. Comparative trials of manures were inaugurated, one of the aims being to ascertain their efficiency on various soils. Encouragement was given to finding improved methods of cultivating cabbages, potatoes, beans and carrots. As the Society wanted to foster the spread of the most vigorous varieties of all kinds of plants it supported the distribution of seeds, cuttings and grafts. Indirectly, by awarding its prizes to those who could raise pure strains of grass seeds and to those who conducted enquiries which compared the different methods of producing permanent pasture, the Society was helping to improve the techniques of establishing and maintaining lawns. It was extremely keen to extend the flow of useful plants between Britain and other countries and wanted to find ways of ensuring the definite survival of vegetation during the long land and sea journeys that were involved. A premium was offered to anyone who could establish a chemical method of preserving the vitality of seeds, although the prize does not appear to have been awarded. The Society did much to develop the vegetable productions of Britain's colonies and its contribution to horticultural science here will be discussed in a later section.

In 1826 gardening was mentioned specifically under agriculture and James Harrison, Fellow of the Horticultural Society of London, was appointed to the adjudicating committee. This sub-heading was retained for over a decade. As well as continuing to support the same sort of enquiries and experiments that I have just mentioned, several new areas of investigation were introduced. Premiums were now offered for carrying out experiments to find a way of making plants flourish in climates and situations very different from their natural habitat or for presenting information on this issue. Awards were offered for investigations into the improvement and management of fruit and kitchen gardens. The Society showed a renewed interest in the development of glass-houses and granted premiums for improvements in their construction, their heating and their maintainence. 126

The Transactions of the Royal Society of Arts were an important vehicle for publicising and detailing the Society's aims. Besides listing awards and laying down conditions and terms, the Transactions contained prize-winning reports. They were a channel for the communication of practical and scientific horticulture. These reports reflect the Society's effort to encourage systematic and careful investigation. Occasionally, they acted as a forum of discussion. Sometimes writers in

126. Ibid., See 44, (1826), 45, (1827) and 46, (1831).
reporting the results of their experimental work directly concerned with or relevant to horticulture, would refer to the investigative work of others and marshal the ideas of theorists to support their findings.\textsuperscript{127} The \textit{Transactions}, unlike the journal of the Royal Society, the Royal Institution and the Horticultural Society of London, was not devoted to issues connected with the internal structure of plants.

Having discussed the work of a number of societies which were involved in various scientific activities besides horticultural enquiry, I want now to turn to institutions which were established solely for the encouragement of improvements in gardening.

2.5 The emergence of specialist horticultural societies

The Horticultural Society of London was formed, along somewhat similar lines to many of the existing agricultural societies,\textsuperscript{128} for the improvement of useful and ornamental horticulture. H.R. Fletcher, who wrote the standard history of the Society, noted that it intended to achieve this objective with the aid of science.\textsuperscript{129} As I shall explain, the Horticultural Society involved itself in a variety of practical and scientific gardening activities. During the Society's

\textsuperscript{127} Trans. R. Soc. Arts., (n. 125).
\textsuperscript{128} Dawson, (n. 112), p. 498.
\textsuperscript{129} Fletcher, (n. 2), p. 48.
early years much of its own experimental work and a great deal of its patronage reflected the interests of two important members, Sir Joseph Banks and Thomas Andrew Knight. Their influence ensured that the Society gave a great deal of attention to improving the strains of fruit and vegetables. In the 1820s the Society sent out collectors to many parts of the globe to bring back plants, shrubs and trees. It acquired an experimental garden and financed a great deal of investigatory work but, surprisingly, the Council only got round to undertaking experiments in chemistry in the 1840s inspite of the interest shown in this science in the early years of the century. The Society wanted to improve the training of its gardeners and John Lindley did a great deal to introduce certificated courses, part of the syllabus being devoted to a study of horticultural science. Also, the Horticultural Society stimulated the development of other Societies, such as the Horticultural Society of Ireland, and acted as a model for some, as in the case of the Caledonian Horticultural Society.

John Wedgwood (1766-1844), banker and keen gardener, first proposed the formation of a horticultural society to Sir Joseph Banks in 1801. Wedgwood envisaged that this society would collect information on the culture and treatment of plants and trees, publish a journal similar to the Transactions of the Society of Arts and award premiums for improvements in horticulture. Anon, The official handbook to the gardens of the Royal Horticultural Society of South Kensington, (London, Royal Horticultural Society, 1864), p. 10.
Wedgwood's Society was formed soon after and in 1804 it held its first anniversary meeting. By 1805 the Earl of Dartmouth was President, there were twenty members on the Council and there were a hundred ordinary members. Thomas Andrew Knight, in the same year, was requested by the Committee to write a pamphlet for national distribution outlining why the Society was formed and explaining some of its aims. Knight's report was a highly personal one and, as will be shown, he saw its compilation as an opportunity to continue his feud with a fellow horticulturist.

Knight was a paternalistic Whig who encouraged his tenants to adopt modern farming techniques, opposed extension of the sufferage and vote by ballot and helped to administer the New Poor Laws at Ludlow, Shropshire. He was made President of the Society in 1811 and retained this position until his death in 1838. Knight believed that developments in horticulture would help to improve life generally and observed that although agriculture was well served by organisations and societies which fostered its evolution, there was (until the formation of the Horticultural Society of London) no national body to promote horticulture. Knight pointed out that there


was still a great deal of ignorance about the native country of plants, there were few experiments to assist the culture of flowers and fruits and, '... there was an ample and unexplored field for future discovery and improvement ...'.

He intended the new Society to overcome some of these omissions and, as fields for future discovery and improvement, he drew attention to the importance of raising new fruits from seed, of developing forcing houses and understanding the principles behind them and of extending knowledge of the use and application of manures.

Like other contemporary specialist societies, the Horticultural Society of London was keen to promote and publish the results of careful investigation and experiment. However, Knight took these aims further. He criticised the, '... common gardener who pursues dull routine and rarely possesses sufficient science and information to deviate with success ...' and argued that an important function of the Society was to, '... proceed with cautious circumspection to publish well ascertained facts only, to detect the errors of ignorance and to expose the misrepresentations of fraud ...'.

It is these statements, I believe, which reveal not only Knight's scientific philosophy but also that he was continuing his

134. Ibid., pp. 6-7.
135. Ibid., p. 4.
personal argument against William Forsyth (1737-1804), Gardener to the Royal Gardens at Kensington. Forsyth had produced a 'plaister' which he claimed would combat canker in fruit and forest trees and would help rejuvenate decayed trees. Knight was convinced that his own experiments had proved that canker was a symptom of senility and was, therefore, incurable. A reviewer in an issue of the Monthly Review of 1798 compared these conflicting opinions and came down on the side of Forsyth. Knight was outraged and between 1800 and 1808 conducted a critical campaign against Forsyth, who was a skilful but practically minded gardener, and took the controversy to the level of personal insult.\footnote{Guy Meynell, 'The personal issue underlying T.A. Knight's controversy with William Forsyth', Journal of the Society for the Bibliography of Natural History, 2, Part 3, (1979), pp. 281-287.} It spilled over into the founding of the Horticultural Society of London and possibly involved a power struggle over who was to be at the head of the Society with Forsyth and his ally Dr James Anderson (1739-1841), editor of the monthly Recreation in Agriculture, agricultural journalist and inventor of a patent hot-house, in one faction and Knight and Sir Joseph Banks in another.\footnote{Ibid., p. 285} Thus, as well as laying down scientific guidelines for the Horticultural Society, Knight saw the compilation of his report as an opportunity to strengthen his own position within the Society and, indirectly, to continue his dispute with the late William Forsyth.

To encourage the evolution of scientific horticulture the Society
provided a number of facilities and services for its fellows and employees and for those who were not members and financed a range of activities. One of its priorities was to build up a library of scientific works on botany and horticulture for reference and borrowing which could be used by fellows and staff who were carrying out investigations. The Society also developed a herbarium, commissioned botanical artists to compile carefully and accurately coloured engravings of the distinct varieties of fruit that were cultivated in the experimental garden and purchased outstanding collections of botanical drawings of foreign fruits. New or rare plants were distributed, at no charge, to members, nurserymen, private and public botanic gardens and colonial establishments. The idea was both to replace existing plants with improved varieties and to encourage the spread of plants that seemed to offer the chance of commercial exploitation. The Society played a role in the development of colonial horticulture, which will be discussed in the final section.

To diffuse information about developments in gardening the Society regularly held meetings at its London house where papers on scientific and practical horticulture were given. Lectures in horticultural botany and chemistry were introduced for the benefit of fellows and for the

139. Fletcher, (n. 2), p. 82.
Society's trainee gardeners, some two hundred and sixty four apprentices being taken on between 1822 and 1846. In 1831 John Lindley gave a course of three lectures on the application of botany to horticulture and up to 1833 presented an annual series of six talks.\footnote{140} After this date the course was discontinued but it does show the Society was attempting to extend its range of scientific activities. In 1843 Edmund Solly (1819-1886) was appointed as the Society's chemist. One of his duties was to give a course of lectures to fellows and their friends on 'chemistry applied to the arts of cultivation'.\footnote{141} His chemical investigations for the Society will be mentioned later.

The Society's Transactions were a forum for new ideas and for the discussion of scientific horticulture. They were first published in 1807 and were distributed to members and sold to the general public, some two and a half thousand copies being printed in 1822. An examination of the volumes issued up to 1840 indicates that a great deal of attention was paid to fruit and vegetable cultivation. Although in its early years, the Society saw the growing of decorative flowers, shrubs and trees

\footnote{140}{Mins. Vol. 10, (n. 121), 30 November 1830 and May 1833.}

\footnote{141}{Mins. for 28 May 1841, Lib. R.H.S., Vol. 11, 1838-1847.}
as activities worthy of support, it believed that it was very important to cultivate kitchen garden and fruit crops. New varieties of ornamental plants were discussed and botanically described but the emphasis was on the utilisation of science and technology to produce better strains of fruit and vegetables and to improve the techniques of their cultivation. Undoubtedly, this emphasis owed something to the influence exerted within the Society by Thomas Andrew Knight (it was probably strongest during the first two decades of his Presidency).\textsuperscript{142} Knight set the Society an exemplary standard by contributing sixty-three papers over a period of roughly thirty years.\textsuperscript{143} They covered the production of culinary crops, greenhouse gardening and vegetable physiology.

In keeping with its intention to diffuse a knowledge of horticultural science, the Society dispatched complimentary copies of its Transactions to those institutions which patronised horticulture. Volumes were sent to the Dublin Society, the Linnean Society, the Royal Society, the Royal Institution, the Horticultural and Agricultural Society of Edinburgh, the East India Company and the English Agricultural Society, renamed the Royal Agricultural Society of England in 1840.

With a view to encouraging the development of experimental gardening the Society decided to award medals to those who had raised new vigorous and productive varieties of fruit and vegetables or made important discoveries in horticulture.\textsuperscript{144}

\textsuperscript{142} Hadfield, (n. 2), p. 273.
\textsuperscript{143} Bentham and Lindley, (n. 110), pp. X-XII.
Knight, standing by the results of his early experimental work on fruit trees, was anxious that some of these awards should be given to those who had raised superior strains of fruit from seed, which he believed produced a healthier plant than those raised from grafts: '... new varieties of every species of fruit are generally better obtained by introducing the farina (pollen) of one variety of fruit into the blossoms of another than by propagating from any single kind'.

The Council also granted awards to individuals who had publicised and distributed these new varieties. The gold Banksian medal and the Knightian medal were conferred on those who had been of service to the Society or who had made a meritorious contribution to improved horticulture. The silver and bronze medals were for more frequent distribution and normally went to those who had exhibited at meetings and shows what were considered to be the best varieties of fruit and vegetables raised by cross-breeding. Silver medals were sent to provincial horticultural societies with the stipulation that they should be awarded to members who had provided the greatest number of superior exhibits, or had developed an improved technique of cultivation or had sent in an original communication.

An important part of the Society's activities was the experimental garden. In 1818 one and a half acres of


146. Mins. for 1 August 1815 and generally for the period 1815-1816, Lib. R.H.S., Vol. 1, 1815-1817; Knight, (n. 133), p. 6.

147. Fletcher, (n. 2), pp. 28-30, 53-54.
land were acquired at Kensington and an auxiliary nursery was set up at Ealing but this proved to be too restrictive. In the early 1820s the Duke of Devonshire leased to the Society thirty three acres at Chiswick, the gardens being laid out in 1823. Here, the Society both determined and followed modern practice. Registers were started so that readings of the barometer, thermometer, hydrometer and rain gauge could be recorded. Hundreds of varieties of fruit and vegetables were grown experimentally to ascertain their botanical characteristics, the aims being to contribute to the standardisation of nomenclature and to find the most advantageous mode of cultivation.

Experiments in forcing fruit, in the construction of pineapple pits, in observing the effects on glass-house plants of wood treated with certain chemicals and in the comparative growth of new varieties of potatoes were conducted. Throughout the 1820s and 1830s many collectors, who were financed from a variety of sources such as membership fees, voluntary subscriptions, private donations and the profits from the Society's fashionable breakfasts and flower shows, were sent to China, India, Africa and America to bring back new and unusual hardy and greenhouse plants. By extending the experimental garden's stock of these plants and by participating in schemes of plant exchange the Society added to, and helped spread, horticultural knowledge.


149. Ibid., p. 4.


151. Fletcher, (n. 2), pp. 91-106.
At the end of our period the Horticultural Society began to undertake chemical investigations. In 1841 the sixth Duke of Devonshire, who was President, expressed to the Council that:

'... it would be desirable with a view to promote the science of horticulture that an officer should be appointed to conduct experiments in horticultural chemistry, more especially for the purpose of investigating the exact nature of the influence produced upon garden plants by soil and by the substances employed as manures'. 152

The Council approved, persuaded no doubt by the Duke's assurance of a donation of £50 per annum over a period of four years, and Edmund Solly began his investigations in the experimental garden at Chiswick. 153

The Horticultural Society saw the education of its own gardeners as one of its most important objects 154 and regarded its experimental garden as being, '... a National school for the propagation of Horticultural knowledge ...'. 155 The Society trained its apprentices for two years and because it was confident they would eventually go on to become gardeners in the most important horticultural establishments in the country, took care to ensure they left with, '... a degree of respectability and talent ...'. 156 To assist


trainees to gain this understanding of horticultural science and practice they were given access to all the catalogues and documents relating to the garden as well as to the relevant elementary text books, and the Council voted money to increase this stock. Also, as I have previously mentioned, student gardeners in 1836 had to perform satisfactorily in an end of course examination if they were to be recommended for employment. By introducing this stipulation the Society was helping to lay down prescribed standards for the training of gardeners. Though H. R. Fletcher's suggestion that, '... the Society's Garden now provided better facilities for the education of professional gardeners than those to be found anywhere else in this country, or indeed abroad ...', may be an exaggeration, the Horticultural Society nevertheless made an important contribution in this field and continued to do so throughout the nineteenth century. The seriousness with which the Society viewed its function as an educator is also illustrated by the assistance it gave to the Royal Institution and the University of London, enabling these bodies to present discourses in botany. Drawings of plants and living specimens from the experimental garden were lent by the Society to assist Professor Brande at the Institution and Professor Lindley at the University to deliver their lectures on botanical science.

The formation of the Horticultural Society of London

157. Ibid., p. 9; Fletcher, (n. 2), p. 80.
158. Fletcher, Ibid., p. 83.
159. Mins. Vol. 9, (n. 121), 28 April 1829 and 24 March 1830.
heralded an enormous expansion in similar independent provincial and local organisations. The Caledonian Horticultural Society of Edinburgh modelled itself on the London Society. During 1816 the Royal Horticultural Society of Ireland was founded to protect and promote the science of gardening. It is instructive to note that by 1839 there were approximately two hundred and nineteen provincial horticultural, botanical and floricultural societies. The role of these societies in co-ordinating some of the great interest shown by the population in gardening and in contributing to the development of scientific horticulture has yet to be assessed.

As E.H.M. Cox has explained, the Caledonian Horticultural Society's objective was to encourage and improve the cultivation of the best kinds of fruit, flowers and vegetables. Cox, however, has not emphasised that the Society was extremely interested in, and actively promoted, scientific gardening. Like the Horticultural Society of London, it issued bound volumes of papers which combined science and practice. It awarded medals for the production of improved varieties and for important communications, the gold medal being given for the most outstanding contribution. Also, it gratuitously


distributed buds, grafts and seeds to members. Part of the Society's experimental garden was devoted to the collection, identification and evaluation of fruit trees. There were plots for curious and select investigations, for experimenting with tender exotics and for making comparative enquiries into different modes of cultivation. All the specimens in the garden were fully labelled with details of their botanical characteristics, their mode of culture and their various properties and qualities. This enabled staff, members and visitors to identify clearly all the plants in cultivation, to discriminate between different varieties and to assess their usefulness for horticulture or for agriculture. By undertaking these activities the Caledonian Horticultural Society was helping to develop and diffuse horticultural science in Scotland. The Society's foundation and work reflects the influence of the Horticultural Society of London and the impact of some of the methods it used to promote scientific gardening. In turn, those who formed the London Society and shaped its early development used as guidelines a number of contemporary agricultural societies and scientific institutions.

2.6 Self Improvement and useful horticulture

The subject of this section is two organisations which were

involved in the transmission of serviceable horticultural information, the Society for the Diffusion of Useful Knowledge and the Labourer's Friend Society. The object of the Society for the Diffusion of Useful Knowledge was to impart, '... useful information to all classes of the community, particularly to such as are unable to avail themselves of experienced teachers or may prefer learning by themselves'. One of the main methods used in an attempt to achieve this objective was the, '... periodical publication of treatises under the direction of a superintending committee...', each one containing, '... an exposition of the fundamental principles of some branch of science ... their proofs ... application to practical uses ... and explanation of facts or appearances'. It launched several different, and often quite ambitious, series of publications and acted as an intermediary between author and publisher to ensure these ventures were accomplished satisfactorily. Although the Society was greatly interested in scientific subjects it provided information on other topics and its periodicals and volumes contained facts about the Royal Family, the law, banking, taxation, government, education and commerce. Horticulture and agriculture were regarded as activities of great utility. By importing useful information on gardening, the Society intended artisans and labourers to supplement the family income, to enjoy a healthy recreation and even to contribute

165. Ibid., p. 2.
to horticultural science by raising new and improved varieties of vegetables and fruit. 167

The motives behind this paternalism are not readily discernable. The desire to bring harmony to the lives of those adversely affected by the industrial revolution 168 and by agrarian changes appears to have been quite strong in the minds of the Society's founders and subscribers. This seems to be born out if one considers the benefits, mentioned above, that the Society hoped would result from the transmission of horticultural information. Harmony was to be achieved through the diffusion of cheap reading material. Most probably, a great number of subscribers regarded the Society as a vehicle for containing social unrest and saw science as an important means of achieving a harmonious, ordered society, believing that scientific education could exert a particularly stabilising influence. 169 Some, no doubt, also viewed the Society as a means of expanding their own social and career opportunities. 170 Certainly, the section on cottage and spade husbandry contained in the books and almanacs commissioned by the Society conveyed useful and constructive practical agricultural and


170. Ibid., p. 110.
horticultural information in a relatively simple and easily understood manner. In some instances, it was based on scientific theory. Technical details about the nature and properties of all trees, plants and vegetables cultivated for food or profit, plus reports of special horticultural interest, appeared in the *Farmer's Series* whilst information on soils and minerals figured in the volumes entitled *British Husbandry*. Whether the Society intended certain parts of this information to be read by labourers and artisans is an arguable matter. It seems doubtful if these groups would have been able to understand fully even the less complicated passages. John Lindley's section on botany and gardening, in a volume on natural philosophy published in the late 1830s, contained a great deal of technical detail. Lindley's contribution was the result of the Society's plan to include in their tracts on natural philosophy certain aspects of botanical and horticultural science, namely, the chemical functions of vegetation and the structure and function of plants and their diseases. The plan was partially realised thirteen years after its inception with the appearance of Lindley's section, which was part of a series given the name *Library of Useful Knowledge*. Lindley covered structural, physiological, systematic and descriptive botany and utilised some chemistry


172. Percival, (n. 166), p. 3.

in his discussion on physiology although he did not consider, as originally planned, the diseases of plants.\textsuperscript{174} This work was probably not intended for the lower orders. It could have been directed at those who were in a position to encourage labourers to take an interest in gardening and to adapt efficient methods of cultivation, such as teachers, clergymen, landowners, agents and stewards.

The aim of the Labourer's Friend Society, founded in 1831, was to disseminate, '... knowledge beneficial to the farmer, the landowner, the labourer and our country'.\textsuperscript{175} Rural discontent and sporadic outbursts of incendiarism and machine breaking were features of the 1830s and early 1840s\textsuperscript{176} and the Society's emergence should be set against this background. It is quite likely that its intention, as in the case of the Society for the Diffusion of Useful Knowledge, was to try and smooth over the cracks that were appearing in the fabric of British society. Its early work conveys a sense of great urgency. In an effort to ameliorate the living standards of poorer classes and mitigate discontent it campaigned vigorously to encourage landowners to set up allotment schemes for the poorer

\begin{itemize}
  \item \textsuperscript{174} \textit{Natural Philosophy}, (London, Baldwin and Cradock, 1838), Vol. 4.
  \item \textsuperscript{175} Anon, \textit{Proceedings of the Labourer's Friend Society}, (London, Dean and Mundy, 1832).
\end{itemize}
classes. The idea was to rent out to agricultural labourers strips of land of between twenty and forty poles, situated very near their dwellings, to enable them to produce cheaply a good stock of vegetables. The system was analogous to the scheme advocated by the Society for Bettering the Conditions of the Poor in the late eighteenth century and by Arthur Young (1741-1820), Secretary of the Board of Agriculture, in the early nineteenth century. Both this Society and Young proposed that agricultural labourers should, if they wished, be allowed to cultivate a piece of ground adjacent to, or else quite near, their cottages. The Society and Young were supported at the time by a few landocrats who introduced allotments on their estates. The campaign was continued by social reformers well into the century.

The Labourer's Friend Magazine and Facts and Illustrations, both issued monthly, were published by the Labourer's Friend Society. They contained articles which supported its aims. The latter was

177. The Society published, Facts and Illustrations, demonstrating the important benefits, "... which have been, and still may be, derived by labourers from possessing small portions of land ..." which was produced between 1831 and 1833. The Society also issued the monthly Farmers Magazine, (1834-1841). Its purpose was to disseminate, "... information on the advantages of allotments of land to the labouring classes and other means of improving their condition".


180. Stubbs, Ibid.
blatantly propagandist, consisting of testimonials from landowners and others on the benefits of the allotment system, but it occasionally explained the science behind practical tasks and encouraged horticultural experimentation. The former regularly contained articles on the cultivation of fruit and vegetables and the management of plantations. It also fostered innovation and experimentation and commented on the reasons for carrying out practical tasks, sometimes providing fairly detailed scientific explanations. It is unclear what sort of readership the Society was aiming for. Landowners may have been using these two periodicals to convey information to an agricultural labouring class audience in order to encourage them to improve their living standards by taking up gardening. Nine years earlier, William Cobbett, (1762-1835), the nurseryman and political commentator, had written his Cottage Economy (1822) partly for such an audience. His book gave household tips and advocated the efficient cultivation of a garden. Alternatively, these magazines may have been aimed at fellow landowners and their agents and stewards with the idea of persuading them to adopt schemes on their estates which would benefit the agricultural workforce. It seems probable that an objective of the Society was to encourage social stability. The 1830s and 1840s, as I have remarked, were a period of acute

181. Anon, Cottage husbandry, (n. 178), passim. This was a compilation of articles and comments from the publications of the Labourer's Friend Society.
social tension and quite possibly the Society and its publications were a manifestation of the attempts that were being made at this time to preserve the social order\textsuperscript{182} — in other words the Society was, in part, an agent of social control.

These two organisations attempted to create an interest in horticulture because the cultivation of plots of land was seen as a realistic measure to alleviate some of the problems caused by poverty and unemployment. By providing scientific data about gardening and by making use of current theories and ideas to explain practical tasks, they contributed to the growth and diffusion of horticultural science.

2.7 Horticulture, colonies and overseas trade

A number of institutions already discussed showed an interest in the colonies. The Royal Society of Arts, Kew Gardens and the Horticultural Society of London were keen to develop commercial agriculture and horticulture in Britain's overseas territories. They promoted a flow of plants between Britain and her dependencies. Kew and the Society of Arts tried to encourage the colonial territories to exchange plants with one another on a regular basis. In pursuing their objectives these organisations

fostered the development of horticultural science both at home and abroad.

The commercial and scientific voyages of discovery in the eighteenth and nineteenth century had, as Lucile Brockway appositely remarked, opened up the whole world's vegetable riches to European botanists. Every new plant was appraised in order to assess its value as a food, fibre, dye or medicine.\(^{183}\) The Society of Arts was not slow to realise that this flora had enormous potential and that its exploitation could expand the country's wealth. It wanted to see the colonies, rather than other nations, become the most important supplier of Britain's raw materials and foodstuffs.\(^{184}\) The establishment of new colonial botanic gardens to act as research and co-ordinating posts and the strengthening of contacts with existing ones so that its aims could be even more strongly promoted, were seen by the Society as being essential pre-requisites of success. Premiums were offered to encourage their foundation and to persuade the superintendents of existing gardens to undertake experiments to raise plants that were new, rare and commercially useful.\(^{185}\) To ensure close


\(^{184}\) Luckhurst and Hudson, (n. 124), p. 155.

contact with the Society was maintained, superintendents were made
honorary correspondents. Premiums were also offered to those
who could find a way of successfully combating the insects
that attacked plantation crops and to those who planted
the largest acreage of a specified crop or established a
serviceable plant. 186

Sir Joseph Banks fully realised the value of Britain's colonial
empire and was convinced that the scientific study of plant life
was the key to its rapid economic development. He believed
Kew Gardens could play a significant role in this expansion.
H.D. Cameron summed up Banks' attitude extremely well when
he wrote that this patron of the sciences regarded Kew as,
'... the great exchange house of the Empire where the possibilities
of acclimatising plants from one part of the globe to another
might be tested and from which material for experimental work
in any climate would always be available'. 187 For Banks,
the botanic gardens at Kew were to be an advisory unit and
a centre for controlling the development of botanical and
horticultural exploration and experiment. Under his
guidance tea, sago, date palm and mangosteen were successfully
transplanted to India and many gardeners who were trained

186. Wood, (n. 124), pp. 84-112; Trans. R. Soc. Arts, 12, (1794). See the list of premiums on offer
under the section, 'Colonies and Trade'.

under Banks' regime at Kew took up posts in the various botanic gardens of the empire.\textsuperscript{188}

The Horticultural Society of London, where Banks exercised a great deal of influence and guidance,\textsuperscript{189} was anxious to contribute to the economic development of Britain's empire. The Committee wanted to send to the dominions plants which offered the prospect of commercial exploitation (and which would ultimately benefit Britain) and to expand the stock of its own experimental garden with new or rare foreign specimens.\textsuperscript{190} To achieve these ends the Society distributed seeds, plants and trees to the colonies at its own expense, appointed as corresponding members a number of people who were working there, sent out collectors, conducted investigations and experiments in order to acclimatise and propagate plants which promised to be of utility to these territories, and gave technical advice to colonial governments.\textsuperscript{191}

The East India Company also played a role in the development of scientific horticulture. It was founded originally to trade with India and the Far East. By 1800 it had evolved into

\textsuperscript{188} \textit{Ibid.}, pp. 82-101.

\textsuperscript{189} Fletcher, (n. 2), pp. 20, 27-30, 53-54, 70.

\textsuperscript{190} Mins. for 22 January 1822, Lib. R.H.S., Vol. 5, 1822-1823.

a territorial enterprise controlling a substantial part of India, supported by its own army and fleet of ships.\footnote{192}{Berman, (n. 1), pp. 77-78.} The Company was controlled by the Court of Directors (largely bankers and financiers) who were enormously keen to exploit the possibilities offered by the colonial empire. Between 1780 and 1820, spurred by the prospect of increased profits and dividends, the East India Company established botanic gardens in the sub-continent and took over some that were already in existence.\footnote{193}{Mildred Archer, 'India and natural history: the role of the East India Company 1785-1858', \textit{History Today}, 2, (1959), pp. 737-738.} Sir Joseph Banks was involved with the Company and gave assistance by helping to co-ordinate experimental work, by identifying plants and insects, by judging botanical papers, by giving scientific advice and by recommending gardeners for appointment to its service.\footnote{194}{Dawson, (n. 112), pp. 289-296.} As Mildred Archer quite rightly points out, some knowledge of botanical and horticultural science was needed if gardens were to be maintained carefully, if enquiries and experiments were to be carried out and if a plant's commercial potential was to be recognised.\footnote{195}{Archer, (n. 193), p. 736.} The Company, therefore, tried to appoint those who were skilful and knowledgeable as superintendents of their botanic gardens. It secured the
assistance of those of its servants (notably doctors) who had some familiarity with botany and horticulture. These employees organised, or participated in, the collection of specimens.

A good example of the kind of work carried out under the patronage of the East India Company is provided by the efforts of Dr William Roxburgh (1751-1815) who was Superintendent of the Calcutta Botanic Garden between 1793 and 1813. Roxburgh began a systematic collection of plants, laid out the gardens according to the Linnean system, established a herbarium and trained a small group of Indians in the techniques of botanical draughtsmanship.196

Under the direction of Sir Joseph Banks and with the munificence of the East India Company, Roxburgh produced three volumes of botanical descriptions and illustrations of plants that grew along the coast of Coromandel.197 He intended this work, which was published between 1795 and 1819, to be of use to those engaged in medicine, the arts and manufactures. With its accurate coloured engravings and detailed descriptions it was of value to botanists and

196. Ibid., p. 737.
197. William Roxburgh, Plants of the coast of Coromandel; selected from drawings and descriptions presented to the Hon. Court of Directors of the East India Company, (London, George Nicol, 1795-1819, 3 vols.).
horticulturists. 198

Profit was the dominant motive which led the Company to set up these botanical and horticultural institutions, make expert appointments, sponsor plant hunting expeditions and subsidise scientific publications. There was also an element of scholarship and, it seems, an awareness that such efforts were helping to advance science. The Company in 1801 started a library and museum in East India House, in Leadenhall Street, to display its scientific books, drawings and dried specimens. 199 In 1818 the Directors suggested to the Horticultural Society of London that some of its servants could become corresponding members. 200 Throughout the 1820s and 1830s the Company donated to the Linnean Society and the Horticultural Society of London duplicates of its herbarium specimens which had been collected by employees.

198. It is possible that some of these illustrations were amongst the thirty six drawings of Indian fruits purchased by the Horticultural Society of London in 1821, Mins. Vol. 4, (n. 135), 29 January 1821.

By organising the Calcutta Botanic Garden according to the Linnean system Roxburgh was introducing to Indian culture a western system of taxonomy. In fact, during the 1830s and 1840s the scientific work of William Cobbett, T.A. Knight, John Loudon and Humphry Davy seem to have had an impact on Indian agriculture and horticulture. Davy's method of soil analysis, for example, was adapted in Central India. See respectively: G.T. Speede, Indian handbook of gardening, (Calcutta, W. Thacker and Company, 1840), pp. 3, 49, 94 and Henry H. Spry, Modern India, (London, Whittacker and Company, 1837), pp. 271-273.


of the Company who were stationed in India.\footnote{201} Between 1828 and 1832, sixteen thousand dried plants had been distributed.\footnote{202} Profit was tempered, therefore, by a certain altruism towards scientific endeavour.

Conclusion: This survey has indicated that many different quarters were variously involved in the patronage of horticultural science during the first forty years of the nineteenth century. The following were important promoters: the aristocracy, bankers, industrialists, a landed gentleman, venerable scientific institutions, agricultural organisations, newly founded societies, botanic gardens, bodies which concerned themselves with the well being of the labouring class, the East India Company and the state. The government, although not a generous patron, did help to finance voyages of discovery, Kew Gardens, the Board of Agriculture and the Dublin Society. It also allowed botanical collectors to travel on board admiralty ships. The state's contribution to the development of horticultural science is by no means fully documented.

In one sense, it is artificial to separate individuals from institutions. I have outlined how horticulturists amongst the landed nobility encouraged experimentation and innovation on their estates and belonged to societies and bodies which were themselves patrons of scientific horticulture. I have also


\footnote{202.}{Desmond, \textit{Ibid.}}
shown how keen gardeners such as William Roscoe and Thomas Andrew Knight belonged to institutions and organisations which promoted horticultural science. Roscoe helped to found and finance the Liverpool Botanic Garden. Knight beavered away on experiments in horticultural physiology on his estate and presented his findings to the Royal Society and the Horticultural Society of London. These organisations, therefore, drew disparate elements together, helped to focus interest, co-ordinated activities and presented to the world a solid front, a tangible symbol of shared concerns and common endeavours.

Institutional interest in horticultural science, as the foregoing has revealed, was quite extensive. Although many of these were London based, I would like to suggest that this patronage could be taken as an indication of the general interest that was shown in horticulture throughout the country by all classes of Society, from the aristocrat to the cottage labourer. The horticultural activities of the nation have been largely ignored by economic, social and scientific historians whereas agriculture, a closely related subject, has been well documented over the last twenty years or so. Of course, farming in the early nineteenth century was still a major economic activity even though the country was becoming increasingly industrialised and quite rightly deserves close attention. Nevertheless, it could be argued that some activities such as fruit and vegetable growing, which have been treated under agriculture, could more properly be regarded as horticultural productions.
It has not been the intention of this chapter to make a detailed exploration of the motives behind this institutional interest in scientific horticulture. For one thing, a great deal more needs to be known about the people who directed policy and about those who sanctioned what went into publications. Moreover, these controlling forces changed with time and much more data would be needed in order to make any useful comments or conclusions on this issue. It seems likely that the prospect of profit was important. The desire to participate in scientific activities and contribute to the development of science also need to be considered. Possibly, too, during times of social discontent it was believed that science could help to restore stability and maintain the status quo. In order to try and clarify some of these issues and to gain a better understanding of the patronage of science by a member of one of these interested groups, the landed aristocracy, the next three chapters will examine the activities fostered by the sixth Duke of Bedford at Woburn Abbey.
3.1 The sixth Duke of Bedford and Woburn Abbey

John Russell became the sixth Duke of Bedford in 1802 and made great efforts whilst he reigned at Woburn Abbey \(^1\) to develop the parkland and the gardens. F.M.L. Thompson has drawn attention to the fact that one of the main activities of country house owners and their families in the nineteenth century was the pleasure and interest to be derived from the gardens and park, the others being country sports, giving and receiving hospitality, supervising stewards and agents and an involvement in local county affairs. \(^2\) For Thompson, these major activities formed the skeleton of the structure of country life, the interstices being filled in with agricultural, philosophical, literary or scientific activities.

1. The Abbey was founded in 1145 by a band of Cistercian monks from Fountains Abbey in the West Riding of Yorkshire. With the general dissolution of the monasteries in the sixteenth century the Abbey and many other monastic properties were given to John Russell, who was made first Earl of Bedford in 1550. He demolished the buildings and created on the same spot a family seat appropriate to the status and dignity of his new position. See: Stephen Dodd, *An historical and topographical account of the town of Woburn, its Abbey, and vicinity, containing also a concise genealogy of the House of Russell, and memoirs of the late Francis Duke of Bedford*, (Woburn, Private printing, 1818), pp. 21, 32-39; P.F. Robinson, *Vitruvius Britannicus*, (London, J. and A. Arch, 1833). The relevant section is entitled, 'History of Woburn Abbey: illustrated by plans, elevations and internal views of the apartments, from actual measurement', pp. 1, 2, and 10; Georgiana Blakiston, *Woburn and the Russells*, (London, Constable and Company Limited, 1980), pp. 54-55.

pursuits.  

I would like to extend Thompson's analysis by examining not only the sixth Duke of Bedford's pursuit of horticulture but also his patronage of the scientific aspects of the subject.

The sixth Duke, as several writers of horticultural history have shown, was interested generally in gardening and was a particularly keen collector of plants, trees and shrubs. J.C. Loudon commented in the *Gardener's Magazine* in the late 1830s that he thought the Duke was second only to the Duke of Devonshire as the greatest encourager of gardening in England and considered that he was, '... a model for an English nobleman in all that respects gardening and rural matters ...'. None of these historians, however, have acknowledged the fact that Bedford encouraged the development of scientific horticulture. The most recent book on Woburn


Abbey and the Russells has provided a little more detail about the sixth Duke's gardening interests but has not attempted to appraise the Duke's involvement in, and contribution to, horticultural science. The aim of this and the next chapter, therefore, is to assess the sixth Duke's role in horticulture and to show how a landed estate could foster the development of scientific gardening: the Duke was an important patron of horticultural science and under his patronage Woburn Abbey became a centre for horticultural experimentation and innovation.

Financial support for science in the first half of the nineteenth century came from a variety of sources. Industry, commerce, the law, learned societies, publishers, wealthy individuals, groups of proprietors of societies and institutions and to a lesser degree and more indirectly, the state, all provided funds. The sixth Duke's investment in horticulture should be seen as part of this, '... spectrum of science patronage'. Compared with France and Germany, the British government's financial support of science was uneven and niggardly. The late 1820s and the 1830s was an age of


laissez-faire (a minimum of state interference) and successive
governments more or less, as J.B. Morrell has pointed out,
'... left British science to run itself in a voluntarist
way'.

Patronage of horticultural science by single
individuals, like the sixth Duke, or by voluntary
associations of interested individuals, such as the Royal
Institution, the Royal Society of Arts and the Horticultural
Society of London, was of great importance.

The sixth Duke of Bedford's support of scientific horticulture
was in no way the casual activity of a dilettante. The Duke
pursued his interest with vigour and a sense of purpose.
Unlike his predecessors, the sixth Duke decided not to
make any large scale structural alterations to the Abbey
itself and elected to concentrate on horticultural improvement.

Humphry Repton (1752-1818), an architect who was involved in
practical and scientific gardening, was employed roughly
between 1803 and 1810 to make substantial changes in the
grounds and to develop radically the gardens. The idea was
to enhance the beauty of the house, make the parkland and


11. The fourth Duke hired Henry Flitcroft in the mid­
eighteenth century to plan the re-building of the west
front and Henry Holland was employed at the end of the
century by the fifth Duke to alter the south side of
the Abbey. See Blakiston, Woburn and the Russells,
(n. 3), pp. 111, 118-121, 155-156.
gardens attractive, amusing and enlightening for the Duke, his family and his visitors and to provide facilities which would enable him to develop his interest in botany and horticulture. Repton altered the lakes in front of the Abbey, improved the vistas of the parkland by utilising lawns, avenues of trees and wild eminences, designed a range of glass-houses, constructed an arboretum, divided part of the garden into distinct zones where specimens from different countries could be cultivated and created an experimental garden for the scientific classification of plants.¹²

By the end of the 1830s the gardens had been enormously altered through Bedford's general horticultural improvements and his specific investigations. As a result of his efforts, the Abbey contained greenhouses holding collections of exotic plants, a palm house, a cacti house, a heathery, an English and Scottish rosarium, an American and a Chinese garden, a grass garden, a grotto garden and the Duchess and the children's garden. There was also an extensive arboretum,

a thornery, a salicetum (a collection of willows), a pinetum and several nursery plots where flowers, shrubs and trees could be raised. The Duke also introduced changes in the vegetable and fruit plots by creating, a quarter of a mile north-west of the Abbey, a new seven acre kitchen garden and a nine acre holding of fruit and herbs. A peach house, a vinery, a fig house and pits and frames for raising pineapples, melons and cucumbers were constructed in these gardens. In addition, the grounds also contained a deer park and, equidistant from the Abbey and the town of Woburn, Park Farm. The farm was a model agricultural establishment set up by the fifth Duke. 13

The Duke's interest in the fine arts in many ways dovetailed with his pursuit of horticulture. As David Spring rightly points out, the sixth Duke was something of a connoisseur. 14 He loved paintings and sculpture and during continental tours collected for his sculpture gallery (formerly a greenhouse) and museum of antiquities. At home, he supported some of the best English painters (Hayter, Wilkie, Allan, Eastlake)


and commissioned a series of miniature portraits of his family. 15 His horticultural collections were treated with similar reverence. Bedford ordered a painting to be made on a window of a room adjoining his heath house of some of the most striking heaths in his collection and had a folio of drawings made of some of the most magnificent of the Woburn evergreens. 16 The Duke financed the compilation of botanic catalogues of his collections of grasses, heaths, willows, pines and cacti. They were written by the estate head gardeners and were tastefully produced, beautifully engraved and literally combined art with science.

The sixth Duke had the resources to spend freely on these interests. The Russells, holding roughly eighty seven and a half thousand acres, were amongst the largest landowners in England and were one of the wealthiest aristocratic families. 17 The Duke obtained part of his income from estates in Bedfordshire, Buckinghamshire, Cambridgeshire, Northamptonshire, Devon, Cornwall and London. He


drew on these riches to gratify his pursuits and was not averse to utilising his potential for borrowing. Bedford was not alone in this, for many landowners were similarly inclined to use their wealth and some used it quite extravagantly. Arthur Young noting the profusion of expense everywhere at Woburn thought that, '... an extravagant Duchess, Paris toys, a great farm, little economy and immense debts, will prove a canker in the rosebud of his garden of life'.

I have not been able to ascertain what proportion of revenue was spent on horticultural ventures but the Woburn stewards and agents periodically expressed concern over the sums that were being expended on the gardens. Certainly, the seventh Duke thought his father's love of spending, particularly on horticultural schemes, had raised the family debt from two hundred thousand pounds to over half a million pounds and left encumbrances which were costing the estate forty thousand pounds a year in interest charges.


Undoubtedly, the sixth Duke was an immoderate and self-indulgent man. To an extent, his expenditure on horticulture and on scientific gardening was a reflection of this but as we shall see, the Duke was also seriously committed to the promotion of scientific horticulture.

As I have shown in chapter two, many of the organisations and societies which the Duke subscribed to encouraged the spread of the best horticultural and agricultural practices, were keen to extend knowledge and supported investigative work. The Duke was in sympathy with these aims. When he was Lord Lieutenant of Ireland (1806-1807) he gave advice and encouragement to the Farming Society who were endeavouring to arrange a charter and saw to it that the Society heard a course of botanical lectures on grasses given by Dr Walter Wade. Bedford sent his catalogues to the Horticultural Society of London, the Society of Arts, the Royal Institution and the Linnean Society. He hoped that their members would find them of some scientific value and encouraged his gardeners to correspond with their secretaries over such matters as the identification of plants.
and classification of plants. He also motivated his stewards and gardeners to enter for the medals and prizes offered by the Royal Society of Arts and the Board of Agriculture. The Duke endowed a medal to the Bath and West Society, which was to be presented annually, and suggested that it should be awarded in the first instance to an essay which shed some light on the subject of manures. The first recipient was Arthur Young who emphasised the need for farmers to understand the progress that was being made in the fields of chemistry.

Bedford enlisted the aid of his family to help him bring his horticultural schemes to fruition. Those sons who were in the forces or who held government posts were especially useful to the Duke. During Lord George William Russell's diplomatic missions to Spain and South America he was encouraged to send pine cones and seeds of various other trees to England so that his father could build up the Woburn pinetum and arboretum. When Lord Edward Russell was commanding a naval vessel off the coasts of South Africa and South America he was requested

24. One of the Duke's stewards received a gold medal from the Society of Arts in 1806 for an article on pruning, another was awarded a gold medal from the Board of Agriculture for an essay on the use of salt as a manure and animal feed in 1805, and a head gardener submitted a prize essay to the Board in 1820 on the value of salt as a manure.


26. These matters are frequently discussed in the letters written by the sixth Duke during the 1830s to Lord George William Russell. See, Letters to Lord G. William Russell, (n. 20), Vols. 1 and 3.
by the Duke to assist the plant collectors working for Woburn and for Sir W.J. Hooker (1785-1865), Professor of Botany at Glasgow University. Bedford campaigned for seven years to turn the Royal Gardens at Kew into a national scientific institution, with Hooker as director, and sought the advice of Lord John Russell who was a cabinet minister. Lord John was persuaded by his father to use political influence to achieve these goals. All these instances illustrate the Duke's commitment to horticultural science and indicate the seriousness of his intentions.

The sixth Duke had a great deal of time to give to schemes of horticultural experimentation and innovation. With the resignation of the Grenville Administration in 1807, he was recalled from Ireland. This marked the end of his political duties and appointments (he had been the Whig M.P. for Tavistock between 1788 and 1802), although not the end of his political campaigning. Freed from political demands he was able to concentrate on agricultural and horticultural innovation. The Duke believed agriculture was the foundation of the country's economic well-being, as did almost everyone


else in the early nineteenth century, and thought agricultural improvements were a vital necessity because they ensured the nations continued prosperity. A remark in 1826 to one of his sons reveals this: 'Agriculture is the basis of a nation's prosperity and happiness, and hence spring commerce, manufacture, arts, sciences and everything that contributes to a nation's health and grandeur'.

These beliefs led the Duke to give his support to causes which were concerned with maintaining the prosperity of farming. He fully approved of the Corn Laws and thought protection was necessary because it enabled the farmer to accumulate sufficient capital to pay government taxes and to ensure the country could be self sufficient if it became embroiled in wars with other nations. He opposed the increased tax on hides and the duties on salt, which were imposed by the government during the French Wars (1793-1815) in an attempt to raise additional revenue. In 1812 Bedford spoke against the leather tax in the House of Lords and argued that it would be detrimental to the small farmer who produced hides and would cause unemployment for the lower classes who worked in

30. Ibid., pp. 51, 53.
the leather trades. Other aristocratic landowners such as the Duke of Norfolk and the Earls Spencer, Stanhope, Spinney, Rosslyn and Harwicke supported the Duke in this.

It seems probable that they were concerned about the possible loss of revenue on their estates as a consequence of a reduction in the sale of hides or a fall in the rent roll owing to financially embarrassed tenant farmers. The heavy duties on refined salt and its waste products had put it beyond the reach of farmers who had previously regarded it as a cheap, easily obtainable and effective general 'fertiliser' and cattle food. The Duke wanted to show the government that it was too useful to be subject to duties.

In 1805 and 1818, therefore, he introduced comparative trials at Woburn which he believed demonstrated that salt improved the diet of cattle and markedly increased the yield of certain garden and farm crops.

The Duke was a paternalistic landowner and was aware that if an


32. Edmund Cartwright, 'An experimental essay on salt as a manure, and as a condiment mixed with the food of animals', Communications to the Board of Agriculture on subjects relative to the husbandry and internal improvement of the country, 4, (1805), pp. 370-381. I have not been able to trace George Sinclair's prize essay for the Board of Agriculture but a full account is published in Cuthbert William Johnson, An essay on the uses of salt for agricultural purposes and in horticulture, (London, W. Simpkin and R. Marshall and J. Ridgway, 1830, Third edition), pp. 31, 42, 62, 89 and 145.
estate was efficiently managed it improved the opportunities for employing those who lived on estate property. He wanted to create employment for his own labourers and their children and made use of science in an attempt to achieve this. These and a number of other points in this paragraph will be expanded later and in chapter five. Nationalistic feelings also played a role in influencing the Duke to patronise scientific agriculture and horticulture on his estate and to foster their development nationally. He was aware that his privileged position entailed a certain obligation to the country and, as Kenneth Hudson and others have pointed out, many landowners felt it was their duty to experiment on behalf of the nation.33

The Duke's botanic catalogues, the product of several years' quite detailed scientific investigation at Woburn, were large volumes that contained coloured engravings. This made them costly to produce. The first edition of the tome on grasses was expensive to buy from a bookseller and the volumes on heaths, willows and pines, privately printed in limited editions, were not for public sale. Only an individual of the Duke's wealth could contemplate such undertakings. Besides being an exercise which brought prestige, the Duke saw it as both a pleasure and a duty to finance these ventures and to distribute his catalogues to those horticulturists, botanists and institutions whom he thought would derive most

benefit from them. By financing and distributing these works, the Duke believed he was contributing to the development of botanical and horticultural science. His efforts to turn the Royal Gardens at Kew into a national botanic establishment also sprang from nationalistic feelings: the Duke wanted them to rival the botanic gardens of Europe and be of service to Britain and her empire.

3.2 Robert Salmon and aboricultural science.

Robert Salmon (1763–1821) was the sixth Duke of Bedford's steward at Woburn and the controller of the woods at Chenies in Buckinghamshire. He had been given these positions in 1806 in acknowledgement of his many abilities and in recognition of the importance of investigations in aboriculture which he undertook for the Duke between 1804 and 1806. Salmon had been engaged by the fifth Duke in 1794 as Woburn's resident architect-surveyor and mechanic and was also given the management of several of the estate's fir plantations. Whilst at the Abbey Salmon designed a great deal of innovative agricultural machinery which became a popular feature of the estate's annual sheep shearings (an opportunity for aristocrats and local gentry to view agricultural improvements), and several of his


36. For details see the D.N.B.
inventions were awarded medals and premiums by the Society of Arts and the Board of Agriculture. 37

In 1804 Salmon was instructed by the sixth Duke to collect evidence which would demonstrate the advantages to be gained from pruning and efficiently managing the Woburn fir plantations. 38 Bedford wanted his woodlands to be managed, '... upon the best system, combining profit and utility, with ornament and beauty'. 39 Salmon was directed in this way because the Duke could not make up his mind whether the pruning operations introduced into the Woburn fir stands by the previous Duke had been really necessary. The sixth Duke believed fir plantations were a valuable commercial product with a potential that had not been fully exploited. 40 He had such faith in the value of these woodlands that he wanted other landowners to increase their acreage of firs and believed that if an efficient system of management was established at Woburn it would improve his


own estate revenue and would be an example and an encouragement to others. It is difficult to appraise the success of the extensive plantings of coniferous trees at Woburn and to judge whether the Duke's views on the potential of fir timber were correct. I have not been able to estimate how much of the timber met local, regional or national markets. The Abbey timber accounts reveal many sales but the use to which the wood was put after sale and the occupation of the buyer is not indicated. Occasionally, stands of timber were sold to contractors who cut and marketed it. Their sales were independent of the Woburn accounts.

The great importance of these and other types of woodland to the estate itself and to the local community encouraged the Duke to ensure his plantations were efficiently managed. Various timber, including fir, was used in the construction of agricultural implements and machinery for the estate and for the erection of farm buildings and cottages. The lighter wood was made into fences and gates, provided poles for hedging, was used for land drainage, supported plants in gardens and allotments and became faggots for use in the domestic hearth. A letter from the Agent-in-Chief to the

41. Ibid.

42. George Sinclair, Useful and ornamental planting, (London, Baldwin and Cradock, 1832), p. 47; See the vouchers for the wood accounts, B.C.R.O., R.V., Box R/358, Woods 1780-1816.
Woburn steward in 1830 concerning some work to be carried out on the estate reveals the Duke's paternalism \(^{43}\) and is indicative of the stance he took throughout his term at Woburn:

'But mere economy is not my object ... the Duke has great duties towards those ... who depend on him for their support and no one can be influenced by more benevolent and liberal feelings than he is. I don't desire, therefore, to have the work done by strangers though it may be somewhat cheaper, nor do I desire our own people to do it at less than a fair remuneration ...'. \(^{44}\)

And, as F.M.L. Thompson has pointedly remarked, paternalism could be exercised most effectively from a well-run establishment. \(^{45}\)

The Duke had a great many dependants. His woodlands provided employment for skilled workers such as superintendents, bailiffs and supervisors and occasional or part-time employment for labourers who were needed in the nurseries and plantations to prepare the ground, sow seeds, take cuttings, weed the rows, plant out saplings (hundreds of thousands per year), pollard, prune, thin and fell the timber, strip bark, make hedges and build roads. \(^{46}\)


45. Thompson, (n.2), p. 17.

46. Vouchers for the wood accounts, (n. 42).
For the Duke, therefore, Salmon's investigations were an important step in putting the management of his woods on a sound, systematic and profitable footing. It was left to Salmon's own judgement and initiative to devise a method of collecting the required proof. He interpreted his instructions broadly and began by creating a neat system of accounting.\footnote{Woburn and neighbouring estates - Account of timber, underwood and material produced from his Grace the Duke of Bedford's woods and plantations, covers, farms, park, building, kiln, fuller's earth mine, Michaelmas 1803 to Michaelmas 1804, B.C.R.O., Salmon Pps., R5/176.} This became standard practice at Woburn. Having put the accounts in order, Salmon focussed his attention on the technique of pruning that had been adapted at the Abbey under the fifth Duke, particularly since foresters were beginning to question its validity.\footnote{Letter from Robert Salmon to the Royal Society of Arts, Manufactures and Commerce, n.d., B.C.R.O., Salmon Pps., R4/608/15/5. This letter was probably written in 1806.} The fifth Duke had been induced by the, '... mischief and damage arising to plantations in general from a bad system of pruning or neglect ...' to hire William Pontey (d. 1831), a Huddersfield nurseryman and landscape gardener, to '... direct a series of experiments ... on his extensive plantations in the neighbourhood of Woburn'.\footnote{William Pontey, The forest pruner, (London, J. Harding, 1810), p. VIII.} As a result of these investigations, which began in the 1790s, Pontey advocated and popularised in his books a technique called close pruning. He was, in fact, one of several writers who were in favour of this technique at this
time. 50 He argued that as a tree developed the lower branches became increasingly unnecessary because they acted as a rival to the main stem and attracted the sap or nourishment of the tree. According to Pontey, the large branches (or rivals) had to be removed and they needed to be taken off very close to the trunk in order not to leave spurs which would cause deadknots and detract from the value of the timber. 51

Salmon believed a comparative examination was best and selected from the Woburn plantations trees that had been close pruned by Pontey, timber that had been pruned some distance from the trunk and trees whose branches had not been removed at all. Specimens were taken from all of this timber at intervals along the trunk and after a thorough examination Salmon believed that he had sufficient evidence to prove the advantages of close pruning. He published his findings in the, Transactions of the Society of Arts, and was awarded a silver medal for his paper. An innovatory feature was the use of eight diagrams of transverse sections of timber to illustrate and prove his argument. The sections of timber that had not been close pruned showed deadknots and other imperfections and


Salmon argued that these defects would not have occurred if close pruning had been carried out. This evidence helped Salmon establish his 'fundamental principle,' which stated that close pruning should take place between April and September and should occur when the tree was six years old or when five tiers of boughs had appeared. He thought this was just before the tree entered its maximum period of growth. Such knowledge was derived from tables of the height and girth of trees which Salmon had been carefully and systematically compiling for several years in order to help him estimate the value of timber and to decide when was the best age to fell the Woburn plantations. At this stage, the three lowest tiers of branches had to be removed. The process had to be repeated every three or four years, according to a formula based on the tree's age, girth and height, until the trunk had reached forty feet. Thereafter, the tree could be left to nature.

Salmon's interpretation of the wood specimens and the drawings he made of them demonstrates a reasonable degree of botanical


53. Salmon's letter, (n.48).

54. Calculations of the periodical content of Scotch fir timber, B.C.R.O., Salmon Pps., R3/2114/559. Salmon was frequently required to measure and value standing timber. In order to carry out this work efficiently and accurately he developed a system of measurement which utilised moveable rods and a horizontal scale. See, Anonymous, A biographical sketch of Mr Salmon, who died at Woburn Park, Bedfordshire, October 6, 1821, (London, private printing, 1822).

competence and, in particular, a sound grasp of vegetable physiology. At this time, vegetable physiologists who were interested in aboriculture concerned themselves with questions about the role of leaves and branches and their relationship to the root system, the factors concerning the growth of leaves in the spring, the process whereby soft new wood turned into hard wood, the reasons for the nature of the grain in wood and the function of the trees capillary vessels. Salmon's estate notebooks and papers on aboricultural matters reveal a familiarity with technical terms and indicate that he was thinking about, and speculating on, some of these issues. He used his knowledge of vegetable physiology in conjunction with the timber specimens and the tables of measurements to justify close pruning. Salmon pointed out that in gardening it was generally accepted that pruning side branches made the trunk grow stronger and longer. Good quality, fine-grained timber would result from

56. For example, see: George Bentham and John Lindley (ed.), *A selection from the physiological and horticultural papers, published in the Transactions of the Royal and Horticultural Societies, by the late Thomas Andrew Knight, Esq., President of the Horticultural Society of London, etc., etc., to which is prefixed a sketch of his life*, (London, Longman, Orme, Brown, Green and Longman, 1841), for some of Knight's papers dealing with several of these topics; Anonymous, 'The planter's guide or a practical essay on the best methods of giving immediate effect to wood, by the removal of large trees and underwood', *Q. Jl. Agro.*, 1, (1829), pp. 83-96; George John Towers, 'On the decay of the heart-wood of the larch', *Q. Jl. Agro.*, 4, (1832-1834), pp. 547-554; Stephen Ballard, 'On pruning to increase the growth of timber', *Fmrs. Mag.*, New Series, 1, (1836), pp. 296-300, 343-344.

close-pruning, stated Salmon, because sap in its rise and fall had a finer, more rapid circulation through not being diverted or delayed by boughs. Therefore, he argued, most of the increase in wood occurred at the top of the tree and the sides on the lower parts received the least. Consequently, there was an addition to the length of the head, each annual increase being finer than the previous one. The result, concluded Salmon, was the production of a, '...close-grained, clean, long and regular easy tapering, useful piece of timber instead of a coarse-grained, short, sudden-tapering trunk with a quantity of boughs and knots'.

Robert Salmon's work on close pruning was really a verification of William Pontey's ideas but the difference was that Salmon had made a much greater use of botanical science to argue a case. At Woburn, science had assisted the formulation of a policy of woodland management. The sixth Duke believed the timber specimens had proved the necessity of adopting a system of good management on the fir plantations. The Duke was convinced that Salmon's arguments and his fundamental principle were correct and approved of all of his plantations being close pruned. Salmon vigorously applied the technique to the

58. Salmon, 'Pruning fir trees', (n. 52), p. 76.
Russell plantations in Bedfordshire and his surveys and reports to the Agent-in-Chief and to the Duke indicate that it was widely carried out on all kinds of timber and not just on fir plantations. On Salmon's retirement in 1820 one of the deputy woodsmen took over and close pruning was continued throughout the 1820s.

By the late 1820s the sixth Duke was beginning to have doubts about his system of woodland management. He had heard from Lord Tavistock about a different system of pruning practised at Holkham Hall, the seat of Thomas Coke, and had written in 1828 to Coke's steward and aboriculturist, Francis Blaikie (fl. 1830s) for information and advice. Blaikie replied that Pontey's writing on close pruning had been generally misunderstood and the technique had been wrongly applied to older forest trees. He explained the system of foreshortening, developed at Holkham, which could be carried out on all types of tree. The idea was to reduce over-luxurient branches by pruning just before the axil of a lateral shoot that was growing from this branch. 60 This meant that part of the branch was still left whereas under Ponty's system it was entirely cut off. Blaikie also recommended natural pruning for clumps of forest trees. Here, the trees were thinned annually after their sixth year to provide them with the space to attain the desired height

and girth. This spacing resulted in luxurient growth and gradually the branches became overcrowded. According to the argument, these branches eventually dwindled away, as in natural woodland, and thus the trees pruned themselves. 61

Bedford admitted to his Holkham consultant that Pontey's system had not proved suitable for the older trees on the estate. 62 The wounds on some of the trees had not healed properly and, as a result, the quality of timber had been affected. However, the Duke believed the wounds on young close pruned trees soon healed and that the technique was capable of producing good quality timber. In 1831, after seeing Holkham timber specimens at Downing Street being used to demonstrate the correctness of natural pruning, the Duke ordered timber to be taken from his own plantations and concluded after examining it that the Woburn specimens reaffirmed the validity of close pruning young trees. 63 It appears that Blaikie's advice had some impact because in the 1830s foreshortening was practised on the older trees in the Woburn woodlands 64 and close pruning was reserved for young plantations.

61. Ibid.

62. Letter from the sixth Duke of Bedford to Francis Blaikie, 5 February 1829, Ibid.

63. Letter from the sixth Duke of Bedford to the 2nd Earl Grey, 26 August 1831, University of Durham, Department of Paleography and Diplomatic, Earl Grey Papers.

It is highly probable that the debates on the various techniques of woodland management that were appearing in the books on forestry and in articles in the agricultural and horticultural journals during the 1820s and 1830s contributed to this modification in the policy of management at Woburn. In several of them the technique of close pruning was strongly criticised. The literature was a response to the increased interest landowners were showing in their forests during the early nineteenth century and their need for guidance and advice on how best to manage these resources. The appearance of the _Gardener's and Foresters Record_ in 1833, edited by Joseph Harrison (d. 1858) gardener to Lord Wharncliffe at Whortley Hall near Sheffield and an entrepreneur of horticultural periodicals, was an attempt to exploit this demand for information commercially. Many of the writers in their discussions on pruning demonstrated a sound grasp of botanical science and, like Salmon, used botanical terminology with confidence and precision and drew upon the work of vegetable physiologists to argue their case. A feature of these debates was that they were conducted more from a theoretical than a practical standpoint. The experiments and investigations carried out by botanists such as Stephen Hales (1677-1761) and Theodore De Saussure (1767-1845), by Jan Ingenhouse (1730-1799), a court-physician, by horticulturists such as

65. William Cobbett, _The woodlands_ (London, Private printing, 1825); Thomas Cruickshank, _The practical planter_ (Edinburgh, William Blackwood, 1830); J.C. Loudon, _An encyclopaedia of gardening_ (London, Longman, Rees, Orme, Brown, Green, Longman, 1835 edition); See also the articles by the following: Anonymous, Towers, Ballard, (n. 56).
T. A. Knight and by chemists such as Humphry Davy in the eighteenth and early nineteenth century provided a foundation on which theories of pruning and other techniques of horticulture could be constructed. If aboriculturists did not read their work, summaries could be obtained from the general textbooks of popularist writers. For example, Joseph Hayward's, *The science of horticulture*, published in 1818, relied on the works of Davy, Ingenhouse, De Saussure, Hales and Knight.

Most likely, the issues raised by these debates, coupled with the discovery of injury in some of the timber on the estate, led to changes in the management of the Woburn woodlands. Robert Ireland, who succeeded Salmon as woodsman in 1820 and who continued the policy of close pruning during the 1820s, was instructed in the 1830s to report on the condition of the trees that had been close pruned by his predecessor. Ireland's report of 1833 noted that some woods had been overpruned and concluded that only young trees needed to be pruned. In a communication to J.C. Loudon in the 1830s Ireland stated that Salmon had taken


68. Report 1833, (n. 64).
Pontey's system too far. By cutting off large branches Salmon had caused a number of trees to become unhealthy. He believed the reason why the trees pruned under the direction of Pontey between 1802 and 1803 were now in a healthy state was because they had been close pruned when young and only a few branches had been removed. 69 The seventh Duke, in an appraisal of his father's management policy, blamed Salmon for ruining the plantations by wildly extending Pontey's technique. 70 Thirty years later the Bedford steward echoed this dissatisfaction by censuring Salmon for causing much damage and impairing the Bedfordshire woods to an amount in excess of ten thousand pounds. 71

These condemnations stand in stark contrast to the opinion given in 1806 by William Adam (1751-1839), the Agent-in-Chief, who believed Salmon was, '... bestowing a great deal of very judicious thought on every part of his business'. 72 It seems unlikely that Salmon was responsible for all this loss to the


71. Thomas Bennett, A review of the management practised previous to the year 1839 and since that date, 10 July 1869, B.C.R.O., Papers of Thomas Bennett, R4/41.

woodlands. In 1838 William George Adam, who became the Agent-in-Chief in 1816 and who was the son of William Adam, wrote to the Woburn steward that, 'The woods have now become a very important part of the income and I think the returns prove the goodness of the management'. Some of the trees must have been managed by Salmon and he deserves some credit for producing such saleable timber. Between 1835 and 1838 the demand for wood from the Woburn plantations caused by the construction of the London-Birmingham railway encouraged a new optimism and probably the current system of management was a little over-praised. No doubt Salmon did injure some older trees. Wounds caused by lopping large branches off these trees would have healed only slowly and would have increased the trees susceptibility to attacks of fungus diseases. If such diseases gained a hold timber could be severely damaged. The possibility remains, however, of satisfactory timber being produced inspite of pruning techniques. The trees were carefully reared in a nursery before being moved to the plantations and once in their permanent situation were given room to grow. Sound, practical management such as this must have led to the production of healthy and vigorous trees able to withstand all kinds of lopping and pruning. Close pruning may have

given extra length to the trunk but it seems improbable that it would have eliminated imperfections in the timber.

In the course of developing a system of woodland management the sixth Duke, his foresters and advisers had to grapple with various problems and try to reach some sort of decision in areas where there was conflicting opinion and even open hostility. The work at Woburn illustrates some of the practical and theoretical difficulties which lay in the way of the development of aboricultural science and highlights the role of the great estate in this process. Robert Salmon made use of various ideas about the functions of the internal parts of trees to assist him in formulating a rationale for close pruning. The rise of this technique had depended, though not exclusively, on scientific argument and scientific debate had helped lead to a re-appraisal of Salmon's system in the late 1820s. Thus, the Duke and his aboriculturists had utilised science to help them establish a sound policy of woodland maintenance. The expectations behind this were that an improved system of management would extend the economic and social benefits which the woodlands were already bringing to the estate and its dependants. Later aboricultural work at Woburn, in contrast, consisted of building up

collections of various trees and compiling their botanical characteristics. Why the Duke was more concerned to direct funds towards these ends rather than on further experiments and investigations on pruning methods will be discussed in the next chapter. Let us now turn to another group which carried out investigative work at Woburn, the gardeners, and examine the enquiries of the sixth Duke's first head gardener, George Sinclair.

3.3 George Sinclair, scientific gardener

George Sinclair (1786-1834) came from a Scottish family where gardening had become a tradition. His father enjoyed a reputation as one of the best gardeners in the south of Scotland and his uncle had been superintendent of some Lanarkshire farms, grounds and gardens. It is not known what sort of education Sinclair received but after his schooling he went into the service of the Gordon family where he obtained much of his early horticultural training. The marriage of Lady Georgiana Gordon to the sixth Duke of Bedford in 1803 brought Sinclair to the Duke's attention. In 1807 Sinclair came to Woburn and replaced Dowdale as the gardener looking after the pleasure grounds and Froxfield Gardens. The soundness and importance of his work

75. For details see the D.N.B.
76. John Donaldson in his Agricultural biography, (London, Private printing, 1854), p. 113, believed that Sinclair's education was, '... superior to the common learning of that grade of society'. Caution is needed here, though, as Donaldson is not a reliable primary source.
enhanced his standing at Woburn and with the death of Martin in 1814, he became virtually the head gardener controlling the Froxfield and pleasure gardens and the kitchen garden.\textsuperscript{78}

The Woburn estate accounts refer to him as a botanist and a gardener. W.A.G. Armytage has pointed out that gardeners in the eighteenth and early nineteenth century were really gardeners-cum-botanists and that these 'skilled technicians' produced work which was of major consequence for their employers both aesthetically and practically.\textsuperscript{79} Some head gardeners, Armytage not unreasonably argues, displayed outstanding practical abilities and produced books showing such skill that they can claim to be professionals.\textsuperscript{80}

Sinclair was certainly the type of horticulturist that Armytage has outlined but he was more than a botanic gardener. He also had an understanding of the principles of chemistry and so could fairly be described as a gardener-cum-chemist. Much of Sinclair's work reveals a more than competent understanding of chemistry and botany and this ability to utilise both these sciences in horticultural tasks makes him an atypical head gardener. When he left the Duke's service

\textsuperscript{78} Voucher bundle number 8, 18 July 1814, B.E.O., H.V., Box 42; Voucher bundle number 11, 28 May 1814, B.C.R.O., R.V., Box R/425.


\textsuperscript{80} Ibid.
at the end of 1824, he was almost at the top of his profession and the skills he developed and the experience he acquired at the Abbey were largely responsible for this.

Besides the day-to-day planning and supervision of the operations in the gardens and glass-houses of the Abbey, Sinclair carried out a variety of careful and systematic investigatory work. In 1813 he was conducting aboricul tural experiments in the fruit garden. It is not clear if the Duke ordered these enquiries or whether they were Sinclair's own idea. In an attempt to induce cropping in old, unproductive pears the Duke's gardener removed the bark from the trunk and branches (decortication). During the first quarter of the nineteenth century the technique of removing bark from fruit trees became the subject of investigation and George Sinclair's work should be regarded as an example of such enquiries. Sinclair decorticated some branches, grafted young shoots on others and left the remainder as they were. The careful trials lasted five years and at their conclusion he noted that the branches with the hardened epidermis continued barren whereas the decorticated limbs had produced good quality fruit. The grafted branches had eventually proved to be the healthiest and most productive. Sinclair believed that his systematic investigation had shown that the "... thickening and hardening of the epidermis has a very considerable influence on

81. Sir John Sinclair, Account of some experiments to promote improvement of fruit trees by peeling the bark, with a description of the instruments calculated for that purpose, and engravings of them, (London, W. Bulmer and Company, 1820).
the health and influence of a tree'. \textsuperscript{82} Much of Sinclair's attention whilst he was at Woburn Abbey, however, was occupied by two major projects. Firstly, the Duke wanted to investigate the nutritive qualities of grasses in order to provide the best pasture for cattle and Sinclair was instructed to carry out the necessary enquiries. Secondly, the Duke was recovering from a severe illness in 1822 and decided to begin a comprehensive collection of exotic and indigenous heaths as an aid to recuperation. \textsuperscript{83} Sinclair had the task of amassing and nurturing a great many specimens. Whilst accumulating, tending, observing and classifying the various grasses and heaths for the Duke, he was able to extend his botanical and horticultural skills.

Sinclair was also provided with the opportunity of extending his knowledge of chemistry. The sixth Duke had applied to Humphry Davy to find out whether it was practicable to use chemical analysis to ascertain the nutritive properties of grasses. The reasons for the Duke's interest in chemistry and Sinclair's work here will be discussed in the ensuing section. Davy replied encouragingly and provided a method for analysing grasses and gave advice on the equipment that

\textsuperscript{82} Sinclair, \textit{Useful planting}, (n.42), p. 6.

\textsuperscript{83} George Sinclair, \textit{Hortus ericaeus Woburnensis}, (1825). See the Duke's introduction to this privately printed catalogue.
was needed. Armed with Davy's instructions and following the Duke's directive, Sinclair embarked on a lengthy and detailed programme of investigation. Initially, the grasses for analysis were sent to Davy but, later, Sinclair carried out the whole process at Woburn. This experience gave him the confidence to embark on a programme of soil analysis in order to understand as much as he could about the natural environment of the grasses he was studying. Sinclair acknowledged the value of Davy's book, *Elements of agricultural chemistry*, for he had used it to obtain some of the instructions that were needed to carry out an analysis of soils and to assist him in finding out the type of apparatus that was required.

These projects reveal who made the important decisions about agricultural and horticultural improvement and investigation at the Abbey. Moreover, they also indicate the attitudes of the head gardener, the steward and the agent towards innovation and allow us to assess the role they played in assisting horticultural experimentation. In nearly all cases, the sixth Duke thought up the project or initiated

84. George Sinclair, *Hortus gramineus Woburnensis*, (London, James Ridgway, 1869), p. 5. I have not been able to find out whether letters containing instructions and queries passed between Davy and Sinclair or whether correspondence was conducted through the sixth Duke.


a line of enquiry and his employees put these schemes into operation. However, the Duke was receptive to ideas and one major investigation of the different species of willow, involving much time, effort and expense, was undertaken at the suggestion of George Sinclair.\footnote{87} Once the Duke had decided upon a particular scheme, his employees were given a great deal of freedom to complete the job and to use their initiative. Such freedom could entail working out a particular method of investigation, ordering necessary equipment, entering into correspondence with those who could give advice on points of uncertainty and following up related lines of enquiry. The Agents-in-Chief at Woburn were concerned with the efficient management of the estate and gave their support to agricultural improvement. Their role, though, was essentially an administrative one and they did not initiate or develop agricultural or horticultural improvement or embark on investigative work. It was the stewards who were active in these areas. As noted above, Robert Salmon introduced a new system of wood accounts and carried out investigations and experiments in aboriculture. His predecessor, the Rev. Edmund Cartwright, managed the experimental Park Farm, conducted investigations into ways of fattening livestock and enquired into the manurial qualities of certain substances. The projects on grasses, heaths, willows, pines and cacti were carried out by the head gardeners. My

impression is that Sinclair's investigation of grasses met with the agent's approval whilst the other projects were regarded as being of lesser importance. In the 1820s and 1830s the agents were more concerned with limiting horticultural expenditure than with extending experimental and innovative work. Thus, at Woburn the ideas and energy of the Duke, his stewards and his head gardeners were the driving force behind much of the agricultural and horticultural improvement and scientific investigation whilst the agents gave most of their attention to the efficient management of the estate.

After leaving Woburn, Sinclair spent a large part of 1825 in Scotland and attended lectures at Edinburgh in chemistry, anatomy, natural history and Scottish law. Towards the end of the year he went into partnership with Cormack and Son, seed and nurserymen of New Cross, Surrey. Most of Sinclair's time was thereafter spent developing his professional activities. He expanded his horticultural and agricultural business in 1830 by taking one of the two conservatories in the newly opened and re-designed Convent Garden Market and, with the Duke as his landlord, was able to strengthen his Woburn connections. Sinclair acted as a consultant generally on practical and scientific matters that concerned agriculture, pastures, lawns and agricultural and horticultural chemistry. When the Duke was trying to decide whether the


waste products from the Market would be of any value as a manure, he sought the advice of Michael Faraday, Professor of Chemistry at the Royal Institution, and requested Sinclair also to undertake enquiries. In his detailed and technical report to the Duke, Sinclair discussed the principal gases emitted by various manures, the process of vegetable decomposition, the influence of temperature and drainage on putrification and gave an assessment of the value of vegetable manure. Besides advisory work he also carried out valuations of woods and plantations and continued to write books and articles.

Sinclair's literary output both at Woburn and New Cross Nursery is fairly impressive considering that many mundane and practical matters demanded his attention. The scientific works written at Woburn include a volume on grasses, a catalogue on heaths (both financed by the sixth Duke) and articles published in the *Agricultural Magazine*, the *Memoirs of the Caledonian Horticultural Society* and the *Transactions of the Horticultural Society of London*. He also edited the posthumous work of his friend Benjamin Holdich, *An essay on the weeds of agriculture*, which was published in 1825. After leaving Woburn, Sinclair enhanced his reputation...


91. Letter from George Sinclair to Thomas Coates, 7 June 1827, University College of London Library, Manuscript and Rare Book Room, Papers of the Society for the Diffusion of Useful Knowledge, George Sinclair, 24.
with a corrected volume of the indigenous and exotic plants in the Cambridge Botanic Garden and a book on trees for the Society for the Diffusion of Useful Knowledge. He was commissioned by the Society to write a number of technical and scientific articles and contributed to the Transactions of the Highland Society of Scotland, the Gardener's Magazine, the Quarterly Journal of Agriculture and Baxter's library of agricultural and horticultural knowledge. Most of his articles were concerned with the cultivation of grasses and the preparation of pasture land and Sinclair was regarded by the editors of these magazines and journals as something of an expert on such matters. The fact that many of his articles were accepted for publication indicates that his views commanded a degree of respect. Loudon believed that Sinclair had a considerable knowledge of chemistry and was a good vegetable physiologist and rightly pointed out that his writings reflected scientific enquiry and practical skills.92 Sinclair's book on grasses was translated into German in 1826 and it was held in such high esteem that he was made a member of the Stuttgart Board of Agriculture.

Cuthbert W. Johnson regarded him as a, '... mild and honourable man, anxious to communicate knowledge and neat and accurate in all his attempts'.93 Sinclair's practical skills and his painstaking scientific investigations undoubtedly were

amongst the reasons why he was admitted as a Fellow of the Horticultural Society of London, made a corresponding member of the Caledonian Horticultural Society and became a Fellow to the prestigious Linnean Society. At Deptford he was a respected member of the local community and an Overseer of the Parish. 94

When Sinclair died at his nursery at New Cross he was highly regarded by many of his contemporaries and much of his work received acclaim. Johnson, in an accurate and perceptive summary, wrote that he gave great care and unceasing attention to his immensely valuable experiments and was ever labouring to collect new facts and observations. 95  Sinclair's reputation rested primarily on his skills in chemistry and botany and the final sections of this chapter examines his activities in these two areas.

3.4 George Sinclair's horticultural chemistry

The assurance given to the sixth Duke of Bedford by Humphry Davy that it was a feasible proposition to ascertain the nutritive properties of pasture grasses by chemical analysis inaugurated George Sinclair's quite lengthy series of investigations at Woburn. They began in 1809 and lasted until Sinclair left the Abbey at the end of 1824. Sinclair


approached his project in a very systematic manner and, over a period of several years, formulated a distinct methodology. Initially, he collected and identified a number of these grasses. Then, the quantity of nutritive matter they contained was ascertained and, finally, the soil in which they had grown was analysed chemically.

Why the Duke decided to enlist the aid of chemistry to determine the feeding value of these grasses is a complex issue. It seems probable that an important factor was the combined influence of a number of writers at the turn of the century who were pointing out the relevance of chemistry for agriculture, horticulture and botany. Richard Kirwan, the Earl of Dundonald and William Henry were particularly influential in arguing that chemistry could be useful, or at least enlightening, to agriculture. They all pointed out that a chemical analysis of the soil could reveal deficiencies which the farmer could then put right.96 Both Kirwan and Dundonald gave details of the chemical tests which could be carried out and discussed soil types and Dundonald also provided a full account of the

96 Richard Kirwan, What are the manures most advantageously applied to the various sorts of soils and what are the causes of their beneficial effect in each particular instance, (Dublin, George Bonham, 1794), p. 71; Earl of Dundonald, A treatise showing the intimate connection that subsists between agriculture and chemistry, (London, Private printing, 1795), p. 152; William Henry, A general view of the nature and objects of chemistry and of its application to arts and manufactures, (Manchester, J. Johnson, 1799), p. 25.
apparatus that was needed. These writers were concerned with suggesting the utility of chemistry. Erasmus Darwin also considered the significance of chemistry, but for different reasons. He was primarily a Romantic for whom science was but one means of communing with Nature. Darwin pointed out that existing methods of using chemistry to analyse soils were inaccurate. He suggested, however, that chemistry could help botanists improve their understanding of plant physiology and hinted that this knowledge might ultimately benefit horticulture and agriculture.

In chapter two I explained how several institutions, notably the Board of Agriculture and the Royal Institution, supported the application of chemistry to agriculture and I outlined some of the work undertaken for these organisations by Humphry Davy. Besides Davy, the proprietors of the Royal Institution also engaged Frederick Accum (1768-1838). Accum held the post of assistant chemical operator. Both chemists campaigned to persuade landowners that chemistry could be of great service to agriculture and horticulture. Building on the work


99. Ibid., pp. VII-VIII.
of Kirwan, Dundonald and Davy, Accum argued in his book of 1803, *A system of theoretical and practical chemistry*, that the farmer, gardener, cook, dairymen, vinter, brewer, pharmacist and doctor all needed a knowledge of chemistry to carry out their work successfully. He quite grandly claimed:

'Agriculture can only be rationally improved by calling in the assistance of the chemical philosopher; for it is chemistry which explains the phenomena of vegetation, germination, the growth, the ripening and the death of plants ... The gardener ... equally needs its assistance. The nature of the different manures necessary for the various kinds of vegetables, the influence of light, the different temperatures, the quantity of moisture, the preservation of seeds, roots, plants, &c., are all founded upon chemical principles'.

Besides providing a list of the chemical preparations that were needed and giving details of apparatus and instruments, Accum advertised his own chemical chests, portable laboratories and chests of recreation.

It was, however, a paper to the Board of Agriculture by Davy that consolidated the efforts of all these writers and provided not only a full list of apparatus that the farmer and gardener needed but also a set of simple and clear


101. Ibid.

102. Ibid., Vol. 2, p. XXVII.
instructions of how to go about analysing soils. This communication was published in 1805 and in the same year the Board provided for Davy a soil analysis laboratory in its own house. Davy's paper was incorporated in the 1807 edition of Accum's book and was the basis of a section on soil analysis in William Henry's tome, The elements of experimental chemistry, of 1810 before finally ending up as part of Davy's own Elements of agricultural chemistry. It is in the context of this literature that George Sinclair's agricultural and horticultural chemistry should be placed.

A product of Sinclair's researches was his book of 1816, Hortus gramineus Woburnensis. It dealt with three hundred and twenty grasses. By the time the second edition had appeared in 1824, fifteen hundred plants had been investigated. Sinclair wanted to ascertain which grasses provided the best pasture. Using a simple 'chemical process' recommended by Humphry Davy, Sinclair tried to estimate the quantity of 'nutritive matter' (the part of the plant providing nourishment, and possibly assisting food absorption) contained in each grass. Following Davy's instructions, Sinclair dissolved dried grass (and sometimes fresh material) in hot water, filtered the liquid to separate the woody fibres, then evaporated the solution by a gentle heat. The residue (nutritive matter) was then weighed. On a few occasions a

103. Humphry Davy, 'On the analysis of soils, as connected with their improvement', Communications to the Board of Agriculture on subjects relative to the husbandry and internal improvement of the country, 4, (1805), pp. 302-318. Here, Davy referred to the work of Richard Kirwan, Lord Dundonald and Arthur Young.

chemical analysis of this residue (mucilage, sugar, albumen, bitter extractive and saline matter) was provided, derived from Humphry Davy's enquiries. One conclusion of the Hortus gramineus Woburnensis was that grasses were most nutritious when their seed had just ripened. \(^{105}\) Sinclair warned that this was a, '... new path of investigation', \(^{106}\) and advised a certain amount of caution but believed this method was much superior to that which had been introduced by the fifth Duke because it produced more accurate and less variable results. \(^{107}\) The previous Duke had tried to establish both the merits of different animal breeds and the qualities of certain fodder crops by comparing the recorded weights of the animals and the feed. \(^{108}\) Sinclair's criticism rested on the fact that mere details of weights did not reveal how nutritious each fodder was. He was aware that the whole issue of nutrition was very involved and realised that even his technique had its limitations because it could not take into account such factors as the variation in the quality of feed, the age of the

\(^{105}\) Sinclair, Hortus gramineus, (1816), (n. 86), p. 6.

This was by no means the only analytical work Sinclair was carrying out. He was investigating dung from sheep and deer that had been raised on specific grasses and compared the quantity of soluble matter obtained from this dung with that from the leaves of grasses, Ibid., p. IX. Sinclair also compared the masticated grass found in the stomachs and other organs of newly killed sheep and oxen with grass that had been bruised in a mortar and was examining Swedish turnips, field turnips and oil cake. See, Results from an experiment on grasses made by his Grace the Duke of Bedford, 1812, pp. 96-100, B.C. R.O., Salmon Pps., R3/2114/211.

\(^{106}\) Hortus gramineus, Ibid., (1816), p. VI.

\(^{107}\) Ibid., pp. V-VII.

\(^{108}\) Ibid.
animals, their exposure to heat and cold and the way each breed, or individuals within a breed, differed in their ability to put on weight. 109

In undertaking these investigations for the sixth Duke Sinclair was participating in a pioneering scientific venture. Woburn was the only estate where the nutritive content of an enormous number of pasture grasses was being investigated. On the basis of his careful observations, calculations and experiments Sinclair concluded that a mixture of grasses with differing quantities of nutritive matter was highly desirable for pasture lands. An excess of one grass, he pointed out firmly, could lead to red water disease in sheep and a predominance of over-succulent grasses could have an undesirable laxative effect on cattle. 110

A further stage in Sinclair's enquiries into pasture grasses was an analysis of the soils where they grew naturally. This work was begun sometime during the second decade of the nineteenth century and was well underway by 1814. The substantial amount of data which Sinclair had already

109. Ibid., pp. VI-VIII.
110. Ibid., p.X.
accumulated on grasses led him to believe that it was, 'Important to distinguish soils as each soil produces grasses peculiar to itself'. He criticised existing books on agriculture and horticulture for not using precise terms to describe the different earths and suggested that a simplified method of chemical analysis, like that given in Davy's, *Elements of agricultural chemistry*, would remedy this defect and, '... assist in raising the art of agriculture to the certainty of a science'. Borrowing Davy's categorisation, Sinclair in his *Hortus gramineus Woburnensis* outlined five major classes of soil (loam, clay, chalk, sand and peat), gave the proportion of their main constituent and explained how they could be recognised by the application of simple chemical tests. Part of his systematic investigations had involved collecting fifty kinds of soil and composts, complete with their local names, from different parts of the country. The Woburn estate accounts reveal that Sinclair had his own chemical apparatus and caused the Duke to buy consignments of chemicals. He very probably had a portable laboratory and it is possible that more permanent facilities were

113. R.V., 1814-1823, B.C.R.O., Box R/422-443.
available at Park Farm. Using the knowledge he had gained from this survey, the data he had obtained from a chemical analysis of these soils and the information provided by Davy, Sinclair suggested that the five major classes could be divided into twelve types. Their characteristics were described and for each he provided a detailed chemical analysis.

At Woburn the grasses under observation were not given extensive field trials. Instead, they were grown in four foot square beds, enclosed by boards, in the earth where they were known to flourish in their natural habitat.

The observations Sinclair made here, and those from his investigations in general, caused him to consider a number of problematic issues connected with soil fertility. Sinclair acknowledged the fact that the subsoil was of as much importance as the top-soil and that an analysis of its properties was desirable. But apart from recognising this fact, he did not undertake any investigations. Possibly because

115. These were: poor siliceous sandy soil, siliceous sandy soil, black siliceous moor soil, rich siliceous soil, sandy loam, rich black clayey loam, clayey loam, tenacious clay, rich alluvial soil, vegetable mould, fertile peat moss and barren peat moss.


117. Ibid., p. LXVI.
Sinclair believed the nature of the subsoil could only be partially altered he thought that his efforts would not have achieved a great deal. The Woburn gardener tried to explain why certain plants impoverished the soil more than others. Sinclair examined various crops to see if they contained similar quantities of nutritative matter and consulted the work of Davy to obtain a chemical analysis of this matter. He then tried to relate his findings to their impoverishing effect. Sinclair decided that those containing saccharine matter, gluten and mucilage were general impoverishers because they impoverished the soil for successive crops of their own kind as well as for all other vegetables. Partial impoverishers were crops which contained mucilage and gluten, or starch and albumen, and robbed the soil of nutritive matter for an immediate succession of themselves but only in a small degree for other plants whose nutritive matter differed. He analysed the soil before and after such crops but could only find a loss in the quantity of humus and had to admit that his science could not suggest an answer: 'An analysis of plant and soil appears insufficient to account for the true causes of the impoverishing principle of vegetables to the soil and why one species should exhaust more than another'. This kind of enquiry is representative

118. Letter from George Sinclair to the third Lord Hardwicke, 28 December 1814, Brit. Lib. Dept. Mss., Add Ms., Correspondence of the third Lord Hardwicke on agriculture 1795-1829, Vol. 352, 35700, f. 276. General impoverishers were oats, rye, potatoes, carrots, mangel worzels, cabbages, kohl rabi and burias orientalis.

119. Ibid., Partial improvers included wheat, barley, peas, beans, turnips, clovers, sanfoin, lucerne and mown grasses.

120. Sinclair, Hortus gramineus, (1816), (n. 86), p. 286. Sinclair suggested that the gardeners and farmers daily practice and observations would be the greatest help in deciding on a course of action.
of much of the investigative work which Sinclair and others carried out at Woburn between 1802 and 1825. The emphasis was on the solving of practical rather than purely scientific problems.

Sinclair's belief in chemical investigation was not shaken. As a result of his methodical and comprehensive trials and observations, his calculations and his analyses of soils he felt able to make up grass seed mixtures suitable for different types of pasture land. He also rather boldly asserted that soils could be improved, and even altered, without too much difficulty in order to provide the best growing medium for grasses. \(^{121}\) Sinclair confidently applied the techniques he had learnt and his broad knowledge of chemistry to other innovatory investigations. In 1815 a variety of perennial kale, which had been growing for some years at the Abbey as an ornamental plant, was put on trial with green and purple sprouting broccoli in order to compare their qualities as farm and garden crops. The Woburn kale on an unmanured plot gave a much higher yield than the manured broccoli. The kale was carefully investigated and Sinclair found that it contained almost the same quantity of nutritive matter as the broccoli.

\(^{121}\) Ibid., p. LXV.
and believed this proved its worth as a garden vegetable. 122

To extend his knowledge of the composition of various vegetables and the quantity of nutritive matter they contained, Sinclair examined turnips, cabbages, carrots, mangel-wurzels and kohl rabi. 123 The Duchess of Bedford requested Sinclair to similarly investigate the Barbados potato that she had introduced, so that its nutritive value could be appraised. 124 Besides utilising chemistry in this way, it is likely that Sinclair was using various chemicals at Woburn in order to promote the germination of difficult seeds. Quite possibly, he was experimenting with chlorine gas in an attempt to encourage tropical seeds with hard coats, or shells, to sprout. 125

Sinclair conducted trials with salt to compare its effects as a manure on various crops. Edmund Cartwright had been


123. Sinclair, Hortus gramineus, (1816), (n. 86), pp. 310-313.


125. George W. Johnson, The principles of practical gardening, (London, Robert Baldwin, 1845), pp. 37-38. Johnson was reporting on George Sinclair's experiments. Sinclair mixed muriatic acid, black oxide of manganese and water in a glass retort, placed it in a hot bed and connected the opening with the drainage hole of a pot of seeds so that the chlorine gas could pass through the soil.
experimenting with salt as a manure and a cattle feed in 1805. The Duke's promotion of Cartwright's enquiries at Woburn was probably part of the initial flush of enthusiasm around the beginning of the century to apply chemical science to horticulture and agriculture. Also, it was most likely an attempt to encourage the government to reduce the salt duties by demonstrating it was an essential and effective general manure. 126 No further trials were carried out until Sinclair's investigations between 1818 and 1820. Around this time, there was strong agitation by writers, industrialists, noblemen, gentlemen and even M.P.s for the repeal of the salt duties, 127 especially since the government could no longer claim that extra revenue was needed for the war effort. A persistent advocate of the cause and a friend of George Sinclair was Cuthbert W. Johnson who used a great deal of experimental evidence to prove that careful applications of salt increased the yield of certain crops. Humphry Davy lent ammunition to the case. Although in 1813 he wrote cautiously about common salt, in the 1821 edition of his

126. Cartwright, (n. 32). Fourteen different kinds of manure were used in sixty different combinations and Cartwright analysed soils using methods similar to those favoured by Humphry Davy. He applied these manures to potatoes, turnips and buckwheat and concluded that salt was generally superior as a manure and produced outstanding results when mixed with soot.

127. Sir Thomas Bernard, The case of the salt duties, (London, John Murray, 1817); Samuel Parkes, Letters to farmers and graziers, (London, Baldwin, Cradock and Joy, 1819); Johnson, An essay, (n. 32), (1821); Rev. B. Dacre, Testimonies in favour of salt as a manure and as a condiment for horse, cow and sheep, with testimonies of its vast importance in the arts, manufactures and in the fisheries, (Manchester, Private printing, 1825). Acts of Parliament in 1816, 1817, 1819 and 1823 gradually reduced the various duties. In 1824 they were removed altogether.
Elements of agricultural chemistry, he stated that its use as a manure had been fully proved. Sinclair's enquiries should be seen as part of this movement and was the second attempt by the Duke to use scientific evidence to back up the argument for repeal.

The objects of Sinclair's investigations were to note how the growth and yield of certain crops were affected by applying salt to the soil, to ascertain the affects of employing different quantities of salt, to find the most economical and efficacious mode of administering it and to record its performance when mixed with other substances that were used as manures. Wheat, barley, potatoes and carrots were grown on plots of land twelve yards square and both the soil and a portion of the resultant harvest were subjected to a chemical analysis. It was found that where applications had been high, the crops contained the largest portion of salt. Sinclair deduced from this that common salt was taken up by the roots and was used as a food by the plants. His findings were published as a prize essay by the Board of Agriculture and contained much tabulated information. After considering his observations and examining the results of his painstaking enquiries,


130. Ibid., p. 4
Sinclair believed that salt caused an enormous increase in grain when applied to wheat and a reasonable increase in the yield of barley and potatoes. Furthermore, he found that it had produced remarkable results in carrots when mixed with soot.\textsuperscript{131} For the Duke and Sinclair, the case was proven.

Finally, another innovatory measure was Sinclair's application of chemical analysis to the cultivation of heaths. During the early 1820s the sixth Duke began to collect heaths seriously. It was Sinclair's responsibility to build up a comprehensive collection and to maintain them in a good state of health. To carry out his duties efficiently, he began a systematic investigation to find the best possible growing conditions. This involved collecting different varieties of heath soils and analysing their constituents. After continuing his careful experiments and investigations for several years Sinclair concluded that the major components were humus, derived chiefly from decayed leaves, and sand.\textsuperscript{132} He also collected calcareous soils from around Luton and Dunstable and hoped, by mixing them in various proportions with peat ashes, to find a potting medium suitable for the

\textsuperscript{131} Ibid., pp. 31, 42, 62, 89, 145.

\textsuperscript{132} Sinclair, \textit{Hortus ericaeus}, (n. 83), p. VI.
more exotic greenhouse specimens. This proved unsuccessful and in his catalogue of the Woburn heath collection, *Hortus ericaeus Woburnensis*, (1825) Sinclair recommended a natural heath soil as being the most suitable for growing different species. An original feature of the catalogue was the provision of a detailed chemical analysis of this soil. Contemporaries, though, largely ignored these efforts to apply chemistry to the cultivation of ericas. Sinclair's approach was not discussed in the horticultural journals. Moreover, a well respected monograph on Cape heaths published in 1832 and written by William McNab (1780-1848), Superintendent of Edinburgh Botanic Gardens and a Woburn correspondent, praised the skill that had been shown in accumulating and maintaining the Duke's collection but made no reference to Sinclair's chemistry. Nevertheless, the catalogue stands as a good example of George Sinclair's particular brand of horticultural science, which combined skills of chemical analysis and


botanical taxonomy. Sinclair's research at Woburn, in fact, is as much a testimony to his expertise in botany as it was to his competence in chemistry. The botanical science that was involved in his investigations of grasses and heaths will be examined in the final section.

Sinclair's use of chemistry had its origins in the work which Humphry Davy carried out at the Royal Institution and for the Board of Agriculture. I have suggested earlier that one reason the sixth Duke of Bedford, and other progressive landowners, particularly favoured chemistry was that its utility for agricultural and horticultural improvement was being suggested by a number of writers during the late eighteenth and early nineteenth century. Davy was particularly important because he, above all others, was propagandising chemistry in an exceptional manner and was able to justify to landowners their investment and belief in science. 136 His work at the Royal Institution for the Board of Agriculture, or for individual landowners, demonstrated precisely how chemistry could be applied to a wide variety of agricultural and industrial problems and enquiries. Davy analysed the

136. Berman, (n. 104), p. 65. The Duke may also have been receptive to the ideas of Professor Walter Wade. When Bedford was Lord Lieutenant of Ireland he attended Wade's lectures on grasses at the Dublin Society's Botanic Gardens at Glasnevin. Wade argued that chemistry was of great significance to agriculture. The Duke later arranged for Wade to give these lectures to the Farming Society of Ireland. See Walter Wade, Sketch of lectures on artificial or sown grasses, delivered in the Dublin Society's Botanic Garden, Glasnevin, (Dublin, Dublin Society, 1808), p. vi; Letter from the sixth Duke of Bedford to John Hamilton, 17 July 1806, Irish Corr., (n. 22).
composition of potatoes, the constituents of spring, English and blighted wheat, the properties of soils, the dyeing qualities of the prickly pear and the bark of various trees (to see if it was suitable for tanning leather). He also investigated seed germination, studied the effects of paring and burning clay and marl and reported on the manufacture of artificial fertilisers.\footnote{137} Davy campaigned vigorously from the lectern. His lectures to landowners at the Royal Institution on the usefulness of chemistry to agriculture were delivered clearly and effectively and they later included practical demonstrations. They were published as the \textit{Elements of agricultural chemistry}, which became the standard text for several decades.\footnote{138}

Davy made a strong impression on the sixth Duke and probably had a similar effect on other great landowners who welcomed and entertained him and toasted him at agricultural exhibitions.\footnote{139} Davy attended the sheep shearing of Thomas Coke and was a frequent visitor to Woburn.\footnote{140} Such occasions provided Davy

\footnote{137. Common Place Book, R.I.A., Davy MSS. 12, pp. 246-256; Laboratory notebook, October 1805 to July 1809, \textit{Ibid.}, Davy MSS Box 6, pp. 13-14, 17, 21; Personal Notebooks 1795-1823, \textit{Ibid.}, Davy MSS. Box 13, B.C. Brown Notebook, pp. 80-118; Berman, (n. 104), p. 59.}

\footnote{138. Berman, \textit{Ibid.}, pp. 58, 61.}

\footnote{139. \textit{Ibid.}, p. 68.}

\footnote{140. \textit{Ibid.}, pp. 68-70.
with the opportunity of persuasively discussing his ideas. Besides advising the sixth Duke on the use of chemistry to investigate pasture grasses and carrying out the initial work by conducting experiments on ninety seven grasses, Davy gave the Duke counsel about the turnip fly. The damage caused by the fly was causing concern amongst landowners and, following Davy's suggestions, the Duke ordered a large scale experiment at the Abbey's Park Farm, using a mixture of sulphur and lime as a dressing for the turnip seedlings.\textsuperscript{141}

It should be stressed that landowners like the fifth and sixth Duke of Bedford were convinced of the value of science before Davy began his work at the Royal Institution. The industrial growth in the late eighteenth and early nineteenth centuries (particularly that generated by the spread of the steam engine and of textile machinery) was, arguably, to some extent the result of the utilisation of technology and applied science. By 1800 science had become closely associated with the wealth that had been created by this accelerating industrial growth.\textsuperscript{142} Crucially, Davy and others reinforced the landowner's perception that chemistry was useful and Davy was careful to emphasise that agricultural chemistry was

\textsuperscript{141} Davy, \textit{Elements}, (1813), p. 191.
\textsuperscript{142} Berman, (n. 104), pp. 39-40, 65.
founded on simple and easily acquired principles. It is unclear why chemistry at this time had such a great attraction for landowners. Possibly, as Berman suggests, they had absorbed the entrepreneurial spirit of the industrial revolution and were focussing it on their estates through the medium of science and that chemistry, far more than any other science, symbolised, '... their image of themselves as active, entrepreneurial and culturally avant-garde'.

Chemistry had played a major part in horticultural and agricultural experimentation and investigation at Woburn Abbey. Aspects of botanical science, were also important, particularly the skills of plant identification and the techniques of classification. The only other progressive direction the sixth Duke could have required Sinclair to take would have been to embark on a programme of cross-breeding grasses. T. A. Knight's researches were helping to publicise and popularise such methods and the Duke who took the journals where Knight's papers appeared, would

143. Ibid., pp. 48, 66-67.
144. Ibid., pp. 75, 52.
145. I have obtained this information from examining the main library at Woburn Abbey and the early nineteenth century library catalogues held in the archivists office, as well as the library bills in the estate papers held at B.C.R.O., and B.E.O.
have been aware of such advances. I have indicated that Davy made use of Knight's researches in horticultural botany and incorporated some of the results in the Elements of Agricultural chemistry. Knight was a friend of Davy and Davy frequently visited Woburn. It is improbable that the Duke would have remained in ignorance of these methods. The opportunities for producing new strains of grasses were not taken up and it was the use of chemistry and the cataloguing of various plants which became the most notable innovatory features of Sinclair's scientific enquiries at Woburn.

3.5 George Sinclair's botanical science

3.5.1 Research on grasses

George Sinclair's major work on grasses, Hortus gramineus Woburnensis, the product of roughly eight years of systematic and thorough investigation, was almost an encyclopaedia of botanical and practical information. It contained details of the characteristics, properties, habits and comparative value of three hundred and twenty grasses. This information was of relevance to botany, horticulture and agriculture. Sinclair's comprehensive treatise drew attention to the existence of a vast range of pasture grasses and emphasised the importance of obtaining pure grass seed. Up until the final third of the eighteenth century, knowledge of the characteristics of pasture grasses was very limited and most
farmers and gardeners were not aware that some swards could contain many different varieties. The provision of reasonably pure seed for pastures, walks or lawns was a problem. A common practice was to utilise the dried flower spikes from haylofts. Several writers on agriculture and horticulture disapproved of this practice and recommended saving seed from good, clean, upland meadows.\textsuperscript{146}

A turning point was the publication of Benjamin Stillingfleet's investigations in 1759. Stillingfleet provided a number of engravings of the grasses that he had investigated and commented on the most appropriate soils, the season of flowering, their suitability for different animals and their qualities for fine turf, pasture and hay.\textsuperscript{147} This, and the works of subsequent writers, provided the foundation for George Sinclair's own enquiries. Stillingfleet's comments were


fleshed out by the books of the Rev. G. Swayne and William Curtis. Besides giving botanical information and dried specimens, Swayne pointed out that no conclusion could be reached about the merits of different species until detailed experiments had been carried out.148 Curtis attempted an analysis of the various grasses found in turf, a technique which was utilised and extended by Sinclair, and advertised his own packets of mixed grass seed.149

William Amos further developed these ideas. In his Minutes in agriculture and planting he included a table of various soils with the grasses most suited to them. By listing the chemical composition of vegetables in the section on vegetable physiology, Amos suggested a new direction.150 The work by J.K. Knapp, Gramina Britannica, (1804), contained a hundred and nineteen coloured illustrations of grasses and seems to have furnished the framework for Sinclair's own extensive volume.151 When Sinclair began his researches for the Duke of Bedford, therefore, the subject had been opened


149. William Curtis, Practical observations on the British grasses best adapted to the laying down or improving of meadows and pastures, (London, Private printing, 1790, Second edition).


The general opinion amongst the writers of the early nineteenth century was that the only effective way to extend knowledge of grasses was to undertake much more thorough and detailed investigative work. In approaching his task with meticulous care and great attention to detail, Sinclair was responding to their challenge and stimulation.

A variety of motives led the Duke to instruct his gardener to begin investigating pasture grasses. The House of Russell was renowned for patronising agricultural improvement and the sixth Duke was conscious of maintaining this tradition. His predecessor had developed plantations, introduced sheep shearings, initiated schemes of drainage, improved the breeds of cattle, inaugurated experiments on cattle feeding and had begun trials of grasses. At the start of 1802 all of these schemes were progressing satisfactorily. On his deathbed in March of that year the fifth Duke had strongly urged his brother not to abandon them. Bedford, having given his word, felt honour bound to support agricultural improvement. As I have mentioned earlier, the sixth Duke was concerned with the welfare of the country and saw it as his duty to undertake investigations which could bring long term benefits. He believed that, 'The markets of England could not have been supplied so cheaply had it not been for the great improvement in the breeding

of feeding stock which had occurred in the last twenty years'.

It was a natural step to investigate pasture grasses in order to fatten cattle most efficiently and economically and thus benefit society generally. The Duke hoped his investigations would spur other landowners to improve their pasture lands and undertake their own investigations and thus raise the 'spirit of enquiry'.

The prospect of increased estate revenue was also probably in the Duke's mind. A great interest was shown in grassland by the landed classes and various scientific institutions during the French Wars (1793-1815). One study of literary evidence and farm records in an area around Reading has shown that the traditional picture of generally rising grain prices, of a great extension in arable cultivation and of a less spectacular rise in meat prices may be in need of modification. This study found that beef prices were increasing faster than wheat and that there was an expansion in the acreage devoted to grass.

153. Letter from the sixth Duke of Bedford to John Foster, 1 October 1806, Irish Corr., (n. 22), Vol. B.

154. Sinclair, Hortus gramineus, (1816), (n. 86), p. V.


If this is true for other regions it could be that profit motives pushed landowners to improve further their breeds of cattle and encouraged them to use science to enhance the productivity of their pasture lands.

One of the aims of George Sinclair’s enquiries was to find out which grasses were most profitable for permanent pasture, alternate husbandry, dry or upland pasture and irrigated meadows. For each of the grasses included in the *Hortus gramineus Woburnensis*, Sinclair gave details of the soil it was grown in, the computed weight of the produce per acre at flowering time and the period when the seed was ripe and when the grass was dry. There were also helpful comments about the earliness or lateness of growth, the time of the year when it was most nutritious, the combination in which it was most effective and its susceptibility to disease. The book was also rich in pieces of practical advice based on short research projects which had been undertaken to try to solve various subsidiary problems that had arisen from the main line of enquiry. For example, Sinclair had conducted trials to find out which was the most appropriate time to harvest grasses to ensure the seeds would be at their ripest and in the most suitable condition to ensure maximum germination on future sowing.\(^{157}\) This resulted in simple practical advice on how to recognise a plant with a mature seed spike and the procedure to adapt

when collecting the seed.

Sinclair's eight year programme of close observation and careful experimentation led him to believe that the most valuable properties in a grass were its nutritive powers, its produce, its early growth, its facility for growing rapidly after being cut and its ability to grow well from seed. Using these criteria he recommended seventeen grasses as being the most suitable for making the very best permanent pasture.\(^{158}\) He provided lists of mixes of grasses suitable for the various types of pasture and took into account differences in soil and situation.

Another important aim of the book was to provide, as far as possible, a series of reliable facts useful for the recognition of the different varieties of grasses. Great pains were taken by Sinclair to identify all the types on trial at Woburn and they were labelled according to their characteristics and habits. He stressed the fact that farmers did not make use of more than two or three species and pointed out that knowledge of the subject was still in its infancy.\(^{159}\) To encourage the adaption of a greater number of grasses it was necessary to demonstrate the existence of an immense range and to provide the means by which they could be

158. Ibid., pp. 118-123.

159. Ibid., p. 111.
distinguished. At a time when new varieties of vegetation were being discovered at home, in Europe and in the colonies, reliable sources of identification were important. They helped those interested in the study/collection of plants to avoid confusion. Fresh discoveries offered the possibility of economic exploitation and accurate identification was the first step in an appraisal of a plant's potential. For these reasons nearly all the grasses in the 1816 edition were illustrated by actual specimens, which had been dried and coloured. Examples of the seed were also included. Each grass, labelled with its Latin and its common name, was accompanied by a description of its botanical characteristics and an explanation of where it originated. As an aid to further reference, Sinclair listed his sources of information.

It was in the compilation of such data that Sinclair displayed his skill as a botanist. A knowledge of plant morphology and classification were needed in order to collate the research findings. Of course, other skills were demonstrated too. A facility in mathematics was required to handle the statistical information and present it in tabulated form. Some understanding of chemistry was necessary in order to analyse soils and ascertain the nutritive quality of grasses. Few books written by head gardeners in this period displayed such a broad range of scientific skills. The work exhibited a desire for consistency and accuracy in the use of terminology. Indeed, A. R. Beddows in an extremely thorough survey of the history of ryegrass, regarded Sinclair
as, '... the first scientific agronomist who carried out the first scientific study of grasses'.\textsuperscript{160} Although this is a slight exaggeration as it understates the value of the botanical work of earlier writers such as Stillingfleet, Swayne and Knapp, it does stress the importance of Sinclair's efforts and acknowledges the expertise that was required to carry out these investigations.

A good many of Sinclair's contemporaries received the book warmly. Loudon quite correctly thought it contained a vast quantity of original and important matter and found it, '... difficult to do justice to the author of a work of so much scientific research and careful experimentation'.\textsuperscript{161} G.W. Johnson (1802-1886), experimental horticulturist, gardening writer and Professor of Moral and Political Economy at a Hindoo College in Calcutta, regarded the findings as excellent and believed the book reflected one of the greatest efforts to put the cultivation of plants upon an enlightened footing that had ever been written.\textsuperscript{162} The book became a work of reference and was quoted by others who wrote texts about grasses. Sir E.J. Russell writing

\textsuperscript{160} A. R. Beddows, 'The ryegrass in British agriculture: a survey', Welsh Plant Breeding Station, 17, (1953), Bulletin Series H, p. 27.

\textsuperscript{161} J.C. Loudon, 'Hortus gramineus Woburnensis', Gdnr's. Mag., 2, (1827), pp. 67-68.

in 1966 justifiably commented that, 'These Woburn Abbey observations and experiments provide a great fund of knowledge on grassland which has not been sufficiently recognised'. 163

The *Hortus gramineus Woburnensis* reflects the concern felt by botanists at this time over the various methods of plant classification. Sinclair in 1816 believed that the natural system compared to Linnaeus' artificial method, had the merit of great simplicity, but was imperfect to some degree as several species had characteristics which fitted more than one section. 164 By the time the second edition of his book had been published Sinclair was becoming more convinced of the advantages of the natural system. Towards the end of the 1820s, after he had left Woburn, he believed grasses, '... should be arranged according to the natural affinities, as affording the greatest assistance to memory and presenting the most pleasing general view of the different species ...'. 165

My impression is that Sinclair was keen to adapt the best system for arranging grasses but was not really interested in contributing to the debate on classification. Possibly,


164. Sinclair, *Hortus gramineus*, (1816), (n. 96), pp. XLVII-XLVIII.

165. George Sinclair, 'On cultivating a collection of grasses in pleasure grounds or flower gardens', *Gdnr's Mag.*, 1, (1826), p. 116. In his book on trees the natural arrangement was chosen. Linnean descriptions were, however, provided. Sinclair believed they were equally as accurate and had the merit of saving space.
he felt confident enough to comment on his preference but regarded his botanical knowledge as not being of sufficient breadth to be able to contribute meaningfully to the discussions.

His desire for accuracy and precision and his faith in chemistry is illustrated by the debate he conducted in the *Agricultural Magazine* with Dr Richardson (1740-1820), writer on geology and agriculture, over the issue of fiorin grass (*agrostis stolonifera*). Richardson, a strong protagonist of this plant, objected to certain experiments which had been carried out on the grass, particularly those involving the use of chemistry, because he thought they underplayed its value. Sinclair pointed out that the differences in opinion about the value of fiorin had been caused by the existence of seven kinds of agrostis, four of them being fairly common and inferior to Richardson's variety. He suggested that chemical enquiry had very definitely shown the truth of Richardson's claims and implied that if the doctor had looked up the discriminating characteristics in the works of eminent botanists, such a misconception would never had arisen. To Sinclair, this was the justification for acquiring


167. George Sinclair, 'Mr Sinclair in answer to Dr Richardson on fiorin grass', *Agricultural Magazine*, New Series, 2, (1813), pp. 154-156.
botanical skills and one of the benefits of compiling data on the characteristics of plants. Richardson's reply highlighted their different approaches. The doctor scornfully noted that Sinclair, "... looked to the whole subject ..." and, in trying to embrace every species and variety, merely toiled to increase the catalogue. Richardson believed his own efforts to reduce the list of grasses to the least possible number would serve agriculture far better.

When Sinclair left Woburn to become a nurseryman he applied the knowledge he had gained from his research on grasses to developing the science of lawn construction. The common method of making lawns was to lay down turf from the finest pastures. Using seed was not favoured because there was a risk of impurities and there was the danger that weeds could gain a hold during the length of time it took for the lawn to become well established. Sinclair's solution was to advocate a number of lawn seed mixes of relatively pure seed suitable for various soils. He also undertook a chemical analysis of his customer's soil in order to see what improvements could be made. In other words, this was a carbon copy of his work on pastures. If necessary, he made up special mixtures to suit exactly the

168. Correspondence between Dr Richardson and Mr George Sinclair on fiorin grass, *Ibid.*, pp. 73-78.
peculiarities of the buyer's soil and the lie of the land. Sinclair was confident the seeds would quickly grow and form a dense cover.

In his capacity as a nurseryman, Sinclair was able to publicise his ideas and display his lawn and pasture seeds at the various agricultural shows and at his premises at Covent Garden Market and New Cross. Along with seedsmen like Thomas Gibbs and Peter and Charles Lawson, Sinclair pioneered and popularised this sort of technique and gained a reputation for a scientific approach and practical skills. His work helped to develop the theory of lawn making. It is an example of how research directed towards one particular problem produced results which were applied to a related problem area. The Abbey, true to its reputation as an enterprising estate, purchased its customised lawn seed from Sinclair's nursery and seed business.


172. Bill from Cormack and Sinclair for the pleasure ground, 1 November 1834, B.C.R.O., R.V., Box R/469, Bundle number 22.
3.5.2 Research on heaths

George Sinclair's last major text for the Duke was the Hortus ericaeus Woburnensis, published in 1825. It was a catalogue of the sixth Duke's collection of heaths and gave the botanical details of several hundred plants. The Duke had long been an admirer of this genus and was attracted by the variety and exquisite loveliness of their colour shades. Their beauty appealed to the Duke's aesthetic nature to such an extent that his catalogue contained sumptuously coloured engravings and he commissioned a folio of some of the most outstanding heaths in his collection. There was prestige to be gained from collection something beautiful which had not yet become fashionable. This may also have encouraged the Duke to establish his collection. In the early nineteenth century exotic heaths were not a popular glass-house plant even though attempts had been made to extend their cultivation. Sir Joseph Banks in the late eighteenth century had introduced species from the Cape of Good Hope and established a substantial collection at Kew. Lee and Kennedy, who owned a seed and nursery business at Hammersmith, tried to encourage their adoption and reared hundreds of plants. The Duke thought their reputation for being difficult to grow was caused by the

173. Sir W. J. Hooker, Copy of a letter addressed to Dawson Turner Esq., F.R.A. and L.S. on the occasion of the death of the late Duke of Bedford particularly in reference to services rendered by his Grace to botany and horticulture, (Glasgow, George Richardson, 1840), p. 5.


indifference shown by many nurserymen, characterised by an unwillingness to take the necessary precautions to ensure that these plants became well established. 176 In spending so much money building up a collection and in constructing a special greenhouse for his rare specimens, it is likely that the Duke regarded himself as a creator of fashion, which fitted into his status and role in society. He did, in fact, encourage others. William McNab believed the Duke's patronage had given a considerable stimulus to the cultivation of these plants. 177

It was ill health, however, which caused the Duke in 1822 to begin collecting earnestly. A severe illness had left him in a debilitated state and as an aid to recovery he made the decision to raise a large number of British and foreign heaths. 178 The Duke felt unfit for almost any other occupation except this, '... pleasing and rational pursuit'. 179 Quite possibly, the Duke was following the advice of Sir John Sinclair, who wrote about health as well as about farming and gardening. Sinclair had compiled a paper of hints for those suffering from paralytic or apopleptic


179. Ibid.
disorders and suggested that the human mind had to be occupied and amused. He recommended '... surveying the beauties of nature and directing the operations but not joining in, the labours of gardening', and thought, 'the management of a greenhouse and attention to the culture of plants are excellent means of occupation'. 180 It does seem reasonable to assume that Sir John's ideas had some influence, particularly as the Duke kept a copy of this paper, began collecting enthusiastically just after his illness and played a part in the design of the new heath house. 181

To work out a reliable technique of cultivation and a sound system of management, George Sinclair proceeded in an empirical fashion. Several writers on heaths had given directions that were at variance with each other. 182 By a process of trial and error the Duke's head gardener arrived at the most appropriate summer and winter temperatures and discovered the requirements for moisture and ventilation. Occasionally, specimens from abroad arrived in a very sorry state, making identification difficult. Such plants needed intensive care. Sinclair was equal to the task and grew four hundred distinct

180. Sir John Sinclair, Hints to persons afflicted with paralytic or apoplectic disorders, 7 February 1823, Duke's Ltrs. and Pps., B.E.O.


species and raised many new varieties and thus extended the range of plants in cultivation. The Duke's plants soon gained a reputation for being, '...one of the best collections of ericas in England'.

The first part of Sinclair's catalogue was a general section. It contained an alphabetical arrangement of all the different species and conveyed botanical details in shorthand form. Sinclair had developed these abbreviations from the data he had obtained as a result of his systematic observations and enquiries and used them to present a great deal of useful information. He hoped this would assist the gardener in clearly determining the different species without recourse to lengthy scientific descriptions. The adoption of the natural system of classification in the second section of the Hortus ericaeus Woburnensis was an innovatory feature. Sinclair chose the shape of the blossom as the major means of discrimination and used the mode of inflorescence, calyx and bractea as the basis for subdivision. A new specimen could be accurately classified, therefore, simply by referring to the flower. Compared with the standard work on heaths by H. C. Andrews (d. 1828), botanist, artist and engraver, this was a new departure. The text of Andrews' work was

written by James L. Wheeler (fl. 1820s–1870), Botanical Demonstrator at the Chelsea Physic Garden. Wheeler pointed out the inefficiencies of the artificial system but could not suggest an alternative. Consequently, he concentrated on straight-forward botanical description. 185 Moreover, in Sir J.E. Smith's section on heaths in his *English flora*, which Sinclair had used as a work of reference, the natural system of classification was acknowledged but Smith preferred to use the Linnean method. 186 Sinclair hoped that anyone could quickly and easily determine doubtful species by referring to both the systematic and alphabetical arrangement simultaneously. 187 This double system was undoubtedly helpful. Possibly, however, it suggests caution and implies there was still some doubt in Sinclair's mind about the reliability of the natural system. As I have shown in the section on grasses, it was not until the late 1820s that he became almost fully convinced of its merit.

A further innovation was the inclusion of a method of defining the colour of flowers. There was no standard nomenclature to aid gardeners in this task. The term red, for example, could be applied to a wide variety of hues. 188

188. Ibid., p. 39. 'Blue' and 'yellow' were applied equally loosely.
Nurserymen and others were maddeningly inconsistent when they described blossoms. Without standardisation a certain amount of disagreement and confusion was inevitable. George Hayter (1792-1871), the portrait and historical painter, designed for the *Hortus ericaeus Woburnensis* a colour chart which was based on the form of the mariners compass. Hayter had made use of the scientific arrangements proposed in a work on perspective that had been written by his father. The chart was included as an appendix to the Woburn catalogue. The sixth Duke believed that if it was adopted universally it would be found to be of general utility, though it does not appear to have influenced subsequent writers on heaths.

By providing concise cultivation instruction, by showing there was a vast range of varieties to cultivate, by demonstrating that exotic heaths could be grown relatively easily, by including new varieties and by supplying accurate illustrations and botanical descriptions, the catalogue 

189. Ibid., see the Duke's introduction.


provided a valuable service to gardeners and botanists. Sinclair wanted his work on heaths to be accepted as a book of reference. He took great pains to ensure that the botanical data provided was free of errors and believed that only by maintaining high standards could the science of horticulture and botany be furthered.

Conclusion: The agricultural and horticultural enquiries introduced at Woburn Abbey by the sixth Duke of Bedford between 1802 and 1824 strengthened the Abbey's reputation for scientific experimentation and innovation. A wide range of activities were patronised by the Duke. Fir trees, grasses, manures, pears, vegetables and heaths were all the subject of investigations and experiments. Most of the aboricul tural work was undertaken by Robert Salmon, one of the Woburn stewards. Edmund Cartwright, the previous steward, carried out experiments on various substances which could be used as 'fertilisers'. Nearly all other enquiries were conducted by the estate head gardener who, at the Duke's instigation, wrote a treatise on grasses and compiled a catalogue of the heath collection. There were many reasons for the Duke's patronage of agricultural and horticultural science. Duty to the country and to the estate, the reputation of the family name, honouring a promise, status and prestige, involvement in legislative repeal, profit, belief in scientific progress, appreciation of beauty, illness and a developing interest in horticultural botany all need to be taken into account.

Clearly, much of the initial research, including that undertaken by the head gardener, had an agrarian impulse behind it. The
results had a significance for farming and for horticulture. However, in the early 1820s although the Duke was still interested in agriculture, his concern with farm animals and their nutrition had lost its passion. He resigned as President of the Smithfield Club\(^{192}\) partly because of ill-health but mainly because he thought, '... the objects of the Society were fully accomplished and that the science of agriculture had attained a state of perfection that was not likely to be surpassed'.\(^{193}\) He was still involved in their shows, continued to enter his cattle and maintained comparative trials on the fattening properties of different breeds,\(^{194}\) but gardening was becoming more important to him. The projects at the Abbey began to have a stronger horticultural than an agricultural flavour about them, although the Duke hoped some of the work would benefit agriculture as well. During the second quarter of the nineteenth century the influence and attraction of Humphry Davy's chemistry weakened and the Duke was becoming more preoccupied with horticultural botany.

Sinclair was succeeded by James Forbes. With a different head gardener at the Abbey in 1825, several new schemes developed.


Chapter Four - Investigation and innovation at Woburn Abbey, 1825-1839

Between 1825 and 1839 the sixth Duke of Bedford became increasingly preoccupied with gardening matters. Indeed, by the early 1830s horticulture had become a major interest. In a letter written to one of his sons in 1833 the sixth Duke stated, 'Gardening is my hobby horse and my chief occupation and amusement ...'.

It was at this time that the Duke involved his family in his schemes and enlisted its aid to bring certain projects to fruition. The sixth Duke patronised horticultural enquiry on his estate with great vigour and enthusiasm and the Abbey continued to evolve as an important centre of experimentation and innovation. During the tenure of James Forbes the Duke instigated investigations of willows, pines and cacti and introduced innovative glass-house technology. Besides discussing these developments I also want to survey the general horticultural work that was carried out at Woburn throughout this period.

4.1 James Forbes and aboricultural science

Little is known about the early life of George Sinclair's successor. It has been established that James Forbes

---

### Key to the plan*

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Abbey.</td>
<td>13</td>
<td>Stable courts.</td>
<td>25</td>
<td>Menagerie.</td>
</tr>
<tr>
<td>2</td>
<td>Parterres in front of the libraries.</td>
<td>14</td>
<td>Chinese dairy.</td>
<td>26</td>
<td>Wired compartments for menagerie.</td>
</tr>
<tr>
<td>3</td>
<td>Her Grace's private flower garden.</td>
<td>15</td>
<td>Larders.</td>
<td>27</td>
<td>Keeper's apartments, Canary room.</td>
</tr>
<tr>
<td>4</td>
<td>Covered walk.</td>
<td>16</td>
<td>Children's garden.</td>
<td>28</td>
<td>Alders and birches.</td>
</tr>
<tr>
<td>5</td>
<td>Sculpture gallery.</td>
<td>17</td>
<td>Rock work.</td>
<td>29</td>
<td>Poplars.</td>
</tr>
<tr>
<td>6</td>
<td>Parterres in front of the sculpture gallery.</td>
<td>18</td>
<td>Willow garden.</td>
<td>30</td>
<td>Species of ash.</td>
</tr>
<tr>
<td>7</td>
<td>Greenhouses.</td>
<td>19</td>
<td>American bank.</td>
<td>31</td>
<td>Elms.</td>
</tr>
<tr>
<td>8</td>
<td>Camellia house.</td>
<td>20</td>
<td>Hardy heath garden.</td>
<td>32</td>
<td>Temple and Platanus'</td>
</tr>
<tr>
<td>9</td>
<td>Greenhouse for pelargoniums.</td>
<td>21</td>
<td>Site for heaths when out of doors.</td>
<td>33</td>
<td>American oaks.</td>
</tr>
<tr>
<td>10</td>
<td>Plant stove.</td>
<td>22</td>
<td>Collections of hollies.</td>
<td>34</td>
<td>Arbour.</td>
</tr>
<tr>
<td>11</td>
<td>Riding house.</td>
<td>23</td>
<td>Rosarium Britannicum.</td>
<td>35</td>
<td>Different species of the genus Pinus.</td>
</tr>
<tr>
<td>12</td>
<td>Tennis court.</td>
<td>24</td>
<td>Grass garden.</td>
<td>36</td>
<td>Porter's lodge.</td>
</tr>
</tbody>
</table>

*The plan has been taken from James Forbes' *Hortus Woburnensis*. I would like to thank Marilyn Ward of the Library, R.B.G.K., for her assistance in obtaining copies from Forbes' work.*
trained as a gardener in Scotland and later became steward and gardener to Lord Harland at Stokestown House in Ireland, an estate of over a thousand acres with an extensive kitchen garden. From here Forbes went to the Botanic Garden at Trinity College Dublin, probably during the second decade of the century, and was a gardener-botanist assistant (in other words a sort of Deputy Curator) to the Curator James Townsend Mackay. Forbes had the opportunity to gain a specialist knowledge of certain areas of horticultural botany whilst working under Mackay. The Curator had established a valuable and systematically organised collection of English willows at the garden and his deputy must have become familiar with many varieties. In the early 1820s Mackay was putting the finishing touches to a detailed survey of flowering plants and ferns indigenous to Ireland. Very likely, Forbes gave some assistance in its compilation. Mackay's catalogue, which included details of the habitat of rarer varieties, was published in 1825. The arrangement followed Linnaeus and the terminology used was based on Sir James Edward Smith's *Flora Britannica* (1800-1804).


5. J.T. Mackay, *A catalogue of the plants found in Ireland with descriptions of some of the rare sorts*, (Dublin, R. Grasiberry, 1825), pp. 3-4.
Forbes left Dublin towards the end of 1824 and officially took up his position as head gardener at Woburn Abbey during the beginning of 1825. Such people generally moved around in this way. By doing so they were able to widen their experience. It is not known how Forbes was recruited but it was common practice for landowners, head gardeners and botanists to write to one another to recommend gardeners for posts or to enquire who might be available for employment. Forbes' botanical skills and his knowledge of the willow family were the reasons why he was appointed at Woburn. The sixth Duke was contemplating forming a collection of willows and George Sinclair's departure meant a gardener was needed who was a competent botanist. In addition, the new head gardener had to be sufficiently diligent to be able to undertake the careful work that was needed to establish an extensive willow garden. Apart from building up a salicetum and carrying out experiments and investigations for the Duke, James Forbes' duties at Woburn included the management of the following: the pleasure garden, tho Froxfield nursery ground and the fruit and vegetable plots. Forbes was a very able practical gardener and his care and expertise ensured that the various horticultural collections at the Abbey were well maintained and considerably


extended. Joseph Harrison believed, quite correctly, that the Woburn horticulturist was a '... very talented and excellent gardener ... under whose skilful management the gardens and grounds have attained a high degree of perfection ...'. Beside these considerable tasks, Forbes found the time to write four books and to contribute articles to several horticultural journals. Most of these were praised, some highly, by his horticultural and botanical peers. The Linnean Society made him an Associate in 1832 and he became a Corresponding Member of the Horticultural Society of London. It is puzzling why Forbes did not have some affiliation to any of the Scottish or Irish horticultural societies. On the sixth Duke's death he became gardener to the seventh Duke and spent the rest of his life at the Abbey.

As the foregoing has indicated, the first major project which the Duke gave Forbes was to build up a salicetum and compile a catalogue of the collection. Forbes began his exhaustive investigations in 1825, making use of Sinclair's preliminary work. It took four years to form a comprehensive collection and in 1829 the Duke's catalogue, *Salictum Woburnense*, was published. The Duke interested himself in these trees partly as a result of the promise he had made to his brother

---


to continue with the Woburn schemes of improvement. At
the fifth Duke's request substantial plantings of willows
had been made on the estate and Bedford felt a certain
obligation to extend their cultivation. The sixth Duke
was also interested in the salix because they were valuable
articles of commerce. He thought their quick growth would
bring profit to the planter and demonstrated his faith by
laying out two large plantations on the Woburn estate. The
Duke believed that the wood from these trees could be used
to produce agricultural implements and to line carts, waggons
and ship's bottoms because it was tough and durable. Willows
had medicinal value and were useful to paper manufacturers.
The Duke stressed that they made excellent poles and that
their bark was eminently suitable for tanning leather.

Apart from economic motives, the belief that he was making
an important contribution to botanical science led the sixth
Duke to finance a four year investigation of willows and to
issue a carefully illustrated and finely coloured catalogue
of the Woburn collection. The Duke was helping to maintain
a well established British and, indeed, Western European tradition.

10. Sir W. J. Hooker, Copy of a letter addressed to Dawson
Turner Esq., F.R.A. and L.S. on the occasion of the
death of the late Duke of Bedford, particularly in
reference to the services rendered by his grace to
botany and horticulture, (Glasgow, George Richardson,
1840), p. 6.

A feature of botanical art in Western Europe between 1600 and 1900 (and possibly later) compared to Western Asia, India and East Asia, was its marked scientific and analytic bias; a bias characterised by, '... ever greater demands for minute accuracy'. Moreover, the early nineteenth century was, as Wilfred Blunt correctly argues, a period when scientific illustration reached its zenith. The flora of Britain and foreign lands were the subject of carefully compiled studies because accurate drawings of specimens, coupled with exact botanical description, were a necessary preliminary to plant classification. As one historian of science has observed:

'In the second half of the nineteenth century, the interest of scientists shifted towards more detailed studies, usually concerned with evolution, and the period when beautifully illustrated books were simultaneously first-rate contributions to science drew to a close ...'.

The sixth Duke was aware that British and foreign works on willows were not totally reliable because, in some instances, the illustrations and botanical descriptions had been taken from dried specimens and not from living plants. Existing


15. Ibid., pp. 167-168.
British textbooks dealing with willows were similarly botanically incomplete. Also, it was not easy to distinguish between different varieties and to illustrate them accurately. Linnaeus had recognised this. The length, width and form of the leaves of wild trees, particularly young ones, were liable to change according to the soil and the situation. Cultivated varieties differed in size and general habits from those in a wild state. As a result, botanists found they could not always identify specimens positively and those who wanted to use a particular variety for some economic purpose were often baffled because they did not know one willow from another. The Duke was anxious to produce a work which would help to overcome some of these problems and, '... render great service to botany...'. Bedford was influenced, too, by aesthetic feelings. He liked willows as graceful ornamental trees and thought they enhanced pleasure gardens and the landscape. The colour and texture of their leaves delighted him.

An innovatory feature of the *Salix Woburnense* was the

18. Forbes, (n. 4), p. VIII.
19. Ibid., pp. IV, XIV.
inclusion of one hundred and fifty finely engraved and coloured illustrations of all the native and foreign willows that could be found in British collections. Many of the indigenous specimens had only recently been identified and those from abroad had been newly brought in. Compared with the following standard works which dealt with willows: Sir J.E. Smith's *English botany* (1790-1814), Sir James' *The English flora* (1828, Vol. 4), Carl Ludwig Willdenow's *Caroli Linne species plantarum* (1797) and William Townsend Aiton's *Hortus Kewensis* (1810-1813, Second edition), and the article written by Smith in Ree's *The cyclopaedia* (1819); the *Salix Woburnense* contained the greatest number of engravings of these trees.

To make sure the Duke's catalogue was reliable, Forbes had to examine very carefully the branches, buds, leaves and flowers of the willows that were being cultivated at Woburn all through their different stages of growth. These examinations were made daily. Forbes compared his notes with the descriptions and delineations in the texts mentioned above. Smith and Willdenow had depended to a certain extent on dried specimens and so were not fully reliable.

In his botanical descriptions of the willows Forbes made known any points of doubt. He also entered into disagreement with various authors if he thought some varieties had been wrongly named. This was not standard practice and it enhanced the value and credibility of the catalogue as

20. *Ibid.*, See the list of authorities consulted and quoted and also pp. XI, XIII.
discrepancies and areas of uncertainty were not glossed over. It also demonstrated the integrity of its author. The thorough botanical descriptions included comments on the nature of the trunk, the habits of the branches, the shape and length of the leaves and catkins and observations on the characteristics of the sexual parts. All of these details aided identification. The Duke intended the Salictum to be more a work of botanical and horticultural science than a gardening manual and hoped it would complement existing works of reference. Consequently, very few cultural instructions were provided. Apart from explaining how to take cuttings, warning not to plant in saturated soil and recommending varieties for chalky land and sandy common, there was little information for the practical gardener. In comparison, Walter Wade's essay (1811) on willows and Smith's article in The cyclopaedia gave detailed instructions on propagation and cultivation as well as useful botanical information.

A further innovation was Forbes' modification of the criteria which Sir J. E. Smith had suggested could be used to discriminate between willows. In his Flora Britannica

21. Ibid., pp. V, VIII, XIII.
22. Ibid. p. XV.
23. Walter Wade, Salices or an essay towards a general history of sallows, willows, osiers, their uses and best methods of cultivating them, (Dublin, Graisberry and Campbell, 1811).
Smith put forward the idea that discrimination could be based on whether the germen was stalked or sessile, the comparative length of the style and the division of the stigma. Forbes used these characteristics in the *Salictum Woburnense* because he thought they were constant, and thus more dependable, together with two new features which he had derived from his systematic investigations — the hairiness and the smoothness of the germen.  

Earlier works of reference had suggested that botanists should take into account whether the margins of the leaves were entire, toothed or serrated and whether the surface was smooth or villous. Forbes did not entirely dismiss these criteria but he regarded them as of secondary importance because they were variable and thus not particularly sound. The Woburn gardener would have liked to have adopted the natural system of classification in the *Salictum Woburnense* but lacked constructive guidelines. No botanist, it seems, had been successful in laying down a sensible plan for the natural arrangement of the *salix*. Most likely, as I have already indicated, the tendency of the leaves and the general form of the tree to vary considerably in different locations made the task a seemingly formidable one. Forbes decided, therefore, to be guided by the precepts

25. Ibid., pp. XI-XII.
26. Ibid., p. XII.
27. Ibid., p. XI.
contained in the works of Sir J. E. Smith. In his later writings, Smith had adopted the method of classifying willows proposed in Wildenow's *Caroli Linne species plantarum*, which was itself based on the ideas of Linnaeus. Sir J.E. Smith, in fact, greatly assisted the Duke's project on willows. This will be discussed in chapter five. The outcome of James Forbes' enquiries was a catalogue that was decidedly Linnean in arrangement. In advocating two other features as additional criteria for discrimination, the Duke's gardener contributed to ideas on classification, although it is difficult to determine whether Forbes' suggestions were taken up by other gardeners and botanists.

The *Salictum Woburnense* was an example of the sixth Duke of Bedford's unwavering patronage of scientific enquiry and innovation. The catalogue received the approbation of contemporaries. David Don, (1799-1841) Librarian to the Linnean Society and later Professor of Botany at Kings College, London, thought that:

'... in so extensive a genus as that of *Salix* it is impossible to determine species satisfactorily without the aid of figures and therefore the publication of the *Salictum Woburnense* has supplied a most important desideratum in botanical science'.

Don was entirely correct in his judgement. The Duke and Forbes had created a finely illustrated volume which

28. Letter from David Don to the sixth Duke of Bedford 26 January 1830, B.E.O., Dukes Ltrs. and Pps., Box 2. See the documents relating to the *Salictum Woburnense*.
botanists, horticulturists and students could use (as a substitute for a living willow collection) for the purpose of identification. It really was an authoritative catalogue and a major piece of observational work on the external features of the willow. The Salictum assisted Sir W.J. Hooker in his botanical investigations and in his teaching.

In 1830 Hooker told the Duke that:

'To me no work could have come more opportunely or have proved more truly acceptable for I am now engaged in printing, mainly for the students of my classes, a complete British flora ... From your Grace's elaborate work I shall derive, I feel, some great advantage in determining our British species and shall refer to the admirable figures with very great satisfaction'.

Like the earlier works on grasses and heaths, and like the subsequent catalogue on pine's, the Salictum reflected the sixth Duke's concern with descriptive and classificatory horticultural botany. There were few investigations at Woburn into aspects of internal plant physiology. The willow project involved Forbes in collecting different varieties, collating botanical characteristics, filling out dossiers based on careful observations of the nature of the gamen, stigma, style and leaves, and evaluating the reliability of the different criteria of classification.

29. Ibid., letter from Sir W. J. Hooker to the sixth Duke of Bedford 26 February 1830.

30. The sixth Duke found plant physiology an absorbing subject but concentrated on the external features of plants. As far as I can ascertain, the only major investigation which utilised a knowledge of internal plant physiology was Robert Salmon's examination of close pruning.
Although the full page illustrations of the catalogue contained insets showing the components of the flower, Forbes did not discuss their function and made no comments about the role of any of the other parts or of the internal structure of the trees.

Having developed a varied salicetum of two acres, the Duke decided in 1833 to form an arboretum. Work began in earnest in 1836 and a large field was earmarked for this addition to the pleasure ground. 31 The nucleus of the collection was the evergreen garden which had been originally laid out by the fourth Duke in 1742. The sixth Duke desired his collection to be a prestigious one and was anxious to obtain a wide variety of British and foreign specimens. He made the oak, a valuable timber tree which he regarded as the monarch of the woods, as the foundation of his arboretum 32 and was particularly keen to obtain a number of horse-chestnuts as he had heard there were at least twenty different kinds. 33 Bedford wanted his tree collection to be of interest and value to visiting botanists, horticulturists and landed proprietors. One purpose of systematically arranging the arboretum was to show that there were many

31. Spruce, silver firs, hemlock spruce, Weymouth pines, hollies, evergreen oaks, cedars, arbuteses, cypresses, rhododendrons and poplars made up the evergreen plantation.


varieties suitable for plantations and gardens. The sixth Duke wanted to ensure his visitors could not only recognise the various kinds but also distinguish between them. 34

Both the Duke and James Forbes were concerned that the specimens in the collection were accurately named and debated with correspondents whether the different sorts sent to the Abbey were new varieties. 35 Forbes, therefore, set about organising the arboretum with these aims in mind and decided to place the trees in clumps where the species of each genus could be together.

It must be remembered that the Duke was spending freely on his favourite pastime during the 1830s and did not hesitate to gratify his desires. The arboretum provided him with a great deal of enjoyment and satisfaction. Bedford's appreciation of beauty and his propensity for self-indulgence over and above his desire to add to scientific knowledge played a part, therefore, in the foundation of the Woburn tree collection. Friendly rivalry with the sixth Duke of Devonshire 36 and, possibly, the wish to keep pace with recent developments on the Duke's Chatsworth estate, which had a reputation for horticultural improvement, also need to be

taken into consideration. The sixth Duke of Bedford paid
a visit to Chatsworth with the idea of observing the arboretum,
which was especially sound, and of obtaining some useful hints.
Joseph Paxton, Devonshire's head gardener, gave the Duke a
great deal of advice which was passed on to James Forbes.
By the late 1830s the Duke's tree collection at Woburn
occupied ten acres. Apart from the specimens planted by
the fourth Duke, the arboretum contained about sixty species
of oak and a dozen varieties of scarlet and red horse-chestnuts,
as well as hickory and other trees, mainly from the Americas.

At the same time as he founded his arboretum the sixth Duke
established a pinetum at the Abbey. The publication of the
three volume work on pines written by Almyer Bourke Lambert
(1761-1842), Vice-President of the Linnean Society, encouraged
the sixth Duke to take an interest in conifers. These

37. Letter from the sixth Duke of Bedford to Sir W.J.

38. The accumulation of new imported species proceeded
slowly because the combination of the long sea journey
and ignorance of the best methods of storage meant
seeds and young plants sometimes arrived completely
perished.

39. Letter from the sixth Duke of Bedford to Sir W.J.
1832-1835, A-B, Vol. 3, Number 177; Idem., 21 October
1837, Ibid., 1837, Vol. 9, Number 68.

40. James Forbes, Pinetum Woburnense, (London, James Moyes,
1839), p. III.
volumes, issued between 1803 and 1837, listed and illustrated about a hundred different pines and aroused the Duke's curiosity. He was particularly struck with the valuable and fascinating information given in the third volume of 1837 which dealt with the specimens discovered by botanical explorers in Northern Asia, Mexico and California. The discoveries of David Douglas (1799-1834), a collector employed by the Horticultural Society of London, also aroused the Duke's interest. Douglas sent to England pine seeds and young trees from North and South America. Many of the plants raised from the cones which this botanical explorer had collected grew perfectly well in the British climate and were distributed to various members of the Society. Douglas fanned the enthusiasm of collectors by widening the range of available specimens and by publicising his discoveries in the Transactions of this Society and of the Linnean Society. The sixth Duke was able to enrich his own collection from


44. Forbes, Pinetum, (n. 40), p. XIII.

the plants grown from Douglas' seed in the garden of the
Horticultural Society. 46 Lord Greville played a role, too,
in stimulating the Duke to establish a pinetum. Greville
set up a pinetum in 1809 at Dropmore, Buckinghamshire.
Throughout the 1820s and 1830s it was generally regarded as
the best in the country. It contained many specimens of
considerable beauty and their impressive girths demonstrated
their usefulness as timber trees. 47 Lord Greville wrote
encouraging letters to the Duke (although I have not been
able to trace this correspondence) and sent rare varieties
to Woburn. 48

In establishing the Duke's pinetum James Forbes had to identify,
classify, arrange and plant many specimens. He was also given
the task of compiling a catalogue of the Woburn collection.
This was published as the Pinetum Woburnense in January 1839.
The factors which encouraged the Duke to produce a catalogue
of his pinetum were similar to the ones which led him to finance
a work on willows. He believed coniferous trees, '... ought
to become the ornament, utility and splendour of our woods
and forests'. 49 Both the sixth Duke and James Forbes emphasised
in the Pinetum the commercial advantages to be derived from

46. Forbes, Pinetum, (n.40), pp. 45, 51, 64.
47. Ibid., p. XII.
48. Ibid., p. IV.
49. Letter from the sixth Duke of Bedford to Sir W.J.
1839, Vol. 12, Number 46.
growing these trees. They pointed out that pine timber could be used in shipbuilding, tanning and medicine and was a source of turpentine, tar and pitch. The Duke, therefore, wanted landowners, '... to increase their zeal and efforts in cultivating this truly valuable family of trees'. Their hardy and ornamental qualities were discussed. Bedford appreciated the different forms of the trees, the attractions of the size and shape of the cones and the various shades of foliage. Moreover, the pine tribe had pleasing associations of thought for the Duke, reminding him of the Holy Scriptures and of certain frigates built out of fir timber. The Duke hoped his catalogue would be a useful contribution to botanical science. He perceptively observed that the, 'Culture of the family of the coniferae may be said to be almost in its infancy in this country'. Apart from Lambert's work, there were no books by British botanists or horticulturists devoted solely to coniferous trees at this time. Whilst Lambert's volumes gave a great deal of helpful information, some of the pines had been illustrated from dried specimens from his herbarium. Such a practice did not inspire complete confidence and left areas of doubt. Furthermore, the work underwent three editions between 1824 and 1839 and many errors were perpetuated, having escaped the notice of the publishers,

50. Forbes, Pinetum, (n. 40), pp. V, VIII, IX.
51. Ibid., p. VIII.
52, Ibid., see the Duke's introduction, pp. IV-V.
53. Ibid., p. VIII.
and even copies of the same edition differed in content and arrangement.\textsuperscript{54} This unreliability caused annoyance and helps to explain why the Duke thought that a carefully compiled, comprehensive and well illustrated catalogue would be a contribution to science. Forbes took great pains in his investigations of all the different varieties of pines and the Duke trusted that botanists would find the carefully noted characteristics of each species of some value.\textsuperscript{55}

An innovatory feature of the \textit{Pinetum Woburnense} was to base the sixty seven coloured engravings on living, and not dried, specimens. The engraver had taken a great deal of trouble to ensure that the colour matched, as far as possible, the actual living pines. Each illustration depicted mature leaves and cones and, as a further aid to identification, at the base of each drawing were a number of small coloured insets showing flowers, sexual organs, young cones and immature leaves. Unlike willows, which were noted for their quick growth, pines took longer to mature and as the sixth Duke's pinetum had only been established in 1833 the number of fully developed pine cones was limited. The solution at the Abbey was to obtain living specimens from the collections and gardens of Lord Greville, the Duke of Marlborough, Kew and the

\textsuperscript{54} H.W. Renkema and John Ardagh, \textit{Alymer Bourke Lambert and his 'description of the genus pinus',} (London, Linnean Society, 1930), p. 441.

\textsuperscript{55} Forbes, \textit{Pinetum}, (n. 40), pp. III, V.
Horticultural Society of London. During the planning and investigation stages the Duke sought the advice of the eminent botanist Sir W.J. Hooker. Bedford and Forbes discussed with Hooker the names of various pines and requested information about new varieties. Throughout the catalogue the Duke's gardener considered carefully the names given to the pines and stated any reasons he had for disagreeing with accepted opinions.

Forbes made an innovatory suggestion in the *Pinetum Woburnense*. Normally, pines were divided into four distinct genera: *abies*, *pinus*, *larix* and *cedrus* but the Woburn horticulturist argued that there should be six divisions. He pointed out that the *piceae* (or silver fir), with its linear flat leaves and erect cones with their deciduous scales, were sufficiently distinct to be separated from the spruce of *abies*. The latter had pendant cones and persistent scales. The leaves of the *abies* were also very different in their form and mode of growth from the silver fir. Forbes explained that *abies Canadensis* should also be a separate genus as its cones were closer allied to the *larix* and its leaves to the *piceae*. Surprisingly, and for reasons which are not apparent, Forbes did not put these ideas into practice. Possibly, he merely wanted to

---


make the suggestion and then see how other horticulturists and botanists responded to his ideas.

In arranging the Woburn collection the Duke's gardener followed the natural system of classification, which was becoming increasingly popular during the 1830s, and grouped together those kinds which bore the greatest resemblance to each other in their foliage and natural habitat. If his detailed investigations could not show that a plant was distinct it was excluded until more evidence had been obtained. To help him arrange the pines in the catalogue, Forbes used J.C. Loudon's *Arboretum et fruticetum Britannicum* (1838, 10 Vols.). He found this work extremely valuable because, apart from adapting the system advocated by Jussieu, it included a great deal of information about the growth of trees in different parts of Britain. Forbes' work on classification, and his catalogues on willows and pines generally, indicate his strengths and weaknesses as a scientific gardener. Undoubtedly, Forbes was an able botanist. He could more than competently carry out careful and systematic observations and collate data. But, when major innovatory steps were called for in systematic botany, he preferred to follow others rather than set a precedent. I have explained how in 1829 Forbes wanted to arrange the *Salictum Woburnense* according to the natural system but


failed to do so fully because he lacked guidelines. A decade later he was able to put his belief in this system of classification into practice in the Pinetum Woburnense, but he needed to have the foundations laid by Loudon and others.

I have mentioned that the sixth Duke and Forbes were keen to search for new species of pine. George Sinclair's discussion about the natural system of classification possibly helps to explain this eagerness. Sinclair believed that when the natural system was perfected it would prove to be superior to the Linnean method because a plant's name could be inferred from noting its external structure. To perfect the natural system, explained Sinclair, all the different plants which comprised the vegetable kingdom had to be located, discussed and examined. This included all those that had become extinct and left their impression on fossils. It was the Duke's policy to examine closely pines from Britain and other countries to see if they were fresh discoveries. The ones that proved to be distinct were then accurately named and carefully described and portrayed in the Duke's catalogue. By

60. George Sinclair (ed.), Hortus Cantabrigiensis: or an accented catalogue of indigenous and exotic plants cultivated in the Cambridge Botanic Garden, (London, Longman, Rees, Orme, Brown and Green, 1831). Sinclair revised and improved the twelfth edition of James Donn's work, which was originally published in 1796. Donn (1758-1813), was the Curator of the Cambridge Botanic Garden between 1794 and 1813.
promoting the cultivation of many different kinds of pine, by supporting the introduction of potentially new species and by putting the Pinetum Woburnense into circulation the Duke was helping to encourage the development of the natural system of classification.

The publication of the Pinetum Woburnense further enhanced the Abbey's scientific reputation. There was little information on the methods of pine cultivation because the Duke regarded this work in the same way that he regarded his volume on willows, as a scientific catalogue rather than a book of cultural instructions. 61 J.C. Loudon, in a lengthy review in The Gardener's Magazine, praised the work and believed it was a magnificent contribution to botanical science on account of its carefully coloured engravings and precise descriptions of the different species and varieties. 62 Its reputation lasted throughout the century. In the second edition of a volume originally written by George Gordon (1806-1879), superintendent of the Hardy and Hot-House Departments at the Horticultural Society of London's garden at Chiswick, the Pinetum was ranked as one of the three great English publications devoted to the coniferae. 63 J.D. Hooker (1817-1911), Director of Kew Gardens (1865 to 1885) commented in an article

61. The only practical information Forbes gave was to recommend six abies and six pines as being ornamental and frost resistant, to warn about the dangers of overcrowding and to describe the best soils for these trees.


written in 1902 that it was a work of high scientific value. 64

4.2 The Duke's flower, greenhouse and fruit collections.
Here I want to examine the cultivation of bedding plants, orchids, cacti and fruit at Woburn Abbey and give further consideration to the work and activities of James Forbes.
On his own initiative Forbes wrote the **Hortus Woburnensis** (1833) which was both a botanic catalogue of all the plants that were cultivated at the Abbey and a general textbook on the management of fruit, flowers and vegetables. It was intended to be of use to the young horticulturist, the amateur and the botanist. Forbes' book is particularly valuable because it indicates the number and variety of plants that were grown at the Abbey and reveals the techniques that were in current use on a progressive estate. His text was compiled under the patronage of the sixth Duke of Bedford and published with the aid of a national public subscription. Notable subscribers were the Dukes of Devonshire and Northumberland and a large number of subscriptions came from the head gardeners of landed estates. 65

The botanical section of the **Hortus Woburnensis** was intended to be an aid to identification. An innovatory feature


was the fusion of practical horticultural instruction with abbreviated information of the generic and specific characteristics of plants. No individual work before the appearance of James Forbes' book had attempted this. Forbes was prompted to introduce this fusion by the frustration he experienced when using the following standard works: James Domn's *Hortus Cantabrigiensis* (1796), Robert Sweet's *Hortus Britannicus* (1826) and J.C. Loudon's *Hortus Britannicus* (1830). He felt they were, '... deficient in not giving the specific and generic characters essential for discriminating one plant from another'.

This, however, was the only new departure in the botanic catalogue. The rest of the section relied heavily on the ideas contained in these standard works. For example, Domn had used abbreviations composed of letters and symbols to convey concisely a great deal of botanical data and Forbes adopted and extended this system. From Sweet, Forbes took the style of abbreviation, the technique of giving the colour of the flower in words (he believed it allowed more accurate description) and the method of referring to the botanical works in which the plants being dealt with had first been figured and described. Many of the ingenious signs which Loudon had used to encompass

66. Forbes, *Hortus*, (n. 34), pp. IV-V.
68. James Domn, *Hortus Cantabrigiensis*, (Cambridge, Private printing, 1796). The symbols Domn used are given in the preface.
the different habits of plants were incorporated in Forbes' own set of symbols.\textsuperscript{70} Nevertheless, in providing a multitude of botanical data in abbreviated form the catalogue was a useful aid to identification.\textsuperscript{71} By incorporating information about the month of flowering, the soil that was required and the method of propagation it was also a guide to cultivation.

The second part of the book, which was a general text, contained original material on glass-house construction which will be discussed later. It also included information about the trials of flowers, vegetables and fruit which were conducted at the Abbey (for the benefit of the estate). Some of the plants which Forbes listed, and the details given about them, had not previously been reported. The sixth Duke, '... who has always been anxious to have the various improvements introduced and their efficiency put to the test in the Woburn Abbey gardens',\textsuperscript{72} liberally supported these trials. Empirical investigation at Woburn enabled the suitability of imported plants and seeds for the British climate to be ascertained, the yield of flowers, vegetables and fruit to be judged, the vigour of new strains or hybrids to be assessed and the best

\textsuperscript{70} J.C. Loudon, \textit{Hortus Britannicus}, (London, Longman, Rees, Orme, Brown and Green, 1830); Forbes, \textit{Hortus}, (n. 34), p. IV.


\textsuperscript{72} Forbes, \textit{Hortus}, (n. 34), p. VI.
techniques of cultivation to be worked out. By such a process of trial and error James Forbes slowly accumulated knowledge about the behaviour and characteristics of plants.

The trials at the Abbey were extensive. Normally, at least half a dozen varieties of one species were tested but in some instances several hundred types were grown. As a result of these systematic investigations, Forbes found that forty-nine kinds of geranium were suitable for planting out of doors during the summer months and one hundred and ninety sorts of dahlia were good enough for bedding displays. The Abbey gardens also had on show forty-three varieties of chrysanthemum, thirty-three lobelia, twenty-five azaleas, one hundred and thirteen mesembrianthems and ninety asters.

In the 1820s and 1830s several of the fruits and vegetables raised by T. A. Knight were tried out. During the 1830s eleven kinds of apricots, one hundred and thirty-one varieties of pears, one hundred and eighteen of apples, forty-two of plums, twelve of cherries, eight of raspberries, fifty of gooseberries, five of currants and forty-two varieties of strawberries were grown. This gives some idea of the amount of effort

73. Ibid., pp. 149-156, 190-192.
75. Bill from Buchanan and Oldroyd, 22 December 1822, B.C.R.O., B.V., Box R/443, bundle number 2; Bill from T. Gibb, 6 September 1823, Ibid., Box R/445, bundle number 18; Bill from Cormack Son and Sinclair, 20 June 1826, Ibid., Box R/449, bundle number 1; Bundle headed 'kitchen gardens' n.d., Ibid., Box R/485; A list of fruit trees planted for an orchard by the Park Keepers Lodge, Woburn Park, April 1836, B.E.C., Duke's Ltrs. and Fps., Box 1; Bill from Cormack, Son and Oliver, 1837, Ibid., bundle headed 'Lady Day 1837 to Michaelmas 1837'.

and attention that was required of Forbes and the scale of cultivation at Woburn.

Although the basic horticultural instruction given in this part of the Hortus Woburnensis was sound it reported nothing new and merely repeated what was standard practice. Robert Sweet's The British flower garden (1823-1829), which Forbes made use of, gave a much better service because it provided coloured engravings of the plants as well as instructive comments. In a specialised section on camellias, Forbes seems to have reproduced information from an authoritative treatise by Samuel Curtis, A monograph of the genus camellia (1819). Forbes could have provided valuable details about the growing habits and culture of the more choice and unusual hot-house exotics as a section of one of the large greenhouses at Woburn was devoted to their cultivation. He missed this opportunity and provided his readers with some very general comments which seem to have been culled from standard works written by Smith, Loudon and Sweet. However, since Forbes' intentions were to provide helpful general comments and not to write a definitive text, we should not expect him to have contributed significantly to the improvement of


cultivation techniques as a great deal of his time was taken up with identifying and classifying willows, pines and cacti. In these tasks he was contributing importantly to the development of horticultural and botanical science.

The *Hortus Woburnensis* received mixed reviews and was the first publication from the Abbey which did not meet with almost general approval. No-one doubted the horticultural skills of Forbes. His idea to include descriptions of the generic and specific characteristics along with cultural instructions was not criticised. This format was a novel approach but, unlike the coloured engravings in the *Salictum Woburnense* and in the *Pinetum Woburnense*, it did not fulfil any urgent need or solve any great problem. It was, however, the organisation of the book, its cost and its size which met with censure. J.C. Loudon in the *Gardener's Magazine* unfairly concluded that it was, '...an unfortunate attempt at bookmaking'.

Joseph Paxton in the *Horticultural Register* and Edmund Murphy in the *Irish Farmer's and Gardener's Magazine*, together with Loudon, quite reasonably pointed out that the book was too big and costly. They pertinently observed that if it had been compressed and reduced in price it would have reached the market which Forbes had stated that he had been aiming for. Murphy thought the catalogue should have contained more ornamental and rare plants and Loudon wished the generic characteristics had been all placed together instead of being

distributed amongst the characters of the species. These, too, were constructive and justifiable criticisms.

Apart from his writing commitments, James Forbes had to maintain the Abbey grounds to a high standard. He and his team of gardeners and labourers were instructed to provide showy displays of flowers in the glass-houses and in the beds and parterres of the garden. The organisation of the herbaceous borders, though, reveals more than just the desire for a good display. During the late 1820s the plants in these borders were systematically arranged according to the natural system of Jussieu. Unlike the plots of annuals or the strips of ground where greenhouse plants spent the summer months, these beds were a permanent feature. They affirmed the Duke's preoccupation with horticultural botany and his efforts to encourage horticultural improvement. This marks the period when Forbes and the Duke were quite convinced that the natural system was superior to Linnaeus' method. Despite his conviction, Forbes, as I have suggested, felt unable to arrange the Salix Woburnense according to Jussieu's classification. It is possible that compared to willows, with their great variation in foliage and form, herbaceous plants were relatively easier to arrange.


As the sixth Duke of Bedford's interest in gardening increased he became more ambitious in his horticultural schemes and began to specialise in those glass-house plants which were not in common cultivation and which required the services of a skilful and knowledgeable horticulturist. Orchids and cacti particularly attracted the sixth Duke's attention. During the 1830s the rearing of orchids was something of a novelty and cacti were not widely grown. New varieties were normally obtained by plant hunters who, on behalf of their patrons, scoured the continent for rarities. The Duke's role in sponsoring expeditions will be examined in chapter five. By 1837 he had become a serious collector and a special greenhouse had been constructed for these plants. At the end of the decade the Abbey's orchids were a noted feature. Bedford's holding of cacti was one of the finest in the country and enjoyed a considerable reputation. These ventures, therefore, were innovative. The importance of the work carried out at Woburn on both cacti and orchids is shown, firstly, by the way the influential professors of botany John Lindley and Sir W.J. Hooker dedicated new species to the sixth Duke and James Forbes and, secondly, by their comments about the efforts made at the Abbey to rear these plants. Hooker thought the botanical arrangement of the cacti and their health and vigour were a credit to Forbes and named a cactus


84. James Mangles, The floral calendar, (London, F.W. Calder, 1839), p. 104; Sir W.J. Hooker, 'Epiphyllum Russellianum', Curtis' Bot. Mag., 13, (1840), Number 3717. Although the pages in the magazine were not numbered each plant was given a number.
Oncidium Forbesii, after him as a compliment to his horticultural skills. 85 Lindley dedicated an oncidium to the Duke, and Hooker an orchid and a lisianthus; both professors regarded Bedford as a liberal patron of botanical science. 86

It was usual practice during the 1830s for collectors such as the sixth Duke to send details of new varieties of plants to the *Botanical Magazine*. The botanical editor was Sir. W.J.Hooker. Hooker took this post in 1826 and under his direction the magazine became more seriously scientific. The range of plants covered was considerably extended and greater botanical detail was added to the plates. 87 If a plant proved to be a new variety its botanical characteristics and a carefully coloured engraving (executed by the other editor, Samuel Curtis) were published. At Woburn, duplicates of those specimens suspected of being new, (or parts of the plant, generally the flower and several leaves) were dispatched to Sir W. J. Hooker or sent to the Glasgow Botanic Garden, to which Hooker was affiliated, for verification. As a rule, the *Gardener's Magazine*, edited by J.C. Loudon, *Paxtons Magazine of Botany*, and the *Botanical Register*, edited by Sydenham Teast


Edwards and John Lindley, gave accounts of these discoveries. These reports were based on the details given in the *Botanical Magazine*. Therefore, in amassing a collection of orchids and cacti and in informing Hooker's and Curtis' journal of fresh discoveries, (and in thus providing information for other periodicals,) the Duke was contributing to the development and diffusion of botanical and horticultural science.

Bedford was probably drawn to collecting these plants because of the novelty and social kudos of accumulating specimens that were unique. Cacti became the favourite glass-house plant of the Duke and he was prepared to make considerable investments accumulating and cultivating them. Probably, as Sir W. J. Hooker suggested, their different and striking forms and the beauty and sweet smell of their flowers appealed to the Duke's aesthetic nature. From Hooker's description of the Woburn cacti house in 1839 it is not difficult to see why the Duke found them appealing:

'In the stoves at Woburn the great columnar kinds of Cereus (and, especially the noble specimen of C. Senilis, two of which have attained to twelve feet, and are clothed with long pendant white hairs)


contrast admirably with the strangely broad and depressed forms of the Melocactus and Echinocactus group, beset, too, as these are, with spines of every shape and colour; again, the latter kind present a most curious difference of aspect from the flattened and pointed stem of the Opuntiae and Epiphylla; while the magnitude and fragrance of the blossoms of some, and the brilliancy of colour in others, are surpassed by few vegetable productions'.

It is possible that health reasons played a part in directing the sixth Duke to favour these plants especially. He could not stay long in the hot and moist environment of his tropical stoves and felt more comfortable in the dryer and cooler conditions of the cacti house. Both the cacti and the orchid collection stirred up feelings of pride in the Duke and also bestowed prestige. Bedford felt immensely pleased with his accumulation of cacti in the mid 1830s because he possessed eighty or so more plants than the collection at the Glasgow Botanic Garden. He also felt he was making a contribution to science by possessing a large holding of correctly identified and named specimens.

Great reliance was placed on James Forbes' practical skills

90. Hooker, 'Epiphyllum Russellianum', (n. 84).


93. Ibid.
to ensure that the collections at Woburn flourished and expanded. The standard text on orchids, John Lindley's *The genera and species of orchidaceous plants* (which was published in six parts between 1830 and 1840), did not provide any cultural instructions. It is true that between 1837 and 1843 James Bateman produced a work on the orchids of Mexico and Guatemala which contained information on cultivation but it came a little late to help Forbes in the crucial stages of building up an extensive stock. In comparison with some other plants, there was very little written about the cultivation of cacti and there was no specialist textbook on the subject. To ensure the Woburn specimens survived and flourished Forbes had to recreate their natural environment in the cacti house. The Duke was so concerned for their well being that he even wrote to Sir W.J. Hooker to find out their true habitat. Most probably, the Duke contributed to the spread of the cultivation of these plants by demonstrating at Woburn how a collection could be established, maintained and extended.

A botanic catalogue of the Abbey's collection of cacti was


published. It appeared as an appendix to James Forbes' *Journal of a horticultural tour* (1837). The decision to write the *Journal* was made by Forbes and not by the Duke. Bedford had sent his horticulturist on an eight week European tour in 1835 to obtain cacti from botanic gardens, nurserymen and private collectors in order to swell the Woburn collection. The foundation had been laid by the purchase of specimens from Mackie's nursery at Norwich.97 This firm, which Forbes regarded as an extremely competent establishment, regularly supplied the Abbey with plants and seeds. Forbes had three hundred and thirty four cacti under his care in 1836 and by 1839 the number had risen to four hundred and twenty two. The most important feature of Forbes' appendix, and an innovation, was his list of over four hundred specimens. It contained a great deal of concise botanical and horticultural information. The botanical descriptions included the systematic name, the form of the stem, the colour of the flowers and spines and the number of spines. Almost all of the details were indicated by symbols taken from the *Hortus Woburnensis*. As in his works on willows and pines, Forbes was careful about labelling the plants accurately and he used asterisks to denote those whose name required to be verified by further investigation. The practical instructions were an improvement on the brief but helpful advice provided by Loudon's *Encyclopaedia of gardening* (1822) and his *Greenhouse companion* (1824); Loudon gave this

advice in the section on succulents. Unlike Loudon, Forbes stressed the need for a waterproof greenhouse and altered the compost Loudon had given by suggesting that leaf mould should be included with the sandy peat/loam and lime rubbish. Also included, in an abbreviated form, was information about the types of glass-house suitable for these plants. The native country of each specimen was detailed too.

Sometime in the late 1830s the sixth Duke made the decision to publish an illustrated book on cacti similar to his catalogues on heaths, willows and pines. The idea was innovatory because there were so few other works devoted to these plants. Unfortunately, the Duke died before the project could be completed. The basis of the catalogue was to have been the information which James Forbes had published in his list of cacti in the Journal of a horticultural tour. Its major feature would have been the provision of an extensive number of carefully executed coloured engravings of various cacti, with insets showing details of parts of the flower. Their purpose was to aid identification. These illustrations

98. Ibid., p. 148.

99. The seventh Duke in his desire for economy did not allow it to be finished off or published. I have been unable to find out if Forbes tried to persuade the seventh Duke to change his mind.

100. See the, Drawings of cactae in the collection of the Duke of Bedford, comprising of seventy one coloured engravings. This is held in the library at Woburn Abbey.
and the text could, I believe, have made the work an important contribution to botanical and horticultural knowledge. The Duke engaged Walter Hood Fitch (1817-1892), a botanical artist under the care of Hooker at Glasgow, to come to the Abbey and draw the various species in the cacti house. Here, science was patron to art. When Fitch was not in attendance and the cacti were in flower, the blooms were sent by post to Glasgow. 101

The Duke's gardener was in regular contact with Hooker over the execution of the plans and sought Hooker's advice about the naming of many new varieties. 102 Forbes was pleased with the way the project was developing and in 1838 he wrote to Sir William, 'I think a work of this sort with coloured plates would be a valuable addition to botanical science'. 103

My brief discussion of Forbes' task of raising flowers, vegetables, fruit and greenhouse plants at the Abbey shows how innovation was encouraged and how the Duke's gardener, in some instances, had to develop his own techniques of


102. Idem., 15 September 1838, Ibid., Number 159.

cultivation. The gardens were regarded by the Duke as a horticultural showplace. In summer the public were admitted on a certain day of the week but for visiting noblemen, botanists and superintendents/curators of gardens, there were hardly any restrictions on opening hours. It was part of Forbes' duty to show these people around and let them examine the latest acquisitions and innovations. The greenhouses were an important feature of the estate because they enabled an enormous variety of plants to be grown and thus greatly extended Woburn's range of activities. They were themselves an innovatory feature and merit further consideration.

4.3 The Woburn glass-houses
The Duke of Bedford had been interested in glass-house horticulture since he first resided at Woburn. In the late 1820s and during the 1830s he devoted a great deal of attention to this aspect of gardening and initiated a programme of substantial expansion and improvement. The decision to construct greenhouses at the Abbey and incorporate innovations was taken, as in the case of every other scheme for horticultural and botanical improvement, by the sixth Duke. The Duke generally involved himself throughout all the developmental stages. He decided on the contractors, examined the plans when they were submitted, kept an eye on the construction

work and set the deadline for completion. However, the successful execution of a particular improvement in the greenhouses at Woburn depended on the abilities of James Forbes. Besides being a sound practical gardener and a competent botanist, Forbes was knowledgeable about the technical aspects of the building of plant houses. He had a familiarity with the structural qualities of various metals and the working and cost effectiveness of different heating systems. Forbes was also well-informed about the discussions between various horticultural writers in the second decade of the century over the correct angle of elevation of the roof of different types of glass-house. The designer of the new Woburn peach, fig and vine houses had consulted Forbes and, jointly, they worked out the most suitable dimensions and angles for these structures. The area of land under glass increased noticeably. The three new fruit houses were a hundred and two feet long and twelve feet wide, two hot-houses had a length of roughly seventy feet and were between three and ten feet wide, and several forcing pits were approximately seventy feet by six and a half feet (some were divided into compartments). The new


106. Forbes, Hortus, (n. 34), p. 310


flower house complex built a decade later was four times as large as the fruit and hot-houses constructed in the kitchen gardens during the late 1820s. This expansion of glass and the adoption of technical innovation improved the operation of forcing, the production of luxury fruits and vegetables and the cultivation of exotic plants. It also enabled existing collections to be maintained more efficiently and provided the means to extend them.

The following outline of the greenhouses that were in use at the Abbey during the early years of the century helps to show how innovatory the later additions were. In the 1800s the sixth Duke requested the construction of several hot-houses They had sloping roofs and the walls were composed of sashes which reached the ground. Heat was provided by hollow flues which carried hot air from a fire. This form of heating was common in the eighteenth and in the early nineteenth centuries and the flues could be built into the back wall or constructed as exposed features (a late eighteenth century innovation) and led along the front and back of the house.


At Woburn extra heat was provided by hot beds of fermenting tanners bark (tan pits), a method which had been employed in Britain since the seventeenth century. A hot-house for the purpose of forcing roses and other flowers was situated against the end wall of some stables. It contained a tan pit and an exposed flue system which was maintained by two fires. The house, forty feet long and sixteen wide, had a roof of wood and glass and walls of stone. As a rule, such glass-houses were adequate in preserving tender foreign plants. Under some of the most practised gardeners these structures could be extremely efficient. A drawback was that the fires had to be carefully maintained throughout the night, particularly in winter, and if the flues were not properly grouted the escaping fumes could harm both the gardeners on duty and the plants in their care.

A further addition was the construction of a greenhouse for the collection of heaths. The heathery was completed in 1824. With the bill totalling two thousand two hundred and twenty pounds, it was a fairly expensive acquisition. An innovatory feature was that it was built above the ground over a covered walk and both its span roof and long narrow sides were fully


Bedford played a major part in this innovation. Sir Jeoffrey Wyattville (1766-1840), who for a time acted as the estates general architect, was advised by the Duke that the heathery had to admit plenty of air and light to ensure the health and vigour of the plants. The resultant designs (which Wyattville had drawn up) proclaimed the Duke, afforded, '... a fuller exposure to both light and air, than could have been possibly obtained by any other means'.

Later, when other glass-houses were built the sixth Duke again consulted Wyattville and also sought the services of specialists.

Towards the end of the 1820s the Duke embarked on an extensive programme of improvement. The kitchen gardens were re-sited and enlarged at considerable expense; the cost was just over twelve and a half thousand pounds; and several innovations were introduced in the hot-houses. One new addition was the installation of hot water heating systems in the existing greenhouses and in the new peach house, vinery, pineapple stove and forcing pits (glass covered frames). The Duke was a gourmand and his love of fine food no doubt spurred him to order the production of these luxury fruits. Out of season strawberries, melons, figs, cherries, French beans, potatoes, asparagus and rhubarb were also raised in these structures. It seems that since the seventeenth century


the challenge of cultivating exotic fruits played a part in attracting the interest of the aristocracy to hot-house horticulture. 117 In the glass-house complex the sixth Duke had an apartment which was fitted out to entertain company. Bedford's taste for fine art also played a role here. The ceiling was ornamented with figures of birds, the floor was inlaid with different kinds of oak from the estate and the walls were hung with pictures of fruit. 118

The decision at Woburn to rely on the heat provided by hot water was a bold one. The equipment that was needed had only been recently developed and was not yet fully proven. 119 It was also the subject of discussion and controversy because its performance was being compared with steam heating. The use of steam for heating plant-houses had been extensively developed during the first quarter of the nineteenth century and it was gradually replacing the ubiquitous flue heating system. 120 There is evidence, in fact, to suggest that the


120. Ibid., p. 39; Cox, (n. 111), p. 107.
incorporation of steam and hot water pipes in glass-houses was paralleled by the adoption of these methods of heating in dwellings, offices and factories.  

T. A. Knight, in a paper published in the Transactions of the Horticultural Society of London in 1817, pointed out the possibility of heating greenhouses by hot water and suggested it would be more effective than maintaining temperatures by steam. The influential J.C. Loudon, on the other hand, strongly advocated steam heating and was opposed to hot water pipes. He predicted (quite erroneously) in his Encyclopaedia of gardening (1822) that hot water heating was unlikely to become very general and, on the evidence of heresay, concluded that the apparatus for circulating hot water was more likely to go out of order than one adopted to circulate steam.

Steam heating was never taken up at Woburn and the greenhouses were fitted out with hot water pipes. The plans had been drawn up by William Atkinson (1773-1839), who specialised in the design of such apparatus. Atkinson had been inspired


by an experiment he had seen Count Rumford perform in 1799 and began his own investigations in the 1820s. The equipment for the Abbey was supplied by Messrs. Barwell of the Eagle Foundry, Northampton. The pipes in the hot-houses were positioned on arches and were nine inches wide and forty two and a half inches deep. They were placed on edge in order to expose a greater surface of heated metal and thus raise the temperature more quickly. A circular return pipe conveyed water from the reservoir and back to the boiler, which was located in a niche in an end wall. A shed built behind the wall gave access to the boiler.

Although James Forbes thought steam heating was suitable for large establishments with extensive ranges, he preferred to use hot water heating. Such apparatus, he believed, was simple to understand, easy to manage and very suitable for general purposes because, compared to smoke flues and steam, the temperature could be raised more quickly and hot water retained it heat longer. In addition, the boilers did not consume as much fuel. He found that the whole system required less attention and that in severe weather it was more dependable.

124. Ibid., see the new edition of 1835, probably the sixth, p. 597. Count Rumford (1753–1814), physicist, Fellow of the Royal Society and an influential figure at the Royal Institution during its early years, discussed the use of water as a means of propagating heat in, (n. 121), Vol. 2, 1797, pp. 199–382.


126. Ibid., pp. 323–325.
In the *Hortus Woburnensis* Forbes provided figures of fuel consumption at Woburn and reported the results of his investigations. His enquiries involved stoking up the greenhouse at night and, in frosty weather, recording the temperature losses after fifteen hours with the aid of self-regulating thermometers. He believed these trials confirmed the reliability of this method of heating. It is difficult to know how far Forbes' investigations influenced others to adopt such a system. The installation of this heating in the Abbey glass-houses met with some initial difficulties owing to an error in the construction of the pipes. Eventually, these were overcome and the heating apparatus stood as a model for the consideration of other horticulturists. Commentators viewed the introduction favourably. Joseph Paxton was convinced that it was very efficient and a valuable guide for all those who wanted to heat their glass-houses in the same manner, and even Loudon thought the heating system in the Abbey hot-houses was a superior one. Charles Macintosh wrote in 1853 that he regarded the hot-water walls at Woburn as being one of the best examples of that mode of heating.

127. *Ibid.*, pp. 325-326, 378. A loss of only $5^\circ$ was recorded which proved to Forbes that hot water heating had the propensity to answer all horticultural purposes, even in the most inclement season.


Paxton, though, did not consider hot water heating was desirable for forcing and at Chatsworth he preferred flue heating because he believed it was less costly and more efficient. 131

The utilisation of metals: cast iron, wrought iron, copper and lead; as construction materials for the Abbey greenhouses was a second major group of innovations. Copper sash bars had been introduced by the fifth Duke in a vine house in 1793 but it was only in the late 1820s that all these metals were incorporated into the structure of fruit and hot-houses at Woburn. 132 Such a combination, as Forbes correctly pointed out, made the Duke's ranges unique. 133 The widespread use of iron and copper in the new glass-houses was quite probably an outcome of the important technological changes which occurred in the processing of metals, particularly wrought iron, between 1780 and 1820. These changes contributed to an increase in the production of these materials and helped widen their range of usefulness. 134

Not all horticulturists were won over to the idea of metal plant houses. Despite the efforts of both J.C. Loudon,

133. Ibid., p. 312.
who pioneered the use of the wrought iron sash bar as a construction material for greenhouses (which I have mentioned in Chapter One), and W. and D. Bailey of Holborn, the construction firm to which Loudon transferred the rights of his invention, iron glass-houses still aroused suspicion. Forbes discussed this topic at length in the Hortus Woburnensis. He based his judgements on his observations of the metal plant houses on nurseries and other estates and on the calculations that he had made at the Abbey. In this way he brought the various arguments to the attention of the public. Generally, Forbes supported Loudon's idea of using metal in the construction of greenhouses. Loudon's wrought iron sash bar was not adopted in the forcing houses at Woburn, however, even though the Abbey gardener believed it to be light, elegant and less expensive than rafters or sashes. Forbes argued that this metal was liable to corrode and allowed heat and cold to pass through rapidly. He was not very impressed with the recently introduced wrought iron curvilinear forcing houses, even though they were a unique design and, supposedly, admitted a greater amount of light than other structures. The Duke's head gardener pointed out they were deficient in ventilation because the grills

in the front and the back did not modify the temperature
in hot weather. Forbes found cast iron bars unsatisfactory,
too, because of their weight and their tendency to snap owing
to the brittleness of the metal. Once this happened repairs
were impossible as they had to be re-cast entire.

The answer at the sixth Duke's estate was to make the sash
bar out of copper, the rafters, standards, spouts and sills
out of cast iron, the frames for the glass out of wood
(because they were light and easy to move up and down),
the trellising out of wrought iron and the lining for the
gutter out of lead.\textsuperscript{137} To refute criticism, Forbes argued
in the *Hortus Woburnensis* that wood was not so durable as
iron and that after five years use the metal hot-houses were
proving entirely satisfactory. He explained that contraction
and expansion of the metal had not caused the glass to crack
and that the copper sash bars had not bent with the strain
or caused water to drip on the plants.\textsuperscript{138} The initial cost
of installing such houses, concluded Forbes, was higher than
those of wood but the benefit was in durability, elegance
and a greater admittance of light and sun in winter and
spring. The Woburn ranges were built by John Jones and
Company of Birmingham, who were known for greenhouse construction.

\textsuperscript{137} \textit{Ibid.}, pp. 312-313, 322, 334.
\textsuperscript{138} \textit{Ibid.}, pp. 314-319.
\textsuperscript{139} \textit{Ibid.}, p. 320.
Naturally, J. C. Loudon viewed the use of cast iron in the Woburn hot-houses favourably and Charles Macintosh was complimentary. Macintosh, however, was critical over the use of so many materials as he thought it defeated the object of producing an effective yet plain and inexpensive house. He was right to point out that the wooden coping over the cast iron rafters to lessen the effects of contraction and expansion and the lead lining of the gutter were superfluous. But, it was a little unfair not to recognise the attempts Atkinson and Forbes were making to be experimental and to try and improve glass-house construction. The aim at Woburn was not to build as cheaply as possible but to produce a building of high quality that was eminently functional.

Another innovation in the vegetable garden was the construction of pits for pineapples, melons and cucumbers with double walls. The plans were designed by William Atkinson who used a four inch space between the walls so that an insulating layer of warm air was created. This was a very recent idea and seems to have been proposed, independently, by Atkinson and T. A. Knight. All of these pits were heated by hot water and the pineapple frames also had a hot bed of fermenting dung and leaves.

140. Loudon, 'Iron hot-houses at Woburn Abbey', (n. 129), p. 213.
141. Macintosh, (n. 130), pp. 348, 546.
142. Ibid.
143. Forbes, Hortus, (n. 34), pp. 399, 404.
A new range of flower houses was constructed at the Abbey in the late 1830s. The complex, designed by Sir Jeffrey Wyattville, consisted of a large palm house in the centre flanked by smaller units for cacti, geraniums, camellias, orchids, rare exotics and oranges. It was extremely expensive, costing the Duke just over eleven and a half thousand pounds; a figure which shocked the Woburn steward. The same materials that were used in the construction of the hot-houses were again employed, with the addition of stone. A major difference was the extensive use of wrought iron supports. A London firm provided the hot water heating and companies from the Midlands supplied the iron work, the glass and the lead.

The sixth Duke's adoption of metal glass-houses heated by hot water was not confined to Woburn. He also made sure that his re-designed Covent Garden Market, opened again in 1830, was similarly innovative. The success of iron and copper as construction materials in the Abbey hot-houses and the efficiency of the hot water heating apparatus caused the Duke to incorporate these features in the two newly built


Conclusion: During the time when James Forbes was head gardener the sixth Duke of Bedford consolidated and enhanced Woburn Abbey's reputation for horticultural improvement and enquiry. The schemes inaugurated at the Abbey in this period were the outcome of the Duke's extraordinary devotion to horticulture. Agricultural considerations were still important but horticulture was primary. The gardens and grounds were substantially altered with the addition of a salicetum, an arboretum, a pinetum, collections of orchids, cacti and camellias, a range of hot-houses and a flower house complex. A few months before his death the Duke was contemplating a considerable extension to his pinetum. He supported James Forbes' general text Hortus Woburnensis and a volume by Forbes outlining a horticultural tour of Europe. The Duke also published his own botanic catalogues of willows and pines, began work on a catalogue of cacti and very probably was planning a similar work on camellias.

Between 1825 and 1839 the sixth Duke's attention was focussed on horticultural botany. Humphry Davy's agricultural and horticultural chemistry had been largely abandoned. It is possible that it had fallen short of expectations and that the Duke felt, along with critics of Davy, that it was


not of great practical value.

The main emphasis of Woburn during the period when James Forbes was head gardener was plant identification, description and classification. The sixth Duke's botanic catalogues contributed to knowledge of naming and ordering vegetation. A notable feature of scientific activity in the years between 1800 and 1840 were the attempts made at classification and nomenclature, particularly in areas of chemistry\textsuperscript{148} (and even in physics). It seems appropriate, therefore, to regard the work at Woburn as an aspect of this important feature of early nineteenth-century science.

Chapter 5 - Woburn's network of communication and the scope of its influence.

5.1 Correspondents.

The sixth Duke of Bedford and his scientific gardeners at Woburn Abbey inevitably called upon the skills and expertise of others to assist them in carrying out their experimental and investigatory work in horticulture. This led to the development of a regular correspondence between several of these advisors and the Duke and his gardeners. Indeed, I shall demonstrate that the horticultural and botanical enquiries from the Abbey gave rise, in S. F. Cannon's terminology, to a network of correspondents and that the more regular communicators shared with Bedford, George Sinclair and James Forbes common botanical and horticultural aims. To give substance to my argument I am going to examine Sinclair's work on grasses and Forbes' cultivation of willows, orchids, pines and cacti.

An important figure in the Woburn network was Humphry Davy. Davy's ideas and investigations markedly affected the development and the nature of certain aspects of Woburn science during the first quarter of the nineteenth century. The Duke sought his advice on the possibilities of using chemistry to estimate the nutritive content of pasture grasses. As discussed in Chapter three, Davy consequently instructed George Sinclair in the

technique of examining these grasses and his writings helped the Duke's gardener to embark on a lengthy programme of soil analysis.

Thomas Gibbs (1771-1849), seedsman to the Board of Agriculture, was a further strand in this network. Gibbs had a nursery at Brompton in London, another at Ampthill in Bedfordshire and a shop in Piccadilly. He was frequently consulted by Sinclair, who regarded him as something of a horticultural expert, and they became close friends. Sinclair had a high opinion of Gibbs' technical ability and valued his extensive knowledge of grasses. This was quite justified. Gibbs was an active and skilful horticulturist who communicated scientific and practical information to Curtis' Botanical Magazine. He specialised in pasture grasses (a grass garden was established at the Brompton nursery in 1798), bred hybrid primroses and cowslips, grafted improved varieties of apples and pears, experimented with manures and helped Sir John Sinclair compile the section on horticulture for the Code of Agriculture.²

Sinclair's letters sent to the Piccadilly shop between 1809 and 1822 indicate he treated Gibbs' ideas and judgements with respect. They also reveal the role Gibbs played in the preparation of Sinclair's Hortus gramineus Woburnensis. Gibbs

sent many grasses in a flowering and a seeding state to Woburn. This enabled Sinclair to add to his list of specimens, to discriminate between different varieties, to extend his work on classification and to continue his evaluation of their nutritive qualities. Furthermore, Sinclair sent drafts of the manuscript to Gibbs for critical comment. He sought Gibbs’ advice on the identity of specimens, on what was correct nomenclature, on whether plants were indigenous or foreign, on the recognition of specific characteristics and on the adaption of the most appropriate botanical arrangement. Both gardeners shared the belief that accurate identification and naming and careful botanical description were of the utmost importance. Their scholarly discussions, agreements and disagreements over these points reflect their great interest in, and commitment to, horticultural botany and the seriousness which they attached to their work. 3

Gibbs also aided Sinclair’s investigation of soils. He sent to Woburn Abbey samples of many different types of earth around London, together with their local names. 4 The Woburn correspondent acted as a discussant for Sinclair’s theory as to why certain


plants impoverished the soil more than others. Besides providing Sinclair with information about grasses and soils, Gibbs gave observations on cultivation techniques, commented on newly published horticultural treatises and answered the Abbey gardener's queries about innovatory root crops. Thomas Gibbs, therefore, greatly assisted Sinclair to carry out the sixth Duke's project on grasses and was particularly helpful in the period leading up to the publication of the *Hortus gramineus Woburnensis*.

Like Gibbs, Sir J.E. Smith had also been communicating with Woburn since the early years of the century. Smith, one of the country's foremost botanical experts, was primarily a taxonomist. He enjoyed a prestigious and influential position in scientific society and was called upon to proofread botanical works and give opinions on matters concerned with nomenclature and terminology. His books and lectures advocated and helped spread the Linnean system of classification. The sixth Duke and George Sinclair sought Sir James' advice on the development and the cataloguing of the Woburn grass garden and the salicetum and acted upon his suggestions. The existing letters of the Duke clearly show that he regarded Smith as a leading authority on horticultural botany. Smith displayed meticulous accuracy in his comprehensive botanical descriptions,

5. Letters from George Sinclair, (n. 3).
6. See the D.S.E., and the D.N.B. for details.
7. For example, see the letters from the sixth Duke to Sir J.E. Smith covering the years 1804 to 1827 in Smith Corr., Lib. Linn. Soc., Vols. 2, 7 and 25.
his aims being to determine and define species and to provide others with a straightforward and reliable means of identifying trees, shrubs and flowers. He ensured that the illustrations in his works were faithful portraits of the actual living or dried plants. To accomplish this, Smith made certain that the buds, shoots, leaves, flowers and fruit shown in the engravings of particular specimens all came from the same plant. A letter he wrote to the Secretary of the Linnean Society in 1824 sums up the importance he attached to these goals and conveys his professional attitude:

'Varieties, indeed, are rarely ever fixed. Any attempt to define or stamp them is no better than the multiplication of species so absurd in some authors. I always aim at defining and describing every species as to include all known varieties, which can lead to no confusion. Horticulture is properly conversant with varieties, and to highly useful purposes. While cultivators and florists distinguish, it is our business as botanists, with more comprehensive and scientific views, to combine or at least keep in view more specific and generic limits, preventing the distraction of real species'.


9. See the D.S.B. and the D.N.B. for particulars.


Sir J.E. Smith's botanical work with its emphasis on precision, accuracy and thoroughness seems to have been a model for the Duke and his head gardeners.

Seeds and actual grasses were sent from Woburn to Smith so that he could determine whether they were distinct species. He was presented with plans of the Abbey's grass garden for perusal and was obliged to give an opinion on the Woburn kale and to pass comment on Sinclair's analysis of its nutritive content. Sinclair entered into discussion with Sir James over the grasses that were cultivated at Woburn, giving the professor his opinions and describing the various investigations that had been undertaken to try to identify certain varieties. The Duke desired Smith to judge whether the title of Sinclair's treatise on grasses was botanically correct. In fact, Bedford was so anxious to ensure that the whole of the Hortus gramineus Woburnensis was technically accurate, that he requested Sinclair to correspond with, amongst others, the Rev. Thomas Martyn, (1735-1825), Professor of Botany at Cambridge. Martyn, a populariser of the Linnean system in England, was a Vice-President


of the Linnean Society. He settled in Pterenhall Rectory in Bedfordshire in 1798.\textsuperscript{15} Sir J. E. Smith became the sixth Duke's most important and influential botanical consultant on willows. Sir James had made a particular study of these trees and assisted Forbes to develop the Woburn collection in a variety of ways. The botanist even laid the foundation of the Abbey's willow garden by sending a number of cuttings from his Norwich salicetum. The professor advised which willows would be valuable additions, distinguished between various specimens, gave an opinion on new acquisitions, appraised the botanical arrangement of the collection and their descriptions in the manuscript version of the Duke's catalogue and compared the Woburn salicetum with other collections.\textsuperscript{16} Smith's high standards and his opinions of what constituted a proper mode of enquiry, therefore, had a great impact on the sixth Duke's investigations of grasses and willows. Undoubtedly, Smith was Woburn's first leading scientific adviser on botanical matters. Almost all of the major work in horticultural botany undertaken at the Abbey between 1806 and 1823 reflect quite markedly the influence of Smith's advice, ideas and methodology.

\textsuperscript{15} For biographical details see the D.N.B.
\textsuperscript{16} Letters from the sixth Duke to Sir J.E. Smith, (n. 7).
Another communicator was the banker Edward Forster (1765-1849), Secretary and later Vice-President of the Linnean Society, writer of botanical monographs, possessor of an extensive herbarium and cultivator of rare British plants. Forster specialised in the collection of willows and, being extremely knowledgeable, was consulted by Sir J.E. Smith over problems concerning their botanical description and identification. The sixth Duke and James Forbes received much assistance from Forster. This keen botanist sent new varieties to the Abbey, verified the identity of many of the willows destined for inclusion in the *Salictum Woburnense* and settled a number of doubtful points. Help was also provided by nurseriesmen and the curators of botanic gardens. The firm of Loddiges of Hackney supplied parcels of foreign willows to Forbes. J.T. Mackay of the Dublin Botanic Garden gave some guidance on willows that were native to Britain.

With the death of Sir J.E. Smith in 1828, Sir W.J. Hooker became Woburn's most influential and prestigious botanical


advise r. The Duke believed, 'Sir W.J. Hooker is, confessedly, with the exception perhaps of De Candolle, the first botanist in Europe ...' Hooker began exchanging letters with the sixth Duke of Bedford in about 1817 and with James Forbes probably sometime during the late 1820s, and continued the same standards and values that Smith had constantly maintained. This is not surprising. Sir J.E. Smith had a high regard for Hooker's ability as a botanist and took an interest in his career. Smith freely gave Hooker friendly, frank and encouraging advice on how to improve his botanical skills and style of writing. Smith saw Hooker as one of the botanists who would carry on the British botanical tradition and extend Britain's reputation for scholarship in this science. A letter he wrote to Hooker in 1820 plainly conveys these sentiments and also shows what he regarded as being the foundation of scientific botany:

'I want to discuss with you nomenclature, terminology, etc. If we remain correct and classical, supporting each other, we shall be a tower of strength in support of what is right. We may keep up the dignity of the British school. But if we give way to authorities who have no sound principle of their own, our science will crumble into dust.'


23. Letter from Sir J.E. Smith to Sir W.J. Hooker, 5 March 1820, Ibid.
Hooker was an accomplished botanical artist and could put into practice what he preached. His response to his student's wishes for a book to help them learn how to draw plants accurately was to publish his own simple guide to botanical illustration.  

Much of his early work followed the Linnean method of classification, which was advocated by Smith, but in later publications he began also to arrange plants according to the natural system.

Hooker identified and named specimens of willow, pine, cacti, orchid and chrysanthemum for the Abbey, sent plants for the collections and advised James Forbes whether various discoveries were distinct species. In his letters to the sixth Duke, Hooker answered queries concerning the prospect of success of botanical expeditions, the capabilities and competence of gardeners, the true habitat of cacti, the nomenclature for rhododendrons and pines and the reliability of certain botanical


25. In W. J. Hooker's *Flora Scotica* (London, Hurst Robinson and Company, 1821), the cryptograms were classified according to the natural system. The natural orders were given in his, *Exotica flora* (Edinburgh, William Blackwood, 1823-1827, Vols. 1-3), whilst the arrangement of willows in the *British flora* (London, Longman, Rees, Orme, Brown and Green, 1830), followed the natural system suggested by William Borror, (1781-1862), who had an extensive knowledge of the salix tribe.

26. See the letters from James Forbes to Sir W.J. Hooker for the years 1830 to 1839, A.R.,R.B.G.K., Eng. Lets., Vols. 1, 2, 4, 7, 9, 10 and 12.
works. Hooker was also asked for duplicates of plants and trees from the foreign collections in Glasgow Botanic Garden and was required to judge whether certain plants at Woburn were new varieties.

It can be seen, therefore, that a nurseryman, an amateur botanist, a superintendent of a botanic garden, a president of a scientific society, a professor of botany and a professor of chemistry corresponded with the Duke, Sinclair and Forbes and were significant components of the Woburn network of communication. They all provided plants and seeds and gave advice about equipment and techniques and so helped to make the sixth Duke's horticultural projects a practical reality. Quite likely, the number of correspondents was more far reaching than has been outlined. The sixth Duke was at the centre of the Abbey's network and in most cases he made the initial contacts. His position and status in society and his expenditure on horticultural enquiry and experiment were the forces which drew it firmly together. The various strands in Cannon's Cambridge network, in contrast, converged in a loose manner. Also, the network at Woburn was not purely intellectual, which it was at Cambridge, as there were commercial as well as scholarly strands. Besides scientific horticulture, practical problems connected with gardening and estate management were discussed by Bedford, Sinclair, Forbes and the Abbey's correspondents. A considerable number of issues were concerned with applied science. However, I would like

27. See the letters from the sixth Duke of Bedford to Sir W. J. Hooker for the years 1830 to 1839, A.R., R.B.G.K., Eng. Lets., Vols. 1, 3, 7, 9, 10 and 12.

28. I have omitted the aboricultural correspondence of Robert Salmon simply because it has not, as yet, come to light.
to suggest that, possibly, there were certain similarities. The personal letter, the most crucial form of contact in Cannon's Cambridge Network, was a very important means for the exchange of scientific ideas and opinions at the Abbey. The members of the Cambridge network shared common aims. This was true also of the Woburn correspondents: the Duke, his head gardeners and their communicators all believed that the careful identification, botanical description and classification of plants was of the utmost importance.

It is probable that face to face contact was of some importance especially since the Woburn sheep shearings, and the Duke's policy of allowing men of science and keen horticulturists to examine the grounds and gardens, encouraged this personal contact. The sixth Duke occasionally sent Sinclair and Forbes on travels around Great Britain and on the continent. 29 Such trips took in nursery grounds, great estates, private establishments and botanic gardens. The objectives of these visits were to gain information, to collect plants and to obtain materials which would assist the development of the Duke's schemes. Some of the English tours lasted for almost three weeks and took in several dozen towns and horticultural establishments. 30

29. James Forbes, Journal of a horticultural tour through Germany and part of France, in the autumn of 1835, (London, James Ridgway and Sons, 1837); B.V., B.C.R.O., in Box R/443 - Box R/493, covering the years 1822-1839.

30. James Forbes' sundry disbursements for journeys to sundry places, 5 October 1833, Ibid., B.V., Box R/455, Number 20.
The network of communication at Woburn consisting largely of personal correspondence and, to a lesser extent, verbal discussions arising from face to face contact, was probably an extensive one. The letters I have examined give a glimpse of the way practical and theoretical knowledge of horticulture was transmitted. They show who the Duke and the Woburn gardeners regarded as being worthy of consultation and the issues which these consultants perceived as being of importance. The work in horticultural botany carried out by Sinclair and Forbes was guided, in part by the standards and precepts set initially by Sir J.E. Smith and then, later, by Sir W. J. Hooker. Sir William continued and extended Smith's methodology.

5.2 The local and national impact of the research at Woburn

The following discussion of the impact of Woburn science in the local community concentrates on the tenantry, the owners of nearby woodlands and the agricultural labourers who were employed on the Duke's estate.

The sixth Duke wanted to encourage his tenant farmers to manage their timber efficiently and to adapt the technique of close pruning. In chapter three I explained how the Duke was convinced that this scientific method of treating timber was correct and ordered it to be widely adopted on the plantations around Woburn. Salmon, eager to put the Duke's plans into operation, suggested an inspector be appointed to advise tenants and to have the power of introducing close pruning where it was
necessary. Although it is difficult to gauge how far this
was introduced and how successful it was, close pruning appears
to have been adopted by some of the Duke's tenants. Twenty
five years later Thomas Bennett, the Woburn steward, was alarmed
at the way the tenantry were close pruning hedgerow timber (which
had been recommended by Salmon) and was considering ways to
dissuade them from this practice. The owners of Bedfordshire
woodlands who desired an appraisal of their resources were
also making use of Robert Salmon's scientific enquiries.
In his capacity as an aboriculturist, Salmon ascertained the
value and quantity of timber for local notables (and possibly
tenant farmers). The method he adapted was based on his
systematic investigations on pruning carried out for the sixth
Duke between 1804 and 1806.

To encourage improved cultivation the Woburn steward in 1836
distributed to farmers a pamphlet on subsoil ploughing and
under drainage, which was printed at the Duke's expense. The
steward was particularly concerned to deliver it to those
who were known to be receptive to improvements.

31. Robert Salmon's comments on the Estate North of Bedford
1817, Cursory Survey of Woods and Timber, B.C.R.O., Salmon
Pps., R3/2144.

32. Letter from Thomas Bennett to Christopher Haedy, 1842,

33. Valuation of timber, 18 October 1813, B.C.R.O., Salmon
Pps., R4/608/16/2.

34. Letter from Edward Crocker to W. G. Adam, 1836, B.C.R.O.,
science may have also been diffused at the Duke's sheep shearings. These were social as well as scientific and business occasions. They provided a chance for those who were important and influential in Bedfordshire and the surrounding counties to meet and discuss agricultural, horticultural and social issues (and other matters).35

There was a tradition at Woburn of providing labourers with plots of land for garden cultivation. The fifth Duke of Bedford had made certain that the cottages he built for his labourers had sufficient tracts of cultivable land and had awarded prizes to the most skilful gardeners.36 D.C.Bennett has drawn attention to the fact that between 1790 and 1840 landowners shared an increasing interest in providing land for the rural poor and has pointed out that by 1833 this practice was fairly widespread.37 I want to add to these observations by suggesting that on the sixth Duke of Bedford's estate, science was used in an attempt to ensure the success of these allotment schemes. The Duke employed George Sinclair


(as has been outlined in chapter three) to investigate whether a perennial kale growing in the grounds of the Abbey could be of value as a cottage garden crop. Sinclair set up comparative trials and subjected the tops and side shoots of the kale and other brassicas, the part of the plant destined for the labourer's table, to his 'chemical process'. He concluded that the kale was equal to the best winter greens and believed its hardiness and its ability to crop well without manure made it entirely suitable for cottage gardens. The Duke, convinced by these results, distributed plants and cuttings of this perennial vegetable.

The sixth Duke became increasingly interested in the provision of strips of land for the poorer classes in the early 1820s. At Woburn in the years between 1829 and 1838 he set up a very extensive allotment programme. The Duke became the county's most influential promoter. Each allotment on the estate was roughly between a quarter and a half of an acre in size. During the 1830s outbreaks of rural discontent were common throughout the country. The southern and eastern regions experienced the most frequent and severe outbursts. Unrest was fanned by low wages, a dissatisfaction with the poor laws and the fear of unemployment (which the spread of innovations


39. Ibid.

like the threshing machine seemed to promise. In Bedfordshire the situation was exacerbated by an over-supply of labour and a failure of the wheat crop in a wet season. The Duke's willingness to embark on allotment schemes during the thirties should be seen as a response to this unrest. The sixth Duke belonged to the Society for the Diffusion of Useful Knowledge and the Labourer's Friend Society. Both of these organisations, as I have indicated in chapter two, encouraged landowners to provide garden plots and attempted to explain, in a simple fashion, the science behind horticultural tasks. It is surprising that the Duke did not provide some rudimentary instruction in scientific horticulture. Such measures were not unknown. Mary Anne Gilbert developed an allotment system for labourers during this period. She explained to them the advantages of forking the soil and of conserving liquid manure and used printed cards to discuss the purpose of manures and the method of constructing compost heaps.

During the 1820s the sixth Duke was keen to set up a straw plaiting industry in the village of Woburn for the production of hats. Lord Francis Russell had originally suggested the idea to his father in 1822. The Duke wanted to provide


42. Ibid., p. 332.

employment for local girls and women and to eliminate lace making from the locality, probably because he believed it was dangerous for the eyes. In itself, straw plait was not unhealthy. Its manufacture compared favourably with the production of lace. The straw hat industry was an important activity in the county. It became firmly established in Bedfordshire sometime during the late seventeenth century. By 1830 the manufacture of straw hats and bonnets was an expanding activity. Dunstable, Luton and to a lesser degree, St. Albans and Bedford, had become principal centres. A marked feature of the industry was the independence of the plaiters. They were not tied to a dealer either in the purchase of the straw or in the sale of the plait (apparently, straw and plait factors were always distinct). This helps to explain why plaiting was taken up by so many families and why the industry had such a flexible structure.

George Sinclair, was ordered to embark on an investigation of grasses to find one which would produce a straw comparable to Italian leghorn. Leghorn was considered the best material as it was light in weight, comparatively

44. Agar, (n. 41), p. 126.


47. Doney, Ibid., pp. 61-63.
tough and had a fine natural golden colour. Sinclair began his enquiries in 1822 and used the knowledge of botany and chemistry he had gained from compiling the *Hortus gramineus Woburnensis*. He sowed varieties of wheat, oats and perennial grasses on different soils which had been subjected to a chemical analysis. Sinclair observed that the finest straw came from the perennial grasses and found the wheat straw recommended by William Cobbett, too coarse. Cobbett had written about the use of English grass and grains for the manufacture of hats and bonnets in the *Cottage economy*, (1823) and had been awarded a gold medal for his investigations by the Society of Arts. After completing his thorough and careful trials, Sinclair concluded that in order to provide good quality straw it was necessary to sow a number of selected grasses that had common properties, and believed that it was crucial to suit the grasses to the different types of soil. He compiled a list of seed mixtures tailored to suit various soils and was confident Britain could become an exporter of fine bonnets if his instructions were taken up. In coming to these conclusions Sinclair was guided by the ideas which he had formulated while undertaking his lengthy investigation of pasture grasses.


The technical processes connected with bleaching and plaiting the straw came under his scrutiny. They were discussed in the second edition of the *Hortus gramineus Woburnensis* (1824). An innovation was to suggest flattening the straw with a hand mill after, and not before, it had been woven and braided. Sinclair believed this gave a finer finished product. He drew attention to the fact that the technique of bleaching in the sun, advocated in Cobbett's *Cottage economy*, lasted eight days and argued that if various acids and chemicals were used instead, this time could be markedly reduced. Sinclair described the technical stages that were involved, explained the basic principles and was careful to point out that bleaching with acid gave results equal to those achieved by following Cobbett's method.

On the basis of these findings, the Duke and the Duchess set up a girls school in the village in 1825 for the manufacture of plait and for conveying moral and religious instruction. These schools were not uncommon in Bedfordshire at this time. Generally, children were employed in village workshops in plait schools under the eye of a plait school mistress, who sometimes provided a rudimentary eduction in the three R's.

The girls school was the next step in establishing a permanent local industry and Sinclair supplied it with prepared specimens of perennial grasses.\(^55\) The Duke, therefore, was successful in introducing the production of plaiting in Woburn. By 1842 sixty nine children were attending the school.\(^56\) A straw hat industry did grow up in the village but it is not clear how far the Duke was responsible for this. Probably, Sinclair's scientific investigations and the Duke and Duchess' school played a significant role. The Duke was unsuccessful, though, in the elimination of lace making. Pigot's trade directory of 1823 gives no mention of hat manufacture in the village of Woburn.\(^57\) The issue of 1831, however, specifically refers to a plaiting industry and lists two people who produced straw hats.\(^58\) One of these specialised in articles of high quality. The production of lace was also noted. In a directory of 1850 lace, straw plait, corn and timber were described as the main articles of commerce and three straw bonnet makers were named.\(^59\) By 1885 the hat industry had undergone further expansion.

\(^{55}\) Bill from T. Staffe for specimens of plait, 3 September 1824, B.C.R.O., H.V., Box R/447, bundle number 19; Monies for preparing grasses for Woburn Girls School from 13 to 25 June 1825, B.C.R.O., H.V., Box R/448, bundle number 14.

\(^{56}\) See the Bagshawe Collection, County Hall Library, Bedford, Local History Section, Number 108.


\(^{59}\) Slater's royal national and commercial directory and topography, (London, Isaac Slater, 1851), pp. 34, 36.
Kelly's Directory of Bedfordshire for that year included eight milliners for the Woburn and Woburn Sands district. This example further illustrates how Woburn science was utilised in an attempt to improve the social and economic conditions of the labouring class. It is one facet of the paternalism that landocrats displayed and which David Roberts has so well documented. The use of science to assist the development of paternalistic schemes, though, is an aspect of the subject that he has not considered and is one which could repay further investigation.

Finally in this section, I am going to broaden the perspective by considering the impact of the investigative work at the Abbey on horticultural and botanical science in general.

One method of approaching this is, firstly, to see how far Woburn science generated debate in periodicals and books. and, secondly, to examine the extent which it became incorporated without controversy into specialised and standard scientific works of reference. The remainder of this section explores these questions.

The aboricultural science practised on large and progressive estates did not normally go unnoticed. The investigations


patronised by the sixth Duke of Bedford in the 1800s, and carried out by Robert Salmon, aroused an unusual amount of interest in agricultural and horticultural circles in the second quarter of the century. Salmon's article on close pruning met with little controversy when it was published in the Transactions of the Society of Arts in 1806. This was not the case during the late 1820s and throughout the 1830s. Close pruning generated a great deal of attention and was discussed in periodicals such as the Farmers Magazine, the Quarterly Journal of Agriculture, the Irish Farmer's and Gardener's Magazine and the Gardener's Magazine. Most of the articles were of a highly technical nature. They were very critical of the work carried out at Woburn by William Pontey in the 1790s and by Salmon in the 1800s. Nearly all of the authors of these pieces marshalled a reasoned argument against close pruning and made use of current theories of botanical science. The groundswell against Pontey's and Salmon's method was maintained by the publication of several specialist books on aboriculture and

by the issue of a number of general horticultural texts. Stewart's Planter's guide, Cruickshank's The practical planter and Wither's The acacia tree all argued against close pruning and J.C. Loudon in two of his major works reported what he considered to be the fallacy of the theory and practice of Pontey and Salmon. By provoking scientific argument and by stimulating further investigations the work at Woburn contributed to the development of aboricultural science. It is these criteria which should be borne in mind when assessing the importance of the Duke's aboricultural schemes. Whether the science of Pontey and Salmon was correct is of lesser importance.

Next, I am going to consider the scientific works that were written by the head gardener's at the Abbey and which were the end result of projects inaugurated by the sixth Duke. These books were never meant for mass distribution. I have mentioned previously that most of the Duke's efforts to diffuse science were aimed at his peers, professors of botany and members of scientific institutions, who could also be botanists and landed noblemen. The Hortus gramineus Woburnensis of 1816 was a costly folio containing dried grasses and seeds (although later editions


were printed more cheaply and featured drawings of the grasses) and the catalogues on ericas, willows and pines were lavishly illustrated and published privately in limited editions. It could be argued that as the Duke wanted to encourage the diffusion of science it was shortsighted of him to continue with this policy. This was not so. One of the major advantages of the productions from Woburn was that they contained an abundance of finely drawn and carefully coloured engravings which captured exactly the appearance of the living specimens. It is doubtful whether such accuracy could have been achieved in works that were destined for a mass market and it was precisely for this attribute that the Duke's catalogues on willows and pines were praised.

The botanical content of Sinclair's *Hortus gramineus Woburnensis* was well received by those interested in the scientific aspects of horticulture, agriculture and botany (as outlined in chapter three). Sir J.E. Smith regarded it as a work of scientific merit. Smith firmly believed in the need for careful and systematic investigation and so to have included the first and the greatly extended second edition of Sinclair's book as sources of reference in his own *English flora* was a

---

substantial mark of approbation. Smith's five volume *Flora* became a standard text for botanists and horticulturists and at the time it was, as the D.S.B. has stated, the most complete treatise of its kind. By being incorporated in a respected work by an eminent botanist the science at Woburn reached a much wider audience. The *Hortus gramineus Woburnensis* maintained its reputation as a reliable and comprehensive scientific work on grasses well into the second half of the nineteenth century. It was quoted in Robert Sweet's *Hortus Britannicus* (1830), a dependable catalogue of plants cultivated in the gardens of Great Britain. Successive editions of E.J. Lowe's sound text, *A natural history of British grasses*, also mentioned it. Furthermore, it took its place amongst the scientific writings of such illustrious botanists (Sir J.E. Smith excepted) as Sir W.J. Hooker, A. P. De Candolle and A.L. De Jussieu. Some of the ideas in Sinclair's treatise were developed in the *Agrostographia* (1853) of Peter Lawson (fl. 1770-1821) and Charles Lawson (1794-1873), Edinburgh seed and nurserymen,

66. See the account of Sir J.E. Smith written by Diana M. Simpkin, *D.S.B.*, p. 472.


69. Peter Lawson and Son, *Agrostographia*, (Edinburgh, private printing, 1853), pp. 20-22, 31-34. This was formerly called *The agriculturalists manual*, (Edinburgh, William Blackwood and Sons, 1836). It referred to the work of the Woburn gardener and advocated, as Sinclair had done, various mixes of grass seeds for pastures and lawns.
which was itself regarded as a valuable scientific compilation. The *Hortus gramineus Woburnensis* has retained some of its importance as a piece of botanical and horticul
tural investigation in the present century. Quite recently, various commentators have reasonably suggested that Sinclair's work is still useful. 70

What did arouse controversy was George Sinclair's efforts to utilise chemistry. W.H. Aiton, an agriculturalist, vigorously critised Sinclair and Humphry Davy in the *Farmers Magazine*. 71 Aiton fully realised that chemistry could aid agriculture but perceptively commented that it had not been of much practical value. He believed, a little unfairly, that the '... errors of these gentlemen proceeded from an overdegree of confidence in their botanical and chemical knowledge, and in applying these to agriculture of which it is evident they know but little'. 72 John Donaldson, the


agricultural biographer and author of a treatise on manures, made similar comments. Aiton and Donaldson were right in doubting the practical value of Davy's agricultural and horticultural chemistry and in Sinclair's chemical investigation of soils and grasses but failed to appreciate the innovatory nature of Sinclair's work. James Scott and May Hobbs in their more recent study, Great farmers, (1951) have given support to Aiton and Donaldson but have also omitted to mention that Sinclair was undertaking pioneering enquiries and have ignored the botanical aspects of the Hortus gramineus Woburnensis. Sinclair contributed to the progress of agricultural and horticultural chemistry, rather as Robert Salmon had assisted the development of scientific aboriculture, by generating debate in magazines and books. Thus, Woburn science was brought to the attention of a national audience.

George Sinclair's other Woburn volume, the Hortus ericaeus Woburnensis, was used by J.D. Hooker, who succeeded his father as Director of Kew Gardens, and G. Bentham (1800-1884), botanical scientist and President of the Linnean Society, in their erudite and monumental Genera plantarum (1862-1883).


74. Watson and Hobbs, (n. 70), pp. 122-123.

This work, a model of accuracy, clarity and completeness, still remains a standard. Incidentally, the practice among keen horticulturists and botanists of lending out scientific works helped to diffuse a knowledge of Woburn science. For example, Sir W.J. Hooker lent his copy of Sinclair's catalogue of heaths to the renowned botanist and plant hunter Baron von Ludwig. It was sent to Cape Town, South Africa as the Baron was residing there. The *Salictum Woburnense* of the Duke's other head gardener, James Forbes, was frequently referred to in Hooker's respected *British flora* (1830) and in his *Supplement to the English botany*. J.C. Loudon used it to help write the *Arboretum et fruticetum Britannicurn*, which became a standard scientific work on aboriculture and the *Salictum* was of assistance in the compilation of Bentham and Hooker's *Genera Plantarum*. Forbes' *Pinetum Woburnense* was also a work of reference for the *Arboretum et fruticetum Britannicurn* and for the *Genera*

76. D.S.B., 1, p. 615; Ibid., 6, p. 491.
77. See the title page of George Sinclair's, *Hortus ericaeus Woburnensis*, (Private printing, 1825), in R.B.G.K.
79. Loudon, *Arboretum*, (n. 64), passim.
It figured with increasing importance in the various editions of The pinetum, a reliable and relatively cheap and accessible work on pines by George Gordon, a Superintendent at the Horticultural Society of London's Chiswick garden. The Pinetum Woburnense assisted a horticultural writer to compile an extensive list of conifers for the Journal of the Royal Horticultural Society in the early 1890s. Forbes' catalogue was still regarded as an important work in the first quarter of the present century. The author of a general book on trees recommended it as a leading text and in 1923 it was listed as a reference in a handbook on conifers.

The last work from the Abbey that I want to consider is James Forbes' Hortus Woburnense. Charles Macintosh's The book of the garden (1853), a comprehensive and very sound general text on horticulture, relied heavily on the practical and scientific information contained in the Hortus. In this way further emphasis was given to Woburn science. Besides quoting Forbes at length on the techniques of cultivating

81. Ibid., p. 433; Loudon, Arboretum, (n. 64), passim.

82. George Gordon, The pinetum, (London, Henry, G. Bohr, 1858). This and the second edition of 1875 refer to the Pinetum Woburnense. The third edition of 1880 has abundant references to this work.


various plants, Macintosh provided scientific and technical information about the different glass-houses that had been used at Woburn in the 1820s and 1830s. The Duke's science was also diffused by several other means. J.C. Loudon's regular editorial comments in the *Gardener's Magazine* occasionally gave details of the Abbey's innovations. Curtis' *Botanical Magazine* now and then included technical descriptions of plants cultivated in the Abbey greenhouses and was particularly interested in the specimens that had been recently brought back by botanical explorers. The books written by Sinclair and Forbes were reviewed in agricultural and horticultural journals. These reviews provided useful information by indicating the direction in which Woburn science was moving.

To sum up. The innovative and investigative work at Woburn Abbey had a national impact in both the short and the long term. The short term impact was a result of the discussion, debate and controversy that Woburn science caused in books, journals and periodicals published during the 1820s and 1830s. However, it should be noted that Woburn science was not presented at societies and none of the major enquiries figured in institutional journals. This impact also took place, to some extent, as a consequence of eminent botanists and respected writers

on horticulture utilising the books of Sinclair and Forbes to compile their own scientific texts (the works of these botanists and writers were published between 1824 and 1838). In the long term, Woburn science made an impression because data from the various volumes and catalogues written by the Abbey's head gardeners were included in horticultural and botanical works of reference, in specialist books and in general texts used well after the gardener's enquiries were completed. Certain results from the Duke's investigations at Woburn Abbey, therefore, had a potentially wide readership amongst horticulturists, agriculturalists, botanists and students. It illustrates the process whereby data from investigative work becomes absorbed in the mainstream of scientific knowledge and demonstrates how the work at Woburn contributed to the development of nineteenth-century botanical and horticultural science in general.

5.3 The sixth Duke's social and political influence

The sixth Duke of Bedford's strong interest and active involvement in scientific gardening caused him to use his social and political influence to further his horticultural schemes. The following examination of this helps shed light on the ways in which a landed aristocrat, and a prominent Whig, could use his privileged position in society to encourage the development and diffusion of science. The Duke's peers (as well as the group comprising the landed gentry) were
socially and politically a very powerful force in the first half of the nineteenth century. G. Kitson Clark has succinctly observed that:

'In the middle of the nineteenth century ... the political system was still to a remarkable extent the plaything of the nobility and gentry, and in particular of the hereditary owners of the great estates'.

Besides considering the Duke's use of social and political influence to advance science, the following discussion also briefly explores some of the limitations of aristocratic patronage.

In chapter three I explained that the sixth Duke's position in government ended when he was recalled as Lord Lieutenant of Ireland in 1806. This, I pointed out, did not signal the decline of his concern with politics. The Duke continued to take an interest in the affairs of the nation. Throughout the 1820s and 1830s he often discussed political topics in his correspondence with his sons. Bedford was, to use his own words ' ... the Father of Parliamentary Reform ...'. For over forty years he had suggested that the system of parliamentary representation was in need of modification. Interestingly, J.B. Morrell


87. G. Kitson Clark, Ibid., p. 214.


and A. Thackray in their recent book about the early years of the British Association for the Advancement of Science have discussed an aspect of the relationship between science and politics. These two historians of science have indicated that certain aristocratic and non-aristocratic members of the Whig party in the second and third decades of the nineteenth century involved themselves, for a number of reasons, in the development and the application of science. Morrell and Thackray set this involvement in the context of parliamentary reform and social unrest. Perhaps the sixth Duke should be included amongst these members, although the whole issue needs further investigation before we can be certain.

If the sixth Duke's absence from political office after 1806 did not signal the decline of his concern with politics neither did it diminish his political influence and his circle of contacts. The Duke continued to cultivate confidants by inviting important political figures to spend some time at Woburn. Undoubtedly, the sixth Duke was able to improve his access to information (and probably also increased his influence) when one of his offspring, Lord John Russell (1792-1878), entered the government in the early 1830s and held positions of responsibility. Lord John took on the post of Paymaster General in the Whig government of 1830 to 1834, was a major architect of the Reform Act, was made a minister of the Home Office in the government of 1835 to 1841 and became Prime Minister in 1846. When the sixth


Duke was pursuing various schemes connected with botanical and horticultural science he took advantage of Lord John's position in the government and his son's political contacts to try and bring these plans to fruition. The periods when Lord John and his parliamentary colleagues were invited to Woburn for shoots, parties and conferences provided an opportunity for the Duke to gain further knowledge of political matters and to widen the network of Woburn correspondents.

To develop this analysis I am going to examine how the sixth Duke of Bedford used his privileged social and political position to secure a professorship of botany for Sir J.E. Smith and an order of the empire and a knighthood for W.J. Hooker. I also want to consider how the Duke used his position to obtain plants, bulbs and seeds for Woburn from overseas and to encourage the botanical works of others. Finally, I shall outline how Bedford utilised his diplomatic experience and his social position in an attempt to transform Kew Gardens into a national scientific institution, with Hooker as director.

Sir J. E. Smith applied for the chair of botany at Cambridge

93. See, for example, the letter from the sixth Duke of Bedford to Sir W.J. Hooker 15 October 1838, A.R., R.B.G.K., Eng. Lets. A-G 1838, Vol. 10, Number 59. Letter number 38 in the same volume and letter 75 in volume 12 of this correspondence provide more detail.

University, previously occupied by the Rev. Thomas Martyn, in 1816. Sir James was a friend of Martyn and an occasional lecturer at the University and was very anxious to become its professor of botany. In an effort to fulfil his ambition Smith had written to the third Earl of Hardwicke, the sixth Duke of Bedford and a number of other influential landed aristocrats asking them for their support. As I have previously indicated, Smith was held in high regard at Woburn. The sixth Duke was a friend of the botanist and derived satisfaction from campaigning on his behalf. Bedford believed that such an appointment would benefit science and would confer prestige on British horticulture and botany and was convinced, '... there is no man in the land who would do equal honour to the appointment'. The Duke contacted a number of friends and explained to them the necessity of supporting Smith. Lord Hardwicke was canvassed. Hardwicke then wrote to his contacts at Cambridge and gave them favourable accounts of Sir James. The Duke also persuaded his

95. D.N.B., 18, p. 470 and D.S.B., 12, p. 471.


98. Ibid.

eldest son Francis Russell (1788-1861), a Cambridge M.A. and a confidant of both political parties, to enter the campaign. Lord Francis tried to obtain the support of his associates who could exercise an influence at the University. This support proved ineffectual as Sir James did not receive the appointment. Apparently, Cambridge could not allow a Dissenter into its ranks. Smith, bitterly disappointed, wrote two pamphlets protesting against this system.

W. J. Hooker also applied to the sixth Duke of Bedford for support. Hooker was beginning to feel discontented with his chair of botany at Glasgow University. He was looking for a fresh challenge and wanted to return to England, particularly to the scientific life of London. In 1824 he unsuccessfully applied for a post at Cambridge University. A decade later he was contemplating applying for the vacancy at Oxford University caused by the death of the Professor of Botany, George Williams (1762-1834). The Duke, taking heed of the failure of his support for Sir J.E. Smith's application to Cambridge and realising that he had no influence whatsoever at Oxford, informed Hooker that he could not be of much use.

100. Letter, 22 January, (n. 97).
102. Allan, (n. 21), pp. 81, 92.
The Duke saw Hooker fulfilling another role, that of director of Kew Gardens, and encouraged his patronee to set his sights there. This will be discussed later. The sixth Duke of Bedford did use his influence to obtain the Order of Hanover and a knighthood for Hooker. Such awards, the Duke believed, would bring prestige and honour to horticulture and botany, just as he felt these benefits would accrue from Smith's professorship at Cambridge University. Furthermore, he thought that by conferring these honours on Hooker, the government would be encouraging the development of science in Britain and her dominions. The Duke advised Hooker on the most appropriate diplomatic tactics, badgered government officials on his behalf and persuaded Lord John Russell to engineer the professors recommendation for honours to the king. The Duke's patronage paid off and in 1836 Hooker received his order and knighthood.

A further example of how the Duke used his political and social influence, and also his wealth, for scientific ends was his support of botanical exploration. The efforts of plant hunters acting on behalf of botanic gardens, scientific, agricultural and horticultural societies and trading companies


104. Ibid.; Idem., 31 March, Ibid., number 67; Idem., 10 April, Ibid., number 68.
has been well documented by horticultural historians. 105 These writers, however, have not sufficiently stressed that certain members of the landocracy in the early nineteenth century made up a small, but fairly important, group who were interested in the diverse flora of the Far East, Europe and Britain's colonial empire and who provided funds for plant hunting expeditions. The sixth Duke placed great significance in the acquisition of seeds, plants and roots from other countries and numerous cases of specimens were imported into the Abbey. This enabled Sinclair and Forbes to build up impressive and extensive collections of flowers, trees and shrubs in the gardens and glass-houses. Bedford was very much aware that it was essential to encourage these horticultural expeditions at home and abroad because it was a major way in which new varieties could be discovered, identified, classified, described and brought into cultivation. He hoped his collectors would make, '... many and very interesting acquisitions to both botany and horticulture' these pleasing sciences'. 106 Thus, by encouraging botanical exploration the Duke saw himself as a contributor to the development of science.


The sixth Duke helped to finance botanical hunting parties in the United States, Mexico and South America. These countries held the promise of a rich botanical harvest. The Duke believed the area around Calcutta had largely been exploited by Lord William Bentinck (1774-1839), Governor General of India and second son of the Duke of Portland. Some of these schemes were organised by Sir W. J. Hooker and Joseph Paxton and Bedford donated sums of roughly between ten and a hundred and fifty pounds. On several occasions the Duke volunteered an open purse. In 1835 Hooker had organised an expedition to South America and his patron wrote and told him, 'I give you carte blanche to put down my name to any sum you please...'. The Duke hoped that this hunting party would bring back new and unusual plants for Woburn. He also believed that by helping to sponsor these expeditions he was acting in the interests of the nation. Apart from providing financial assistance, the sixth Duke gave prestige to such undertakings. It is quite probable that the Duke realised that his name on the subscription lists lent a certain status to botanical expeditions by virtue of his social standing and his reputation as a keen patron of horticulture and botany. Bedford also used his influence


to obtain plants for the Abbey in more material ways. The Duke secured passage in Admiralty ships for his botanical collectors, he provided them with letters of introduction and wrote to officials in different countries on their behalf to ensure they had safe conduct. He did not stop there. The Duke corresponded with John Parkinson, who was Consul-General in Mexico, and persuaded him to organise collecting expeditions for Woburn. Parkinson hired a botanical traveller (collector), under contract to the Duke, who was paid an annual salary of four hundred and eighty pounds. The collector, though, had to bear the cost of transporting the plants to the ports and pay packing expenses. However, there was a gratuity of a hundred pounds if the contract was terminated after one year.

The sixth Duke of Bedford, as we have seen, was not averse to using his paternal influence as head of the Woburn household and the Russell dynasty, to persuade his sons to contribute


to his scientific endeavours. Lord Edward Russell, who was commanding a British naval vessel off the coasts of South America in the mid 1830s, conveyed some of the plants accumulated by the Duke's plant hunting parties to England\textsuperscript{112} as did Lord Francis Russell who was stationed at the West Indies.\textsuperscript{113} Lord George William Russell, on his diplomatic missions in Spain and Germany, sent seeds and plants to his father.\textsuperscript{114} The Duke used Lord John's ministerial frank to send letters to Hooker discussing the organisation of these expeditions and it was sometimes used to convey specimens from Woburn to Glasgow.\textsuperscript{115}

Besides backing these enterprises, the sixth Duke subscribed to horticultural and botanical works on mosses, ferns and orchids.\textsuperscript{116} Undoubtedly, his name gave great prestige to these scientific undertakings and possibly encouraged others to lend their support. He regarded Hooker's manuscript for a book on ferns as a valuable contribution to science and


\textsuperscript{113} Idem., 3 June 1837, Ibid., Eng. Lets. 1837, Vol. 9, number 48.


worthy of publication. Sir William based this work on the original coloured drawings made by Francis Bauer, Kew's botanical artist. Sir William based this work on the original coloured drawings made by Francis Bauer, Kew's botanical artist. Bedford persuaded Hooker that the volume could be printed provided a large enough sum was raised to pay the publishers. Characteristically, the Duke offered a donation of a hundred pounds. The Duke helped extend Hooker's herbarium. The professor's collection of dried plants was of great scientific value because, apart from having been very skilfully arranged, it was one of the most extensive in Great Britain. Hooker wanted to add to it by obtaining certain dried plants from the herbariums of collectors in Britain and in other countries. The Duke, who was on friendly terms with some of these collectors, wrote to them explaining the situation and was able to secure a number of specimens for Hooker.

To close this section I am going to consider the transformation of Kew Gardens into a national botanic establishment. The sixth Duke's efforts to convert these gardens into an important scientific centre and to ensure that W.J. Hooker (Professor


118. Allan, (n. 21), p. 17.

of botany at Glasgow University) became their director has been noted by several historians of Kew. Here, I want to consider more fully some of the issues that the Duke believed to be important. Bedford was convinced that the appointment of Hooker would be of the greatest advantage to the science of botany. The Duke's high regard for this botanist has already been mentioned. My impression is that the Duke thought Hooker could bring to Kew the glory and the immense prestige it had enjoyed several decades earlier, under the direction of Sir Joseph Banks. It is likely that the Duke envisaged Hooker further extending British botanical science by guiding Kew with great expertise and skill. The sixth Duke also believed that the gardens could help Britain fully exploit its empire. Besides these concerns Bedford was influenced by feelings of national pride. He wanted Kew to become the finest establishment of botanical science in Europe, which may


not only rival but be very superior to the Jardin Des Plantes at Paris'. 124 The Jardin became extremely important in the eighteenth century under its director Georges Louis Leclerc Comte De Buffon (1707-1788), who enriched its collections and developed the buildings. 125 Its fame was extended early in the next century through the work carried out by its Professor of Botany Antoine-Laurent De Jussieu. 126

To fulfil these hopes the sixth Duke made full use of his social position and political contacts. From 1833 he wrote emphatically about the importance of Kew and the virtues of Hooker to influential members of the government and to those who were concerned with the fate of the gardens. The Duke encouraged Lord John Russell to join the campaign. Lord John solicited support for Kew and Hooker amongst political colleagues and spoke to the Queen about these matters. Bedford used his contacts to find out who were sympathetic to the cause and advised Hooker to approach them. The Duke provided the professor with letters of introduction, helped him write memorials and suggested the most appropriate occasions in the parliamentary calendar to pursue the quest for the directorship. 127 The sixth Duke also advised Hooker to


125. See the *D.S.B.* for details.

126. For further details see the *D.S.B.*

127. The various tactics and approaches used by the Duke are occasionally detailed in the letters sent to Hooker between 1833-1839, *A.R.*, *R.B.G.K.*, Vols. 3, 7, 9, 10 and 12.
collaborate with John Lindley (Professor of Botany at the University of London and Secretary of the Horticultural Society of London) who had been appointed by the government early in 1838 to report on the conditions of the gardens. During January of that year a Parliamentary Committee had been formed to investigate the unsatisfactory state of all the Royal gardens in and near London. Their brief was to examine management, efficiency and expenditure. The Committee decided to appoint an investigative team headed by John Lindley, who was instructed to make a special study of Kew. 128 Lindley's report, published in the following February, bluntly stated that the gardens should either be abandoned or made into a scientific institution worthy of the nation. 129 The investigation provided the occasion for renewed speculation about the function and future

128. Instructions to Dr Lindley, 8 February 1838, P.R.O. Kew, Correspondence of the Committee appointed to enquire into the superintendence, management and expenditure of the Royal Gardens, T90-189, pp. 69-70.

129. See the copy of John Lindley's, 'Report upon the present condition of the botanic garden at Kew, with recommendations for its future administration, 1838', R.B.G.K., Kewensia, Royal Gardens Kew - Reports and documents 1784-1884, p. 4.
of Kew and gave a further opportunity to the opponents of the gardens to voice their discontent. This crisis situation caused the Duke to renew his efforts.

The sixth Duke believed that the Royal Botanic Society's scheme for constructing a botanic garden in Regents Park was a threat to his plans for Kew. The Society's proposal came late in 1838 and the Duke was not convinced that the garden could make a valuable contribution to horticultural and botanical science. He pointed out to Hooker that the soil on the site in the Park was poor, that the smog of London would be harmful to the plants and that the gardens would be plagued by parties of cockneys who would interrupt the pursuit of science. Hooker was warned by the Duke to disassociate himself from the project because, '... it would interfere with the far more important plan of establishing a great National Botanic Garden at Kew'.

The Duke died in the middle of this furore. His efforts on behalf of Sir W.J. Hooker and Kew had lasted over six years. However, Hooker was not left without patronage. As the


131. Ibid.
controversy over Kew continued, 132 Lord John Russell kept up the campaign and the seventh Duke acted on the professor's behalf. In a letter to Hooker the seventh Duke explained his position and his motives:

'Although I am fond of plants and flowers ... I do not profess to understand Botany or to take the same interest as my father did in the higher branches of that rational and useful science. I ... am anxious to serve you in the best of my power, first because I am persuaded that you deserve it and that in serving you I would serve the public ... and secondly, because I feel that in doing so I shall be urging into effect one of the fondest wishes of my father'. 133

Success came in 1841 when the gardens were given to the nation and Hooker was made their director.

Conclusion: The sixth Duke of Bedford was seriously involved in the pursuit and support of botanical and horticultural science. This involvement was extensive. The investigations he introduced at Woburn had an impact locally and were recognised nationally. The Duke's patronage of Sir J.E. Smith and Sir W.J. Hooker, his publication of botanic catalogues, his subscription to works of science and botanical expeditions, his use of science to try and improve


133. Letter from the seventh Duke of Bedford to Sir W.J. Hooker, 19 May 1840, Ibid., number 52.
the living standards of agricultural labourers and his lengthy campaign to make Kew a national centre for horticulture and botany, quite plainly show this. An important subsidiary aim of this chapter has been to make clear that the sixth Duke was far from being a dabbler in his scientific endeavours. It was not unusual for the nobility to become interested in gardening. I have hinted that other members of his Peer patrinated horticultural science in their estates. Further research is needed if we are to see whether they used their wisdom and personal power to support science through the use they so often made. It would be useful to have records of the number of landed estates that supported scientific patronage. From the noble house to the more rural establishments, and of the mode of activities that were patronised.

The initiatives also included the various institutions, societies and organisations that involved in scientific horticulture. Institutional patronage generated a variety of experimental work. These included all the gardens that
Chapter Six - Conclusion

I have shown how the development and diffusion of science became a central preoccupation of the sixth Duke of Bedford. During his early years at Woburn Abbey the Duke was keen to foster scientific farming. Later, he became strongly involved in botanical and horticultural science. Indeed, by supporting experimental work at the Abbey and by introducing innovation, the Duke became a significant patron of English scientific horticulture. To further these activities the sixth Duke made full use of his position and influence in society.

It was not uncommon for the nobility to become interested in gardening. I have hinted that other members of this group patronised horticultural science in their estates. Further research is needed if we are to see whether they used their status and personal power to support science in quite the same way as the sixth Duke. It would be useful to have some idea of the number of landed estates that encouraged scientific gardening, from the highly committed to the more casual establishment, and of the sorts of activities that were patronised.

The foregoing has also indicated that various institutions, societies and organisations were involved in scientific horticulture. Institutional patronage promoted a variety of experimental work. These enquiries and the schemes that
were undertaken by individuals in response to institutional encouragement, in total, formed an important part of the broadly developing investigatory front of early nineteenth century horticultural science. I have concentrated largely on those societies and institutions supported by the sixth Duke. The list, therefore, is by no means comprehensive and, clearly, could be considerably extended. It should be remembered that by the 1830s there were well over two hundred provincial horticultural societies in Great Britain and that little is known of the part they played in the development of early nineteenth-century scientific gardening.

To explain the interest of societies and organisations in horticultural science is a matter of great complexity and involves weaving together various economic, social, political and scientific threads. As J.B. Morrell has pointed out, science, '... could be a vehicle for social mobility, cultural affirmation, rational entertainment, moral uplift, theological edification, social anodyne, civic pride and perhaps paid employment'. Shapin and Thackray, quite rightly, would also add technical curiosity to the list. My brief survey has indicated that if we are to understand this institutional encouragement of scientific gardening, the following ought to be taken into


account: the prospect of profit, the consideration of the well being of the population as a whole, the need to develop a means of social control, the wish to advance and diffuse science simply for its own sake and the desire to provide adequate instruction for various trainees and students. A large number of the horticultural experiments and enquiries fostered by societies were in response to practical issues connected with the acquisition, identification, botanical arrangement and cultivation of plants. Thus, great emphasis was placed on solving problems of applied science.

Possibly, we also need to bear in mind the approximate doubling of numbers in England and Wales between 1800 and 1850, even though the causes and effects of population growth throughout this period remains a controversial issue amongst historians. Contemporaries were aware of the economic benefits and social problems resulting from such an expansion. A number of these consequences were emphasised by the work of the political economist Thomas Malthus (1766-1834). The 1803 edition of Malthus' book, Essay on the principles of population, stressed that social improvement was possible providing action was taken to avoid the 'checks' or dangers outlined in his original somewhat pessimistic work of 1798.  

3. For further details, see the D.N.E.
In 1801 the government put into operation a ten yearly census. This was the first attempt at a thorough counting of heads. The publication of the results of each census undoubtedly demonstrated to contemporaries this marked increase in numbers.

At present, as I have stressed before, it is only possible to suggest some relationship between population growth and societal patronage of horticultural science.

Our knowledge of those who belonged to many of these institutions is generally sketchy. A list of the members who supported horticultural experimentation and investigation together with details of their social background, occupation and attitudes would be of assistance in clarifying motives. The sixth Duke and other landocrats (which I have mentioned in Chapter Two) subscribed to a number of these societies and organisations but it is not clear whether they took an active role in promoting or initiating policy. In addition, some account needs to be taken of how the influence of such individuals, or of interest groups, varied over time.

The sixth Duke of Bedford, as we have seen, was one of the


5. The sixth Duke's Woburn estate seems not to have suffered from a local increase in numbers between 1802 and 1839. It does not appear, therefore, that population expansion directly encouraged the Duke to introduce horticultural improvement and investigation at Woburn. Population growth may have some relevance, however, to his support of institutions, societies and organisations.
proprietors of the Royal Institution. After 1820 the landed interest's proprietorial control of the Institution declined. Michael Neve in a review of Maurice Berman's pioneering book, *Social change and scientific organisation: The Royal Institution, 1799-1844*, makes the interesting postulation that it was only because the Institution was regarded by landowners as relatively unimportant that it was allowed to fall into the hands of the professional middle classes at this time. The Board of Agriculture, an organisation which was also largely controlled by landowners, was disbanded in the early 1820s. There may well be, in fact, some link between the Board's demise and the disinclination of the landed proprietors to use the Royal Institution for agricultural purposes. Of course, this does not mean that there was a general decline in the nobility's broad patronage of science. Possibly, they transferred their interest and energy to other scientific institutions or to other projects which were connected with science. Certainly, this was true of the sixth Duke. After 1820 he vigorously patronised scientific gardening at Woburn Abbey and turned it into a leading horticultural estate. Moreover, between 1820 and


7. See Michael Neve's review in, *Isis*, 7 (1979), p. 624. However, the Journal of the Royal Institution between 1816 and 1830, under the control of William Brande (1786-1866), its Professor of Chemistry, seems to have catered for the horticulturally minded amongst the landed gentry. A not inconsequential number of articles appeared on scientific gardening. The issues in the years covering 1829 to 1830 were particularly crowded with such papers. Articles covered practical, morphological, taxonomic and physiological aspects of the subject and were written by such renowned horticulturists as T. A. Knight, John Lindley and Cuthbert W. Johnson.
1839 the Duke continued his membership with many societies connected with, or interested in, horticulture, botany and agriculture, joined new ones and became a shareholder of University College, London.

Woburn Abbey, in fact, was like an institution because of the range of its activities. Along with the Board of Agriculture, the East India Company, the London and Caledonian Horticultural Societies, the Royal Dublin Society, the Royal Institution and the Royal Society of Arts (also Kew and other botanic gardens) the Duke inaugurated enquiries and experiments and employed competent people to carry out this work. A small group of the permanent staff at Woburn; the Rev. Edmund Cartwright, James Forbes, Robert Ireland, Robert Salmon and George Sinclair, were directed to investigate various scientific and technological aspects of horticulture and agriculture. All were skilful and knowledgeable in their different areas. Occasionally, the sixth Duke hired outside help to work full-time at Woburn for short periods. These contractors included the landscape Humphry Repton and the glass-house technologist William Atkinson. Bedford ensured that those conducting enquiries at the Abbey were supplied, usually quite generously, with the necessary land, equipment, apparatus and

materials to carry out their work. Some societies and institutions maintained libraries and granted reading privileges to their staff. Likewise, the sixth Duke built up a library at Woburn containing books which covered various aspects of horticulture, botany and agriculture and gave his staff access to them.

T. A. Knight believed that one of the advantages of having affluent individuals in Britain was that only they had the independence, freedom and wealth to embark on horticultural experimentation. Gardeners could not do so, suggested Knight, because they risked losing their jobs and could not afford the time or the great expense which such work entailed. This opinion is not quite accurate for I have shown how institutions could sponsor experimental work. Knight's remark, however, does contain a degree of truth. Woburn, during the years between 1820 and 1839, was in a better position financially than most learned societies to foster horticultural science. The wealth of the Russell estates and the Duke's habit of utilising his facility for borrowing to support his

scientific ventures has already been alluded to in Chapter Three.

Throughout this period the Linnean Society, 'With very limited means ... could not cope with the increasing flood of investigations'. Its purchase of the herbariums of Linnaeus and Sir J.E. Smith led to several years of impoverishment. As a result, the Society lost its position, "... as the main channel for the communication and publication of biological investigations". The prosperity of the Royal Society of Arts suffered a serious decline at this time and was, therefore, unable to foster investigative work with the same vigour as formerly. This was also the case with the Bath and West Society which was so short of money that for most years it just managed to fund existing premiums. Between 1820 and 1840 Kew Gardens lacked someone of the calibre of Sir Joseph Banks to attract, and contribute, funds and so it had to be careful in its expenditure.

11. Ibid.
During the mid 1820s and in the early 1830s the Horticultural Society of London was obliged to make economies, especially as a promised government subsidy of five hundred pounds (towards the completion of its Chiswick Garden) never materialised. Owing to these difficulties the Society was not able to undertake as thorough a comparative trial of the various glass-house heating systems as it had intended. In 1831 the grant which the British government had awarded the Dublin Society since 1749 was reduced and the Society had to economise and curtail some of its investigative work.

Some societies and organisations experienced quite marked changes in policy and this meant that they did not always actively encourage the diffusion of horticultural science. After the 1820s the Royal Society stopped publishing papers on vegetable physiology and its attention became focussed entirely on different scientific activities. The Journal of the Royal Institution, which gave so much space to horticultural and botanical science, was discontinued after 1831. In 1822 the Board of Agriculture collapsed. The reasons for the Board's demise have not been convincingly explained. Even so, its


17. Analysis of the report, and epitome of evidence taken before the Select Committee of the House of Commons in the session of 1836, on the Royal Dublin Society, (Dublin, The Royal Dublin Society, 1836), pp. 2 and see the appendix, p. LXXI. Between 1800 and 1836 the grants given to the Society, in total, came to approximately £276,154.
collapse does seem to reflect a change of opinion within the government and, possibly, amongst the landowners. With the ending of the Board's journal-cum-specialist publication (issued in annual volumes) horticulture lost one of its communication channels.

Obviously then, the varying fortunes of these societies and organisations meant that their support of horticultural science was inconsistent. Moreover, in some instances, policy changes meant their patronage was discontinued. Woburn, on the other hand, remained unwavering in its encouragement. Indeed, it was far more than just consistent. With each decade the sixth Duke's interest in horticulture increased. By the 1830s the promotion of scientific gardening had become a major preoccupation of the Duke. In the last years of his reign at Woburn, Bedford developed and extended the greenhouse collections and established a salicetum, an arboretum and a pinetum. A number of botanic catalogues and horticultural texts were published by the Duke's head gardener between 1829 and 1839.

Thus, Woburn Abbey was an important segment of the broad developing front of scientific horticulture. It could be argued that the Abbey was a microcosm of the nation's gardening. Some British contemporaries believed that British horticulture was generally superior to that of other countries. Their observations of the growth of horticultural chemistry, of the

increase in experimentation and investigation, of the production of new varieties of ornamental and esculent plants, of the efforts made to identify and classify vegetation, of the expansion in scientific and technological horticultural literature and of the innovations that were being made in glass-house technology caused them to reach this conclusion. The enquiries and introductions at Woburn do seem to reflect many of these developments. I now want to relate the activities at the Abbey to the major features of scientific gardening which I outlined in the opening chapter.

Much of Woburn's energy was directed towards plant nomenclature and taxonomy. The sixth Duke was eager to collect new varieties of plants to add to his collections and desired that they were accurately named and classified. Woburn Abbey gardens, like those belonging to other stately home owners who had a concern for horticulture and those owned by the Horticultural Society of London, the Caledonian Horticultural Society and the botanic gardens at Brompton, Chelsea, Kew and Liverpool were a repository for rare plants. By building up systematically arranged and extensive collections of grasses, heaths, willows, pines, camellias and cacti the Duke was helping to push forward horticultural botany. Besides examining the external features of plants, contemporaries also grappled with problems connected with internal physiology. English botany and botanical horticulture up until the 1860s, however, was characterised largely by a devotion to describing, naming and classifying vegetation. This contrasts markedly with the work of
continental plant physiologists who were expanding and
deepening knowledge of the internal mechanisms of plants. 19

This, perhaps, was a weakness of English horticultural science.

Woburn did not play a particularly outstanding role here
and the only important enquiry was Robert Salmon's
investigations of the internal functions of trees, undertaken
in the 1800s. The Duke was interested in the subject but
did not make a sustained contribution to this area of
horticultural science. Woburn, therefore, remained on
the sidelines.

Whilst working for the Duke, George Sinclair and James Forbes
compiled between them six volumes on horticulture and wrote
over eleven articles for gardening magazines. In this way
the Abbey contributed to the increasing volume of scientific
gardening literature. Woburn was not alone in this, naturally,
and the head gardeners of other estates published important
books on horticulture. William Speechley at Welbeck Abbey
(seat of the Duke of Portland) wrote a worthwhile text on forcing
grapes and one on forcing pineapples. 20

19. See Neil Morgan, The development of biochemistry in
England through botany and the brewing industry, (1840-1880),
Ph.D., University College, London, 1982, particularly,
Chapter Two.

20. William Speechley, A treatise on the cultivation of the
vine, was combined with, A treatise on the cultivation
of the pineapple, (London, Longman, Hurst, Rees, Orme
and Brown, 1827, third edition).
(head gardener of the Duke of Buccleugh at Dalkeith Palace, Scotland) published five books on gardening before 1840. 21 Joseph Paxton, the sixth Duke of Devonshire's head gardener, produced a slim but innovative volume on dahlias. 22 In the 1830s Devonshire was regarded by Sir W.J. Hooker as an important, and by Loudon as the greatest, patron of horticulture yet the Duke's gardener penned only one horticultural text in this decade. What made Woburn significant was its substantial output of scientific works. Compared with institutions, societies, organisations, botanic gardens and other estates, the Abbey was the only place which produced catalogues containing extensive sets of carefully engraved and coloured drawings. The object was to assist plant identification. It is true that coloured engravings appeared in the journals and transactions of several institutions but they did not cover particular species in depth and were not so carefully illustrated as the Woburn catalogues. Although the issues of the Horticultural Society of London's catalogue of fruits 23 were on the same scale as the Duke's productions, they did not

21. Macintosh was generally highly regarded by contemporaries. Between 1828 and 1860 he wrote seven books, but no great care was taken to ensure plants were carefully illustrated.


contain illustrations and the botanical information was less extensive.

The Abbey thus played a principal role in the evolution of horticultural and botanical science and also contributed to the development of botanical illustration.

Between 1805 and 1824, on the instructions of the sixth Duke, chemical investigations were undertaken at the Abbey. The head gardener, following Humphry Davy's ideas, examined grasses and certain vegetables and analysed soils. Of the landed nobility interested in horticulture, the sixth Duke stands alone in fostering on a significant scale horticultural chemistry and also horticultural botany. Bedford was unique in financing a detailed investigation, lasting some fifteen years, of the nutritive qualities and the botanical characteristics of hundreds of grasses. The scale of such an operation makes Woburn Abbey outstanding. The Duke had set a new standard.

Of the institutions and organisations encouraging the production of new or improved varieties of fruits, flowers and vegetables, the Horticultural Society of London was probably the most vigorous. The role landed estates played in plant breeding is not yet known. Woburn Abbey made a contribution by producing the Woburn perennial kale which became a standard strain. 24 The Duke was keen to add new plants to the gardens.

and plant houses at the Abbey and obtained hybrid varieties from the Horticultural Society of London and from various nurserymen. I have been unable to determine why he did not instruct Sinclair or Forbes to embark on a programme of cross breeding. Rather than become one of the leaders in the field the Duke saw fit to focus his gardener's energies on other tasks, and preferred to follow the investigations that were taking place in plant hybridisation.

Along with a number of societies, botanic gardens and other estates the sixth Duke kept pace with developments that occurred at this time in the use of construction materials for glass-houses and in the equipment used to heat these structures. The sixth Duke was quicker than some horticulturally minded landocrats in adopting innovation. Hot water heating was installed in all the ranges at Woburn by the late 1820s whereas the Duke of Northumberland preferred to keep on heating his greenhouses at Syon with steam.25 An original feature of the Abbey plant houses was the experimental combination of various metals. At Chatsworth it was not until the 1840s that metal became widespread as a construction

material for the Duke of Devonshire's glass-houses. Woburn, therefore, was an initiator in this area of horticultural technology.

We have seen in previous chapters how a variety of considerations acting in combination, motivated the Duke to patronise scientific gardening. As in the case of institutions and organisations, a great deal of emphasis was placed on utility. The Duke chose to patronise scientific ventures that would be of practical use. For example, an object of Robert Salmon's aboricultural investigations was to increase the profitability of the Duke's woodlands. George Sinclair was instructed to carry out certain scientific enquiries because the sixth Duke wanted to develop the pasture lands of his estates and improve the conditions of the labouring class living in the vicinity of the Abbey. The catalogues and scientific volumes that were written at Woburn encouraged landowners to lay down good pastures and extend woodlands by planting willows and pines. The Duke hoped that by adopting such measures these owners would increase the profitability of their estates. The sixth Duke's catalogues were also designed to help horticulturists and botanists accurately identify and classify plants and to provide useful cultural and botanical information. Most

certainly, the Duke was a patron of applied science.

At Woburn, and on the landed properties that have been mentioned, the head gardeners emerge as important figures. They were respected both within the narrow confines of the estate, where they enjoyed considerable prestige and held positions of great responsibility, and in national horticultural circles. Sometimes, they took on the duties of forester and steward. Many of the head gardeners of the landocrats mentioned earlier were expected to carry out enquiries and experiments. Work of this nature at the Abbey was extensive. A number of these horticulturists were referred to by contemporaries as 'botanic gardeners' and 'scientific gardeners' on account of their practical skills, their knowledge of greenhouse technology, their botanical competence (possibly their understanding of chemistry) and their ability to conduct investigations. Many belonged to institutions which took an interest in horticultural and botanical science, most notably the Linnean Society, the Horticultural Society of London and the Caledonian Horticultural Society. Some head gardeners published accounts of their enquiries in the journals of these societies or in the popular gardening periodicals and wrote horticultural texts. One or two edited gardening magazines. E.H.M. Cox has observed that during the eighteenth and early nineteenth century it was common for Scotsmen to secure high positions in various gardens in England, particularly as
the head gardeners of English noblemen. My cursory examination of this class of Society tends to support Cox's generalisation. Certainly this is true of Woburn Abbey. The reliable contemporary observer, Patrick Neill, wrote in 1817 that they were equally as prevalent in Ireland as in England. Probably, as Cox and Neill suggest, this is accounted for by the aristocracy's preference for gardeners who were trained in an unkindly climate, the better chances of employment in England (plus the shorter period of apprenticeship), and the tendency for head gardeners of Scottish birth to employ other Scotsmen. It is almost certain that another factor was the better elementary education available in Scotland. As a group, they are worthy of further study.

To assess fully Woburn's contribution to horticultural science and to place the Abbey in the context of science generally in the years between 1800 and 1840 is a difficult matter. It would be helpful to have a reasonably detailed and reliable history of scientific gardening for the nineteenth century.

29. Ibid., p. 182; Cox, (n. 27), pp. 202-204.
30. Particularly useful would be details of those who developed new concepts or re-fashioned existing theories and an account of the changes that occurred in the perception and approach to problems.
The development of science in England generally in the early nineteenth century has only been partially explored. There is much disagreement amongst scholars and there are still a great many points of uncertainty. S.F. Cannon has stated, somewhat controversially, that the second quarter of the nineteenth century was one of the most, '... formative, searching and basically determinative periods ...' in the history of British science. Horticultural science is a fruitful area for exploring this notion. What stands out unmistakably from my evaluation of a landed estate in the early nineteenth century is the close cooperation that existed between landocrats, wealthy individuals, professional botanists, horticulturists and various societies and organisations. They shared a number of aims, and they were quite willing to send one another rare, unusual or useful specimens, to discuss contentious issues and exchange scientific information and to give advice. It is these sorts of activities that suggest the early nineteenth century may, as Cannon states, have been a formative period.

It is not clear why science and the idea of science acquired such prominence in nineteenth-century Britain. Several

historians of science have concerned themselves with this issue. Indeed, Maurice Berman in his work about the Royal Institution has admitted that, '... the problem is probably deeper than the mere sociological analysis attempted in this book could fathom'. Most likely, economic, institutional, social, political and psychological factors need to be taken into account. This thesis has discussed some of the considerations encouraging one member of the aristocracy to patronise scientific gardening but it is impossible, at present, to generalize about the reasons for the involvement of a small number of the landocracy in science. An interesting idea has come from David Spring. He has pointed out that the traditional role of the aristocracy was coming under threat in the early nineteenth century and suggests, not implausibly, that their vulnerability put them on the defensive generally. As a result they, '... maybe found peculiar relish and satisfaction in so vigorously taking the lead in agricultural affairs'. This could help to explain their patronage of horticultural science too.

At Woburn Abbey during the period 1802 to 1839 the sixth Duke of Bedford investigated pruning techniques, developed


33. Berman, Ibid., p. XIX.

horticultural chemistry, collected new varieties of plants, shrubs and trees, financed botanical expeditions, introduced innovative glass-house technology, published a most extensive tome on grasses and produced detailed botanic catalogues on heaths, willows and pines. He used the results of his investigations in an effort to improve the conditions of those living on his estates and he supported the publication of systematically organised texts written by botanists and gardeners not employed at Woburn. Bedford tried to further the career of Sir J.E. Smith and Sir W.J. Hooker and attempted to make Kew Gardens the country's leading centre of horticulture and botany. The Duke's pursuit of these issues is but one facet of the developments that took place in the early nineteenth century in theoretical and applied science and of changes in attitudes towards science. 35

Bibliography

1. Archive sources, arranged alphabetically.

Antonie Correspondence, B.C.R.O.

Bagshawe Collection, Local History Section, Bedford County Hall Library.

Blairadam MSS., National Register of Archives (Scotland).

Covent Garden Estate Records, G.L.R.O.

Sir Humphry Davy Mss. R.I.A.

Foster/Massereene Papers, P.R.O. of Northern Ireland.

Thomas Gibbs Correspondence, E.C.R.O.

Second Earl Grey Papers, University of Durham Department of Palaeography and Diplomatic.

Third Lord Hardwicke Correspondence, Brit. Lib. Dept. Mss.

Sir William J. Hooker, English Letters, A.R., R.B.G.K.

Royal Botanic Gardens Kew, Reports and Correspondence, P.R.O., Kew.

Royal Botanic Gardens Kew, Reports and Documents, R.B.G.K., Kewensis.

John Lindley Letters, A.R., R.B.G.K.

Royal Horticultural Society, Council Minutes, Lib. R.H.S.

Russell MSS., B.C.R.O.

Russell MSS., B.E.O.


Russell MSS., Devon Record Office.

Sir James E. Smith Correspondence, B.M.N.H., Botany Library.

Sir James E. Smith Correspondence, Kew Miscellaneous Correspondence, A.R., R.B.G.K.

Sir James E. Smith Scientific Correspondence, Lib. Linn. Soc.

James Sowerby Correspondence, B.M.N.H., Botany Library.

Woburn Abbey Archives and Library. Catalogues, plans and folios relating to the sixth Duke, his staff and the gardens.

Arthur Young Correspondence, Brit. Lib. Dept. Mss.

2. Publications of the Woburn Abbey head gardeners, listed chronologically.

(a.) Books and articles written by George Sinclair.

'Mr. Sinclair in answer to Dr. Richardson on fiorin grass', Agricultural Magazine, 2, (1813), pp. 154-156.


Hortus gramineus Woburnensis, (London, B. M'Millan, 1816). See also the editions of 1824, 1826 and 1869.

'Hortus ericaeus Woburnensis, (Private printing, 1825).


On the effects of bone manure on different soils', Prize essays and Transactions of the Highland Society of Scotland, New Series, 1, (1829), pp. 75-79.


'Reply to Mr. Aiton Esq., on the nutritive power of grasses', Br. Fmrs. Mag., 3, (1829), pp. 260-266.

Useful and ornamental planting, (London, Baldwin, and Cradock, 1832).


'Essay on the grasses and other plants best suited for pasture during the winter', Prize essays and Transactions of the Highland and Agricultural Society of Scotland, New Series, 4, (1835), pp. 31-47.

(b). Books and articles written by James Forbes.

'Country seats in Ireland, omitted in the "Encyclopaedia of gardening"', Gard. Mag., 1, (1826), pp. 94-95.

'On prolonging the season of hardy fruits', Gardn's. Mag., 3, (1828), pp. 11-12.


'A mistake by the conductor respecting the wages of the assistant gardeners employed in the gardens of Woburn Abbey', Gardn's. Mag., 2, (1833), p. 623.


Journal of a horticultural tour through Germany and part of France in the autumn of 1835, (London, James Ridgway and Sons, 1837).


3. General works, arranged alphabetically.


Bateman, J., The great landowners of Great Britain and Ireland, (London, Harris and Sons, 1878).


Catalogue of the library at the Chelsea Physic Garden, (1956).


Chambers, R., A biographical dictionary (of eminent Scotsmen), (Glasgow, Blackie and Sons, 1832-1835).


Cokayne, G.E., Complete peerage of England, Scotland, Ireland, Great Britain and the United Kingdom, extant, extinct or dormant, (London, George Bell and Sons, 1887-1898, 8 Vols.).


Dictionary of National Biography.

Dictionary of Scientific Biography.


Encyclopaedia Britannica. See the editions from the late eighteenth to the mid-nineteenth centuries.

Freeman, R.B., British natural history books 1495-1900 - A handlist, (Folkstone, William Dawson and Son Limited, 1980).


Maxwell, C.E., A brief bibliography of Irish history, (Dublin, Dublin University Press, 1911).


Potts, T., *The British farmer's cyclopaedia; or complete agricultural dictionary; including every science or subject dependant on or connected with, improved modern husbandry*, (London, Scatcherd and Letterman and M. Jones, 1807).


Simmons, A., *A horticultural who was who*, (London, Royal Horticultural Society, 1948).


4. Other references, listed alphabetically.

A biographical sketch of Mr. Salmon, who died at Woburn Park, Bedfordshire, October 6, 1821, (London, Private printing, 1822).

A continuation to the alphabetical index of the matter contained in the Philosophical Transactions of the Royal Society of London; from the year 1781 to the year 1820, (London, The Royal Society, 1821). See also the continuation published in 1833, covering the period 1821 to 1830.

'A noble heritage', *Apollo*, Special December Number, (1965), pp. 436-441.


Accum, F., A practical essay on chemical re-agents or tests, (London, J. Callow, 1816).

Additional appendix to the outlines of the fifteenth chapter on the proposed general report from the Board of Agriculture on the subject of manures, (London, Board of Agriculture, 1796).

Agar, N., Employment and community in Bedfordshire and Herefordshire in the nineteenth century, Ph.D., University of East Anglia, 1979.


Amos, W., Minutes in agriculture and planting, (London, Private printing, 1804).

An itinerating agricultural book club, (Brighton, Private printing, 1836).

Analysis of the report, and epitome of evidence taken before the Select Committee of the House of Commons in the session of 1836, on the Royal Dublin Society: together with notes and illustrations by a member of the Society, (Dublin, Royal Dublin Society, 1836).


Austin, T.G., The straw plaing and straw hat and bonnet trade, (Luton, Patrick O'Doherty, 1871).

Bacon, R.N., A report of the transactions of the Holkham sheep-shearing, (Norwich, Burks and Kinnebrook, 1821).

Baillie, W., 'Some account of the flower gardens and the Pinetum at Dropmore, the seat of Lord Greville', Gdnr's. Mag., 3, (1828), pp. 265-268.


Ballard, S., 'On pruning to increase the growth of timber', Extra Mag., New Series, 1, (1838), pp. 298-300, 343-344.


Bauer, F., Illustrations of orchidaceous plants, (London, James Ridgway and Sons, 1830-1838).


Bibliography of the publications of the Royal Dublin Society from its foundations in the year 1731 together with a list of bibliographical material relative to the Society, (Dublin, Royal Dublin Society, 1933, Second edition).


Boulger, G.S., The history of Kew gardens: Connections of Kew with the history of botany, (Richmond, 1915). This can be found in R.E.G.K., Kewensia (5).


British husbandry, exhibiting the farming practices in various parts of the United Kingdom, (London, Baldwin and Cradock, 1834-1840, 3 Vols.).


Bucknall, T.S.D., The orchardist or a system of close pruning and medication for establishing the science of orchardising as patronised by the Society for the Encouragement of Arts, Manufactures and Commerce, (London, G. Nicol, 1797).

Burgess, H.W., Drawings of the evergreens at Woburn Abbey, (1837). This is held at the B.E.O.


Cartwright, Rev. E., 'An experimental essay on salt as a manure, and as a condiment mixed with the food of animals', Communications to the Board of Agriculture on subjects relative to the husbandry, and internal improvement of the country, 4, (1805), pp. 370-381.
Catalogue of Number 2 in the map of the Dublin Society's Botanic Garden at Glasnevin, containing the aboretum or systematic arrangement of trees, (Dublin, The Dublin Society, 1800).

Catalogue of Number 19 in the map of the Dublin Society's botanic garden at Glasnevin, containing the herbarium or systematic arrangement of herbaceous plants, (Dublin, The Dublin Society, 1802).


Catalogue of the library of the Royal Dublin Society, (Dublin, Royal Dublin Society, 1839).

Catalogue of the plots Number 14 and 15 in the map of the Dublin Society's Botanic Garden at Glasnevin, containing the graminia vera or true grasses including oats, wheat, rye and barley, (Dublin, The Dublin Society, 1800).


Clark, J., The influence of climate in the prevention and cure of chronic diseases, more particularly of the chest and digestive organs, (London, Thomas and George Underwood, 1829).


Cobbett, W., Cobbett's political register. Most of the issues contain some horticultural information.


Cobbett, W., The woodlands: or a treatise describing the trees, (London, Private printing, 1825).


Collection of Royal Institution circulars 1801-1837. This is held in the British Library.

Communications to the Board of Agriculture on subjects relative to the husbandry and internal improvement of the country, (London, George Nicol, 1797-1819, Vols. 1-7, and New Series, Vol. 1).


'Correspondence between Dr Richardson and Mr George Sinclair, on fiorin grass', The Agricultural Magazine, New Series, 5, (1815), pp. 73-78.

Cottage husbandry, (London, John W. Parker, 1835). This is a selection from the publications of the Labourer's Friend Society.

Cottram, Mr., 'Observations made on the performance of a hot-water apparatus in a pinery at the Earl of Egremont's, Petworth, Sussex, during the severe weather in January last by Mr Harrison, the gardener there, Gdnr's. Mag., 8, (1832), pp. 147-148.

Creation of the Royal Botanic Gardens in 1840. This is held at R.B.G.K., Kewensis.


Curtis, S., General indexes to the plants contained in the first fifty-three volumes of the *Botanical Magazine*, (London, Private printing, 1828), pp. 3-32.


Curtis’ *Botanical Magazine*. See the issues covering the years 1788-1844.


Dacre, Rev. B., *Testimonies in favour of salt as a manure and a condiment for horse, cow and sheep, with testimonies of its vast importance in the arts, in manufactures and in the fisheries*, (Manchester, Private printing, 1825).


Darwin, E., *Phytologia; or the philosophy of agriculture and gardening, with the theory of draining morasses, and with an improved construction of the drill plough*, (London, J. Johnson, 1800).


Davy, Sir. H., 'On the analysis of soil, as connected with their improvement’, *Communications to the Board of Agriculture on subjects relative to the husbandry and internal improvement of the country*, 4, (1805), pp. 302-318.
See, too, the edition of 1821.


Davy, J., Memorial of John Sixth Duke of Bedford, (Woburn, Private printing, 1842).

Dodd, S., An historical and topographical account of the town of Woburn, its Abbey, and vicinity, containing also a concise genealogy of the House of Russell, and memoirs of the late Francis Duke of Bedford, (Woburn, Private printing, 1818).

Dodd, S., Memorials of John Sixth Duke of Bedford, (Woburn, Private printing, 1842).


Dorn, J., Hortus Cantabrigiensiis, (Cambridge, Private printing, 1796).


Drawings of the cactae in the collection of the Duke of Bedford. This is held in the Library at Woburn Abbey.

Dundonald, Earl of, The present state of the manufacture of salt explained, (London, Private printing, 1785).

Dundonald, Earl of, A treatise, showing the intimate connection that subsists between agriculture and chemistry, (London, Private printing, 1795).


Facts and illustrations (1831-1833). This was published by the Labourer's Friend Society.
Farey, Mr, 'On forest pruning - Mr Farey's reply to M', The Agricultural Magazine, New Series, 2, (1814), pp. 79-81.

Farmer's Magazine (1834-1841). This was another journal of the Labourer's Friend Society.


Franklin, T. B., British grassland from the earliest times to the present day, (London, Faber and Faber, 1953).

Fraser, J., A short history of the agrostis cormucopiae or the new American grass, (London, Private printing, 1789).


Gardens and grounds at Woburn Abbey. This pamphlet publicised James Forbes' Hortus Woburnensis.


Granville, A.B., The Royal Society in the XIXth century; being a statistical summary of its labours during the last thirty-five years, (London, Private printing, 1836).

'Grasses best adapted to permanent pasture, and to allotment husbandry', Far'r's. Mag., 26, (1825), pp. 57-70.


Grisenthwaite, W., A new theory of agriculture, in which the nature of soils, crops and manures is explained; many prevailing prejudices are exploded and the application of bones, gypsum, lime, chalk etc., is determined on scientific principles, (Wells, H. Neville, 1819). See the second edition of 1830.


Handbook to the gardens of the Royal Horticultural Society at South Kensington, (London, Royal Horticultural Society, 1864).

Hansard's Parliamentary Debates. See the volumes published between 1802 and 1839.


Henry, W., A general view of the nature and objects of chemistry, and of its application to arts and manufacture, (Manchester, J. Johnson, 1799).


Hills, A.W., Lecture notes for a course of five lectures on Kew Gardens. See the file, Botanic Gardens II, R.B.G.K.


Hooker, J.D. and Bentham, G., Genera plantarum, (London, Reeve and Company, Williams and Norgate, 1862-1883, 3 Vols.).

Hooker, J.D., Miscellaneous notes on the history of Kew Gardens, 1878, R.B.G.K.


Hooker, Sir. W.J., A catalogue of plants contained in the Royal Botanic Garden of Glasgow, in the year 1825, (Glasgow, Andrew and John M. Duncan, 1825).


Hooker, Sir. W.J., Botanical Illustrations, (Glasgow, Private printing, 1837).

Hooker, Sir. W.J., Genera Filicum or Illustrations of the genera of Ferns from the original coloured drawings of Francis Bauer, (London, Henry G. Bohn, 1838).


Hooker, Sir. W.J., Copy of a letter addressed to Dawson Turner, Esq., F.R.A. and L.S. on the occasion of the death of the late Duke of Bedford, particularly in reference to the services rendered by his grace to botany and horticulture, (Glasgow, George Richardson, 1840).


Hortus Gramineus Woburnensis or specimens of the grasses, cultivated at Woburn Abbey, 1812. This unbound copy is kept in the Library at Woburn Abbey.


Johnson, C.W., *The farmers encyclopaedia, and dictionary of rural affairs; embracing all the most recent discoveries in agricultural chemistry, adapted to the comprehension of unscientific readers*, (London, Longman, Brown, Green and Longman, 1842).


*Journal of the Royal Institution of Great Britain*, 1-2, (1802-1803). This became the *Journal of Science and the Arts*, 1-4, (1817-1819) which in turn became the *Quarterly Journal of Literature, Science and the Arts*, 7-21, (1819-1827). Between 1827 and 1829 it was re-titled the *Quarterly Journal of Science and Art*, whilst during 1830-1831 it was called the *Journal of the Royal Institution of Great Britain*.


Kirwan, R., *What are the manures most advantageously applied to the various sorts of soils and what are the causes of their beneficial effect in each particular instance*, (Dublin, George Bonham, 1794).


Lawrence, J., Practical directions for laying down or improving meadow and pasture land, with an enumeration of the British grasses, (London, Sherwood, Gilbert and Piper, 1834).


Lawson, P. and Son, Synopsis of the vegetable products of Scotland in the museum of the Royal Botanic Gardens of Kew, (Edinburgh, Private printing, 1852).


Letters and papers on agriculture, planting, etc., selected from the correspondence of the Bath and West of England Society, for the encouragement of agriculture, arts, manufactures and commerce, (Bath, Bath and West of England Society, 1792-1816).


Lindley, J., The theory of horticulture or an attempt to explain the principal operations of gardening upon physiological principles, (London, Longman, Rees, Orme, Brown, Green, Longmans, 1840).

List of the councils of the Royal Society, commencing with the year 1800, (London, Royal Society of London, 1840).


List of the members of the Board of Agriculture, (London, Board of Agriculture, 1803).


Loudon, J.C., *Sketches of curvilinear hothouses: with a description of the various purposes in horticultural and general architecture, to which a solid iron sash bar (lately invented) is applicable*, (London, D. Redman, 1818).


Loudon, J.C., 'Floricultural and botanical notices, on kinds of plants newly introduced into our gardens', Gdnr's. Mag., 12, (1836), p. 142.


Loudon, J.C., 'Observations upon the effects produced on plants by the frost which occurred in England in the winter of 1837-1838', *Gdnr's. Mag.*, 16, (1840), pp. 475-513.


Macintosh, C., The practical gardener. and modern horticulturist etc. etc., forming a complete system of modern practice in the various branches of horticultural science, (London, Thomas Kelly, 1828-1829, 2 Vols.).


Macintosh, W., A treatise concerning the manner of fallowing ground, of raising grass-seeds, and training of lint and hemp, for the increase and improvement of linen manufacturies in Scotland, (Edinburgh, The Honourable Society for Improving in the knowledge of Agriculture, 1724).

Mackay, J.T., A catalogue of the plants found in Ireland with descriptions of some of the rare sorts, Part 1, (Dublin, R. Graisberry, 1825).


Main, J., The forest planter and pruner's assistant, (London, Ridgway, 1839).


Marshall, W., Planting and ornamental gardening; a practical treatise, (London, J. Dodsley, 1785).


Martyn, T., Flora rustica: exhibiting accurate figures of such plants as are either useful or injurious to husbandry, (London, F.P. Nodder, 1792-1794, Vols. 1-4).


McNab, W., A treatise on the propagation, cultivation and general treatment of Cape heaths, (Edinburgh, Thomas Clark, 1832).


Nearns, J., 'On the coiling system of cultivating the vine in pots', Gdnr's. Mag., 10, (1834), pp. 138-140.
Memoirs of the Caledonian Horticultural Society of Edinburgh. See the issues between 1814 and 1832, Volumes 1-5.

Mercer and Crocker's general topographical and historical dictionary, (Leicester, Mercer and Crocker, 1871).


Milburn, W., Oriental commerce, (London, Private printing, 1813, 2 Vols.).


Miller, P., Dictionary of gardening, botany and agriculture, (London, Orr and Smith, 1834). This was to be a twenty four volume venture with many new articles from some of the most respected horticultural writers. Only three parts were issued.


Murphy, E., 'Hortus Woburnensis', Irish Flm. and Gard. Mag., 1, (1834), p. 204.


Nicol, W., The Scotch forcing gardener, (Edinburgh Private printing, 1797).


Niven, N., 'Details of experiments on vegetable physiology and observations thereon', Gdnr's. Mag., 14, (1838), pp. 161-171.

North, R., An account of the different kinds of grasses propagated in England, for the improvement of corn and pasture, lands, lawns and walks, (London, Private printing, 1760).


Parkes, S., Chemical essays, (London, Baldwin, Cradock and Joy, 1815, 5 Vols.).


Plan of the pleasure grounds of Woburn Abbey in November 1838. This is kept in the library at Woburn Abbey.


Pontey, W., *The forest pruner*, (Huddersfield, T. Smart, 1805). See also the third edition of 1810.


Pontey's "Forest Pruner" versus Cruickshank's "Practical Planter" on the subject of pruning fir trees'. *Gdn's. Mag.*, 6, (1830), pp. 675-680.


Premiums offered by the Board of Agriculture, (London, Board of Agriculture, 1804).

Premiums offered by the Dublin Society for agriculture and planting, manufactures and fine arts, (Dublin, The Dublin Society, 1796).


Prospectus, charter, ordinances and bye-laws of the Royal Institution of Great Britain, together with lists of the proprietors and subscribers; and an appendix, (London, The Royal Institution, 1800).
Pyenson, L., '"Who the guys were": Prosopography in the history of science', *Hist. Sci.*, 15, (1977), pp. 155-188.

Record Book 1804-1826, R.B.G.K., Kewensia. See the volume for the period 1828 to 1847.


Repton, H., Designs, observations and plans for the improvement of the grounds at Woburn Abbey, a seat of his Grace the Duke of Bedford, (1804). This is kept in the Library at Woburn Abbey.


Royal Dublin Society 1731-1841, (Dublin, Royal Dublin Society, 1941).

Royal Gardens Kew - reports and documents 1784-1884, R.B.G.K., Kewensia. This contains John Lindley's report of 1838.

'Royal Gardens, Kew', Horticultural Journal, 8, (1837), pp. 91-98.

'Royal Gardens, Kew', Florist's Journal, 2, (1840), pp. 73-81.


Royal Society List of Members 1768-1770, 1772, 1774, 1797, 1808 and 1809. The bound volume of these lists is kept in the British Library.

Roxburgh, W., Plants of the coast of Coromandel; selected from drawings and descriptions presented to the Hon. Court of Directors of the East India Company, (London, George Nicol, 1795-1819, 3 Vols.).

Roxburgh, W., Hortus Bengalensis or a catalogue of the plants growing in the honourable East India Company's Botanic Garden at Calcutta, (Serampore, Private printing, 1814).

Rules, orders and premiums of the Bath and West of England Society, for the encouragement of agriculture, arts, manufactures and commerce, (Bath, Bath and West of England Society, 1802).


Salisbury, W., The botanist's companion, (London, Longman, Hurst, Rees, Orme and Brown, 1816, 2 Vols.).


Shepherd, J., A catalogue of the plants in the botanic garden at Liverpool, (Liverpool, Private printing, 1809).


Sinclair, Sir. J., Plan for establishing a Board of Agriculture and internal improvement, (1793).

Sinclair, Sir. J., Substance of Sir John Sinclair's address to the Board of Agriculture on the first day of it being assembled, (London, Board of Agriculture, 1795).

Sinclair, Sir. J., Hints on vegetation and questions regarding the nature and principles thereof addressed to farmers, nurserymen and gardeners, (London, Board of Agriculture, 1796).

Sinclair, Sir. J., Address to the Board of Agriculture, on Tuesday the 22 April 1806, (London, Board of Agriculture, 1806).


Sinclair, Sir. J., Account of some experiments to promote improvement of fruit trees by peeling the bark; with a description of the instruments calculated for that purpose, and engraving of them, (London, W. Bulmer and Company, 1820).

Sinclair, Sir. J., Hints to persons afflicted with paralytic or apoplectic disorders, 7 February, 1823. This pamphlet can be found amongst the sixth Duke of Bedford's papers, B.E.O.


Smith, E., A history of Whiteknight, (Reading, the University of Reading, 1957).

Smith, J., A record of a few special events and matters relative to the Royal Botanic Garden at Kew, R.B.G.K., Kewensia.

Smith, Sir J.E., 'An account of several plants presented to the Linnean Society, at different times, by Mr John Fairbairn and Mr Thomas Hoy, Fellows of the Linnean Society', Trans. Linn. Soc., 1, (1791), pp. 249-254.


Smith, Sir J.E., Exotic botany, (London, James Sowerby, 1804-1805, 2 Vols.).

Smith, Sir J.E., Considerations respecting Cambridge, more particularly relating to its botanical professorship, (London, Longman, Hurst, Rees, Orme and Brown, 1818).


Somerville, Lord J., The system followed during the last two years by the Board of Agriculture, (London, W. Miller, 1800).
Somerville, R., *Outlines of the fifteenth chapter of the proposed general report from the Board of Agriculture. On the subject of manures*, (London, Board of Agriculture, 1795).


Speechly, W., *Practical hints in domestic rural economy relating partly to the utility, formation and management of fruit, kitchen and cottage gardens and orchards arranged in sections as proposed by the honourable Board of Agriculture*, (London, Longman, Hurst, Rees, Orme and Brown, 1820).


Spring, D., *'A great agricultural estate: Netherby under Sir James Graham, 1820-1845'*, *Agricultural History*, 22, (1955), pp. 73-81.


Spry, H.H., *Suggestions received by the Agricultural and Horticultural Society of India for extending the cultivation and introduction of useful and ornamental plants with a view to the improvement of the agricultural and commercial resources of India*, (Calcutta, Bishops College Press, 1841).


Steele, R., *An essay in gardening*, (York, Private printing, 1793).


Strickland, M., _A memoir of the life, writings and mechanical inventions of Edmund Cartwright_, (London, Saunders and Otley, 1843).


Swayne, Rev. G., _Gramina pascua_, (Bristol, Private printing, 1790).


Systematic catalogue of green and hot-house plants, in the Dublin Society's botanic garden at Glasnevin, _Dublin, Dublin Society, 1891_.


The official handbook to the gardens of the Royal Horticultural Society at South Kensington, (London, Royal Horticultural Society, 1864).


'Thinning and pruning plantations and orchards', The Labourer's Friend Magazine, (1836), pp. 6-7.


Thompson, J., 'An account of some experiments in physiological botany, undertaken at Welbeck in 1823-1824, and repeated in 1825, with a view to ascertaining probable causes of failure in early forced grapes', Gardener's Mag., 5, (1829), pp. 253-256.

Thompson, J., 'An essay on physiological botany, in continuation of the experiments described in the preceding paper', Gardener's Mag., 5, (1829), pp. 257-266.


Thompson, T., History of the Royal Society from its institution, to the end of the eighteenth century, (London, Robert Baldwin, 1812).


Todd, G., Plans, elevations and sections of hot-houses, green-houses, etc., (London, J. Taylor, 1812).


Toulmin, W.M., Rational amusement: being a series of curious and instructive experiments in chemistry, (Calcutta, Private printing, 1822).


Transactions of the Horticultural Society of London. See the numbers between 1807 and 1842, Volumes 1-7 and Second Series, Vols.

Transactions of the Linnean Society, 1-18, (1791-1841).


Turner, D., Fuci or coloured figures and descriptions of the plants referred by botanists to the genus fucus, (London, John and Arthur Arch, 1808-1819, Vols. 1-4).


Unwin, G., Samuel Oldknow and the Arkwrights, (Manchester, Manchester University Press, 1924).


Wade, W., Sketch of lectures on artificial or sown grasses, (Dublin, Graisberry and Campbell, 1808).

Wade, W., Sketch or lectures on meadow and pasture grasses, (Dublin, Graisberry and Campbell, 1808).

Wade, W., Salices or an essay towards a general history of sallows, willows and osiers, their uses and best methods of propagating and cultivating them, (Dublin, Graisberry and Campbell, 1811).


Weld, C. R., A history of the Royal Society, (London, John W. Parker, 1848, 2 Vols.).


Yeats, G.D., Observations on the claims of the moderns to some discoveries in chemistry and physiology, (London, Private printing, 1798).

Young, A., *An inquiry into the propriety of applying wastes to the better maintenance of the poor*, (Bury, Richardson and J. Hatchard, 1801).

Young, A., *On the advantages which have resulted from the establishment of the Board of Agriculture*, (London, Richard Phillips, 1809).