PIONEERING SCIENCE IN THE PENNINES

a regional heritage in science
explored and celebrated with the aid of museum material at

CLIFFE CASTLE MUSEUM
KEIGHLEY

Weekend course/conference, 30 June/1 July 2001

REPORT AND

SUMMARY OF PROCEEDINGS

Report for WEA Yorkshire North District, 6 Woodhouse Square, Leeds LS3 1AD
(as requested, 8 October 2001)

INTRODUCTION

The meeting whose proceedings are recorded here was planned as a weekend course, and was organised by the Keighley branch of the WEA. It arose from an initiative by people involved in Open University studies of the history of science who wished to explore the heritage of science in their own region, i.e. a region overlapping the boundaries of West Yorkshire and Lancashire.

Several museums were considered as possible venues for the meeting (including one in Lancashire), but only Cliffe Castle had the right combination of good scientific collections and a curator who was responsive to what we wished to do. Then a suitable range of speakers had to be sought, and it was something of a surprise that those with the best knowledge of early science in the Pennines all seemed to come from Oxford (although they had mostly lived in the region or had personal and academic links with it).

In the event, the meeting was a conference rather than a course, because it developed a dynamic of its own and was immensely fruitful in ways we didn't plan for. As historians of science, we were reminded of the ancient Museum of Alexandria, famous for its work in geometry and astronomy. This was called a "museum" because it was intended as a Temple of the Muses - a place of inspiration as well as scholarship. Cliffe Castle Museum also proved to be a place of inspiration (and scholarship) on this occasion, partly because its wonderful natural science collections spoke for themselves, and the session devoted to working with museum objects generated an enthusiasm which pervaded the whole event.

More than that, though, the curator's talk, originally planned as only a brief introduction to museum objects and exhibits, proved to be the keynote speech, opening up new facets of the social history of science for everybody present. She showed how scientific collections in a museum were not only useful for teaching and study in the natural sciences, but could also provide a route into the social history of the sciences in our region. The curator said that no historical research had been done on the Cliffe Castle collections, but the scholarship clearly evident in her paper showed that she had done significant research herself.

This theme emerged so strongly during the meeting that a rather simplistic division is made in this report between social history of science seen from the museum, as compared with history based on university scholarship (often dealing with an earlier period). This means that papers are not summarised here in the order in which they were presented at the meeting.

The summaries of papers in this report have been prepared by a minute-taker at the meeting, who should be blamed for any inaccuracies. In some cases, a full transcript of the talk, or fuller notes prepared by the speaker, is available from myself at: 8 North Street, Addingham, Ilkley, West Yorkshire, LS29 OQY.

Arnold Pacey

Part 1
HISTORY FROM THE MUSEUM

THE LOCAL HERITAGE IN SCIENCE REPRESENTED IN MUSEUM COLLECTIONS

Alison C. Armstrong
(Natural Sciences Curator, Bradford Metropolitan District Council Museums, Cliffe Castle)

Many of you will already have used museum collections and will know that researchers are welcomed. In this museum there are reference collections for petrology, palaeontology, mineralogy, botany (herbaria), entomology, and conchology. (For more details of the natural science collections in Yorkshire and Humberside, see website **www.man.ac.uk/fenscore**).

Today these collections still have a scientific role and provide researchers at all levels (science experts to student projects) with a valuable resource which is otherwise unavailable. The large fossil amphibian on display, discovered in 1868, was removed for research in the 1980s, and yielded the first middle ear bone and complete shoulder girdle known to science from this group of amphibians. Collections help not just with learning but with identification, for comparing species losses and gains in the area, and for DNA and other sampling. The collections represent part of the natural heritage. However, another dimension is the social history of collectors, and their contribution to scientific thought. This is a field that was ignored until recently, but is now of increasing interest, and indicates another way of using the collections.

So where did the older collections inherited by the museum come from, and why were they made? Collecting was a key part of scientific activity during the eighteenth and nineteenth centuries, and the oldest part of our collection goes back to John Dawson's interest in minerals during the late eighteenth century. Fieldwork, collecting and recording were central to the work of several local scientific societies by 1840. The Yorkshire Naturalists' Union, founded in 1861, had a strong geology section, and in the West Riding, a society formed to study coal evolved into the Yorkshire Geological Society. In Bradford, the Mechanics' Institute (from 1825) and the Philosophical Society (from 1839) were both active in collecting geological and natural-history material. In Keighley, a Mechanics' Institute had a geology museum by 1850.

There was remarkable enthusiasm for geology in the mid-nineteenth century which led to the formation of large collections. But these were difficult for voluntary societies to house and care for once the high tide of this enthusiasm had passed, and much of their material gravitated to the public museums founded at the end of the century. So Cliffe Castle's strong geology collections reflect a rich vein in nineteenth-century science and social history.

Bradford Metropolitan District Council was established in 1974, and amalgamated three former council museum services. The present Cliffe Castle collections were formed by combining material from Ilkley, Keighley and Bradford museums, and it is worth giving some history for the two latter. A public museum began in Keighley during the 1890s and acquired several geology and natural history collections (including Jesse Miller's collection of insects, and the Jabez Bancroft collection of stuffed birds). A man named Hutchinson was employed in 1899 to set up exhibits. Some of his dioramas, influenced by the Booth Museum at Brighton (with his signature visible in the bottom corners) continue to display birds effectively, and are

of interest in showing how museum display methods and philosophies have changed over more than a century.

S.L. Mosley, curator in the early years of the twentieth century, took a lead in opposing the killing of birds to provide specimens for scientific study and display, and re-arranged the Hutchinson display cases so they were less crowded. He enriched the museum both by his acquisitions and his enlightened educational policies. When he left in 1910, an extra 16,200 specimens were added from his private collection.

In Bradford, the Philosophical Society built up a geological and natural history museum during the 1840s and '50s. It had become impossibly overcrowded with exhibits by 1866, when new premises were sought. In 1879, a public museum opened, and soon acquired the Philosophical Society's collections. Then Lord Masham gave the splendid Cartwright Hall Museum, purpose-built as a museum between 1898 and 1903. It was named after Edmund Cartwright, inventor of the power loom and symbolic of the textile business in which Lord Masham's fortune had been made. In the grounds of Cartwright Hall was a botanic garden with representative samples of Pennine geology, and of associated plants, though all of this, apart from a replica waterfall is now destroyed.

While the scientific collections in the Bradford and Keighley museums tell us much about the development of local scientific societies and public institutions, many collections were originally assembled as the private collections of individuals such as James Ellison and Joseph Dawson, previously mentioned. Dawson's own personal catalogue for his collection, dated 1810, includes notes on his reading in the scientific literature of the time - Thomas Thomson's book on chemistry, for example, and articles debating the merits of Werner's theory of rock formation. Study of the history of the collections can thus bring insights into the history of scientific ideas. It can also bring in other aspects of social history, as one notes how Dawson worked with Samuel Hailstone in a first attempt to establish a philosophical society in Bradford. Hailstone also had a collection of minerals, and a connection with academic geology at Cambridge, and probably exchanged specimens as well as information with Dawson.

Among later generations of people active in science, our collections and background documentation can shed light on:

- ▶Louis Compton Miall, FGS, paid curator at the Bradford Philosophical Society from 1864, and author of books on geology and botany. He later moved to Leeds and played a distinguished part in the development of the university there.
- ▶William Firth, a coal miner who collected fossils and in 1868 discovered the spectacular fossil amphibian of Carboniferous age mentioned earlier.
- ▶Arnold Lees, author of the definitive botany of West Yorkshire and pioneer of an ecological approach to the subject,
- ▶Abraham Shackleton (1831-1916), a lichenologist and meteorologist.

As museums have developed over the last 150 years, not only has there been a shift from nineteenth century displays of rows of objects in crowded cases towards more visually attractive, and interactive displays, but there has been a shift in the focus of interest from natural history to social history. Cliffe Castle's natural history collections have scientific importance but also record the social history of our area by representing the work of individuals and institutions who were active in natural science. Historians of science will find much material here for new approaches in their research, and their findings can in turn help us interpret the various kinds of science and history the museum represents.

WORKING WITH MUSEUM OBJECTS

For this session the meeting divided into small groups for the following activities:

Geology. In the museum store, in the basement at Cliffe Castle, we saw how mineral specimens are arranged for use as a scientific reference collection. We also observed that many specimens have a series of different labels documenting their history as museum objects. Thus the earliest label may show how a specimen belonged to a private collection; then there might be a label showing how it was recatalogued by the Bradford Philosophical Society; finally it would be relabelled again on coming into the present museum. Thus a fossil not only has a geological history going back millions of years, but also a museological history going back a century or more, which can be interpreted in terms of the social history of science in the region.
Another use of the collection for historical research was demonstrated by comparing fossils in the collection with illustrations prepared for Dr. Martin Lister, c.1670. This could be a check on the accuracy of his observations and his comments on the provenance of the fossils.

Botany. Seven or eight dried plant specimens from a herbarium were made available by the museum for close inspection in the classroom, together with water-colour paintings made for record purposes representing the same plant species. As with fossils, it became apparent that although each specimen had its own natural history and ecology, it could also be related to the social history of science in our region. Bradford Museums hold a herbarium that was assembled by Arnold Lees (1847-1921) when he was working on his great book on the flora of West Yorkshire, which was published in 1888. Since Lees was careful to document the records of each plant made by earlier botanists, going back to John Ray's visits to Yorkshire in the 1660s and some even earlier records, his work and his herbarium can be used as the starting point for a more general social/historical study

Astronomy was represented by two showcases exhibiting brass and wooden instruments made by Abraham Sharp (1653-1742), the Bradford man who worked for a while at Greenwich Observatory. Close examination of his quadrants shows how he engraved the brass himself. In one case, we observed how he improvised an instrument by attaching brass plates to a wooden carpenter's rule, and in another, how he made geometrical models for use in teaching his pupils. This gave us a sense of Sharp's skill as a craftsman as well as his working methods as a scientist, all important for understanding the wider context of astronomy.

HENRY POWER (1623-1668) AND THE TOWNELEY HALL GROUP

Visits outside the museum

In the middle decades of the seventeenth century, Towneley Hall near Burnley was a lively scene of research in astronomy, meteorology and many other subjects. Richard Towneley (1628-1707) and other members of the Towneley family were involved, but their activities attracted many others, including the future Astronomer-Royal, John Flamsteed, who visited Towneley Hall from London during the early 1670s, and a physician named Henry Power from Elland (near Halifax).

Towneley Hall is now a museum, and Henry Power's house at Elland survives as a private residence. We visited both buildings by coach during this meeting, and also saw the sites of experiments with barometers which Power carried out on the steep hill that overlooks Halifax, and later repeated with Towneley on Pendle Hill.
Even though these men's instruments do not survive in a museum, our visits to places where they worked offered something of the same experience as handling museum objects. For example, we understood Henry Power better for seeing the rooms in which he worked and the hills up which he carried his barometers, just as we had a clearer impression of the botanical work done by Arnold Lees by seeing his herbarium specimens, or of the Bradford Philosophical Society by seeing how they labelled and catalogued their geology specimens.

The museum at Towneley Hall is disappointing in its presentation of the Towneley family's scientific heritage, but even so, seeing the family chapel, and the priceless exhibit on the Whalley Abbey cope reminded us of the Towneleys' unwavering Catholicism throughout the period we were studying. Also, the two low towers which are part of the building demonstrated the height of a "water barometer" which Towneley constructed against one of them in the 1650s.

As to Henry Power's house at New Hall, Elland, this wonderully atmospheric building, already quite old when Power moved in, makes an impression as the home of a country doctor who needed a still-room and laboratory in which to make up medicines for his patients. His alterations to the house, dating from 1656-7, gave him a well-lit room for his pioneering work with miscroscopes, and also indicate his taste in architecture. They prompt thought about the relationship of science to architecture at a time when Christopher Wren was about to become a professor of astronomy, but had not yet emerged as an architect.

Henry Power's engaging book, Experimental Philosophy (datelined from New Hall 1661, published 1663) described three kinds of experiment, using microscopes, barometers and magnets. The best material is on microscopy, whilst the section on barometers describes the experiments on Halifax Hill and with Towneley on Pendle. The book was written while Power lived in this house - but was printed in London by a printer who was simultaneously beginning work on Robert Hooke's book Micrographia, with illustrations by Wren.

Studying this book in a library, one thinks mainly of its scientific content. Seeing the house in which it was written awakens thoughts about the social history of the work Power describes, and how it fitted into a busy life visiting patients in their homes over a wide area, which required long journeys on horseback.

Part 2
INSIGHTS FROM UNIVERSITY RESEARCH

LADY MARGARET CLIFFORD AND ALCHEMY

Penny Bayer
(University of Warwick; also Museum of the History of Science, Broad Street, Oxford)

Lady Margaret Clifford (1560-1616; also known as Lady Margaret Russell, Countess of Cumberland) invested in mining and practised alchemy in a life that challenges stereotypes about gender restrictions. She was the wife of George Clifford of Skipton Castle and is emerging from current research as one of the most remarkable individuals in the history of our region.

We need to think back 400 years to a time when the boundaries of science, magic and religion were blurred. Put very simply, the educated alchemist, who was often a vicar, physician or philosopher, believed the material world to be transmutable by human beings, who could mediate between spirit and matter.

The first clear evidence for Lady Margaret's active exploration of the natural world is very practical. From 1589 to 1601, she initiated a number of mining projects, some possibly with Thomas Proctor of Warsill near Ripon; she wrote to Lord Burghley in 1594 asking for a patent for using sea coal, and to Sir Robert Cecil in 1595 regarding another patent for iron smelting. She also had a business partnership with Richard Cavendish (died 1601), MP, translator, and writer, and with him held leases on lead mines in Glusburn. Cavendish had an interest in alchemy, and in 1590 visited John Dee and borrowed a book on the subject. It is easy to see how somebody involved in lead mining should also be interested in the alchemical idea that lead might be turned into its perfected, valuable and natural state, i.e. gold.

Other evidence comes from a painting known as the "Clifford Great Picture" commissioned by Lady Margaret's daughter, Lady Anne Clifford, in 1646. This portrays Lady Margaret with four books: a Bible, a psalter, an English translation of Seneca's stoic philosophy, and a hand-written book of "Alkumiste Apstracios". Elsewhere, Lady Anne described her mother as a "lover of the Study and practice of Alchemy, by which she found out excellent Medicines, that did much good to many". Lady Anne does not mention her mother's interest in mining and metals, but goes to some length to associate Lady Margaret's alchemy with healing, inner virtue and good works. Certainly, alchemy was never just a matter of dispensing medicines or doing experiments: it always had a spiritual dimension. From about 1596, Lady Margaret's name appears quite often in contexts that refer to spiritual alchemy, for example in dedications to books.

However, the best evidence of Lady Margaret's alchemical practice is a letter written by Lord Peregrine Willoughby de Eresby (1555-1601), a soldier and diplomat who was Governor of Berwick-on-Tweed when he wrote in 1599 or 1600. Using alchemical terms in an elegant literary way, he clearly describes Lady Margaret carrying out an alchemical experiment with her own hands. She takes an ordinary metal, possibly a minute portion of silver or gold, heats (digests) it, probably with other ingredients. Then she brings the metal to life, which very often means that the alchemist puts a substance they regard as soul into the mixture. She then "proiects that rectefied oyle... upon an old bowed plate of Saturne" (i.e. of lead), which has the

effect of making the lead look like gold.

The final piece of evidence is a manuscript found in Skipton Castle muniments room which is now in the Cumbrian Archives at Kendal. The cover provided for it when it was found in the 1920s was labelled: "Receipts of lady Margaret Wife of George, 3rd Earl of Cumberland for Elixirs, Tinctures, Electuaries, Cordials, Waters, etc." It may be that this is the MS. book which appears in the Clifford Great Picture, but we cannot be certain. I have done a lot of work on this manuscript, and have studied the handwriting (with help from Heather Ummel, palaeographer, which is gratefully acknowledged), and I believe that most of the writing is in the hand of an alchemist called Christopher Taylour.

I think it plausible that this manuscript was compiled by Taylour during the 1590s under Lady Margaret's patronage. It is a delight for the historian of alchemy because it describes a European network of intellectual alchemists. It refers to manuscripts that were in circulation in France and Germany in the 1590s, and to a circle associated with Edward Kelley, then living in Prague. A Mr. Digges is also mentioned, possibly Thomas Digges the mathematician, and several unknown English men and women carrying out technical alchemy, and I'd like to tell you their names in case you may recognise them from local knowledge. There's honest Mr. John Remis, Mr. Eden, Mr. Crompton, Mr. John the Goldsmith, John Ritell, and Robert Clarke, whose name appears a lot. Two women alchemists are mentioned, though not properly named - there's a gentlewoman of York, and an anonymous "daughter".

Lady Margaret had many connections through family and friends with the most famous English alchemist of the period, John Dee, and it is of great interest in this manuscript to find several references to Lord Willougby. Christopher Taylour, the probable compiler, also had his own links with the international circle centred on Kelley and Dee, but his precise identify is hard to establish. There was a Christopher Taylor of Yorkshire who matriculated from Oriel College, Oxford, in 1585, aged 20. Another Christopher Taylor or Tailer, an older man, was vicar of Bradford until the 1590s (his will is dated 1598).

If we accept that this manuscript book represents Lady Margaret's work and opinions, we can go further than just saying that she was a practising alchemist; we can also claim that she was at the cutting edge of contemporary European alchemy, concerned with work on metals and medicines, and involved in critical discussion on a wide range of complex alchemical books and manuscripts.

JOHN WEBSTER (1610-1682): THE SEED OF FREEDOM

Charles Webster
(Fellow of All Souls College, Oxford)

John Webster, born near Coxwold (North Yorkshire), but more closely associated with Clitheroe (Lancashire), is well-known to local historians in our region, and among historians of radical religion. But with certain honourable exceptions, he is neglected among historians of science. Had he been a Fellow of the Royal Society, I suspect that he would have been applauded as one of the leading scientists of his age.

Little is known of Webster's early life and education except that he acquired a reading knowledge of Latin and was taught chemistry by a Hungarian immigrant named Johannes Hunyades (or Hunniades). We also know that Webster was curate at Kildwick-in-Craven between 1634 and 1637, and that while there, he showed open sympathy with the Grindletonians, a separatist group within the Church of England who formed a natural platform for such further separatist developments as Quakerism. Roger Brereley, the chief figure in this group, began to have trouble with the church courts in 1635, and soon Webster was in trouble too, and was deprived of his curacy.

The emphasis of the Grindletonians was on the capacity of every individual to achieve insight into the truths of religion through the medium of their own Inner Light. This liberated them from the disciplines of church, clergy and inherited dogma, hence the quotation that gives this talk its title, which comes from John Webster's own account of William Erbery: "...there was a seed of freedom in his spirit.."

Webster probably met Erbery when they were colleagues as army chaplains during the Civil War. After the war, Webster was inevitably drawn to London, where his spiritual and scientific activism was at its peak in 1653, at the time of the short-lived "Saints' Parliament". This was the occasion for his first publications: they were sermons in which he spoke for the separatist party. After Erbery's premature death in 1654, Webster got down to editing his writings, thereby making available works that are said to have influenced John Bunyan and William Blake. The writings of Erbery and Webster are also cited as having been used by the founders of the Quaker movement.

The book Academiarum Examen (1654), advocating reform of the universities (and more teaching of practical science and chemistry), is the best-known of Webster's writings, largely because it provoked a number of replies, notably from John Wilkins and Seth Ward at Oxford. Conventionally it is assumed that Webster was put in his place by these two. But Perry Miller, pioneer of intellectual history, described Webster's book as a "most important expression of the new scientific outlook":

> "It is clear, practical in most of its suggestions, and comprehensive. Many of the great scientific discoveries in his own and the preceding age find enthusiastic acceptance and frequently energetic defence in his volume. Copernicus, Brahe, Gilbert, Galileo, Kepler, Harvey are heroes in his eyes. He read Descartes with interest and approval. But to Bacon above all he paid whole-hearted allegiance..."

Dissolution of the Saints' Parliament in 1653 marked the beginning of a decline in the fortunes of Webster and his allies. His response was to return to Clitheroe and withdraw completely from religious and social activism. He practised quietly as a physician, and did not hurry to publish his next book. When it did eventually appear, Metallographia carried a dedication to Prince Rupert which some have interpreted as showing that Webster regretted the error of his earlier, radical ways. But the content

of Metallographia, much of it probably compiled in the 1650s, was the logical outcome of the principles advocated in Academiarum Examen. It attempted to evolve a new body of chemical theory, and also gave sufficient practical information to stimulate utilitarian developments in metal-working and mining. It is consistent with the scientific output of the Hartlib circle that dominated applied science during the 1650s, and reflects the Paracelsianism and Helmontianism of that decade.

So Metallographia can be seen as a statement of Webster's continuing affiliation with the kind of science associated with religious and social radicalism, at a time when it was being discarded in favour of the mechanical philosophy. I suspect that Webster was thinking of the analogy with himself when he said that Paracelsus was "much wronged though most experienced" (p.34) and one interpretation of the book is that it contains an attempted reconciliation between Paracelsian ideas and corpuscularian thinking. How much influence it had is uncertain, but Dobbs concludes that "Newton's copy of Webster's book is heavily dog-eared", and may well have been "the immediate stimulus" to Newton's private writings on "processes in Vegetation".

Webster's final work, The Displaying of Supposed Witchcraft (1677) confronts a subject of keen debate among intellectuals. It was was also a topical issue in local affairs, for Pendle had been a centre of witchcraft suspicions. Webster was a fervently partisan, determined to unmask all pretensions to witchcraft as fraud or disease. He mobilised his deep understanding of the literature of spirituality and Paracelsian natural magic to undermine any residual confidence in witchcraft belief.

Leading figures in the Royal Society had set themselves up as experts on this subject. In particular, Joseph Glanvill published Some philosophical considerations touching the being of witches in 1667. I have argued that the work of Glanvill and his allies was not an insignificant sideshow, but Hunter regards this flirtation with witchcraft belief as an aberration. Accordingly he thinks that progressive elements within the Royal Society welcomed Webster's book as a more suitable reflection of their outlook. Whatever the true state of opinion, Webster's book carried the day. Of course, it was not solely responsible for the collapse of confidence in witchcraft beliefs, but it provided a definitive statement of the case. The book was translated into German and was important in the German anti-witchcraft movement. It also became the model for the book by Francis Hutchinson, an Anglican bishop, which held the field in the eighteenth century. Webster must have taken considerable pleasure in finding that the ideas of Paracelsus had served him so well, and that advocates of the mechanical philosophy had been made to look reactionary and out of touch.

I hope that this short review is sufficient to demonstrate that the little-known figure of John Webster, operating in a situation of disadvantage and some obscurity, was capable of a consistent and inspiring intellectual contribution. The two major books of his maturity are sufficient to establish his reputation. Metallographia is the best-informed book in its field written before 1700. The book on witchcraft looks like an unlikely companion piece, but we must remember that this was an issue of absorbing interest to intellectuals of the period. Earlier, Academiarum Examen was the most effective piece of polemic produced against the academic establishment at any time during the seventeenth century. His religious writings bear comparison with the best works produced within English Puritanism. Doubts about Webster arise from his polemical style, but hot-blooded debate was the norm at this time, and his writing shows a firm command of a wide range of sources. A catalogue of his personal library survives, and shows that he possessed about 1600 volumes, of which 40 per cent were on science and medicine. This compares with the 500 books possessed by Henry Power of Elland. The evidence of the Webster catalogue is that he made his books available to a local community of like-minded individuals, and it is likely that others also opened their personal libraries, so that in science and medicine at least,

regional enthusiasts were not at a disadvantage compared with their counterparts in London.

He was not, of course, a case of isolated genius. The collectivity of the Grindletonians provided the initial catalyst. This is just one reason why Christopher Hill was absolutely right in his intuition that the village of Grindleton, "lying at the foot of Pendle Hill, George Fox's Mount of Vision, should perhaps have a more prominent place on the map of seventeenth-century England than is accorded to it" (Hill, The World turned Upside Down, p. 68)

THE HARD PROGENY OF THE NORTH: GRAMMAR SCHOOLS AND SCIENCE

Robert Fox
(Professor of the History of Science, University of Oxford)

Around 1800, men from northern England who studied at Cambridge had acquired something of a reputation. It was said that "the hard progeny of the north are usually the profoundest in mathematics and philosophy". Taking the Lake Counties and Pennines together, there was Adam Sedgwick (geologist), William Whewell (a carpenter's son who became Master of Trinity), Richard Watson (professor of chemistry before moving on to become Bishop of Llandaff), and Edward Frankland (chemist).

Many of the northerners never lost their accents (e.g. Sedgwick and Whewell), and did not always integrate well into Cambridge life. Some also gained a reputation for obstinacy, as did Sedgwick, who insisted on keeping a dog in College, against all the rules.

One thing these men had in common was a debt to local grammar schools, which offered a free education in Latin and Greek, but with mathematics and other subjects available only if they were paid for. The schools were usually quite small - there were 55 pupils at Bradford Grammar School c.1818 - and often had just one master, helped by an usher or writing master. They varied greatly in financial resources, as can be seen by the range of salaries paid to masters. These varied from only £30 per annum at some of the smaller schools (e.g. Threshfield in Wharfedale), to £160 and £500 at Bradford and Leeds Grammar Schools respectively.

The schools were a strange anachronism, teaching a syllabus established in the sixteenth century. A much-used textbook was Lilley's Latin Grammar, first published soon after 1500, and in continuous use until 1875. Teaching followed a gruelling routine, with lessons starting at 6 a.m. and breakfast at 8 a.m. (Many boys would be boarders). This was not an inspiring approach to learning, but there were two things that made all the difference: