Did They Do Right?
Murder & Mystery
World's Heritage
Lost Gods of Easter Island
Alternative Nepal
Mt Bardon Volcanism

Edwin Lutyens
Meteor Impacts & Life
A Bit Less Green
Mantle Convection
Wintering Gulls
Origins & Innovations

Annual Report
## CONTENTS

### DO THEY DO RIGHT?
- Presidential Address by Ormond K. Smyth  
  
### SIR EDWIN LUTYENS: ARCHITECT OF SYNTHESIS
- by Grant Pitches  
### MURDER AND MYSTERY: THE CRAFT OF THE DETECTIVE STORY
- by Baroness P.D. James  
### METEOR IMPACTS AND THE HISTORY OF LIFE
- by Professor Simon Conway-Morris  
### PROTECTING THE WORLD'S HERITAGE DURING ARMED CONFLICT
- by Professor Patrick Boylan  
### ON BEING A BIT LESS GREEN
- by Dr John Emsley  
### SPECULATIONS ON THE ROLE OF MANTLE CONVECTION IN CONTINENTAL RIFTING BASED ON SEISMIC TOMOGRAPHY EXPERIMENTS
- by Paul M. Davis  
### THE LOST GODS OF EASTER ISLAND
- by Sir David Attenborough  
### ALTERNATIVE NEPAL
- by Dr Franklyn Perring  
### WINTERING GULLS IN VICTORIA PARK, LEICESTER
- by Dr D.A.C. McNeil  
### MOUNT BARDON VOLCANISM
- by Dr M.J. Le Bas  
### ORIGINS AND INNOVATIONS: 200 MILLION YEARS OF VERTEBRATE EVOLUTION
- compiled and edited by Drs R. Aldridge & Mark Purnell  
### INTRODUCTION
  
### TALES OF TEETH AND TAILS by M. Paul Smith  
### WHAT MAKES A VERTEBRATE? by Peter W.H. Holland  
### CONODONTS - THE SOFT TISSUE EVIDENCE by R.J. Aldridge  
### THE NATURE OF THE FIRST VERTEBRATES by Mark Purnell  
### EVOLUTION OF TEETH AND SCALES by Ivan J. Sansom  
### NATURE READ IN TOOTH AND CLAW by Peter Forey  
### BONES AND TEETH IN LUNGFISH by Moya M. Smith  
### SMALL STEPS AND BIG LEAPS by Per E. Ahlberg  

Annual Report and List of Members  

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DID THEY DO RIGHT?

Presidential Address delivered by Ormond K. Smyth, J.P. M.A. M.I.P.R.

Leicester Literary and Philosophical Society has by its invitation to me to follow in a long line of distinguished and accomplished people who have held the office of President, conferred upon me an honour of which I am not worthy. It is possible that in times past others who have found themselves in my position have made similar disclaimers about their own merit; I tell you, not one has ever made them with such heartfelt conviction.

I have however the consolation of knowing that the first President of the society was likewise a Scot who had made his home in Leicester. He was the Rev. Andrew Irvine, Vicar of St Margaret's. I call him the first president, since that was how he was described in the Press in 1836. In fact, this society must be unique in its defiance of the rules of mathematics, not to mention semantics, in that it had no fewer than three "first presidents".

The circumstances are these: when the society was founded in 1835, the members decided to invite Sir Henry Halford, who owned Wistow Hall and who had been physician to King George IV, to accept the office of president. After some persuasion, he did so, on the understanding that he could undertake no duties; however, he would be regarded as president if he was ever able to attend a meeting. In the event he never did, and the duties were fulfilled by a "Chairman pro tem", a Dr George Shaw who had been a member of one of England's first Lit. and Phil. Societies in Manchester (founded 1781, by the way), and had brought the idea with him when he moved to Leicester.

The society struggled through its first year with 60 members paying one guinea each. It was on the appointment of Mr Irvine in 1836 that it came to the attention of the Leicester Journal, a fore-runner of the Leicester Mercury, which stated in lofty editorial tones:

"We cordially approve of the Institution of which Mr Irvine is President, as one calculated to refine the taste, correct the judgment, and raise the moral and intellectual character of our townsmen".

That, my Lord Mayor, ladies and gentlemen, is what we are here for! It must be true: it was in the paper.

The import of the title "Did They Do Right?" is its reference to another of these "might have been's" of history. You will no doubt be relieved to know that you will not at the close be asked severally or corporately to provide an answer. Moreover, I would like to make it clear that in posing the question, I am not implying that I think the answer should be, No.

I do not myself believe that you can fairly ask moral questions of history, or of historical figures who are not able to justify themselves, but you can have some fascinating and harmless fun wondering what might have happened or not happened if the unfolding pattern had taken a different shape: moreover, would it not have been a betrayal of all my journalistic instincts and experience if I had not taken the opportunity to point an accusing finger at someone?

A literary example of the "might have been" practice is in a novel, somewhat uncharacteristic of its author Kingsley Amis, called The Alteration, winner of the Campbell Memorial Award in 1976. Ostensibly the story of a young boy soprano in the service of the Church, it is set against a background that supposes that the Reformation did not succeed in Europe, thus barring the way to much scientific advancement, including the harnessing of electricity, the internal combustion engine, and so on.

What you are about to hear might just as well, and perhaps more accurately be entitled "The World's First Factory".

Up to the latter half of the 18th century, the bulk of the working population of England and Wales was engaged in agriculture of one kind or another, chiefly the production of food and of raw materials for clothing, wool, cotton and linen. Such items of furniture, silverware and the like that have lasted to the present day were made in small workshops mainly by individual craftsmen of varying degrees of skill.

In Gregory King’s oft-quoted National and Political Observations, first published in 1688, he recorded a total of 240,000 artisans and craftsmen out of a total population of 5.5 million. Labourers, servants, cottagers and paupers accounted for over 2.5 million.

There was also a certain amount of mining, for coal and such metals as iron ore, copper, tin and lead, and in small scattered units these were fashioned into the tools necessary for everyday living. In textiles, wool was the predominant material, as Leicestershire well knew, but although there were in several places quite sophisticated centralised units for marketing the finished materials or goods, the actual units of production were small, scattered, mostly household units, cottage industries, to be precise. As late as 1779, the capital value of a domestic clothier’s equipment was less that £10, "equal to the joint value of the spangled cow in the barn, the clock in the house, and the one large Bible in the parlour", as A.S. Turbeville put it in his 'Johnson's England'.

Lack of capital, and lack of commercial enterprise ensured that by and large such a situation remained unchanged over centuries. Success in any business went therefore to whoever could organise the production and distribution, the cloth merchant, or putter-out, as he was sometimes known. The disadvantages of such a system are to us obvious: none of the benefits of mass production or economies of scale could be achieved with such cumbersome methods of manufacture.

But there were some advantages too, notably the nurturing and preservation of the family unit in society, a treasure still spoken of so highly by some politicians and moralists today. As goods were produced on domestic premises, the process habitually included
the whole family, infants not excepted, though of course they were under the watchful eye and care of their parents and siblings. John Saxon, who recalled starting work as a weaver at the age of 11 in his father's cottage, described the work as "irregular, sometimes none at all for a day or two at the beginning of the week, and then at the latter end of the week, they made long days." Earnings were low and there was widespread poverty as King's figures would indicate. However such evidence as we have shows that the general health of the people was good, accepting the limitations of medical knowledge, especially relating to public health, of the time.

Into this idyllic rural setting, sketchily drawn I must admit, there stepped a group of men, with whose names we associate the term Industrial Revolution; we should also link them with a Domestic Revolution, since as a result of their activities, the daily life of huge numbers of the population was irrevocably changed, first in England and subsequently throughout the world.

Among these men was Richard Arkwright, and it is he who has the prime claim to be the creator of the world's first factory.

Arkwright began as a barber and wig-maker in Preston. According to one contemporary, he was "always thought clever in his peruke-making business, and very capital in bleaching and tooth-drawing". He was also a man with a reputation for ingenuity with machines, and around 1755 he was experimenting with the spinning of cotton by means of rollers, seeking a device that would be sensitive enough to imitate the action of the hand-spinner.

A legend, probably apocryphal, has it that he was spending so much time on his machines that he was neglecting his main business, and that in a tantrum his wife smashed one of his models, and thus might have changed the whole course of history.

Since the invention of the fly-shuttle in 1733, weaving of wool, cotton and linen, or a mixture of any two, had been made simpler. Cotton itself was increasingly popular, but its progress was hindered by the difficulty in producing quantities of stable, continuous thread. This was the problem that Arkwright solved with what later became known as the water-frame. Many theories have been put forward to explain his success, including the unlikely tale that he got the idea from overhearing a sailor whom he was shaving describe a machine he had seen in China. It is known that he had a number of collaborators and colleagues, but it is also well established that the finished and successful device had two essential Arkwright features: the critical distance between the two pairs of rollers that drew out the cotton, relative to the staple length of the fibre, and the weighted rollers that made for an even yarn.

It was with this machine that Arkwright left Preston in 1768 and made his way to Nottingham, then a centre of framework knitting and stocking production. For some three years he sought various partners and financial backers to develop his invention and put it into use. The notion of installing several frames in one central premises does not appear to have occurred to any one person as a sudden flash of inspiration, certainly not to Arkwright.

A mill for the production of silk had been set up in Derby as early as 1702, and had it succeeded, that is what might have claimed the title of the world's first factory. Arkwright's venture, where the motive power was to be provided by a team of horses walking round a central capstan, was originally planned for Nottingham,

and that city might also have laid claim to the title.

However, in 1771, Arkwright and his group moved to Cromford, near Matlock, and founded the enterprise that was within a very few years to make him one of the richest men in England and to secure his place in history. Years later he said that he chose Cromford as "a place affording a remarkable fine stream of water, situated in a country very full of inhabitants", adding that vast numbers of them, including small children, could be employed in his works. It has been supposed that he had become familiar with the place in the travels that he made in search of hair for his wigs. At about this time, many of the lead mines of Derbyshire were becoming exhausted, and he may have judged that unemployed miners and smelters formed a ready pool of labour.

If you visit Cromford today, and I hope you will, one of its most awesome sights, rainfall permitting, is the quiet power of the water course; not only in the mill complex itself, which still stands though much altered and of course not in operation, but beyond the village, behind the old corn mill now adapted as a Venture Centre by the Arkwright Society.

There is, to my mind, a certain irony in the fact that, having waited so long, the world got its first factory thanks to water power, when only a quarter of a century later the steam engine developed by James Watt and Matthew Boulton came into widespread use. Indeed, from the beginning, Cromford's days were necessarily numbered, and 70 years after it opened it ceased production altogether, as it was out-moded by steam-driven plants in Lancashire, Yorkshire and Scotland, nearer the power source of coal, and nearer the home markets and the ports that opened up markets overseas.

Passing through Cromford in 1843, Thomas Carlyle described the scene: "This black ruin looks out, not yet covered by the soil; still indicating what a once gigantic Life lies buried there! It is dead now, and dumb but was alive once, and spake . . . Here was the earthly arena where painful living men worked out their life-wrestle -- looked at by Earth, by Heaven and Hell . . . How silent now . . ."

But between its origins at Cromford in 1772, and 1830, the cotton spinning and weaving industry nationwide grew to a point where it employed over 237,000 operatives. Cromford Mill earns however its place in history, not just from the fact that workers now came for set hours to a central point of production, with a common power source, but also because with that power provided nonstop for 24 hours, day and night, Arkwright was able to introduce the shift system, and other features of factory life with which millions and millions have become familiar down the years.

With his second, and perhaps even more significant, invention, the rotary carding engine, which, according to the patent which he took out in April 1775, covered no fewer that ten different machines, he perfected a system that in a single production line under one roof could convert raw cotton into cotton thread.

Before his death in 1792, Richard Arkwright, the poor barber from Preston, had become an exceedingly wealthy man, whose name is still honoured, if that is the word, in many parts of the world. There is even to this day a suburb of Dusseldorf called Cromford, where a German industrialist called Brugelmann, whose father had worked with Arkwright at Cromford in Derbyshire, set up a water-powered cotton mill in 1854. Today, at the Cromford Mill, currently being restored and adapted as an
educational centre by the Arkwright Society, visitors from Japan, for example, often knew more about Richard Arkwright's place in industrial history than Derbyshire natives.

During its first 20 years, the Cromford Mill carried on production round the clock. "The Arkwright mills," it was said, "are worked night and day for at least 23 hours, with one hour allowed for examining, oiling and cleaning the machines."

William Bray, a visitor in 1776, noted that the mill hands worked by turns night and day, with the spinning being done by night and the other processes during daylight hours. Describing the changeover of shifts, John Byng wrote in 1790: "I saw the workers issue forth at 7 o'clock, a wonderful crowd of young people. A new set then goes in for the night, for the mills never leave off working. These cotton mills, seven stories high, and filled with inhabitants, remind me of a first-rate man-of-war, and when they are lighted up, on a dark night, look most luminously beautiful." Workers were allowed up to one hour for lunch, when it can be supposed that some of the frames would be idle.

Arkwright's son, also called Richard, himself described the arrangements for breakfast and tea.

"As to breakfast, he said, it is very irregular. In the summertime the bell rings for breakfast at half past eight; those who go to breakfast, which includes the workmen but not the spinners, go and stay half an hour. There is a room called the dinner-house, in which there is a range of hot plates or stoves, much the same as in gentlemen's kitchens; the mothers, or the younger sisters of the hands employed, bring the breakfasts into this room, probably a quarter of an hour before the bell rings. As soon as the bell rings, a number of boys, perhaps eight, carry those breakfasts into the different rooms in the factory; those who come first may receive their breakfasts probably in two minutes: those who come later may not receive it for a quarter of an hour, so that possibly some of the hands may have eight and twenty minutes at breakfast, while others cannot have more than fifteen, never less.

"In the afternoon the bell rings at four, and they are served in like manner, but very few have their refreshment, probably not one in five, I should think ...

It is understandably difficult for us today to appreciate fully the scale of the transformation of life brought about by the appearance of such a structure in a quiet corner of Derbyshire. The first mill was five stories high: it is doubtful if many of the people living around had ever seen any building so huge, except for one or two churches or the stately homes of the wealthy.

More drastic than the visual impact, however, was the change wrought in their lives. Almost overnight, the daily routine, the social life, the personal freedom, even the eating habits of thousands were transformed. In the succeeding quarter of a century or so, the thousands became millions, and a pattern of work was set that has endured up to the present day. Such a revolution could scarcely have been achieved without some disadvantages, only two of which will concern us here.

The emergence of the factory system gave rise to a social problem that very quickly became a dominant issue for reformers, doctors and politicians: child labour. It is a problem not entirely solved today, though the reasons for its persistence may not be the same as those which applied in the late 1770s. The employment of children in the mills appears to have begun in two distinct ways. Firstly, as whole families had customarily been involved in the manufacturing processes in their homes, it was in the beginning the practice to engage families to work in the mill. Thus, very young children, six years old and even younger, were often employed, not by the mill owner directly but by their parents to help them.

"The way in which many of these infants are first employed is to pick up the waste cotton from the floor," reported the reformer Robert Owen, giving evidence to a Parliamentary Commission on Children in the Manufactories, led by Sir Robert Peel. "They go under the machines where bigger people cannot creep, and the smaller they are the more conveniently they can go under the machines."

It is possible that to many of the youngsters it seemed like a big adventure, with none of the overtones of exploitation that later attached to the employment of minors. Henry Holdsworth said that he knew of children carrying up their parents' tea in the afternoon, being kept by the parents for half-an-hour or an hour to assist in what they called "wiping down", clearing dirt and dust from the machines. These children, he pointed out, were employed by their parents, not by the mill owner.

Inevitably, of course, they would gradually be introduced to the simpler parts of the manufacturing process, and in the course of time be taken-on as full-time hands.

At this stage, there appear the possibility of an element of exploitation. As one writer commented: "The spinning-men or women, whichever they are, have the privilege of employing children of their own selecting; and if they can get a child to do their business for one shilling or one shilling and sixpence, they will take that child before they will give three, four, five, six or seven shillings to an older one."

The second source of juvenile labour consisted of boys described as apprentices, who were in fact pauper children who had little or no choice over their work or conditions, and who were quite often farmed out by Poor Law local authorities, many of them in London, to other parts of the country.

"In most parts of England," Robert Southey was told on a visit to Manchester in 1802, "poor children are a burden to their parents and to the parish. Here, the parish, which would else have to support them, is rid of the expense. They get their bread almost as soon as they can run about, and by the time they are seven or eight years old, bring in money.

There was an additional factor that played a part in the encouragement of child labour. The earlier debut of such machinery as Hargreaves' spinning jenny and (later) Crompton's mule had, as is well known, not met with universal approval, and even some years later Arkwright himself suffered a setback at Birkacre, near Chorley, when in 1779 a mob of several thousands sacked his mill and burned it to the ground, in the belief that machinery was a threat to their employment.

Thus, there had grown up an antipathy among working men to the new mills, and a consequent reluctance to work in them, an attitude not shared by youngsters who saw them as an acceptable way to earn a living. It was indeed partly to avoid the attentions of the Lancashire mobs that Arkwright took his invention to the Midlands, and certainly why he paid so much attention to the provision of door and window locks and other means of securing
his Cromford premises.

Although it was generally admitted that children working in waterpowered mills suffered less serious harm to their health than those employed where the machinery was driven by steam, it was the observed effect of factory work upon their physical well-being, as much as any moral consideration, that motivated the activities of reformers.

"Children in cotton factories are generally puny and squalid," said James Watkins of Bolton. The temperatures of the work-places, necessarily high in the spinning rooms, and the unavoidable creation of dust without proper means of extraction and ventilation, seem to have been regarded as greater threats to health than the long hours or the physical strain of the work.

Of course, there were always the exceptions that, as ever, were seized upon as evidence that all was well. "I have never seen workpeople's breakfasts spoiled or covered with the flyings," one observer testified, while another pointed to a man who had worked for over 20 years at a dust machine and was now 80 years old.

And there were the irrelevancies that clouded the issue. Dr Thomas Turner of the Manchester Poor House, when asked "Do you think it more fatiguing for a boy of twelve years old to work in those factories for 12 hours, or to drive a team in a ploughed field for 12 hours?", replied: "It is much more laborious, I conceive, to drive a team for 12 hours in a field."

Between 1816 and 1819, there were fewer than three Parliamentary committees of inquiry into the employment of children in factories, mainly mills. They led eventually to the Factory Act of 1833, which limited the hours of work of children between the ages of nine and 13 to eight hours a day, of those between 14 and 18 to 12 hours a day, and no night work. It also outlawed the employment of children under the age of nine, and tried to force mill owners to provide at least some elementary schooling.

To Richard Arkwright's credit, it must be said that very early on he began to see the injustice and wretchedness of the working life of many, and began to do something about it. Even if his actions had a basis in self-interest, it has to be conceded that it was, for the times, extremely enlightened self-interest.

Construction of the first mill at Cromford, followed by a second on the same site in 1776, and a third, the ornate Masson Mill in 1783, had obviously augmented the population of the little village. Arkwright's first attention to his workers' welfare was therefore the building of houses, "neat and comfortable, their tenants much better provided than they commonly are in the Southern Counties of England," according to John Farey. (Even 200 years ago, the soft South was considered as a benchmark of privilege!)

Some years later, Peter Gaskell, though a critic of the factory system and of the changes it had wrought, conceded that Arkwright's cottages were among those "exhibiting signs of comfort and cleanliness, highly honourable to the proprietor and the occupants."

After private housing came public housing, with the construction in 1778 of The Greyhound, originally The Black Greyhound. It should not be thought that the workers had had to wait six years to slake their thirsts. The attraction of The Greyhound was that it was a clean, well-proportioned building, quite different from the ale-houses in the villages round about. It also most conveniently provided accommodation and stabling for the many merchants and buyers who visited the mill on business and, in addition, the area in front of the hotel, cleared and levelled, became the site of a regular market to supply villagers with goods of all kinds. Arkwright even went to the length of providing an assortment of prizes to be given at the end of the year to whichever tradesmen had best furnished the market during the twelvemonth -- clocks, beds, cupboards, chairs etc. "They bespeak Sir Richard's prudence and cunning," wrote one visitor. "For without ready provisions, his colony could not prosper: so the clocks will go very well."

The Greyhound and the market place became the focal point for innumerable village celebrations.

Aarkwright was knighted in 1786. Two years earlier he had received what some might regard as a more signal honour, the Freedom of the City of Glasgow. He was visiting Scotland in the company of a Member of Parliament, who, somewhat surprisingly in that hotbed of iconoclasm, had found favour with the working population. In their unaccustomed adulation, the mob wanted to unhitch the horses from the carriages and pull them by human power from the city centre to Kelvin Grove. With admirable adroitness, the M.P. declined, telling them in his best bombastic, "My duty is to set you free, not to put you under the yoke." Arkwright allowed them to pull his carriage.

Sir Richard Arkwright has been credited with being not only the creator of the modern factory system, but even as the originator of what might be called industrial incentives. As early as 1772, the first year of production at Cromford, a newspaper report describes how upwards of 300 of Arkwright's young workers paraded through the streets with streamers flying, led by a principal workman clad in a suit made of white cotton cloth from the thread produced at the mill, marched into the nearby Marshall Hills to gather nuts, and in the evening returned and partook of a plentiful supper, concluding the day with great harmony and decorum. "Industrial relations and public relations in one swoop!"

From then on, each September, Cromford celebrated what was called The Festival of Candlelighting, when, led by a band and watched by "an amazing concourse of people", workers and children paraded round the village and on returning to the mills were given buns, ale, nuts and fruit, and the evening ended with music and dancing. Could this have been the origins of the All-Night Rave?

Nor was spiritual well-being neglected. In 1734, a year that saw a tidal wave of enthusiasm for Sunday Schools. Arkwright went with the tide and set up a school in Cromford, attended regularly in its first year by some 200 children. "Pleasing it is to the friends of humanity, when power like his is so happily united with the will to do good," said the Manchester Mercury.

Such philanthropy was regrettable the exception, and even with such concessions to worker welfare, the state of the nation's health, arising out of industrial concentration, continued to be a matter for concern, notwithstanding the legislation of 1833. In the Leicester Literary and Philosophical Society programme for 1843-1844, there was a lecture entitled The Moral and Physical Condition of the Working Classes, and it was given by none other than Dr Shaw, our true founder.

While the health and longevity of the upper and middle classes
were increasing, he said, the sanitary condition of the working classes in large towns had been for some time deteriorating, a fact that he attributed to the destruction of home life by the factory system, the want of education and recreation, the very imperfect drainage and ventilation of the streets and houses, poor food, bad dwellings, the evil example of Irish immigrants of the lowest class, and the horrible condition of common lodging houses.

There were in Leicester, he said, 12,000 dwelling-houses, of which 300 were unfinished and 1200 stood empty, leaving 10,500 occupied dwellings inhabited by some 50,000 persons. The annual death rate was 30 per 1000, a figure exceeded only by Bristol, Manchester and Liverpool. The rate for all England was 21 per 1000.

Of deaths in Leicester one half were of children under five, and infant mortality was no doubt increased by the mothers working in factories and so neglecting their children.

Ladies and gentlemen, will you allow me to conclude with the presumption that the question 'Did They Do It Right?' might also have been asked and well understood by the man who brought our society into being. I thank you for your patience.

Ormond Smyth,
4 Ingarsby Drive,
Evington, Leicester, LE5 6HA.
SIR EDWIN LUTYENS: ARCHITECT OF SYNTHESIS

Grant Pitches

The work of the Edwardian architect, Sir Edwin Lutyens, is characterised by a remarkable synthesis of historical styles from Surrey vernacular to English Palladian. It is imbued with a highly personal imagination which establishes him, arguably, as one of England’s greatest architects.

Sir Edwin Lutyens (1869-1944) is perceived as one of England’s greatest architects whose work ranged from domestic vernacular, poignant war memorials, to the monumental projects of the Viceroy’s House at New Delhi, and Liverpool Cathedral.

In order to analyze his work, and to assess his contribution to English architecture it is useful to pose the following questions: 1. Which architects were most formative in Lutyens development? 2. What were the key issues raised by Lutyens work? 3. How significant was Lutyens historically?

Before proceeding with an architectural assessment it is crucial to understand the man.

BRIEF PROFILE:

Edwin Landseer Lutyens was born in London in 1869, the son of an ex-soldier, and professional artist and was named after his father’s mentor Sir Edwin Landseer. Edwin was the tenth child, and ninth boy. He did not enjoy good health, and was the only boy not to go to public school or university. As a result he was very close to his mother, a deeply religious woman.

Lutyens’ comment in later life to Osbert Sitwell, quoted by his daughter Mary, is significant:

“Any talent I may have was due to my long illness as a boy, which afforded me time to think.... I was not allowed to play games, and so I had to teach myself, for my enjoyment, ‘to use my eyes instead of my feet’.”

He spent his childhood and early teens, sketching, and seeing how buildings were erected. By his mid-teens it was clearly apparent that he wanted to become an architect, and in 1885 he enrolled as a student at the Kensington School of Art (now the Royal College of Art) where he stayed only two years. He then became articled to Ernest George (Ernest George and Peto) but shortly afterwards set up in practice at the age of twenty at 6 Greys Inn Square, on the basis of his first significant commission, Cocksbury (1889-91) in Surrey.

In the Spring of that year Lutyens met Gertrude Jekyll - he was twenty, she forty five. The host, Harry Mangles, had set up the meeting to introduce Lutyens to a potential client. This was the beginning of a remarkable partnership of talents - Jekyll was multi-talented - artist and craftsperson. Her myopic condition gradually changed her involvement in painting and crafts to gardening. She found in Lutyens an interpretive vision for her detailed perceptions.

In 1897, Lutyens married Lady Emily Lytton, daughter of a Viceroy of India. The Lytton family was opposed to the relationship, and Lutyens was required to insure his life for £10,000, a fortune in the 1890s, before the marriage was agreed. This placed a heavy burden on him throughout his life.

By 1908 they had a family of five children, including only one boy, Robert.

Lutyens was intrinsically shy, despite his charming approach to his clients. His serious nature, however, is revealed in his intense correspondence with his wife, Emily. These letters form an invaluable insight into his values as an architect.

LUTYENS’S CONTEMPORARIES:

Frank Lloyd Wright (1867-1959)

Born two years earlier than Lutyens, Frank Lloyd Wright was to emerge as America’s greatest architect whose work achieved international influence during the first half of the twentieth century. Wright evolved a new language of architecture. The natural beauty of the prairie was his inspiration. “The Prairie has a beauty of its own, and we should recognize and accentuate this natural beauty and its quiet level”.

Over a period of seven years, he developed his concept of interior space which was free from the constraints of traditional construction. He evolved the Open Plan. In his design for a series of houses in the suburb of Chicago, Oak Park, and in Unity Chapel (1904-1907), his first public building, he achieved ‘the destruction of the box’. Cantilever construction replaced load-bearing walls - these were replaced by 'screens'. This transparent treatment of enclosure altered the distinction between inside and outside, and unified landscape with building.

Charles Rennie Mackintosh (1868-1928).

Unlike Lutyens’s prolific range of buildings, Mackintosh only produced about a dozen major works. His significant architectural work was in Scotland. The Glasgow School of Art (1897, and 1909), Queens Cross Church (1898) The Willow Tea Rooms (1903-4), and his two remarkable houses: The Hill House (1902 - 4) and Windyhill (1899-1901). His architecture is characterised by his skill in manipulating space, and responding to functional requirement with charm and imagination. He was influenced by Japanese culture, as was Frank Lloyd Wright.

C.F.A.Voysey (1857-1941)

Lutyens expressed his thinking through drawing; Voysey, however, was an intellectual who theorised about the nature of architecture as well as practising it. He gained an international reputation from his domestic architecture - "The Voysey house was convenient, informal, economical to build and maintain."
His work was published in The Studio magazine, and European journals. His two most famous houses of 1898, Broadleys, and Moorcrigg located in the Lake District, Cumbria, typified the serene quality of his work.

**FORMATIVE INFLUENCES:**

Three architects influenced Lutyens's work at different stages of his career: At the early development of his work, the Surrey vernacular period, it was Webb, and Shaw. Later the influence of Wren changed the direction of his thinking.

**Philip Webb (1831-1915)**

Webb's buildings were much admired by Lutyens. They were unsensational, unsentimental, conceived in materials not in words.

Standen (1891) with its five-gabled facade was heavily influential on Lutyens's design for Homewood (1901) which echoes the multi-gabled treatment of the main elevation.

**Richard Norman Shaw (1831-1912)**

It is considered, however, that the crucial influence on Lutyens was Shaw. His house designs progressed from Tudor vernacular (Leywood 1841) through eighteenth century (70 Queens Gate) to Baroque Classicism (Chesters 1890). Peter Inskip *points out that there is a similar stylistic development by Lutyens: Orchards (1897) Great Maytham (1907) and Heathcote (1905).*

**Sir Christopher Wren (1632-1723)**

Lutyens's transition from the eclectic picturesque style to the Classical has been identified by Hussey as the end of 1904. Lutyens's letter to Herbert Baker dated 15 February 1903 is usually quoted in this context of his honeymoon with the classical style. 'In architecture Palladio is the game! ... The way Wren handled it was marvellous. Shaw has the gift. It is a game that never deceives...it is impossible except in the hands of Jones or Wren. So it is a big game, a High Game'.

Little Thakeham, Sussex (1902), and Papillon Hall, Market Harborough (1903) with its classical circular court indicate Lutyens transition to Classical.

**Lutyens and The Modernists:**

Lutyens ignored the Modern Movement in architecture.

The puritanical search for simplicity was an anathema to him. Mies van de Rohe's (1886-1969) statement 'Less is More' was not a paradox which found support with Lutyens's approach to design. The Modernist's emphasis on Structure as one of architectural design's determinants was also a principle which was irrelevant to Lutyens. An example of Lutyens's disregard for this principle was the steelframe structure of Castle Drogo (1910-1930) which was hidden within the monolithic granite forms of the design. Additionally, the Orthodox Modern emphasis on 'open space', 'flowing space' - so called interpenetration of inside and outside - was the antithesis of Lutyens's response to handling space. His separation of inside and outside with emphasis on enclosure and spatial contrast was in total opposition to the Modernists.

**SYNTHESIS and ABSTRACTION: Pervasive themes of Lutyens's work**

Lutyens was a prolific and disciplined architect. Over a period of approximately fifty years he was responsible for over three hundred buildings. His pattern of architectural development was not evolutionary - he returned to the vernacular style on occasions after his classical projects. Throughout his work, however, two pervasive themes can be identified: Synthesis, and Abstraction.

The range of his work is so vast that it is necessary to select a very limited group of his buildings for analysis in this context. The focus is therefore on his domestic architecture, and War Memorials.

**Munstead Wood, Munstead, Surrey for Gertrude Jekyll (1843-1932).** Built between 1893-97, is considered to be Lutyens's finest interpretation of the Surrey Vernacular style. It is an excellent example of Lutyens's synthesis of styles - he does not copy Surrey vernacular but imbues it with his own 'manner of building'. The house is planned in clear response to Gertrude Jekyll's practical needs: there are large work areas, and a study, but no drawing room. The plan is rambling. The overall image of the house is the dominant roof form, 'spread like a soft felt hat'. The influence of C.F.A. Voysey is evident on the garden elevation featuring his characteristic powerful gables.

Lutyens's understanding of building materials, and his ability to detail, and explore their use is fully developed at Munstead. The fabric is of superb craftsmanship, using brick, stone and tile, and utilising oak trees from the site. Its interior mood of the living areas is quiet, introvert, and lowly lit, responding to Jekyll's emotional needs.

**Folly Farm, Sulhamstead, Berkshire, for H. Cochrane (1906) and Zachary Merton (1912).** This complex of two extensions to a small Georgian farm house typifies Lutyens's synthesis of styles and periods of architecture. The first extension, based on his favourite 'H plan was his version of 'Dutch' style architecture, incorporating a double-story height hall. The second extension of 1912 was his version of an eclectic vernacular style, originally influenced by Norman Shaw. An important dimension of Folly Farm is the relation of the garden to the house, designed by Lutyens and Jekyll. Jane Brown states 'The garden evolved over the vintage years of creation before The War, and somehow it absorbed the spirit of happiness that belonged to those years'. This fusion of house and garden is seen as the peak of the Lutyens Jekyll partnership.

**Heathcote, Kings Road, Ilkley, Yorkshire, for E. Hemingway (1905-1907).** A very significant building for Lutyens as it marks his love affair with Classical architecture, and identifies his genius in interpreting and modifying the Doric Order. It also identifies his witty use of paradox and metaphor. His famous 'disappearing pilaster' is first explored here. Also discernible is the metaphor of the face on the projecting wings of the garden front.

**The War Memorials: Lutyens and Abstraction**

In 1918 three architects were appointed by the War Graves Commission, Lutyens, Baker, and Blomfield, to carry out the design of 918 cemeteries along the Western Front. Prior to this Lutyens and Baker went to France in 1917 to visit the battlefields, and make recommendations to the Commission. A quote from Lutyens's letter to his wife Emily in 1917 July 12 1917 GHQ BEF: 'Met General Orbell. Each day long drives...The battlefields...the obliteration of all human endeavour and achievement...the human achievement... is bettered by the poppies and wild flowers.'
Ribbons of little crosses touching each other across a cemetery.' Lutyens was heavily affected by the horrors of France, and his architecture reflected his emotional reaction.

Two Memorials epitomise this: The Cenotaph, London(1919-20) and The Thiepval Arch, Somme, France. On July 19, 1919 Lloyd George sent for Lutyens and told him 'the Government required a 'catafalque' to be erected in Whitehall, in a fortnight's time ready for the great procession to honour the fallen'. The upshot was that after further discussions Lutyens produced a sketch for a temporary 'Cenotaph' that night. It was ready on time, and a year later the permanent structure was in place. The Cenotaph contains no vertical or horizontal lines. The simple sculptural form caught the imagination of the general public and the acclamation of Lloyd George. 'The Cenotaph by its very simplicity expresses the memory which the people hold all those who so bravely fought and died for our country'.

Lutyens designed monuments to the fallen in a number of provincial centres including Leicester. The arch and its approaches at Leicester is one of the most spectacular in appearance and setting'.

Thiepval Arch, Somme, France (1917-1912. In Lutyens's war monuments it is significant that there is no symbolism, apart from the form themselves which became progressively more abstract. The culmination of this is the Thiepval arch, which Lutyens designed as a series of linked arches based on his favourite ratio two and a half height to width. The multiple surfaces were inscribed with 73,357 names.

Hussey summarises Lutyens's achievement 'There is sublimity in this great abstraction of pure architecture'.

THE ISSUES RAISED BY LUTYENS'S ARCHITECTURE: MORALITY and RATIONALITY

It might appear initially to the layman that the issue of Morality is irrelevant in architecture - surely it is endemic in politics, social sciences, and science, but how does it relate to architecture?

Theorists, Jenkins 12 and Watkin 13 however pose this as a pivotal issue in the field of architecture. Watkin states that there are essentially three explanations of architecture: Religious/political; Zeitgeist (spirit of the age) and Rational or Technological. The two relevant explanations in discussing the work of Lutyens are: Zeitgeist and Rational/Technological.

A cause of the enmity between Lutyens and the architects and theorists of the Modern Movement (formally defined by CIAM - Congres Internationaux d'Architecture Moderne in 1928) was his rejection of the Zeitgeist as a basis for architecture.

That architecture should reflect the 'spirit of the age' was a central tenet of the Modernists. Architecture should be determined by its function, and use the latest technology to reflect this. A protagonist of the Zeitgeist was Professor Nikolaus Pevsner whose central doctrine emphasised that architecture should not be based on historical precedent but on egalitarian cultural and political values. He bitterly attacked all architecture which was the result of 'individual inventiveness' which would preclude the development of a universal style.

Pevsner's views, echoed the Bauhaus' (1919-1933) principles that architecture and the arts should be of their time, and geared to the 'needs of the people'. 'Honesty' in architecture, a corollary of current technology, is implicit with 'truth'.

The architecture of Lutyens, however, was centred on his inspired interpretation of historical precedents, unrelated to technology, and therefore by implication dishonest and immoral.

Watkin, on the other hand takes the view that 'belief in the all-dominating Zeitgeist combined with a historicist emphasis on progress, and the necessary superiority of novelty, has come desperately close to undermining, on the one hand, our appreciation of the imaginative genius of the individual (referring to Edwin Lutyens) and on the other, the importance of artistic tradition'.

RATIONALITY

Lutyens distanced himself further from the Modernists, Le Corbusier (1887-1965) and Mies van de Rohe, in his rejection of a rational or technology basis to his work. Le Corbusier's concept of the house as 'a machine for living in', independent of its site, was an alien dogma to Lutyens. His design for the 'Domino' houses in 1914 which explored the potential of reinforced concrete, while immensely influential to the young Modernist architects internationally, was irrelevant to Lutyens. Ironically, one of Lutyens's significant contributions to English domestic architecture is seen as his total rejection of Rationalist theory.

Lutyens, in his domestic work, did not pursue symmetry of plan or consistency of elevational treatment, but evolved planning and elevational solutions which were essentially 'schizoid'.

Peter Inscapé 15 describes Lutyens's house plans as a fracture between back and front - the facade to the entrance being formal and symmetrical, and the garden facade having a vernacular feeling. This strategy frees, and enriches Lutyens's imagination. Lutyens's handling of internal space was generated by the social Brief i.e. the house geared to the weekend house party: the needs of the family, guests and the supporting role of servants. In essence, a series of carefully interlocked sequential spaces -far removed from Le Corbusier's double-cube open plans.

Tigborne Court (1898) Witley, Surrey is an excellent example of the fractured plan. The West facing entrance court is formal and symmetrical, with wings of a Baroque flavour, capped by Lutyens's ubiquitous tall chimneys. However, the entrance hall leads into a series of asymmetrical spaces culminating with the Drawing Room.

LUTYENS and the POST-MODERNISTS

Robert Venturi's Book Complexity and Contradiction in Architecture (1966) attacked the values of orthodox Modernist architects, and identified Lutyens virtually as the first Post-Modernist architect. It would be a severe distortion of Lutyens's historical significance if this were seen as an evaluation of his work.

In essence, Lutyens's genius lies in his talent to synthesise historical styles, and bring to his architecture a personal interpretation fired with wit and visual joy.

He was not an innovator at the international level of Frank Lloyd
Wright (1867-1959) or CFA Voysey (1859-1941) both of whom were theorists, and architects who offered new visions of architectural space and style.

Lutyens's later work at New Delhi (1912-31) a synthesis of Classical West and Moghal East - and his War Memorials of the First World War, were explorations of three dimensional abstract geometry taken to a mystical level.

He was an intuitive designer, not a theorist, - his domestic work alone places him as one of England's greatest architects. Finally, Lutyens defined his approach in two famous phrases:

"Architecture is building with wit" and "Architecture, with its love and passion, begins where function ends".

REFERENCES
11. ibid p.475.
14. ibid p.115.
15. Inskip ibid p.7.
MURDER AND MYSTERY: THE CRAFT OF THE DETECTIVE STORY

P. D. James

Summary of Lecture delivered on 13th November 1995

The detective story is one of the most versatile, fascinating and resilient forms of popular literature.

It is also one of the most paradoxical. The detective story has at its heart a crime, usually the crime of murder, often in its most horrific form, and yet we read the novels primarily for relaxation, entertainment, a relief from the traumas and anxieties of everyday life. Its raison d'être is the establishment of truth yet it deals in deceit; the writer sets out to deceive the reader, the murderer to deceive the detective, and the better the deception the more effective the book. The detective story is concerned with great issues; life, death, justice, retribution, remorse; yet it uses as the instruments of that justice the ephemeral clues and incidents of everyday life; torn scraps of paper, traces of lipstick, a drop of blood.

The genre is concerned with justice, yet often, particularly in America, it is less than confident in its affirmation of organised law and order and the amateur detective is seen as a symbol of triumphant individualism compared with dull orthodoxy and official incompetence. The detective story deals with theective crime of murder, yet the form itself is formularistic, orderly, contrived, providing a secure structure within which the imagination of writer and reader alike can confront the unthinkable.

The detective story differs from crime writing generally. The words 'crime novel' can cover a wide spectrum of writing from the cozy village mysteries of Agatha Christie, through novels by Anthony Trollope, Wilkie Collins, Charles Dickens, Graham Greene and John Le Carre, to the nineteenth century Russian novelists and some of the highest works of the human imagination. The crime novel may have murder at its heart, but there is frequently no mystery and therefore no detective and no clues.

What the readers of a detective story expect is a central mysterious death, a closed circle of suspects with motive, means and opportunity for the crime, a detective, either amateur or professional, who comes in like an avenging deity to solve it and by the end of the book a solution which the reader should be able to arrive at by logical deduction from clues inserted in the novel with deceptive cunning but essential fairness. The lecturer rejected the criticism that this is mere formula writing; the detective novel may be more structured than so-called straight fiction but it need not be formularistic in its treatment of character and theme.

One of the first decisions to be made in writing a detective story is the choice of detective. The British tradition is for the egregiously-talented maverick amateur in the tradition of Sherlock Holmes. An amateur detective has a number of advantages but can lack credibility since, in real life, amateurs are not constantly stumbling over dead bodies, and lack both the authority and the technical resources to investigate murder. The writer who creates a professional police hero must be meticulous with her research into forensic and police procedural detail if the novel is to be believable to an increasingly knowledgeable and sophisticated readership.

Setting is of great importance to the detective story. It creates an appropriate atmosphere, whether of menace, horror, foreboding or expectation. It influences character and plot, and roots the sometimes bizarre events of the story in the firm soil of recognised place. Setting can also have symbolic importance, while a closed society, which is popular with crime writers, helps to limit the stain of suspicion which cannot be allowed to spread too far if each character is to be a living, breathing human being and not a stereotype to be knocked down in the final chapter. The lecturer stressed that for her the research needs to be meticulous, and plotting and planning often take as long as the actual writing. The original inspiration for a novel is almost always the setting and it is followed by the development of the characters and then the details of the plot including the process of the police investigation.

One of the attractions of the detective story for a novelist is the number of interesting technical problems it presents. Chief among them is the difficulty of reconciling the three main elements; setting, characterisation and puzzle. There is the need to sustain a strong narrative thrust and avoid those mid-novel longueurs when the detective is interrogating each of the suspects. The motive for the murder must be credible. The sanctions against this ultimate crime - legal, psychological, religious and social - are very strong and modern readers are no longer prepared to believe that the rational man or woman will kill to get rid of the difficult partner or to avoid sexual scandal. The lust for money is always a strong motive, and so are revenge, jealousy and hatred. Other technical problems are the most appropriate point of view for telling the story and the management of the final chapter where all the ends are to be tied up, the mystery solved, the clues explained and the murderer and his motive at last revealed.

All popular art forms satisfy a number of basic needs of the human psyche; entertainment and a relief, however temporary from the responsibilities, arduous and anxieties of our own lives or forced on us by television and newspapers; a fantasy world peopled by familiar and reliable friends into which the reader can escape for his comfort even while knowing that it peddles myth not reality; the excitement of vicarious danger and the challenge of the puzzle. The detective story provides for an affirmation of identity, reaffirms our belief that we live in a rational and comprehensible world and that it is possible to bring order out of disorder. It provides, too, a potent means by which both reader and writer can exercise irrational feelings of guilt and anxiety.

But, despite the catharsis of this fictional and carefully-controlled violence, the modern detective story is inevitably less reassuring.
than the comforting concoctions of the 1930s. Murder in Mayhem Parva may frighten but it never really hurts. The violence is sanitised, the blood is not real. At the end of the novel the innocent are vindicated and the guilty punished and we can echo the words of Browning's Pippa: 'God's in his heaven, all's right with the world'. But all is not right with our world, and it is both the strength of the modern detective story and the measure of its maturity that authors today can still work within the conventions of this fascinating genre and try to tell the truth about ourselves and our turbulent world as we move towards the millennium.

Baroness P.D. James,
58 Holland Park Avenue,
London, W11 3QY.
METEORITE IMPACTS AND THE HISTORY OF LIFE

Simon Conway Morris

Summary of the lecture given on 8th January 1996 to a joint meeting with the Geology section,

Peppered across the Earth are craters, some small, others enormous, that are clearly the result of meteor impacts. The number of craters documented is only a tiny fraction of actual arrivals: the ceaseless weathering of the Earth's surface and the endless cycling of the crust by plate tectonics destroys most of the evidence. Nevertheless, it is clear that meteorite impacts have played a major, perhaps even crucial, role in the history of life.

There are three major topics that deserve attention.

1. The earliest history of the Earth was probably marked by an episode of major bombardment. One impact, by an object about the size of the present-day Mars, is believed to have led to the formation of the Moon. No direct evidence of this episode is preserved on the Earth, but it seems reasonable to suppose that some collisions were so violent that the kinetic energy was sufficient to evaporate the entire oceans. The net result may have been to sterilize the Earth of any early life that may have managed to gain a foothold. Interestingly, the first moderately reliable evidence for life is from rocks dated at about 3.8 billion years, which is the time that this major impact episode finally petered out.

2. The subsequent history of the Earth was marked by a whole series of impacts, but it was the one 65 million years ago that terminated the Cretaceous which has attracted special attention, not least because it has been linked to the mass extinctions of the dinosaurs as well as many other organisms. The evidence for a giant impact is very strong. The principal crater, in Mexico, has been identified with some confidence. In many parts of the world there is a distinctive horizon (boundary clay) that contains a whole suite of evidence (shocked quartz, melt droplets, soot from wildfires, extraterrestrial amino acids and, most notably, abnormally high concentrations of the element iridium) that are consistent with the arrival of a giant meteorite or comet.

There are, however, a number of unresolved problems. What is the causal link between impact and the observed extinctions? Were most faunas and floras annihilated within a few hours, or were subsequent knock-on effects more important? Why, in particular, is there evidence for the environment remaining severely perturbed for at least half a million years after the impact itself? Was there only one impact, and could there have been several? Why were the end-Cretaceous extinctions so severe, yet seemingly other mass extinctions such as those in the late Ordovician and end Permian lack evidence for extra-terrestrial involvement?

3. From the safety-point 66 million years later the end-Cretaceous disaster may seem rather remote. It may not be wise to be complacent. What happened in the past may re-occur in the future. It is widely supposed that no humans have been killed by meteorite impact. Some reports such as the death of a medieval monk in northern Italy or Dutch sailors near Java are not easily verified or substantiated. In the Chinese records, however, there are dramatic accounts of serious loss of life.

More importantly is how to deal with future threats. There already exists a fairly detailed catalogue of asteroids, and a specific search should provide reasonable coverage and so some future security. Unfortunately there are many more comets, and not only do they travel much faster - giving less warning time - but they only become easily visible when they approach the Sun. The effects of a replay of the end-Cretaceous event on our present-day civilization are almost beyond imagination. How do we protect ourselves? Various proposals are being actively discussed. Some are off-shoots of the Star Wars Programme, but more subtle methods of warding-off disaster may be more feasible. In particular an ingenious proposal has been made to launch satellites towards suspect intruders, which, when adjacent to the asteroid, would expand into a configuration of mirrors that focus sunlight and ablate the surface. Over a few months the loss of mass perturbs the asteroid's movement into a safe orbit.

In conclusion, our long-term aim must be to make the planet safe from any major impact, but in the meantime there remains much to understand about the past history and effects of extraterrestrial visitations.

Professor Simon Conway Morris.
Department of Earth Sciences,
University of Cambridge.
PROTECTING THE WORLD'S CULTURAL HERITAGE DURING ARMED CONFLICT

Professor Patrick Boylan

Summary of lecture delivered on January 21st 1996 - sponsored by De Montfort University

Though there have been very many war-time losses of historic and religious monuments, great libraries, museums, archives etc, from the early 18th century up to and including World War II, cultural destruction in armed conflicts was largely an unfortunate accident of war, not a primary war aim in its own right. The past decade or so has however seen a marked change.

The stripping of the national museum of Kuwait as almost the first act of the invading Iraqi army, separatist bombings of historic and religious monuments and museums in many parts of the world, and above all the past five years' history of events in former Yugoslavia have shown that symbols of cultural identity are now a primary target in regional and ethnic armed conflicts and civil wars. In Croatia, for example, more of the national heritage was destroyed in the first four months of fighting in 1991 than in the whole of the Second World War. In two regions re-captured by the Croatian government in the summer of 1995 not one of more than 160 Roman Catholic churches and monuments were found to be undamaged, and 126 had been totally demolished and the sites cleared, Surveys just getting under way in Bosnia tell the same story in relation to Islamic, Catholic and Orthodox religious buildings, according to region. The new United Nations War Crimes Tribunal sitting in The Hague alleges that every one of the Croatian and Bosnian national monuments displaying the official Blue Shield (Red Cross equivalent) "protection" symbol prescribed in international law has been damaged or destroyed, and in most cases quite clearly deliberately targeted. The scale and degree of destruction of religious buildings and sites (of all three main faiths, though especially Catholic and Moslem) has been unmatched in Europe since the religious wars of the 16th and early 17th centuries.

In view of the growing evidence that "cultural genocide" was stalking the world hand in hand with "ethnic cleansing" (i.e. physical genocide) the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the Netherlands Ministries of Culture and Foreign Affairs jointly appointed Patrick Boylan to carry out a comprehensive review of both the provisions and the implementation of current international law relating to the protection of the heritage in times of armed conflict, particularly the 1954 Hague Convention, and the 1977 and 1980 additions to the Geneva Conventions. Based on extensive research and consultation involving the United Nations, International Committee of the Red Cross and military, diplomatic and legal authorities in a number of key countries, Patrick Boylan's 260 page report was published in both English and French editions by UNESCO in the Autumn of 1993, with three reprints so far.

Since then he has been closely involved in work on the implementation of his recommendations for the updating of the Hague Convention of 1954 and on practical measures in zones of conflict. In the late summer of 1995 he visited newly liberated areas of Croatia - still heavily devastated and with many minefields and booby-traps still in place in and around cultural and religious monuments, and assisted the Croatian Government in preparing its claim at the Dayton peace conference for the return of missing museum collections. At the end of November he took part in an Inter-Governmental Conference on the proposed updating of war crimes law relating to cultural protection, and just a few days ago he attended and advised the Council of Europe Cultural Heritage Committee on emergency aid and reconstruction assistance in ex-Yugoslavia.

Patrick Boylan's lecture to the Leicester Literary and Philosophical Society reviewed the evolution of the principle of protecting the cultural heritage in times of war, examined some of the recent failures in the context of the recent resurgence of nationalism and ethnic and religious divisions, such as those in ex-Yugoslavia, and considered the prospects for improving the systems of regulation, education and control in the future.

Patrick Baylan.
Professor of Arts Management,
The City University,
London.
ON BEING A BIT LESS GREEN

John Emsley

Summary of the lecture delivered on February 5th 1996, Sponsored by the Royal Society of Chemistry

How does information about science get into the media and why does it sometimes end up being so distorted and its message so one-sided? This talk looks at the issue of global warming and the adverse effect this has had on the funding and public appreciation of science.

We have been told ad nauseam by environmentalists and their supporters that the Earth will experience a major disaster in the next century, due to the following sequence of events:

Fossil fuels → CO₂ → greenhouse gas → global warming → Second Flood

However, the middle links in the chain are highly suspect. Global warming theory is now seen to be seriously flawed and for it to happen through increased CO₂ in the atmosphere, then the laws of chemistry will have to be suspended.

Global warming has affected science in two ways: firstly, and thanks to science policy makers, it has diverted funds away from the medical and natural sciences (more is now spent on it than on cancer research); secondly, and thanks to an active environmentalist media lobby, the public has been alarmed by selling them a largely speculative theory as if it were proven fact. In so doing the media lobby has undermined attempts to improve public understanding of science.

Global warming became an issue in the late 1980s. It was over-hyped by the media, but a more careful look at the facts now suggests that the evidence presented was highly flawed scientifically. Ice cores drilled at the poles, which were supposed to prove a link between CO₂ and temperature during and between Ice Ages, now turn out to have little value because of a faulty analysis and a lack of chemical knowledge.

There are other observations which suggest that a Second Flood might not happen. For example, fossils show that in previous geological ages temperatures were similar to those of today yet the level of CO₂ in the atmosphere was at times eight times higher than today. Moreover, and despite the increase in atmospheric CO₂ satellite observations show that there has been no average global temperature increase in the last 15 years.

Anomalies like these can be understood by looking more closely at the chemistry of CO₂. Whilst it is a greenhouse gas, it is much less important than water vapour. Human activities produce CO₂ and there is no doubt that this affects the balance of the carbon cycle in Nature. But higher levels of CO₂ in the atmosphere are more likely to lead to a greening of the Earth, so that in the next century we are just as likely to be enjoying a New Garden of Eden as floundering in the Second Flood.

A more positive message about CO₂ shows that this chemical can bring real benefits to society if it is used correctly. It has a remarkable behaviour as a so-called superfluid solvent and this curious property is being used industrially. Far from being a chemical we should fear, CO₂ is already contributing to better crop production in greenhouses, better flavours in foods and drinks, low-fat snacks and de-caffeinated coffee.

Dr John Emsley,
Science Writer in Residence,
Imperial College of Science, Technology and Medicine,
South Kensington,
London. SW7 2AY.
SPECULATIONS ON THE ROLE OF MANTLE CONVECTION IN CONTINENTAL RIFTING BASED ON SEISMIC TOMOGRAPHY EXPERIMENTS

Paul M. Davis

37th Bennett Lecture, delivered February 26th 1996

Abstract: A new frontier in geophysics involves recognition of the role of small scale mantle convection in tectonics. Upper mantle tomography is revealing heterogeneities at depths corresponding to the lithosphere-asthenosphere transition, but their interpretation and relationship to mantle convection are controversial. The following questions are addressed here: What is the origin of the observed tomographic anomalies; are they generated by partial melt or sub-solidus temperature effects? Do they lie above upwelling mantle convection currents and do the currents erode the base of the lithosphere or are the velocity anomalies caused by modification of the lower lithosphere by injection of heat or volatiles? What role does small scale convection play in continental breakup? Do plates break by slab pull, slab suction, rift push, or asthenospheric drag? We conclude that the velocity anomalies are caused by convective transport of heat or volatiles into the lower lithosphere raising its homologous temperature and reducing its strength. Thermodynamically elevated topography exerts an outward push that fractures the weakened lithosphere. When topographic extension is accompanied by slab suction or slab rollback in the adjacent plate, rifting can become successful forming ocean basins.

INTRODUCTION

Even though plate tectonics has been developed for over 30 years there is still considerable uncertainty as to the driving forces not to mention the role they play in the breakup of continents. A growing consensus finds that plates move over relatively stationary mantle in which hot spots are rooted. The alternative view, that the sub-lithospheric mantle moves faster than overlying plates dragging them behind, does not explain the relative stationarity of hot spots. Thus the asthenosphere decouples faster motions of the lithosphere from the more sluggish motion of the remainder of mantle. This convective circulation occurs on a plate-wide scale. What are the surface effects of smaller scale motions in the mantle including the hot spots which provide a finer scale of circulation? Indirect evidence of small scale mantle convection is the departure of the topography of oceanic plates from that predicted from the half space cooling laws (Parsons and Sclater, 1977). For ages greater than 80 Ma the square root of time relationship breaks down where the deepening of the ocean levels off. In these regions a model of a plate above a convecting asthenosphere which rapidly replaces heat lost by conduction is needed to explain the topography. We examine here the implications of similar small scale convection beneath continental lithosphere.

While the role of plates as the upper cold layer of the mantle convection system is largely understood, the return flow is not. It is unclear whether the convective flow is mantle-wide or largely confined to the upper mantle. The 660 km discontinuity is thought to impede plate penetration. Tomographic images of high velocity zones attributed to slabs suggest that some do penetrate and some do not, flattening out on the transition (Van Der Hilst et al., 1991, 1993) but the interpretation of these images is controversial. Three dimensional convection models suggest that slabs piling up on the 660 km transition avalanche into the lower mantle at irregular intervals (Tackley et al., 1993). Because this discussion is restricted to the forces that drive plates and cause continental breakup, I will not comment further on the return flow, save to say that geochemical evidence appears to indicate a limited flux from the lower mantle and hence favours a return flow mainly in the upper mantle (O’Nions, personal communication).

PLATE FORCES

Although a plate is part of a mantle convection cell, it has been convenient to break the forces moving it into slab pull, slab suction and ridge push. These forces are resisted by asthenospheric drag, such that the net force is zero. The stress state in a plate depends on the geometry of the drive and the resistance which form a balanced double force. If pushed from behind the plate will be in compression; the forces point inwards. If pulled, the plate is in tension; the forces point outwards.

An elementary description of a convection cycle is that hot material rises at ridges displacing cooling material that sinks. Immediately above the rising mantle, buoyancy forces generate tensions that give rise to the mid-ocean rifts. Ridge topography is elevated due to thermal expansion. Gravitational forces integrated across the elevated topography and thickening lithosphere act to push the lithosphere aside. This integrated effect is ridge push. Away from the ridges the push causes the ocean floor to be compressed rather like friction compresses the coils of a spring as it is pushed across a table. Evidence for ridge push compression is found in earthquake focal mechanisms. In ocean greater than 35 Ma earthquakes show compressive mechanisms (Weins and Stein 1985) with the compression axis in the direction of plate motion. At passive continental margins ridge push exerts a compressive stress on the adjacent continent. Much of east North and South America is in a state of compression from the ridge push of the Atlantic.

At subduction zones seismic focal mechanisms reveal that the stress goes from compressive on the ocean floor to extension in the upper part of the subducting slab and then to compressive deep down. The sinking deep portion of the slab pulls on the upper part extending it, while the lower portion compresses when it encounters resistance at the 660 km phase transition. For slabs whose motion includes a component of sinking, slab rollback exerts a suction on the overriding plate. The associated extension can form back-arc basins such as the Sea of Japan. On a continent-wide scale a region of slab rollback tends to form a weak or 'slippery' boundary across which the plate can move or extend. Such boundaries may have played an important role in the
break-up of Pangaea. In contrast to slab rollback, young subducting plates that plunge at a shallow angle can exert a compressive stress on the overriding plate, such as is occurring presently in the Andes and is presumed to have occurred during the Laramide orogeny of West North America.

Any area of elevated topography such as mid-ocean ridges or continental plateaux tends to flatten out by extending laterally. If the lithosphere's elevated topography is strong, it will resist spreading as elastic restoring forces build up to balance the gravitational spreading forces. If it is internally weak, as is the case for mid-ocean ridges or some continental plateaus, the structure will fail and extend until a new equilibrium topography is reached. How far it extends will depend on the resistance offered by the surrounding plate. The strength of the lithosphere depends on two internal strong layers, the upper brittle crust and the uppermost mantle. If either is heated the strength decreases markedly.

**TOMOGRAPHY OF CONTINENTAL RIFTS**

A number of studies of continental rifts have shown that they lie above P-wave velocity anomalies in the upper mantle which extend from the Moho to depths of about 150-200 km and are hundreds of km wide. The largest effect was seen for the East African rift as part of the Kenya Rift International Seismic Experiment, KRISP (Keller et al., 1994) where a 2 second anomaly has been measured (Davis, 1991; Davis et al., 1993; Slack, 1994) corroborating earlier work by Savage and Long (1985). A similar anomaly was observed to lie beneath the Rio Grande rift zone with a perturbation related to volcanism along the Jemez Lineament (Davis 1991, Davis et al., 1993; Slack et al., 1996). The observed travel time anomaly amounted to a delay of 1.5 seconds distributed in the upper 200 km. The velocity anomaly beneath the Baikal rift zone also extends several hundred km either side and to a depth of 200 km with a delay of 1.0 seconds (Gao et al., 1994). The inferred percentage perturbation of mantle P-wave velocities are -12%, -8% and -5% for the East African, Rio Grande and Baikal rifts respectively. By far the greatest amount of volcanism is associated with the largest velocity anomaly in East Africa with an estimated volume of 150,000 km³ (Baker et al., 1972). About an order of magnitude less is associated with the Rio Grande rift (Baldrige et al., 1995) and virtually no volcanism at all is associated with the Baikal rift in the region where our observations were made.

We have interpreted that the observed velocity changes indicate that the mantle lithosphere is these regions is hot, and in extreme cases, possibly partially molten, certainly weak. Sato and Sacks (1989) present laboratory measurements of changes in velocity as a function of homologous temperature (temperature divided by melting temperature) and partial melt fraction for a mantle peridotite. Using their results, we calculate that the effect of raising the mantle temperature from that of a stable continental geotherm to the solids over the depth range of our anomalies will reduce the velocity by an average of 6%. Their relations show that perturbations in observed velocity greater than 6% are caused by temperatures above the solids with each percent velocity contrast corresponding to the presence of about 0.5% partial melt.

We have interpreted the rift tomography results using a model in which rising convection in the asthenosphere has either eroded (e.g., Turoczi and Emerman 1983; Spohn and Schubert 1983) or heated the lower lithosphere beneath each of these rifts. In Africa the -12% anomaly implies that temperatures are higher than the solids corresponding to about 2-3% partial melt. This anomaly lies beneath the Kenya Dome, the region of greatest volcanism in Kenya. Beneath the Rio Grande the temperatures are just above the solids with possibly 1% partial melt, consistent with the lower amount of volcanism found there. For the Baikal rift zone, temperatures are inferred to be below the solids which accounts for the limited to non-existent volcanism.

**PARTIAL MELT BENEATH CONTINENTAL RIFTS**

There is a geochemical problem with the interpretation that partial melt of 2-3% lies in the uppermost mantle beneath the East Africa rift. In magmatic systems such as the Mid Ocean Ridges and hot spots such as Hawaii it has been estimated that partial melt is extracted at very low concentrations e.g., 0.1%, and comes to the surface very fast. Thus long term ponding in these systems is not thought likely. As it stands this is an unresolved problem. It also applies to velocity changes seen beneath mid-ocean ridges that have also been explained as resulting from partial melt (Woodhouse, 1996). Perhaps the calibration from the laboratory experiments is not applicable to partial melting in the mantle that has equilibrated over millions of years and for which melt extraction (McKenzie, 1984) has been operating at high lithostatic pressure? While the percentage of melt must be considered as uncertain, given the widespread volcanism at the surface over the region of the tomographic anomalies for both the Kenya and Rio Grande rifts, we feel it is reasonable to conclude that velocities are low because the mantle lithosphere is very hot, with temperatures throughout near, if not above, the solids.

Another aspect that must be factored into the interpretation is that the velocity anomalies occur in regions where it has been argued (Ashwal and Burke, 1989) fertile lithosphere lies adjacent to depleted lithosphere, typically on the edge of cratons. This would contribute an added contrast in homologous temperatures given the higher melting temperature of depleted lithosphere. Nonetheless we estimate the magnitude of that effect is not large enough to account for the velocity contrasts seen in the tomographic experiments unless there is in addition a strong temperature contrast.

**SMALL SCALE CONVECTION**

Whether the low velocity, high temperature region takes part in underlying asthenospheric convection is debatable. Epsilon Neodymium ratios have been used (Perry et al., 1988) to argue that deep source basalts from the Rio Grande Rift region exhibit asthenospheric signatures. Also convection models find that hot lithosphere, adjacent to cold, is unstable, and would begin to convect and take part in any underlying convection pattern in the asthenosphere. However the alternative view that the base of the lithosphere in these regions has remained intact is not readily dismissed. This view holds that it is just heat that has caused the anomalies and injection of volatiles from an upwelling current in the asthenosphere.

The pattern of basins and swells in Africa led McKenzie and Weiss (1975) to suggest that small scale mantle convection occurs in the upper mantle. Africa's stationarity above the mantle hot spot reference frame (Burke and Wilson, 1972) in effect traps heat due to its large conductive layer of solid lithosphere with the result that the sub-asthenospheric mantle would heat up and begin vigorous convection. The observation that the aspect ratio of laboratory or computational convection models is about unity suggests that the scale length of surface features can be used to infer the depth of the convecting system. In Africa, convection confined to upper mantle depths of 660 km fits these observations.
If the swells and basins of Africa are manifestations of small scale convection in the upper mantle how do plumes fit into this picture? Perhaps the extreme upwellings such as Afar, Kenya, Tristan Da Cunha are plumes from the lower mantle and represent a separate style of convection. Alternatively they could be regions where upper mantle upwelling just happens to be most vigorous, but are, nonetheless, confined to the upper mantle circulation system. For our purposes it suffices to note that numerous regions of upwelling occur that heat and elevate the lithosphere and are more apparent in Africa than on other continents because of its stationarity above the underlying convection pattern.

**PUSH-PULL RIFT MECHANICS**

We assume then that small scale convection in the mantle heats a slowly moving continent and causes localized regions of uplift. The lithosphere beneath the thermally uplifted regions has a higher homologous temperature and is thereby significantly weaker than the surroundings. The load exerted by the spreading forces is concentrated in the brittle crust which fails and forms a rift graben. Rifting is probably linear because it follows old suture zones linking elevated regions, rather than being caused by linear convective upwelling in the mantle. Many rift zones are thought to have developed at ancient continental collision zones. The weakness of old suture zones may be exacerbated by trapped lower crust from those orogenies which, having transformed to eclogite, preserves radioactive heat sources at mantle depths where the crust was hitherto thickened (Ryan and Dewey, 1996).

The question as to whether a rift is successful depends on how easy it is to move the plates on each side. If either adjacent plate is subducting, then slab pull aids in the rifting process, and a rift push-pull mechanism operates. Rift opening is accompanied by further upwelling of hot mantle that renews the topographic push. For example, the Red Sea readily opened in the direction of subduction of Arabia under Iran. If the margin is ringed by ancient slabs that are subducting, then slab roll-back, though not actually pulling the continent apart, presents a slippery boundary allowing the plates to separate and rifting to become successful. Such was the situation for South America in the time of the breakup of Pangaea where back are basins formed long the west coast at the time of breakup, to be eventually overrun as ridge push from the Atlantic gained the upper hand. On the other hand, if the continent is surrounded by compressive tectonic features such as mid-ocean ridges, shallow subducting slabs, or zones of continental collision, rifting is not likely to be successful and having formed a graben some 50 to 100 km across would cease spreading and fail, leaving behind a failed rift.

**CONCLUSION**

On the basis of these ideas will the East African, Rio Grande or Baikal rifts be successful? Much of Africa is surrounded by mid-ocean ridges. To the north it has collided with Eurasia. The continent has the largest number of hot spots for any continental land mass, presumably over upwelling limbs of small scale convection. Upwelling mantle currents on their own probably do not rift continents. They provide two important components: the topographic drive and the weakened lithosphere. The combination of topography and slab pull or suction may be needed for success. Thus at this level of understanding the answer is no, Africa will not be successful. The Rio Grande rift has Atlantic ridge push one side and the San Andreas transform the other, which has replaced subduction of the Farallon plate. Thus the Rio Grande also will not be successful. Baikal probably has originated from a combination of lithospheric thinning by localized convection and the large scale stresses of Asia including the India/Asia collision. Its flanks are not directly connected to slab pull or slab suction. As it stands it appears not to be destined for success. However that may change depending on its interaction with subduction of the western Pacific plate. All of these rifts have evolved over the last thirty million years, the same period as development of the successful Red Sea rift, but only the Red Sea was attached to a nearby subducting plate.

Although hardly satisfactory to make predictions we can never test, perhaps, these ideas can be applied to reconstructions of ocean basins and failed rifts to understand the forces that operated at those times, and how subsequent structures developed as mantle cooling and erosion erased the signature of the driving forces that led to them.

**ACKNOWLEDGMENTS**

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**REFERENCES**


Slack, P.D. and P.M. Davis and the KRISP Teleseismic Working group. 1994
The seismic attenuation and velocity of P waves in the mantle beneath the east African rift, Kenya, *Tectonophysics*, 236, 331-338.


Paul M. Davis.
Department of Earth and Space Sciences
UCLA, Los Angeles. CA 90024.
THE LOST GODS OF EASTER ISLAND

Sir David Attenborough, C.H., F.R.S.

Summary of the lecture delivered on 4th March 1996

The huge stone statues of Easter Island must be among the most instantly recognisable pieces of sculpture in the world. It is unlikely that these figures were ever accorded divine status by the inhabitants of the island. They are much more likely to have been erected as tributes to leaders in the community, and may possibly have been erected in the lifetime, even at the instigation, of those to whom they were dedicated.

The islanders, however, also produced some wooden figures, notably those of bearded emaciated men, called moai kava kava and women with flat plank-like bodies, moai papa. These exist in considerable numbers and have been carved by the islanders for sale to visitors since the early nineteenth century. They do not seem to have a sacred character, though their place and function in the islanders' social and religious life has never been made clear.

In 1984, however, when visiting an ethnographic dealer in New York, I found a wooden figure of a very different kind. It was an image of a grossly elongated man, about a foot long with strange goggling eyes, surmounted by three prominent curving ridges above the eyebrows. I realised that it must be from Easter Island but I had never seen anything quite like it before. The price was extraordinarily low. The dealer explained that it was considered by the auction house to be, if not a fake, then a carving that was so eccentric that it must be very late in date. But it was going so cheaply that he couldn't resist it and he wouldn't want anything except a minimal profit. I bought it and immediately started to try and trace its origins.

All the sale room would tell me, with the usual secrecy about their sources, that it had come to them with a collection of other mixed antiques from a dealer in the Mid-west of America who normally dealt with fire-arms.

Then I discovered a female figure, of similar size and elongated form, with similar eyebrow ridges in the St Petersburg Etnographic Museum. All they could tell me about this was that it was part of a group of objects, called Collection 736, that had been transferred from the Russian Admiralty Museum in 1828 and that they presumed it must have been collected by a Russian expedition that had called at Easter Island. I checked on which these might have been. There were only two - Lisiansky in 1804 and Kotzebue in 1816, but on consulting the accounts of their voyages, I discovered that neither had managed to make anything but the most fleeting of visits and neither made any mention of trading with the islanders. So this provenance seemed very doubtful.

Then in 1985, to my delight, there was published a comprehensive survey of all known drawings and paintings that had been made during the voyages of Captain James Cook, between 1768 and 1775. Included was a drawing of the St Petersburg figure. The original came from an album, now in the Mitchell Library in Sydney, that had belonged to Admiral Isaac Smith, a nephew of Captain Cook's wife who had served with Cook as a junior officer during his last two voyages.

This presented a problem. If the object had been collected by either of the Russian visitors to Easter Island, as had been assumed, how did drawings of them get into Captain Cook's album? After having been made at sea on board the ship of one of the explorers, or in St Petersburg after the objects had reached the Admiralty Museum, the drawings somehow have had to find their way to Britain and then been incorporated by Admiral Smith, or one of his relatives, into an album of material devoted to Captain Cook's voyages that had been completed 29 or more years earlier. This hardly seemed likely.

It was now necessary to examine the records of Cook's visits to Easter Island more closely. Cook visited the island in 1774; he stayed five days and his ship's company included William Hodges, a leading English landscape painter who was the expedition's official artist, and two German naturalists, Johann Forster and his son George, who were responsible for making collections of animals and plants.

Also on board was an 18-year-old youth called Mahine who had been recruited in Tahiti to act as an interpreter. The account of the landings on Easter Island written by George Forster explains that the islanders, for the most part naked, had been most anxious to acquire some of the Tahitian tapa cloth that the expedition had with them.

"The desire of possessing this cloth prompted them to expose to sale several articles which perhaps they would not have parted with so easily under other circumstances. Among these were... several human figures made of narrow pieces of wood about eighteen inches to two feet long, and wrought in a much neater and more proportionate manner than we could have expected after seeing the rude sculpture of the (stone) statues. They were made to represent persons of both sexes, and the features were not very pleasing: the whole figure was much too long to be natural; however, there was something that was characteristic in them, which showed a taste for the arts. The wood of which they were made was finely polished, close-grained and dark brown.

"Mahine was most pleased with these carved human figures, the workman (sic) of which must have excelled those of the carved figures in his country, and he purchased several of them assuring us that they would be greatly valued in Tahiti."
He was not wrong. George Forster later described what happened when Mahine finally disembarked in Bora Bora in May 1774: "All his relations, who were extremely numerous, expected presents as their due... As long as the generous youth had some of those riches left, which he had collected at the peril of his life on our dangerous and dismal cruise, he was perpetually importuned to share them out, and though he freely distributed all he had, some of his acquaintances complained that he was niggardly."

The Easter Island gods had thus made their way to Tahiti. To establish a link with St Petersburg, it was Russian voyages to that island that needed to be checked.

In July 1820 the Russian explorer Thaddeus Bellinghausen in his ship Vostok arrived in Tahiti. His own journal tells how he was welcomed with great enthusiasm by the islanders, who by this time had been converted to Christianity. Eager as ever to obtain European goods, they traded coconuts and fresh fruit, pigs and chickens for calico and cotton prints, mirrors, cheap knives, axes and glassware. Bellinghausen tells how he entertained Pomare, King of Tahiti, on board ship, and how the king pleaded so earnestly for calico that the captain gave him the sheets from his own bed.

The journal entry for the day before their departure reads: "The King and all the other islanders arrived in the morning to do business and brought all sorts of hand-made goods, which we purchased and later placed in the Museum of the Imperial Admiralty."

Museum records show that Bellinghausen's collection was included in Collection 736 and that does indeed contain thirteen objects from Tahiti. And with them, sharing the same number, is the elongated figure from Easter Island.

I had proved that the St Petersburg figure was even more important than the Museum recognised. It was undoubtedly collected by Cook and was the first piece of sculpture to leave the island and reach Europe.

But what about mine? Was it a fake, carved somewhere in Europe in recent years? That possibility was virtually excluded when I took the figure to the Research Laboratory at the Royal Botanic Gardens, Kew. There, after microscopic examination, the wood was identified as coming from the toto-miro tree. This is the traditional material that the Easter Islanders used and the tree grows nowhere else. It seemed certain therefore that the piece was carved on the island.

But could the carver have been an Easter Islander who, in recent times had copied a picture of the St Petersburg woman? That possibility was excluded because the toto-miro tree had died in the 1950's and no timber suitable for carving had been available for many years earlier, and the St Petersburg piece was not illustrated in any book until 1973.

Maybe it was carved soon after Cook had left, when the image of the figures Mahine had taken away was still fresh in a sculptor's mind. Were that the case, however, one should expect there to be other versions in other collections. There are none. Unlike the moaia kava-kava and the moai papa, figures of this kind were never carved for sale.

There is evidence that each family on the island had its own unique collection of god images that belonged exclusively to themselves. When Cook arrived, the islanders had just suffered a major tribal war and the population was greatly reduced. Perhaps one of the islanders on the beach, anxious to obtain cloth, took the figures that had belonged to a recently extinct family, which no longer had relevance to anyone alive, and traded them, as a group to Mahine. No one thereafter had any cause to carve such things and by the time people started carving figures for sale, that strange head had been forgotten.

So I like to believe that my figure had indeed been collected originally by Mahine and represents a god from Easter Island that, until now, has not been recognised. I hope you may think so too.

Sir David Attenborough
ALTERNATIVE NEPAL

Report on the lecture given by Dr Franklyn Perring on March 18th 1996, written by Mrs Doreen Thompson

(The lecture was given at short notice owing to the illness of Richard Mabey who was to have spoken on Flora Britannica. Dr Perring was the General Secretary of the Royal Society for Nature Conservation and President of the Botanical Society of the British Isles, and now runs the Wildlife Travel Company).

A trip to Nepal usually involves scaling the heights, but after three days in the fascinating capital, Kathmandu, Dr Perring's group travelled with their Sherpas, and cook, south to a range of hills about 300 feet high called the Mahabharat. They were able to walk through villages and observe the inhabitants working, less affected by the tourists than they are in the north amongst the mountains. The only access is on foot and everything, for example, branches from the sal trees, used as fodder for the animals, is carried on the people's backs. Road construction only started in Nepal in 1954, and from my own experiences in 1990 was still carrying on then, part of the road to Pokhara being constructed by the Chinese and the other section by the British. Dr Perring showed slides of the famous monkey temple Swayambhunath and explained the influence of the two main religions, Buddhism from the north and Hinduism from the south and also the Muslim influence from North India.

We saw slides of the elaborate window frames and shutters, carved from the very durable sal wood. The leaves of the sal tree are used as plates. Temples are guarded by elaborate gods, male to one side, female on the other. I liked his rather irreverent analogy of the two at the base of the steps to one of the temples in Bhaktapur as bouncers.

Nothing is wasted in the economy, beans are spread on pine needles, which are then used as bedding and finally as compost.

One species of pine, Pinus roxburghii, named after a former director to the Calcutta Botanic garden bears needles in groups of three and has upright cones. Another species wallichiana, also named after a former director, grows up to the tree line and has groups of five needles and large drooping cones. As in other parts of the third world, cultivation by humans and oxen is carried out on narrow terraces, constructed when the forest has been felled, which in some cases leads to serious erosion. The group had intended to camp on a flat grassy area in one village, but this and the village street had been strewn with large boulders carried by water. Streams are directed down through small mills which grind the corn. Tree identification was made easier when they were able to collect the fruits, otherwise many of them have similar shaped tough leaves. Curiosity about the material in the offering at a wayside shrine resulted in the identification of the seeds from a bean pod 18 inches long.

Much of the Terai, in which the Chitwan National Park is situated, close to the border of India, is under threat due to increased population and agriculture, now that there is no longer a malaria problem. However at Temple Tiger there is a healthy population of about 400 one-horned rhinos which do not appear to be poached. These are much easier to see than the famous tigers of which there are about 80.

Ornithologists saw many bird species as they drifted in a boat along the river. The silk cotton tree which has many uses, has a huge red flower 4 inches across growing on bare stalks. Cotton is obtained from the pod to stuff pillows, the seeds are used to feed cattle and the root is said to be an aphrodisiac.

We saw slides of numerous shrubs and plants, some in botanical families familiar to us, others less so. Many plants are associated with religious rituals and therefore found near monasteries.

We saw two species of primula, one resembling our own Primula farinosa, P. denticulata and P. pereulens which grow in damp conditions. There are several species of oak, and attractive magnolias and the peepal tree, Ficus religiosa. The ambition of one group member was achieved when she saw a tree festooned with orchids. I will long remember the slide of Nepal's national flower, the rhododendron tree, festooned with red blooms in front of the magnificent snow-topped mountains.

Another part of holiday was spent on walks from Pokhara up to 8000 feet and trips on Phewa tal lake from which several species of kingfisher and other birds can easily be observed. It was interesting to see slides of the research station at Lunli which was built for returning Garkas. Experiments are carried out on various crops and strains of trees to see which will grow most successfully in the area. Two hundred and fifty people are employed and there is a school for 5-13 year-olds. Dr Perring's company aims to help them financially because funding is being cut.

Doreen Thompson
(Natural History Section)

Dr Franklin Perring,
Green Acres,
Wood Lane,
Oundle. PE8 5TP.
WINTERING GULLS IN VICTORIA PARK, LEICESTER

by D.A.C. McNeil

INTRODUCTION: Following an appeal made by the Leicestershire and Rutland Ornithological Society in 1962 for counts of gulls wintering on open spaces in Leicestershire, the author kept daily records for Victoria Park (SK597030). During the first winter the park was snow-bound and there were very few gulls. Counting was continued, however, with an interruption between September 1966 and January 1968, until the spring of 1975. The purpose of the present paper is to report these observations.

METHODS

Victoria Park is a large rectangular area (69 acres, 30.25 ha) of close-mown grass with tree-lined asphalt paths crossing it. In the winter much of the park was marked out for soccer pitches, which were used regularly on Saturday and Sunday afternoons. At the London Road end there is a slight ridge, the rest of the park sloping to the south-west, towards the Welford Road. The author entered the park opposite Queen's Road and left either by the University exit or past the war memorial (see figure 1).

Counting and identification depended on the weather, the location of the gulls and the commitments of the author. As a result the daily records are incomplete, some giving counts for each species, others of all gulls, and yet others just noting the presence of gulls. The last category is excluded from this analysis. Further, in the more distant areas by London Road some gulls may have escaped counts, although groups of gulls frequently moved at the time the counts were made (mostly between 8.30 and 9.00 a.m.).

Very few immature birds were seen, and no separate counts were kept. No counts were made at weekends when there was too much disturbance for gulls to settle.

Weather notes were kept with these records, though it is not always possible to relate the exact weather conditions to the time of the counts. The records were subjective; only occasionally were the "official" conditions saved. For the purposes of this analysis the weather was classified as cloudy (more than 5.8th cloud cover), clear (less than 6.8th cover) and wet (rain or snow). Wind strengths and directions are subjective. No gulls settled in the park for any length of time when snow lay on the ground, and no count was possible in foggy conditions.

On the assumption that the birds were feeding - individual birds were well spaced out and continually on the move, pecking occasionally at the turf - it may be argued that the effects of football boots on the turf could uncover fresh food supplies, and that counts should be higher on Mondays than for the rest of the week. It is also possible that wet weather may cause animal life to move to or from the surface, which would be reflected by comparing the gull count with that of the previous and next day.

The gull counts were therefore analysed firstly for variation over the 11 winters for which figures were available for each month; for Mondays and other weekdays, for the weather and for counts made 24 hours before and after rain.

RESULTS

Table 1 shows the first and last records of gulls settled on the park together with the highest count recorded for each winter. Table 2 lists the "out-of-season" occurrences of migrating post-breeding birds.

It was found that on average common gulls (Larus canus L.) were about 20 times more abundant that black-headed gulls (L. ridibundus L.) over the period of the study. In 1963 and 1964 the numbers of identified gulls were approximately equal (see figure 2) but thereafter the numbers of black-headed gulls fell away to a very small proportion of the total count. In addition there was a large number of gulls which were not identified. As the vast majority of identified gulls were common gulls, the present analysis has lumped the figures for both species on the assumption that any differences in behaviour of the small black-headed representation would not distort the findings.

Figure 3 shows the mean variation of identified gulls with the month: it may be seen that the species appear at about the same time in October. However, common gull numbers peak in November and again in January, whilst the numbers of black-headed gulls peak in December. An explanation for the lower count in December for common gulls was found.
Table 1. Annual Statistics

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Table 2. Other records of gulls.

1. Black-backed gulls

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2. Black-headed gulls out of season

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The direct relationships between the total number of gulls and the year, month, and the weather was examined using multiple regression analysis. Three variables were found to be significant at the 5% level: the particular winter, the month and the wind force. No relationship between counts and wet, dry, cloudy and sunny days or wind direction was found.

For any indirect influences on numbers through food supply two statistical tests were carried out. The examination of the counts made on wet days and those made 24 hours before or after show by Student-t tests no significant differences (t = 0.61, p > 0.05 120 d.f. and t = 0.75 p > 0.05 112 d.f. log transformed data) strongly suggesting that gull numbers were not influenced by any variations in food supplies caused by rain. Secondly, counts made on Mondays were compared with those made on other days using a Student-t test. Counts on Mondays were found not to differ significantly from other days of the week (t = 1.50 p < 0.05 575 d.f. log transformed data).

CONCLUSION

On the non-breeding season habits and food of the common gull, Cramp et al (1983 pp792-95) state that "when the young can fly, shifts to grassland . . . permanent pasture," and (of food) "Chiefly terrestrial . . . invertebrates . . . preference for drier, well-drained soils . . . extracting earthworms and other invertebrates from the surface".

Flocks of 100-200 birds seem to be the norm. The black-headed gull (Cramp et al 1983 pp750-754) " . . . resorts to lowland inland sites . . . settling on moist grassland, playing fields, urban parks . . . " The food is given as "Mainly animal material, particularly insects and earthworms . . . only supplemented by plant material . . ."
decline in black-headed gull numbers as the common gull population grew. There is no explanation of why the latter event occurred so rapidly. Cramp et al (1983 p792) state that the common gull has been increasing in numbers since the last century, but Bowes et al (1984) have shown that its numbers actually declined in the Midlands between 1963 and 1973. This contrasts with the increase in the numbers of black-headed gulls in the Midlands by over 300%.

Whilst it was clear that the gulls were feeding on the park, and presumably collecting small invertebrates - the author did not see any worms being eaten, and the management of the park did not promote seeding by many of the plants present - the results of this study suggest that mechanical or meteorological disturbances of the abundance of these invertebrates was not the cause of any variations in counts. Also the weather does not seem to affect gull numbers directly, except for strong winds and settled snow, the latter discouraging the gulls completely. In the winter most people not engaged in sporting activities stayed on the paths - except for a few students - and the gulls tended to tolerate their presence.

ACKNOWLEDGEMENTS
I would like to thank Dr F Clark of Leicester University for help with the statistical analysis, and Mr A. Wilson of The British Trust for Ornithology for reading and commenting on this paper.

REFERENCES


Dr D.A.C. McNeil
721 Loughborough Road,
Birstall,
Leicestershire. LE4 4NN.
MOUNT BARDON VOLCANISM

M.J. Le Bas
Chairman's Address to the Geology Section, 13th March 1996

Abstract: The volcanic breccias and domes exposed in the quarries at Bardon Hill are shown to be part of a larger andesite-dacite volcanic caldera complex that is contemporaneous with the bedded tuffs of the Beacon Hill Formation of Charnwood Forest. The domes are the product of the extrusion of lavas which are so viscous that they build up into mounds often 50 m high, such as can be seen growing on dacite volcanoes of Japan and elsewhere. Gravitational instabilities that develop as the domes grow and bulge, may lead to their collapse and this is usually accompanied by explosive volcanism. Geological and geo-chemical evidence indicates that the volcanism was probably entirely submarine within an volcanic island arc system on the edge of the former continent of Gondwana in the late Precambrian.

INTRODUCTION

The ancient rocks that build the hills of Charnwood Forest comprise mainly the sedimentary products of violent volcanic eruptions during the late Precambrian when Leicestershire lay on the edge of the former vast continent of Gondwana (Fig. 1). This edge-piece of crust, recently named the 'Charnwood Terrane' (Pharaoh et al 1996) later broke free from Gondwana and drifted north-westwards with other crustal fragments to form present day Britain. In Bradgate Park, on Beacon Hill and elsewhere in Charnwood, the strata exposed were produced by the fall-out of volcanic dust and ashes, but it has never been certain where that volcanic centre lay. The intrusive and extrusive volcanic rocks, currently well exposed by quarrying activities in the Whitwick-Bardon area, have often been considered to form that centre (Fig. 2).

This address questions this supposition and gives evidence that the main products of the pyroclastic volcanism at the Whitwick-Bardon centre are the coarse-grained agglomerates in the immediate vicinity of Bardon and Whitwick, and possibly also the coarse-grained volcanic breccias and tuffs seen at Nunetson. Of the fine-grained bedded tuffs in Charnwood, only those of the Beacon Hill Formation probably emanate from the Whitwick-Bardon centre, with the Blackbrook and Bradgate tuffs coming from some other unknown sources. The magma types involved are mainly dacite with some andesite. This contribution will focus on the Bardon dacitic rocks and on features pertinent to their origin and distribution.

PREVIOUS INVESTIGATIONS

In 1907, Staceley described in detail the porphyroids and agglomerates then exposed in Bardon Hill quarry, and gave cogent evidence to show that they could be correlated with the

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Fig. 1. Location during the late Precambrian of the Charnwood terrane in Avalonia: E. England; S. Scotland. After McKerrow et al (1992).
Fig. 2. Map of western Charnwood showing the many horizons of coarse-grained pyroclastic rocks recognized in the Whitwick-Bardon area, compared with the fewer further away. Modified from Watts' 1947 map by the addition of the Thringstone Fault (long dashed line) and of the outline (heavy dashed curve) of the proposed volcanic caldera.

Infra-Triassic Map of CHARNWOOD FOREST

by W.W. Watts

Founded on data collected by the Author while engaged upon H.M. Geological Survey.

Charnian rocks that lay between the 'Felsitic Agglomerate' and the 'Slate Agglomerate', and hence with rocks of the Beacon Hill Formation. Watts and subsequent workers all agreed.

In 1915, Bonney provided further detailed descriptions of the outcrops, together with a discussion on whether the dacite porphyry domes of Bardon and Whitwick were intrusive or extrusive. He considered the porphyries to be lava flows and the
breccias and agglomerates to be extrusive pyroclastic rocks. Watts (in Fox-Strangways, 1900) stated "the precisely similar rock to the Peldar Tor porphyroids on Bardon Hill is undoubtedly intrusive, as its junctions with the compact agglomerate of Bardon are exposed along the north side of the great quarries. The junction is irregular, the rock has a chilled margin, it has reddened and altered the Bardon rock in contact with it, and it includes pieces of that rock." It is shown below that these features bear another interpretation that is more in line with Watts' later (1947) suggestion that "if the junction of the Peldar-Shapley type was of the nature of the "spine" intruded and extruded in the later stages of the eruption of Mont Pelée in 1902, the breaking of it, such as then occurred, would give rise to aggregations of great "bombs" like those at Tin Meadow and Drybrook."

Bennett et al (1928) also discussed whether the fragmental rocks of Bardon were "compacted agglomerate" or "xenolith-bearing igneous rock" noting the significant feature that the fragments or "enclaves occur chiefly near the margin adjoining their respective (porphyroid) parent sources". They tentatively concluded that "a pre-existing agglomerate containing (porphyry) fragments" was invaded by the Peldar-type and other porphyries, and then more "material was intruded across the margins of the . . . porphyries enveloping fragments of them, which were to some extent carried forward into the stiff unconsolidated agglomerate, into which the molten stream diffused itself." This matches many features currently understood about emplacement of magma domes.

In the more recent British Geological Survey Memoir for the area, Worsam and Old (1988) describe andesite and dacite lavas at Bardon Hill and Peldar Tor, with the comment that "Although no vents have been identified it is likely that the source of lavas lay close by." However do quote the report by Moseley and Ford (1985) that a porphyry (dacite) dome intrusion occurs on the northern side of Bardon Hill Quarry (Fig. 3). Watts (1947) also reported the presence of a dome. The present author interprets the dome to be extrusive (for reasons given below).

Readers may be familiar with the extrusive lava-domes of the Puy de Dôme and Puy Grand Sercouei, in the Auvergnes volcanic district of France. They formed some ten or twenty thousands of years ago and their shapes remain close to those originally formed at the time of extrusion.

GEOLOGICAL BACKGROUND

In the late Precambrian, ca 600 million years ago, dacitic and pyroclastic volcanism was active at the edge of Gondwana. To the north and west across the Iapetus Ocean lay the continental plates of Baltica (present-day Scandinavia, Poland and part of NW Russia), of Laurentia (substantially the North America of today) and of Siberia (McKerrow et al 1992). This ocean was beginning to shrink and subduction therefore took place beneath the margin of the Gondwana supercontinent, and this subduction produced the volcanic rocks preserved in Charnwood. In a previous paper (Le Bas 1982), the Charnian volcanic rocks were shown to be of the type recognized in volcanic island arcs marginal to continental masses with granitic crust, e.g. Japan. No granitic crust is believed to exist under Charnwood (Maguire et al 1981), and the island-arc subduction-related volcanism of Charnwood has been confirmed by later studies (Pharaoh et al 1987). Furthermore,
these studies suggest that the Charnian volcanism belongs to the outer-arc type of subduction-related volcanism, which is chemically distinguished as the 'low potassium type', and not to the inner-arc volcanism of 'calc-alkaline type'.

THE VOLCANIC ROCKS OF BARDON QUARRY

Beneath the unconformable cover of Triassic marls and sandstones, there are four petrological rock types quarried at Bardon Hill: (i) porphyroids; (ii) volcanic tuffs; (iii) massive volcanic breccias; (iv) stratified volcanic breccias. In addition, an andesite dyke 1.5 m wide cuts dacite at the eastern end of the upper quarry. Fig. 3 shows the relationships of some of these rocks.

(i) Porphyroids occur both in Bardon Hill Quarry and in the quarries near Whitwick. The porphyroids are mainly dacitic (Table 1). They are dark green to black fine-grained rocks with abundant scattered phenocrysts of rectangular white feldspar crystals 1-3 mm across and glassy subhedral crystals of quartz 1-4 mm across. The felsitic matrix includes a few areas of chlorite, numerous granules of opaque minerals (possibly magnetite) and some small patches of epidote; it also shows outlines of a former texture of perlitic cracks. Around the phenocrysts, the texture indicates flow rather than the perlitic cracking, and the high viscosity of the flow is evident from the way the crystals have been broken and dragged apart. Some subhedral chlorite-magnetite pseudomorphs with a fracture pattern reminiscent of olivine are also present, and they may represent fayalitic olivine sometimes found in dacite (Nockolds et al. 1978).

Volcanic tuffs, mineralogically similar to the porphyroids, are texturally distinguished by the lack of the glassy matrix, by a clastic texture and by a pervasive interlocking crystallography indicative that the matrix of the rock has recrystallized. The many big crystals of quartz and feldspar are embedded in a fine-grained felsitic (quartz and alkali?) groundmass in which there are indistinctly outlined flow-shaped felsitic streaks with alignment of crystallites. The big feldspar crystals are broken, some have recrystallized outlines and all show alteration to epidote and chlorite at numerous scattered points in each crystal. The quartz crystals show strained extinction under the microscope and most have sutured margins. The whole rock is traversed by veins of quartz. This recrystallized rock forms the 'good rock' favoured by the quarriers.

(ii) Massive volcanic breccias, widely exposed at Bardon Hill quarry, carry numerous blocks of pale pink porphyritic dacite and some of andesite. It is thought that these are pink rather than the dark-colour of the less-altered porphyroids because the matrix on devitrifying to felsite has become iron-stained. The blocks vary in size from a few centimetres to over a metre across, some are rounded, most are angular and many have deep pink margins. Some show in situ partial disintegration. The matrix to the blocks is greenish and made of material akin to that of the volcanic tuffs. In some parts of the upper quarry, the pinkish blocks in the greenish matrix are sharply defined, but in most other parts of the quarry the blocky nature of the breccias is very indistinct with the pink blocks becoming darker and their outlines merging into the greenish and increasingly epidote matrix. As with the tuffs, these breccias have been recrystallized.

(iv) Stratified volcanic breccias are few and far between. Bonney described (1915) faint stratification dipping NNE at about 45° in 'fluvio-breccia' pyroclastic rocks. The analysed rock no. 115805 (Table 1) would seem to be one of these rocks. It is composed of quartz and feldspar phenocrysts in a fine-grained matrix like the porphyroids, but the texture of the matrix is unusual. It shows vitriclastic flow seen as fish-shaped streaks with ragged ends and often bounded by bands and flow lines now marked by aggregates of brown epidote crystals. Many of the feldspar phenocrysts are broken up and drawn out by the flow, but at the ends of some crystals in the pressure shadows is secondary calcite. These flow features typify magma explosively erupted, which on landing flowed before solidifying to glass. In between the glassy streaks was fine-grained fragmental ash material which, being porous, permitted migration of hydrothermal fluids that ultimately caused epidote to crystallize. Vitriclastic flow is common where extrusive domes collapse.

COMPARISON WITH OTHER DACITE DOME VOLCANIC STRUCTURES

The interpretation of these Charnian rocks is helped by looking at present-day volcanism where similar processes are operating. The mechanism of the 1980 eruption of Mount St Helens dome in northwestern U.S.A. and the vast debris flow produced might be quoted, but the more instructive Japanese eruptions of Unzen in 1991-95 in Kyushu and of Usu in 1944-5 and 1977-78 in Hokkaido will be taken.

Unzen Volcano is currently inactive after a six year period of dome building and collapsing. It was closely monitored by the Office of Volcanic Observation, Japan Meteorological Agency, Tokyo, and was reported monthly over the INTERNET. The period of activity began abruptly in May 1991 when viscous dacitic lava was extruded at the summit 1300 m above sea level. Being viscous, it formed a dome but within four days it exploded and the first pyroclastic flows poured down the mountain. Within the succeeding month, three cycles of dome-building followed by dome-collapse occurred, each accompanied by large pyroclastic flows which swept down the mountain side burying hundreds of houses near to and within the city of Shimabara 5 km away on the coast. This activity continued intermittently with 13 domes growing and collapsing until early 1995. It illustrates the violence of the volcanic activity that can be associated solely with the extrusion of lava-domes. Not only did the pyroclastic flows contain fine-grained tuffs and ashes, but also many fragmented blocks of lava up to and exceeding 1 m across.

The mechanism of dome collapse at Unzen, described by Sato et al. (1992), helps to interpret the Bardon dacites. For example, Unzen dome 9 began growing on 3rd December 1992 and by the 9th the lava-dome was 200 x 100 m and 30 m high. The dome was internally fed and grew by inflation. The external lava was viscous and blocky. The dome developed a "peel structure" and, because of its instability on the slope and explosive degassing, it tended to break-up and collapse with rockfalls on the down-slope side of the dome often accompanied by pyroclastic flows. On another side, venting of gases and high temperatures (detected by infra-red) caused reddening of older breccias. This was followed by inflation of that portion of the mountain and extrusion of dome 10 (Fig. 4). Dome 11 spread over dome 10 (extrusion rate of about one million cubic metres per day) and developed into a huge lobe 0.5 km long oozing down-slope and producing pyroclastic flows as its nose collapsed. This collapse process, repeated many times, produced great volumes of volcanic breccias interspersed with volcanic agglomeratic material explosively shot out.

Thus at Unzen volcano, instead of the usual strato-volcanic cone and crater, a hummocky volcanic structure developed of domes of
### Table 1. X-ray fluorescent analyses of the dacitic rocks of Charnwood and Nuneaton

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<th>115505 Bardon</th>
<th>116350 Bardon</th>
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dash, not analysed; Fe₂O₃ = total iron

115509 Porphyritic glassy dacite with phenocrysts of subhedral quartz and rectangular feldspar set in a felsitic matrix that shows traces of former plagioclase cracks and a flow texture indicative of the original glassy nature: Eastern dacite of Fig. 2, on north face of upper quarry, Bardon Hill

115505 Porphyritic dacite showing vitroclastic flow, with calcite filling fractures. 10 m from 115509

116350 Recrystallized volcanic breccia with porphyritic dacite clasts in a flow-textured dacitic tuff-breccia; all epitotized and penetrated by quartz veinlets. Near 115505

BU2299. Dacite porphyroid, N of High Sharpley. (Sutherland 1982, Table B2)

EM2. Dacite porphyroid. High Sharpley. (Pharaoh et al 1987, Table I)

115508 Dacite crystal-tuff (Caldecote Volcanics) with rounded quartz and broken feldspar crystals; some devitrified shards; epitotized. Top level, NW end of Judkins Quarry, Nuneaton


viscous dacitic lava extruded on the summit and upper slopes. These domes attained heights of 50-150 m before most of them collapsed producing vast aprons of breccias and pyroclastic flows, as well as volcanic bombs which landed in the immediate vicinity and bedded tuffs further away.

Dome growth was well documented during the eruptions of the Usu volcano in north Japan. The Usu volcanic complex includes a vast caldera 10 km diameter, now occupied by Lake Toya. On the south rim of the caldera in a corn field in mid-1944, steam, then ash were emitted, but viscous dacite magma was extruded, and in nine months the Showa-Shinzan dome (D5 in Fig. 5), 1 km across at the base, grew to a height of 279 m above base with no significant rockfalls and only a few minor ash-producing explosions, and later sinking at the rate of 5 cm per year as it cooled (Minakami et al 1951; Katsui et al 1981). In 1977, a dome (D6, Fig. 5) began growing in the smaller Usu caldera nearby, the later stages of which I was fortunately able to observe. Volcanism began with a powerful explosion and pumice eruption followed by a scree-covered dome along a 1 km long NW-SE crack in the floor of the 2 km diameter crater of Usu. In the first month, the uplift was 1 m per day; in the second it reduced to 0.5 m per day;
and for the following 12 months gradually reduced to zero uplift per day. Uplift was accompanied by minor seismic shocks on average every 20 minutes as the dome cracked its way up, and the summit (D6, named Usu-Shinzan) ceased growing 180 m above the crater floor, all without collapse.

The magma at Usu was viscous dacite like that at Unzen. The difference in volcanic development appears to have been mainly in the gravitational instability of the growing domes, the magma supply rate and the extent of dissolved gases.

SUBMARINE OR SUBAERIAL ERUPTION?

This question is not easily resolved for the Charnian rocks. The many examples of graded bedding, the continuity of individual beds and the lack of signs of wave action all indicate deposition in water below wave-base. This is in keeping with island arc volcanism, but most authorities (e.g. Williams and McBirney, 1979 p 278) consider submarine dacite complexes to be rare or rarely recorded. One such island-arc occurrence is that in the South Sandwich Islands where in 1962 pumice with inclusions floated to the surface (Gass et al 1963). The pumice was low-K dacite and the inclusions were andesitic. Submarine calderas are even less well recognized, but again are known. Busby-Spera (1984) describes an example from the Mesozoic rocks in California which show evidence of eruption from submarine calderas of massive debris flows similar to those at Nuneaton.

At Judkins Quarry, Nuneaton are preserved late Precambrian bedded dacitic volcanic breccias and tuffs, some thick, some thin, that are cut by diorite (markfieldite) and usually correlated with the rocks of Charnwood Forest (Carney and Pharaoh 1993). The thicker breccias and tuffs at Nuneaton closely resemble petrographically the rocks of Bardon, and andesite fragments are entrained in some of the Nuneaton breccias. These fragments have andesine plagioclase phenocrysts in a cryptocrystalline groundmass in which lie many tiny laths of plagioclase each with ‘tuning fork’ terminations. The latter indicate quenching such as occurs in submarine pillow lavas.

Although it is possible that only the summit region of the Whitwick-Bardon volcanic structure might have been subaerial, it would be expected that rocks showing the transition from subaerial to sub-wave-base would be detected among the exposures in Charnwood. There are none, and it is proposed that the Whitwick-Bardon volcanic complex was submarine. Volcanic domes can grow under water; INTERNET reports (30.3.96) that one began doing so 1-2 months ago in the crater lake of the active volcano Ruapehu in New Zealand.

VOLCANISM AT MT BARDON

Combining the petrographic and geological evidence gleaned from the Bardon rocks, with the volcanological evidence gained from the Japanese examples, an interpretation is attempted for the Whitwick-Bardon complex. A cross-section through Usu shows similarities with one through Bardon and Whitwick (Fig. 5). If the
Charnian domes were extruded on the sloping surfaces of an earlier phase of volcanism, then dome collapse and explosive eruption are likely to have taken place, producing the breccias and agglomerates observed.

The rock relationships at Bardon (Fig. 3) are interpreted as showing that the domes are buried by block-bearing tuffs and breccias that broke off or spilled off domes as they grew. But, lack of much fracture in the Bardon domes indicate that they did not suffer major collapse, unlike the dacites at High Sharpley which are much fractured and altered, and are interpreted as representing collapsed dome material.

Moseley and Ford (1985) record 1286 m of coarse-grained tuffs, volcanic breccias, lapilli tuffs and dust tuffs in the Charnwood Lodge area, which is in contrast to the finer-grained and less thick beds elsewhere in Charnwood Forest. This gives evidence that powerful pyroclastic volcanism was centred on NW Charnwood. Worssam and Old (1988) show that the blocks in the 'Bomb Rocks' of Charnwood Lodge can be matched with the dacites at Whitwick, and that the blocks in these breccias are up to 1 m across and of mixed type (e.g. Tin Meadow), indicative of closeness to source and in contrast to the fewer breccia horizons further east which are better sorted and with smaller clasts. Worssam and Old (1988) also record the great increases in thickness of these breccias towards Bardon and Whitwick. The Benscliffe Agglomerate is 75 m thick near Whitwick but thins to 15 m at Rocky Plantation 5 km to the SE. It is proposed that a caldera structure must have existed in the Whitwick-Bardon area as depicted in Fig. 5.

A caldera is further suggested by the possible correlation of the Caldecombe volcanic tuffs of Nuneaton with the dacites of Whitwick and Bardon, with which they are chemically identical (Table 1). None of the Charnian volcanic tuffs to the east and north and outside the immediate Whitwick-Bardon-Charnwood Lodge area are coarse-grained enough to represent the main outpourings from that centre, and therefore the erupted materials must have flowed in the opposite direction, and Nuneaton lies in that direction. The correlation cannot be proved, but the Whitwick-Bardon pyroclastic volcanism lies towards the top of the Charnian volcanic stratigraphic sequence, and the Caldecombe volcanic rocks, all water-lain, lie at the top of the currently preserved Precambrian volcanic sequence. Nuneaton is 2.5 km from Charnwood and that is well within the distance that big submarine pyroclastic flows can travel. A major eruption on Dominica in the Caribbean island are produced a coarse-grained sub-aqueous pyroclastic flow deposit over 200 km long (Cas and Wright 1987).

The topmost main unit of the Caldecombe tuffs is over 20 m thick in Juddkins quarry, Nuneaton and over 10 m at Harthill, 2 km to the northwest. If that is extended back to Charnwood, that would give a volume of one cubic kilometre of explosively erupted magma. This is the same volume as that violently erupted from Mount St Helens, Washington State, U.S.A. on 18th May 1980. It is also the same as the estimated average total annual production for all island arc volcanoes for one year (Fisher and Schmincke 1984). It has been suggested that such big-scale eruption is caused by the introduction of hot basic magma into the bottom of an acid magma chamber. The basic inclusions in some of the dacitic tuffs are evidence of this process having occurred. However, some of the tuffs are Nuneaton appear to show imbrication structures more consistent with transport towards the north-east, which would negate the proposed Charnwood source (Carney and Pharaoh 1993).

Many of the d acitic rocks in the Whitwick-Bardon area grade into andesites. Moseley and Ford (1989) have published chemical analyses showing that at Charnwood Lodge, the bombs and blocks are dacitic but the matrix is partly andesitic and partly dacitic. At Bardon, some of the 'good rock' breccias are andesitic, others dacitic, with both andesite and dacite forming the contained fragments. Worssam and Old (1988) also describe andesite lavas within the breccias. The presence of andesite fragments suggests that andesite may underlie the Whitwick-Bardon area; this accords with the usual structure of dacitic volcanoes. Most subduction-related volcanism begins with andesite, or basaltic andesite, magmatism.

What actually underlies the Whitwick-Bardon area is not known. The Thringstone Fault runs through it, and to the SW of that are down-faulted Coal Measures. Geophysical data give some information. It is an area of magnetic 'high' like the rest of Charnwood, but is also an area of gravity 'low'. The latter may be due to the thick Carboniferous rocks present. However, Kane et al (1967) have shown that gravity lows also characterise the centre of calderas. The magnetic high would accord with the presence of Charnian volcanic rocks at depth, and it may be reasonably proposed that the centre and andesitic core of the Whitwick-Bardon volcanic complex may lie under the Whitwick-Greenhill area to the north-east of Coalville (Fig. 2).

Mineralization and recrystallization commonly occur during the dying and fumarolic phase of volcanism. The dacite domes and tuffs of the Whitwick area show only slight signs of recrystallization, whereas at Bardon it is strong (King 1968) and the tuffs and breccias there are recrystallized to 'good rock'. The overlying 'Slate Agglomerate' appears to be unaffected and therefore post-dates that process. Thus the Bardon area may be interpreted as the site of the final stages of volcanism at the Whitwick-Bardon centre, and it is speculated that one feature of dying volcanism might be the collapse of the water-logged volcanic structure, perhaps triggered by seismic action. This and its aftershocks could have produced the Sliding Stone Slump Breccia and the beds immediately above it, which are so well displayed in Braggate Park just south of the War Memorial near Old John (locality 16 in Sutherland et al 1987).

In the rocks of Bardon Quarry are several large quartz veins occupying fault zones, also some dolomite, hematite and rare gold, belonging to a later mineralization of uncertain date, perhaps Caledonian (King 1968).

**GEOCHEMISTRY**

Table 1 presents three new chemical analyses of the dacites and 'good rock' of Bardon, a new one of dacitic tuff at Nuneaton; and three of comparable analyses taken from the literature. The CaO and Sr contents are variable, in keeping with the localized epidotization and secondary calcite formation. The Charnwood rocks show slightly higher silica which is thought to be related to the recrystallization that produced the 'good rock' of Bardon. The recrystallization seems to have extended to High Sharpley. The higher silica means that some of these rocks could correctly be named rhyolites, but the geological interpretation of these rocks given in this contribution shows they might better be described as silicified dacites.

The high Na₂O contents reflect the albite-rich composition of the alkali feldspar, and this feature is interpreted to be the result of sea-water trapped in the lavas during submarine extrusion.
The difference in composition between the Charnwood and Nuneaton rocks is so slight as to suggest correlation; the trace elements are particularly close (Ba and Zn must be discounted because there is a local barite-sphalerite mineralization at Nuneaton). With normal magmatic differentiation, when Ba content is plotted against for andesites and dacites, Ba rises (being an incompatible element in silicate magmas) while total Fe,O, falls. Fig. 6 show this is true for the rocks in general in the Whitwick-Bardon volcano, but that Ba falls in the mineralized 'good rock'. Ba does not correlate with the K,O content, and this is interpreted to indicate that the loss of Ba is not related to any changes in the feldspar composition but is related to the later mineralization which recrystallized the rocks.

No copper, lead or zinc mineralization is evident at Bardon.

**RECONSTRUCTION AND SUMMARY OF EVENTS AT BARDON**

On the above evidence, a possible 7-stage evolution of the Whitwick-Bardon volcanic complex is proposed. Not included are the Blackmore Formation dacite tuffs and the Bradgate Tuffs above the Sliding Stone Slump Breccia. These are thought not to have any relationship with the Whitwick-Bardon complex.

1. Formation of early andesitic submarine volcano centred just NE of Coalville, which evolved into dacitic volcanism.
2. Caldera formed, marked by massive eruption and formation of the Benciscliffe Agglomerate and possibly also the thick crystal-lithic tuffs and debris flows found at Nuneaton, all of which contain both andesitic and dacitic fragments.
3. Continued pyroclastic eruptions, some strongly explosive some less so, which produced the deposition of thick and widespread tuffs (Beacon Hill Tuffs with its intercalations of coarser-grained horizons in the Whitwick-Bardon area), and at the same time the extrusion of dacite domes (Peldar, Sharpley) some of which collapsed giving violent eruption.
4. Migration of the centre of volcanic activity southeast towards Bardon. More dacite domes and further deposition of thick bedded tuffs (continuation of Beacon Hill Tuffs), formation of breccias, andesite lavas and dykes.
5. Volcanism dies and there is silification of the tuffs and breccias at Bardon by fumarolic action. Widespread albition by reaction with saline groundwaters.
6. Massive collapse of the 'dead' volcanic structure centred on Whitwick, caused by seismic disturbance (faulting?). Production of coarse breccias and submarine debris flows (The Sliding Stone Slump Breccia).
7. Later quartz veins and mineralization and, some 200-300 Ma later, more widespread mineralization in Leicestershire causing much epidotization in Charnwood which reset the *Rb/Sr isotope ratio and hence changed the age that might be deduced.

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**REFERENCES**


Fox-Strangways, C. 1906. The geology of the country between Atherstone and Charnwood Forest: Explanation of sheet 155. H.M.S.O.


Stracey, B. 1907. The north-west district of Charnwood Forest. Transactions of the Leicester Literary and Philosophical Society. 11, 74-80.


Dr M.J. Le Bas.
University Fellow,
Department of Geology,
University of Leicester.
ORIGINS AND INNOVATIONS: THE FIRST 200 MILLION YEARS OF VERTEBRATE EVOLUTION

Geology Section Symposium held at Vaughan College on March 9th 1996

Introduction by

Mark A. Purnell

These are exciting times for vertebrates. Their origin, their phylogeny, and their evolution are all contentious issues, and established theories, some long-held as scientific truths, are being challenged and overturned by new data and new analyses. The vertebrate tree is being shaken vigorously by palaeontologists, molecular geneticists, and developmental biologists, but its roots are also extending deeper and more securely into geological time. The vertebrate tree is, of course, just one of many which share the common root of life on Earth, but it is the branch in which we, as vertebrates, tend to place extra significance. Consideration of how, when and why a creature like amphioxus gave rise to the first vertebrate, for example, is not just the stuff of dry, academic debate, but also raises questions about what we are and where we came from. An ideal subject, then, for a public meeting.

Such a meeting was organised in March by Richard Aldridge and on behalf of the Geology Section of the Leicester Literary and Philosophical Society and Vaughan College of Leicester University. A range of speakers from around Britain provided a brief taste of the excitement and controversy current in this field, and the abstracts that appear below give a summary of their presentations. My intention here is to very briefly review the field and to provide some of the broader context within which recent developments are set. To do this, I will contrast a 'textbook view' with the new picture of vertebrate origins and evolution that is emerging from the developmental, genetic, and palaeontological research of the last few years and months. Inevitably, this Aunt Sally is to some extent a caricature, and few may still adhere to all aspects of the hypothesis as I outline it. But it remains, none-the-less, an effective way to illustrate the dramatic changes that are taking place in this field. Some of the organisms under discussion, their stratigraphic distribution, and possible relationships are illustrated in Figure 1.

According to the traditional view, much of which can still be found in undergraduate textbooks: 1. Pikaia, from the Middle Cambrian Burgess Shale, is the oldest known member of the Chordata, the phylum to which vertebrates belong.

2. The first vertebrates appeared in the Ordovician, and the group evolved rather slowly until a radiation of new forms, including the first vertebrates with jaws, in the Silurian or Devonian.

3. In terms of their ecology, the first vertebrates arose in fresh water or marine environments, and were relatively inactive suspension-feeding organisms, comparable with the living amphioxus and larval lampreys, which feed by collecting microscopic food particles with a mucus lined filter. All the early vertebrates lacked jaws and were probably suspension or deposit-feeders.

4. The earliest vertebrates were entirely soft bodied and their vulnerability to attack by some of the large invertebrate predators that existed in the Early Palaeozoic, such as eurypterids (sea scorpions) and other large arthropods, led to the evolution of the first hard parts as a protective external armour of bony plates or scales.

5. Jaws evolved from the gill arches of a jawless ancestor, only with the evolution of jaws and true teeth could vertebrates adopt a greater diversity of feeding mechanisms, including predatory feeding habits.

6. The first four-limbed vertebrates, the tetrapods, gradually evolved from lobe-finned fishes in the Devonian, and the anatomical changes associated with their developing limbs allowed tetrapods to become increasingly terrestrial.

The evidence for Pikaia being the earliest fossil chordate (1) has recently been challenged by the interpretation of Yunnanozoon, a fossil from the Early Cambrian Chengjiang deposit (Chen et al 1996, see M. P. Smith abstract). Chen et al interpreted Yunnanozoon as a chordate, but another interpretation of Yunnanozoon as a member of the phylum Hemichordata has recently been published (Shu et al 1996). These authors present convincing evidence against the chordate interpretation, and their hypothesis that Yunnanozoon is a semi-chordate is better supported by the available data. So, although still lacking a description, the amphioxus-like Pikaia remains as the earliest fossil chordate.

Work over the last few years presented at the meeting by Peter Holland (and reviewed in Holland and Garcia-Fernandez, 1996), has also confirmed cephalochordates (in the form of amphioxus) as the nearest living relative of the vertebrates and suggests that the common ancestor of vertebrates and amphioxus must have been genetically very similar to amphioxus. Thus investigations into the development and genetics of amphioxus can reveal details of the transition from cephalochordates to vertebrates that the fossil record could never furnish. Examinations of Hox genes have proven particularly informative, as these genes, which play a crucial role in early development and provide important landmarks in embryos and larvae, have revealed cryptic similarities between amphioxus and vertebrates that were not previously apparent. According to the widely held and influential scenario of vertebrate origins proposed by Gans and Northcutt (1983), the development of a head with complex sensory systems and a brain is one of the key evolutionary novelties that marked the emergence of vertebrates. But the amphioxus Hox gene data suggest that the vertebrate head is not a completely new structure; rather, it is an elaboration of pre-existing portions of the anterior nerve cord of the cephalochordate ancestor. Amphioxus also provides clues to the genetic basis for vertebrate origins: vertebrates have double the number of genes of cephalochordates, and this gene duplication at the origin of vertebrates may have
Figure 1. The fossil record and possible phylogeny of cephalochordates and various vertebrate groups discussed by contributors to the meeting. The solid black lines indicate stratigraphic distribution; the grey lines indicate significant gaps in the record between known fossil or living representatives. The white lines illustrate one hypothesis of relationships between living and fossil vertebrates and their nearest living ancestors, the cephalochordates (modified from that of Forey and Janvier, 1994; position of conodonts based on Gabbott et al 1995). Note that in this diagram, the tetrapods (see Ahlberg abstract) are subsumed within "vertebrates with jaws".
provided the genetic raw material on which natural selection worked to produce the vertebrates.

The timing of vertebrate origins and diversification (2) has also been challenged by new fossil evidence. There is still some debate surrounding the exact placement of conodonts within the chordates, but the evidence of fossilized soft tissues and the microstructure of their hard mouth-parts (see abstracts by Aldridge and by Sansom, and reviews listed in the bibliography) strongly suggest that conodonts were vertebrates (Figure 1). The recent reinterpretation of the internal structure of *Anatolepis* provides evidence that they also may belong somewhere among the vertebrates (Smith et al. 1996), and as both conodonts and *Anatolepis* first appear in the late Cambrian, the origin of the vertebrates must be pushed firmly back into the Middle Cambrian at the latest. As for diversification, evidence from conodonts and other groups now points towards a radiation in the Ordovician (see Sansom abstract; Sansom et al. 1996) and contradicts previous hypotheses of slow evolution until the Silurian or Devonian. This work also identifies possible vertebrates with jaws as early as the Late Ordovician.

Although there are recent exceptions (Griffith, 1994), it is now generally acknowledged that there is no evidence to support a fresh water origin for the vertebrates (3). Their nearest living relatives are all marine, as are all the early fossil vertebrates. In contrast, the idea that early jawless vertebrates were suspension-feeders is still widely held (see Forey abstract), despite the hypothesis that the origin of vertebrates was linked with an ecological shift from suspension-feeding to active predation, and that it was this shift that provided the selective pressures which led to the evolution of many of the key anatomical characters of vertebrates (Jollie, 1982; Grant and Northcutt, 1983). The difficulty with looking at feeding mechanisms in fossil jawless vertebrates is that they preserve almost no direct evidence for how they fed, but the picture is different if we include conodonts. The fossil record of conodonts is made up almost exclusively of their mouth parts, and although the hypothesis that conodonts were suspension feeders is still advocated by some (Nicoll, 1995), recent work (Purnell abstract, Purnell, 1995) provides strong evidence that the phosphatic mouth parts of conodonts functioned as teeth. Conodonts, among the earliest fossil vertebrates, were probably predatory, and this lends strong support to the hypothesis that the first vertebrates were also predators. It also contradicts the view that vertebrates were incapable of such feeding habits before the evolution of jaws.

The evidence from conodonts also questions hypotheses linking the evolution of the first hard skeletal parts to the need for protection (4). The only hard parts possessed by conodonts were their feeding elements, and this raises the possibility that the first hard tissues arose, not as a defensive mechanism, but in order to improve prey capture.

The evolution of jaws in vertebrates (5) conveyed significant advantages in that they allowed a great increase in the variety and sophistication of feeding modes possible. However, the origin of jaws, as pointed out by Forey, is still something of a mystery. The hypothesis that jaws are anatomically comparable (homologous) with, and evolved from the gill arches of jawless fishes has a number of problems, the gills in jawless vertebrates are located on the inside of the gill arches, but are on the outside of the arches in vertebrates with jaws, for example. It is possible that jaws have not anatomical counterparts or precursors in jawless vertebrates, but recent work (Mallatt in press) supports the traditional view of the origin of jaws. Interestingly, there was a second event of genetic doubling at the time of origin of the jawed vertebrates (e.g., Holland and Garcia-Fernandez, 1996).

Whatever they evolved from and why, the increasing complexity of the jaws through fish evolution clearly correlated with enhanced food capture and processing ability and must have opened up new ecological niches into which fish were able to diversify (Forey abstract). The evolution of true teeth is closely related to the evolution of jaws, and the patterns of evolution, diversification and adaptation in the teeth of lungfish (see M.M. Smith abstract) provide an example of the constraints that operated and novel solutions to problems associated with feeding.

Without a clear picture of evolutionary relationships, much of what has been said in the past concerning the evolution of tetrapods is little more than a 'just so story' couched in scientific terms (6). But more recent work has analysed changes in anatomical characters within rigorously constructed evolutionary trees, and coupled with discoveries of new fossil material this has led to better models of the transition from fish to vertebrates with limbs (see Ahlgberg abstract). One surprising outcome of this new work is that changes in construction of the braincase and pelvis and the appearance of digits on the limbs all occurred abruptly and simultaneously, suggesting that these characters were linked in some way in tetrapod development (Ahlgberg abstract, Ahlgberg et al 1996).

Speakers at the meeting conveyed much of the novelty and scientific excitement surrounding these advances in understanding of our own corner of evolution, and I hope that those who attended left with a sense of this. This meeting was unusual in that work at the cutting edge of science was presented to an audience comprised largely of non-specialists, a refreshing change from the usual expert to expert communication. It is certainly a very crude measure, but the fact that all the contributors to this meeting have had papers in Nature over the past three or four years (in fact three published since the meeting in March) gives some sense of the significance and topicality of the work.

REFERENCES


TALES OF TEETH AND TAILS - AN OVERVIEW OF THE ORIGIN OF VERTEBRATES

M. Paul Smith

A traditional view of the origin and early evolution of vertebrates would include a first appearance for the chordates, the phylum to which vertebrates are assigned, during the Middle Cambrian followed by the first appearance of true vertebrates during the Middle Ordovician. The first vertebrates were thought to have been heavily armoured, bottom-living fish and, overall, vertebrate evolution was thought to have been slow until the late Silurian or Devonian when a wide variety of jawless (agnathan) and true jawed vertebrates appeared. Over the past decade, a succession of new discoveries has forced a re-evaluation of every one of these statements, and few remain valid.

The oldest generally accepted fossil chordate is *Pikaia* from the Middle Cambrian Burgess Shale of British Columbia. The 4 cm long, laterally compressed body possesses a notochord, muscle segments and a tail with unsupported fins. The bilobed head bears a pair of slender tentacles and, behind it, a row of twelve short appendages may represent the exterior expressions of gill slits. Although the organism awaits a full taxonomic description, its body plan is consistent with that of a pre-vertebrate chordate and it is often likened to living cephalochordates (amphioxus). Very recently an older contender, from the Lower Cambrian of China, has been advanced as a chordate. *Yunnanozoon* is also laterally compressed with evidence of segmentation, but other features are more enigmatic. Chen et al (1995) interpreted circular structures along the length of the body as paired gonads and the segmentation as muscle myomers which, together with a postulated notochord, would be indicative of a cephalochordate relationship. Other palaeontologists remain far from convinced, and more work will be necessary before *Yunnanozoon* can be accepted as a chordate. The oldest universally accepted vertebrates come from a variety of mid-to-late Ordovician localities in Australia, North America and South America (see Sansom and Forey, this volume) but, again, recent developments have radically changed the outlook. The addition of conodonts to the vertebrates (see Aldridge, Purnell and Sansom, this volume) means that the group has an origin in the Late Cambrian, some 40 million years earlier than generally recognised and much closer to the oldest pre-vertebrate chordates.

A final part of the jigsaw is *Anatolespis*, a microscopic scale known from the Late Cambrian to Early Ordovician of North America, Greenland and Spitsbergen. Although initially described as a vertebrate (Bockelie and Fortey 1976) this interpretation has been widely disputed on the grounds that the available data on tissue structure were unconvincing and that the scales fell outside the known morphological range of other accepted early vertebrates. Further doubt was cast upon the vertebrate affinity of *Anatolespis* when specimens from East Greenland were interpreted as the cuticular fragments of arthropods. New work on the morphology and histology of large collections of *Anatolespis* (Smith et al 1996) has demonstrated the presence of dentine, a tissue unique to vertebrates, confirming that the taxon is both a vertebrate and the oldest known fish. It can therefore be concluded that not only had vertebrates appeared as early as the Late Cambrian, but that the radiation of different lineages and body plans was already under way, in distinct contrast to traditional models of vertebrate evolution.

M. Paul Smith.
School of Earth Sciences,
University of Birmingham,
Edgbaston,
Birmingham. B15 2TT.

WHAT MAKES A VERTEBRATE? CLUES FROM GENES AND DEVELOPMENT

Peter W. H. Holland

Where did the vertebrates come from? To answer this we must identify key differences between invertebrates and vertebrates, and then deduce how new characters arose. The traditional sources of evidence have been palaeontology and anatomy. Recently, new answers have started to come from a newly tapped source of data: DNA. These molecular studies have revealed a striking difference between invertebrates and vertebrates: the number of genes they possess. This number increased several fold during early vertebrate evolution; other chordates such as amphioxus retain an archetypal genetic organisation. I argue that vertebrates would not have arisen without these new genes. New evolutionary insights also come from comparing how genes are used in different taxa. For example, a group of genes known as homebox genes reveal cryptic homologies between chordate body plans, and help resolve how anatomy changed during vertebrate origins.

Peter W. H. Holland.
School of Animal and Microbial Sciences,
University of Reading, Whiteknights,
PO Box 228, Reading. RG6 2AJ.
CONODONTS: THE SOFT TISSUE EVIDENCE FOR VERTEBRATE AFFINITY

Richard J. Aldridge

Until recently, conodonts were an entirely enigmatic group of animals, known only from the fossil record, where they were exclusively represented by phosphatic toothlike elements. These elements made up the feeding apparatus of the animal, and almost always became disarticulated and scattered in the sediment when the conodonts died and decayed. Conodonts possessed no other biomineralized skeleton, but in 1982 our knowledge of conodont anatomy was revolutionised when the first of a number of fossils with preserved soft tissues was discovered. That initial find has been augmented by subsequent collecting, but even now well-preserved conodont soft tissues are known from only two places: the Ordovician Soom Shale of South Africa and the Carboniferous Granton Shrimp Bed of Edinburgh, Scotland. In both, the preservation of particular tissues and organs has been highly selective, and specimens exhibit only part of the soft anatomy of the original organism. However, using information gleaned from several specimens, it has proved possible to reconstruct many of the characters of the living conodont animal.

To date, ten specimens have been recovered from the Granton Shrimp Bed, all elongate and up to 55 mm in length. They all exhibit features of the animal's trunk, including V-shaped myomerces and the remains of a notochord. Two specimens preserve the tail, with an apparently asymmetrical caudal fin in which radial supports are evident. On two of the specimens structures in the head are also evident, including a probable pair of well-developed eyes, possible otic capsules, and indistinct branchial structures. A single giant specimen from the Soom Shale (preserved length 120 mm, complete length perhaps 400 mm) displays part of the trunk and head, while at least forty have been found from the same horizon in which apparent eye cartilages are associated with complete feeding apparatuses. The most complete Soom specimen shows exquisitely detailed preservation of the trunk musculature, with clear muscle fibres and myofibrils. These are unlike the extremely flattened muscles of amphioxus, but their rod-like structure compares with the slow fibres of agnathans and other fish. Fibrous structures in the head region have also been interpreted as extrinsic musculature that operated the eyes.

The soft tissue anatomy shows conclusively that conodonts are chordates, while features such as the eye capsules, extrinsic eye muscles, tail fins and biomineralized feeding apparatus point strongly to a phylogenetic position within the craniates. The precise placement of conodonts relative to living protochordates (amphioxus) and agnathans (hagfishes and lampreys) is still controversial, although accumulating evidence increasingly supports an assignment of the Conodonta to the vertebrates.

Richard J. Aldridge.
Department of Geology,
University of Leicester,
Leicester. LE1 7RH.

THE NATURE OF THE FIRST VERTEBRATES AND THE FUNCTION OF THE FIRST HARD PARTS

Mark A. Purnell

According to traditional, textbook views, the first vertebrates were small, soft bodied animals, a few centimetres in length. They had no jaws or teeth and fed by filtering microscopic particles and micro-organisms from the sea water in which they lived. They were not particularly active animals and were vulnerable to attack by some of the large invertebrate predators which existed in the Early Palaeozoic seas, such as sea scorpions (eurypterids) or other large arthropods. The vulnerability of these early vertebrates led to the evolution of the first hard parts as a protective external armour of bony plates or scales. Evidence for this picture of vertebrate origins comes primarily from the ecology of two living animals: amphioxus (Branchiostoma) and larval lampreys (amnocoetes). Amphioxus is generally held to be the nearest living relative of the vertebrates, and lampreys (along with hagfish) are the only living representatives of the once diverse group of primitive jawless fishes which were the first vertebrates. Both amphioxus and amnocoetes are rather sluggish, filter feeding animals with no hard parts. The hypothesis that hard parts first arose in vertebrates as protective armour is derived primarily from the fossil record; until recently, the only fossilized remains of early vertebrates were pieces of bony skin armour.

More recently, an alternative scenario of vertebrate origins has been proposed by developmental biologists. Advocates of this hypothesis contend that many of the definitive characters of vertebrates, such as paired eyes and muscular and skeletal adaptations for active life, would not have evolved unless the first vertebrates were active predatory animals. According to this theory one of the most important steps in the chain of events that led to the first vertebrates was a radical shift in feeding strategy, from sedentary filter feeding to active predation; an ecological shift which may provide the key to understanding the evolutionary pressures involved in the origin of vertebrates. The first hard parts, according to this view, may have served to enhance electroreception and detection of prey.

One of the more serious problems faced by palaeontologists wishing to contribute to the debate over vertebrate origins is the
Vertebrate appearances in North America

- Jawless fish
- "Jawed" fish

Vertebrate appearances in southern hemisphere

- Jawless fish

See abstract by Ivor J. Sanson (opposite page)
extremely low preservation potential of the small soft body of the first vertebrates. Fossilized hard parts are more likely to be preserved, but until very recently there was no direct evidence to indicate how early vertebrates fed. The recognition that conodonts are among the oldest and most primitive vertebrates (Aldridge, this volume), however, shifts the balance in this debate. The hard parts of conodonts, their phosphatic elements, preserve microscopic scratches and chips on their surfaces which indicate that they functioned as teeth, and that conodonts were probably predators. This provides strong support for the hypothesis that the earliest vertebrates were active predators and suggests that the first vertebrate hard parts evolved not as a means of protection, but in order to make our earliest ancestor a more efficient killer.

Mark A. Purnell.
Department of Geology,
University of Leicester,
Leicester. LE1 7RH.

EVOLUTION OF "TEETH" AND SCALES IN THE EARLIEST VERTEBRATES: NEW EVIDENCE FROM MICROVERTEBRATE REMAINS

Ivan J. Sansom

The Cambro-Ordovician is marked by a period of rapid diversification amongst the earliest vertebrates. Two lineages of vertebrates, conodonts and fish, make their first appearance in the fossil record during the Late Cambrian, and both clades undergo a major evolutionary event into the Ordovician. The conodont evolutionary episode is characterised by the appearance of numerous different styles of oral feeding apparatus, and has long been recognised by palaeontologists. The radiation amongst the fishes was traditionally thought to have taken place during the Silurian and Devonian periods, and articulated specimens of whole animals are relatively common in rocks of that age. However, recent studies on fragments of skin armour and bony scales from Ordovician localities in Australia, the U.S.A., Bolivia and Argentina, suggest that most groups of fish had appeared somewhat earlier. The dermal armour of primitive fish and the "teeth" of conodonts consist of the same hard tissues from which our own teeth are formed. The types of enamel, dentine and bone found in Ordovician vertebrates show subtle variations in tissue combination and structure, and by recognising these variations it is possible to discriminate between the major groups of primitive fish. On the basis of these studies, we are able to reveal a more complete picture of the evolutionary history of the earliest vertebrates, although the search for articulated, complete specimens still goes on.

Ivan J. Sansom.
School of Earth Sciences,
University of Birmingham,
Edgbaston, Birmingham. B15 2TT.

NATURE READ IN TOOTH AND JAW

Peter L. Forey

Vertebrate animals, and especially the fish-like vertebrates, show a bewildering variety of teeth and jaws from the sucking mouths of surgeons to the powerful throat teeth of teleost fishes supported by pharyngeal jaws. The fossil record provides yet different examples of prey capturing mechanisms, most of which rely on the presence of jaws. However, the first fishes survived without jaws or teeth and for most of these they fed, or what they ate remains a mystery. Equally mysterious is the origin of jaws, which many scientists regard as the most significant event in vertebrate evolution. Advantages of jaws are obvious but the first jaws may have been without true teeth. Many scientists regard teeth and scales as synonymous but it turns out that true teeth, which are replaceable and formed on a dental lamina, may have been a relatively late addition to vertebrate design.

The development of teeth went hand-in-hand with the development of the jaws which supported them. From simple beginnings the jaws became more complex and able to perform a greater variety of movement; this was associated with an increased complexity of the musculature. The first jawed fishes had a single set of jaws but many modern fishes have up to three sets, with each one adapted for different parts of the feeding cycle.

Peter L. Forey.
Department of Palaeontology,
Natural History Museum,
Cromwell Road,
London. SW7 5BD.

41
BONES AND TEETH: TRANSFORMATION, INNOVATION AND ADAPTATION IN DEVONIAN TO RECENT LUNGFISH

Moya M. Smith

Lungfish (dipnoans) are one of the most highly conserved Devonian fossil fish groups in which little evolutionary change has occurred since the end of the Carboniferous. Three genera still exist today in the continents of Australia, Africa and South America. However, during the Devonian period there was rapid diversification and experimentation, in particular with the dentition, a unique derived feature of dipnoans relative to osteichthyan fish (Smith 1988). The best examples of this Devonian species diversity are found in calcareous nodules in the Gogo Formation, in the Canning Basin, North Western Australia. Here, fossils are exquisitely preserved as complete fish in three-dimensional form and can be recovered intact by acid dissolution of the encasing limestone. This exceptional preservation has allowed a comprehensive study of their morphology and associated histology, providing details of cellular participation in the growth and adaptation of their dentition. One of the unique features of the dentition is that it consists of paired palatal (pterygoid) and lingual (prearticular) crushing dental plates. These were formed from a hypermineralised type of dentine (petrodentine), as hard as enamel but replaced continuously throughout life from below the functional surface by cells situated in an extensive pulp cavity in the underlying bone (Smith 1984). This tissue evolved early in Devonian forms with dental plates, as an adaptation to resist wear of the continuously growing, non-shedding dentition; it is retained in the three living genera (Smith 1988).

Of the living genera, the Australian Neoceratodus is considered to be the more primitive and the African Protorus and South American Lepidosiren to be closely related, sharing a similar form of dentition (Smith 1984). Although most adult lungfish do not possess the typical marginal tooth-bearing bones of most other groups of fish, their relationships are controversial and potentially informative for the understanding of evolutionary processes through developmental change. Examples of change in the structure of the dentition from the juvenile to the adult are known in both fossil and extant species. Significantly, the dentition of the Early Devonian Diabolopsis speratus, considered as the most primitive dipnoan, does possess short marginal rows of teeth on the lower jaw (dentary) and the upper jaw (premaxilla) of the adult (Smith and Chang 1992), in addition to the typical paired, upper and lower opposing dental plates comprised of radiating rows of teeth. This feature also occurs in the juveniles of a Russian Devonian form of dipterid, Andrejevichthys epitomus, where several marginal bones possess conical teeth; these are absent and presumed lost by regression in the adult. This phenomenon has also been described in the living Neoceratodus forsteri, where teeth are present on the margins of the lower jaw as paired dentaries and a symphyseal tooth, but these disappear as soon as the dental plates become functional (Kemp 1995).

The presence of living forms quite unchanged from those of the Carboniferous allows interpretation of the developmental and growth events shown by the equivalent tissues of the fossils. The extant lungfish, together with the extant coelacanth, are all considered as "living fossils" because they are the only representatives of a once widespread group of lobe-finned fish (sarcopterygians) and represent the closest living forms to tetrapods.

Moya M. Smith.
Craniofacial Development,
Division of Dentistry,
UMDS - Guy's Hospital,
University of London,
London. SE1 9RT.
Figure 1 - Arrangement of radial rows of teeth in a typical dipterid palatal tooth plate. Teeth increase in size along each row, the largest and newest teeth at the lateral ends, the smallest and most worn at the origin, which is medio-posterior. Teeth of individual rows decrease in number and in overall size from anterior to posterior.

Figure 2 - Diagrams of individual rows of teeth. A: the morphology in profile of medial 1st row in Dipterus sp., Antarctica, U. Devonian. Progressive addition of separate, larger teeth at the lateral margin, the newest (t11) is the most lateral and is one of four unworn teeth, t1-t5 are worn and contribute to the functional surface. Bar = 1mm. B: vertical, medio-lateral section of Ceratodus runcinatus, growth lines show successive additions of petrodentine each covered by a new layer of enamel, and projected area of tissue loss within the dashed line. Bar = 1mm. C: similar section to B, juvenile Ceratodus parvus with columns of petrodentine under enamel and softer dentine. Bar = 1mm.

b - bone; d - dentine; e - enamel; g - growth lines; p - petrodentine; pc - pulp cavity. [From Smith 1988].
SMALL STEPS AND BIG LEAPS ON THE WAY TO LAND

Per E. Ahlberg

The evolution of the first four-limbed vertebrates (tetrapods) from fishes, starting during the Devonian period about 380 million years ago, involved some fundamental changes in body plan. The paired fins became limbs with digits, the limb girdles and backbone were modified into interconnected load-bearing structures, the median fins and the gills were lost, and a hinge in the middle of the skull (the "intracranial joint") disappeared. During the last ten years, it has become possible to start piecing together the relationships of the earliest tetrapods and their nearest relatives, using the technique of cladistic analysis. This approach generates rigorous testable "family trees" called cladograms, on which the distribution of primitive and specialised anatomical characters can be mapped. In this way it is possible to work out the sequence in which the anatomical changes from fish to tetrapod occurred. At the same time, new discoveries of early tetrapod material, such as the complete bodies of Acanthostega from East Greenland, have provided much new information about the early stages of the transition.

The starting point for the transformation from fish to tetrapod is shown by lofinned fishes like the "osteolepiform" Eusthenopteron. Osteolepiform fishes had some tetrapod-like anatomical features, such as limb-like internal skeletons in the paired fins, but in other respects they appear as "normal" open-water fishes. The next two steps are represented respectively by "panderichthyid" fishes and by the early tetrapods Acanthostega and Ichthyostega. Panderichthyids still have paired fins rather than limbs, but they have acquired the crocodile-like head and body shape typical of early tetrapods. This suggests that they had abandoned the open water in favour of a different mode of life - maybe swimming and crawling through very shallow water near the shore. Acanthostega and Ichthyostega, which come from the latest Upper Devonian, have proper limbs with digits, and limb girdles like those of later tetrapods, but they retain tail fins and (in the case of) Acanthostega gills. This suggests that they had not yet left the water; it may be that most of the tetrapod characteristics evolved initially for use in shallow water rather than on land.

A very curious feature of tetrapod evolution is the contrast in rates of change between different structures. The general shape, and the construction of the external skull bones, shoulder girdle, backbone, and proximal parts of the limbs (out as far as the wrist/ankle) change very gradually up the clade. This is the kind of pattern one might expect on the basis of traditional models of evolution. However, the construction of the braincase (the internal part of the skull) and the pelvis changes very abruptly at the same time as digits first appear on the limbs. This raises two questions: firstly, how could these changes occur so quickly? and secondly, why did they all happen at the same time? The answer to both these questions may lie with the behaviour of major developmental control genes such as homeobox genes. Small mutations in such genes can generate big changes in morphology, and the involvement of some of these genes in the development of both the head and the limbs may explain why both structures changed at the same time. However, for the present these interpretations remain speculative.

Per E. Ahlberg
Department of Palaeontology,
Natural History Museum,
Cromwell Road,
London. SW7 5BD.

REFERENCES AND SUGGESTIONS FOR FURTHER READING

Early vertebrates: general references


The nature and affinities of conodonts


The origin of tetrapods

Ahlberg, P.E. & Milner, A.R. 1994. The origin and early diversification of tetrapods. Nature, 368, 507-514. (This is a broad review article which contains numerous references to other papers).

ANNUAL REPORT AND PROGRAMME FOR THE
154th SESSION 1995-1996

PRESIDENT'S REPORT

Annual reports given by Presidents of Leicester Literary and Philosophical Society are by tradition brief, concise and to the point. None that I have ever heard or read is more than a short sketch of the state of the nation, though, believe it or not, for a few years around 1869, they included comments about the weather, even the annual rainfall.

I do not intend, in this regard, to break with tradition, and will therefore confine myself to expressing genuine and heart-felt thanks to a number of people.

First of all, I thank you, the members, for the honour you bestowed upon me, and for the backing you have given the Council and myself during the season. When I recall the diffidence with which I accepted your nomination, I can scarcely believe that I have enjoyed my term in office so much. That I have done so is due solely to your kind and generous support. You have even laughed at my jokes.

I also thank the Council for tolerating me. It is no secret that the administration of our society breaks most of the rules of democratic government. With a co-operative Council, the wheels still turn more or less smoothly, and they have been a most co-operative and willing team. One member of Council, Mrs Cara Rablen, has indicated her wish to retire, and on behalf of all I thank her for the many practical contributions which she made on many evenings. Happily she plans to continue to sit in the pews as a valued member of the society.

Mr Keith Smithson also left Council, and we didn't lose him either. Having done so much work to enable us to become Registered Charity No. 1047498, with consequent tax advantages, he decided to volunteer as one of the two Independent Examiners required by the regulations to audit our accounts, and so became ineligible for membership of Council.

In what I believe is a more realistic method of calculation, I reckon the current membership to be 349, made up of 119 double (or family) tickets, and 111 single tickets. For some reason that I cannot understand, it has been the practice to assess the membership simply as the total number of tickets paid for, overlooking the fact that there was a so-called 'family ticket', that invariably covered two people, as indeed it was intended to do. At 349, membership is therefore as high as it has been since 1983.

It is also pleasing to record that during the year the average attendance at meetings has also been much higher than usual.

These facts together reflect great credit upon Hilary and Geoff, Lewis, our indefatigable programme secretaries, and I am delighted to express my sincere thanks to them. I am sure they will agree that they in turn receive a great amount of help from one member of the society in particular, Mrs Jean Humphreys, and I would like to record our conjoined gratitude to her. We have enjoyed this year an excellent programme, with perhaps several highlights which I will forbear to identify. Personally I enjoyed them all, star or not, and I hope you did too. I acknowledge our indebtedness to each and every one of our speakers.

We also extend our thanks to our sponsors, De Montfort University, Dillons the Bookshop, the University Bookshop, the Leicester Mercury and the Royal Society of Chemistry, as well as to the Geology and Natural History Sections for their help and support. The Council is not minded to extend the list of sponsors at this time, but in a commercial world, sponsorship enables us to maintain standards and we are grateful to them all.

And I would like to include a word of appreciation for the work of the members of the staff of the Museum and Art Gallery who prepare the room, turn up the lights, welcome us all and then finally send us off into the night with a courteous efficiency that we value highly.

My catalogue of thanks now reaches the Hon. Secretary, Joan Staples, for whose help and guidance I have the highest praise. Her job is not one that comes to life at about 7 p.m. every other Monday. It is an ongoing task that she performs conscientiously and cheerfully throughout the year to the benefit of us all.

Finally, I extend on your behalf and my own, a very special thanks to our Hon. Treasurer, Philip Goodwin. On this occasion last year my predecessor Hughie Jones told you that Philip had been in post for nearly 20 years. I am able to say that he soldiered on to complete the full two decades. No society could ever have a more conscientious steward of its finances, and the healthy state of affairs that he will shortly describe for you owes everything to his painstaking work over the years. He will be too modest, but we know the value of all that he has done and achieved.

As a result of all the effort by all the people whom I have listed in my report, I know that come September 30, I will hand over to my successor, Professor John Holloway of Leicester University Department of Chemistry, a society in tip-top form.

Ormond K. Smyth,
April 22nd, 1996.

46
PROGRAMME FOR THE 1995-1996 SESSION


16th October 1995 THE CONTEMPORARY BRITISH NOVEL by Professor Malcolm Bradbury, University of East Anglia.


8th January 1996 METEOR IMPACTS AND THE HISTORY OF LIFE by Professor Simon Conway-Morris, University of Cambridge. Joint lecture with the Geology Section.

22nd January 1996 PROTECTING THE WORLD'S HERITAGE DURING ARMED CONFLICTS by Professor Patrick Boyle, City University.

5th February, 1996 ON BEING A BIT LESS GREEN by Dr John Emsley, Imperial College.

19th February 1996 PARLIAMENT, PRESS AND PRIVACY by Simon Hoggart.


18th March 1996 ALTERNATIVE NEPAL by Dr Franklyn Perring.

22nd April 1996 Annual General Meeting, followed by a recital by the Kingfisher Chorale.

Summer Excursions 1995


20th May 1995 Finding buried treasure - a geophysics hands-on exercise. Manor Road, Oadby. Leader Dr Ian Hill.

24th June 1995 British Gypsum Mine, Barrow-on-Soar. Leader Graham Stocks.


Winter Programme 1995-96


18th October 1995 GOLD: WHERE WHY AND HOW by Dr Jeremy Richards, University of Leicester.

1st November 1995 WHAT REALLY HAPPENED AT KRAKATOA by Dr Alan Woolley, Natural History Museum.


19th November 1995 THE REVOLUTION IN PUBLISHING GEOLOGY by Dr Marge Wilson, Leeds University.

13th December 1995 Members' Evening.


24th January 1996 WHATS NEW IN TEACHING GEOLOGICAL SCIENCE by Dr Evelyn Brown, Open University.

7th February 1996 SURELY THEY DON'T NEED PROTECTING - THEY ARE ONLY ROCKS by Dr Keith Duff, English Nature.

21st February 1996 Members' Evening.

9th March 1996 ORIGINS AND INNOVATIONS, Saturday School at Vaughan College.

13th March 1996 Annual General Meeting with Chairman's Address on the MOUNT BARDON VOLCANO by Dr M.J. LeBas.

GEOLOGY SECTION REPORT 1995-1996

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Spring 1995 Programme;

January 11th THE WORK OF THE WOODLAND TRUST by Graham Woodall
January 25th THE NATURAL HISTORY OF BADGERS by Bill Cunningham
February 8th HOVERFLIES by Dr Francis Gilbert (joint with the Entomological Society)
February 22nd INTO THE HEART OF BORNEO by Dr Susan Page
March 6th THE CHANGING STATUS OF BRITAIN’S BIRDS by Chris Meade (joint meeting with Parent Body)
March 8th VARIETY IS THE SPICE OF LIFE by Ian Evans
March 22nd CONSERVING LEICESTER’S WILDLIFE by Jenny Owen
April 5th A.G.M., Quiz and Social evening.

Summer Excursions

April 22nd Barnack Hills and Holes - leader David Hughes
May 6-8th Woodchester Park - leaders Jean & Dennis Cooper
May 13th Great Merrible Wood - leader Graham Worrall
June 4th Wye Valley and Forest of Dean - leader Steve Bishop
June 7th Bat count at Charnwood Lodge - leader Jan Dawson
June 24th Empingham Marsh - leaders Barbara Parker & Phyllis Cook
July 8th C.E.G.B Site, Leicester - leader Derek Lott
July 22nd Moth trapping at 20 Acre Piece - leaders John & Sally Mousley & Harry Ball.
August 5th Priory Water - leaders Tony Dakin & Dave Gamble
August 9th Gall meeting in Groby Pool area - leader Les Jones
August 19th River Sence and Sibson Brook - leader Eric
Knight September: 9th Charnwood Lodge - leader Peter Gamble
September 23rd Prior’s Coppice fungus foray. leader R.Illiffe
October 8th North Norfolk coast- leaders R.S.P.B.

Winter Programme 1995

October 25th RED KITE RE-INTRODUCTION PROGRAMME by Ian Carter
November 28th FOREIGN FLATWORMS - ARE THEY TAKING OVER? by Dr Hugh Jones
November 22nd CONSERVING LEICESTERSHIRE’S BUTTERFLIES by Eva Penn-Smith (23rd Sowter Memorial Lecture)
December 6th SLIDES OF TANZANIA by Jean & Dennis Cooper
MEMBERSHIP LIST 1995-96

1969
Alexander, Mrs. L. A. M., MA, 22 Ratcliffe Road, Leicester, LE2 3TB

1984
Ambler, Mrs. A. J., Dip.Ed., 6 Cottesmore Avenue, Oadby, Leicester, LE2 4SX

1988
Anthony, Dr. W. S., 14 Knighton Drive, Leicester, LE2 3HB

1994
Archer, MR M. S., MBA, ACIB, MIBM., Apt.1 Springfield, 2 St. Mary's Road, Leicester, LE2 1XA

1989
Armitage, Mrs. R., 3 Wilmington Court, Glebe Road, Leicester, LE2 2LD

1998
Ashraf, Mr. M. S., MA, 59 Greenhill Road, Leicester, LE2 3DN

1990
Aston, Mr. C. E., BSc.(Hons)/Text. ATL, One B Cairnsford Road, Leicester, LE2 5GG

1991
Bailey, Mr. M. H., MA, 1 Beresford Drive, Leicester, LE2 3LB

1992
Bailey, Mrs. D. M., JP, BSc., 1 Beresford Road, Leicester, LE2 3LB

1995
Baker, Mr and Mrs C., 352 Victoria Park Road, Leicester, LE2 1XF

1996
Barker, Miss M. M., MA, Flat 6 Stoneycroft, 32 Stoneygate Road, Leicester, LE2 2AD

1997
Barker, Mr and Mrs D. T., 9 Spinney View, Great Glen, Leicester, LE8 9EP

1998
Barrett, Mr. D. A., 7 Firs Road, Houghton on the Hill, Leicester, LE7 9GU

1999
Beeson, Mr. R. B. D., The Hollies, Foresworth, Leicester, LE17 5EG

2000
Beeson, Mrs. J., BSc., The Hollies, Foresworth, Lutterworth, LE17 5EG

2001
Bell, Mr. J. A., 19 Hall Close, Kilworth Harcourt, Leicester, LE8 0ND

2002
Bentley, Mrs. M., BSc., 27 Brooks Hill Drive, Oadby, Leicester, LE2 5RE

2003
Bethel, Dr. R. D., CBE, DLitt. LLD. ATD. FCSW. RW 48 Holmfirth Road, Leicester, LE2 1SA

2004
Bevington, Mr. A., B.A., D.Phil., 7 Hazeldene Road, Hamilton, Leicester, LE5 1UA

2005
Bournier, Mr. L. P., 48 Rushmere Walk, Leicester Forest East, LE3 3PD

2006
Boylan, Prof. P. J., BSc. Ph.D. FGS. FMA. FBIM. FRSA The Deepings, Gun Lane, Kibworth, SG3 6BJ

2007
Boynton, Mr. D., BSc.(Eng/Ceng. MIMechE., The Fairway, Oadby, Leicester, LE2 2HH

2008
Brady, Miss R. L., BA(Hons), 38 Lime Grove, Kirby Muxloe, Leicester, LE9 2DF

2009
Brady, Mrs. S., MA, 38 Lime Grove, Kirby Muxloe, Leicester, LE9 2DF

2010
Brock, DR. W. H., BSc. MSc. Ph.D., 431 London Road, Leicester, LE2 3JW

2011
Burgess, Dr. K. F. O., BSc. MBCh. FRCP., 2 The Green, Anstey, Leicester, LE7 7FU

2012
Brunning, Mr and Mrs D. W., Bushby House Main Street, Bushby, Bushby

2013
Bulman, Mr. J. R., 42 Holmfirth Avenue, Leicester, LE2 2BF

2014
Burton, Mr. G., 26 Shirley Avenue, Leicester, LE2 3NA

2015
Campbell, Mrs. J., 12 Broadway Road, Leicester, LE5 7TA

2016
Carpenter, Miss W. S., 236 Kimberley Road, Leicester, LE2 1LT

2017
Catchpole, Mrs. M., 2 Youngland Court, 172 Evington Lane, Leicester, LE6 6DH

2018
Chamberlain, Mr. M. A., MA, The Manor House, Burrough on the Hill, Leicester, LE14 2JQ

2019
Chatterton, Mrs. B. V., Yew Trees, 56 Anstey Lane, Leicester, LE7 7JA

2020
Clark, Mr. E. K., OBE, BSc., 29 Northcote Road, Leicester, LE2 3FH

2021
Clarke, Rev. R.G., 11 Holmfirth Avenue, Leicester, LE2 2BG

2022
Clements, Dr. R. G., BSc.PhD. FGS., 5 Ringwood Close, Wigston, Leicester, LE18 2JL

2023
Cockshaw, Mr. W., 14 Shrophshire Road, Leicester, LE2 8IH

2024
Cook, Mr. F. E., 17 Chorley Wood Road, Evington, Leicester, LE5 6LE

2025
Cooke, Mrs. M., BSc., 447 London Road, Leicester, LE2 3JW

2026
Cooper, Mrs. J., 158 Knighton Church Road, Leicester

2027
Creswell, Mr. N. M. A., BA, MA, 59 Kensington Street, Leicester, LE4 5QG

2028
Cybulnyk, Mr. M., MFPHYS. OPP., 61 Cliffordman Way, Markfield, Leicester, LE6 9

2029
Davidson, Prof. I. M. T., BSc.Ph.D. CChem.FRC.SCR.FRSA., 80 Stoughton Road, Oadby, Leicester, LE2 4PN

2030
Davies, Mr. J. G., FCMA, 15 Petersborough Avenue, Oakham, Rutland, LE15 6EB

2031
Davis, Mrs. M. J., 25 Kingsway Road, Leicester, LE5 7TL

2032
Dean, Mrs. A. J., BA(Hons), 36 Manor Road Extension, Oadby, Leicester, LE2 1FD

2033
Denno, Miss P., 22 Howard Road, Glen Parva, Leicester, LE2 9GQ

2034
Dickinson, Mr. J., BSC.CEng.FI.M.En.F.GS. F.CollP., 118 Meadow Lane, Coalville, Leicester, LE6 3DP

2035
Dockey, Mr. R. W., FFB. FIB.E., 3 Gwendoline Drive, Countesthorpe, Leicester, LE8 5SH

2036
Dixon, Mr and Mrs G., 3 Hawthorne Drive, Evington, Leicester

2037
Doelam, Dr. F. T., 11A Knighton Rise, Oadby, Leicester, LE2 2RF

2038
Drage, Mrs. F. M., 25 Kilby Drive, Wigston, Leicester, LE8 1SR

2039
Edwards, Mr. K. J., Bsc., PhD., MA, Knighton Hall, Leicester, LE2 3WF

2040
Edwards, Mrs. J. N., 19 Rosemead Drive, Oadby, Leicester, LE2 5SB

2041
Evans, Mr. M. I., MA, FMA, MBE., Callithea, Nedd Drummond, By Laing, Sutherland, IV27 4NW

2042
Evans, Mrs. P. B., Flat 8 36 Victoria Park Road, Leicester, LE2 1XB

2043
Evans, Mr. W. H., BA., 12 Park Crescent, Oadby, Leicester, LE2 5YH

2044
Ewen, Miss R. M., 9 Midway Road, Leicester, LE5 5TP

2045
Farmer, Rev. K. W., Mo Fan 26 Deaneagate Drive, Houghton on the Hill, Leicester, LE7 9HA

2046
Findley, Miss E. R., 13 Bankart Avenue, Leicester, LE2 2DD

2047
Fisher, Dr. B. A., 29/4 Sderot Jabotinsky, Netanya, 42277, Israel

2048
Fittin-Brown, Prof. A. D., 2 Sackville Gardens, Leicester, LE2 3TH

2049
Fitzpatrick, Mr. H., 11 College Avenue, Leicester, LE2 0JF

2050
Flinders, Mrs. B. D., 63 Overdale Road, Leicester, LE2 3YT

2051
Floate, Mr. R. H., 31 Half Moon Crescent, Oadby, Leicester, LE2 4HD

2052
Florence, Dr. J. A., BA, Ph.D., 143 Evington Lane, Leicester, LE5 5PS

2053
Ford, Dr. D. T., BSc.PhD.FGS., 21 Elizabeth Drive, Oadby, Leicester, LE2 4RD

2054
Foster, Mr. J. C., Lamcroft 117 Cotes Road, Barrow-upon-Soar, Leicester, LE12 5JB

2055
Foster, Mrs. S. M., Lamcroft 117 Cotes Road, Barrow-upon-Soar, Leicester, LE12 8JB

2056
Fraser, Mrs. E., MA., 19 Guilford Road, Leicester, LE2 2PH

2057
Freer, Mrs. J. M., 9 Coal Lane, Glen Parva, Leicester, LE9 9JR

2058
Gambin, Mr. E. N., 378 Groby Road, Leicester, LE3 9QB

49

Pearson, Mr R.E., MBE, 148 Victoria Park Road, Leicester

Pickard, Mrs I.L., 21 Grenfell Road, Leicester, LE2 2PA

Fickering, Mr P., BA(Hons), 59 Main Street, Bushby, Leicester, LE7 9PL

Pitches, Mr G., MA.ARBIA, 83 The Fairway, Oadby, Leicester, LE2 2HP

Pole, Ms E., ALA, Flat Stonesby Court, 11 Stonegate Road, Leicester, LE2 2AB

Postlethwaite, Prof. L., BSc.PhD.CEng.MIEE.ACGI.MA., 60 South Kingston Road, Leicester, LE2 3LP

Potter, L., Col J.B., TD., 5 Mill Lane, Smeaton Westerby, Leicester, LE8 OQL

Price, Mrs A., JP., 2 Wakerley Road, Leicester, LE6 5AQ

Price, Mrs D.E., Ranmore Gullet Lane, Kirby Muxloe, Leicester, LE9 9BL

Pybus, Mrs M., 21 Rookerry Lane, Groby, Leicester, LE6 0GL

Rablen, Mrs M.C.B., MA., 53 Knighton Drive, Leicester, LE2 3HD

Rice, Mrs C., BSc(Hons) AKC, The Rectory, Old Church Road, Leicester, LE2 8ND

Raper, Mr B., BSc.CEng.FICE., 64 Stoughton Lane, Stoughton, Leicester, LE2 2FH

Rawlings, Dr B.J., DPhil.BA.CChem.MRSC., 1 The Park, 188 London Road, Leicester, LE2 1ND

Rees, Mr W., 166 Leicester Road, Leicester, LE2 9HH

Reeve, Miss J., MBE MA, 23 Osbourne Court, Leicester

Reviil, Mrs S.A., BA(Hons), 8 Central Avenue, Leicester, LE2 1TB

Richardson, Mrs P.M., JP., 20 Powys Avenue, Leicester, LE2 2DP

Riley, Mr P., 78 Leicester Road, Hinckley, Leicester, LE10 1LT

Rowbotham, Miss E., BSc(Hons), 8 Flixfield Close, Groby, Leicester, LE6 0EZ

Rowbotham, Mr N., BSc., FRSC., CC.Fem., 8 Flixfield Close, Groby, Leicester, LE6 0EZ

Samuelson, Ms. J.K., Flat 4 St. Philip's Road, Leicester, LE5 7TR

Schadla-Hall, Mr R.T., MA.FSA.FAMA., 96 New Walk, Leicester, LE1 6DT

Shackel, Mr M., MA., 8 Stulary Park, Leicester

Sharpe, Mr D.E., MSc.CEng., 12A Landscape Drive, Evington, Leicester, LE5 6DA

Sheppard, Mr A.C.V., LTL., 58 Coventry Road, Narborough, Leicester, LE9 5GB

Sheppard, Mr D.H., 6 Harrowden Court, Harrowden Rise, Leicester, LE3 4TL

Shilcock, Mrs M.D., 23a Sportsfield, Glenfield, Leicester, LE3 8AL

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