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Published by the Yorkshire Naturalists' Union

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Readers of *The Naturalist* will have noticed that the number of photographic illustrations has increased in recent years. Good clear photographs, suitably captioned, to accompany articles or as independent features, such as the bird portraits by Arthur Gilpin in recent issues, are always welcome.

To encourage this development, a long-standing member of the YNU, who wishes to remain anonymous, has most generously offered to make a donation, the income from which would finance the publication of a plate or equivalent illustration in future issues whenever possible. The editor, on behalf of the YNU, wishes to record his deep appreciation of this imaginative gesture.

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NATURAL HISTORY AND THE EXPLORATION OF NATURE

Presidential Address to the Yorkshire Naturalists' Union, Rise Park, 4 December 1993

GEOFFREY FRYER

> . . . you may find out many things as yet unrevealed to others, and perchance more precious, by embracing the practice of viewing Nature herself with your own eyes.
>
> William Harvey (1653) *Anatomical Exercitations, Concerning the generation of Living Creatures.* [Transl. of *De Generatione Animalium* (1651)]

The Earliest Natural History Observations

Originally the term 'natural history' embraced all that exists in nature: only in recent times has it been restricted to the study of the earth and its productions. Even in its restricted sense, the inclusion of geology is fully justified. In the delightful terminology of Hugh Miller, geology is 'natural history extended over all ages'. Man has always had an interest in natural history. The earliest true men were hunters and gatherers and must have taken a keen interest in the habits and properties of the animals and plants they sought for food, and in the rocks from which they made some of their simple tools. If one's very life depends on catching animals – from large mammals to mice and snails – and finding roots, seeds, berries and birds' eggs, it is vital to know how animals conduct their lives and where and when plant products can be found. While our forebears, of necessity, would have a utilitarian interest in these matters, I have little doubt that some of them acquired a sense of wonder, and a genuine interest in the natural world of which they were part in a more intimate sense than we are today. Splendid cave paintings, of which the most spectacular were made between 12 and 20,000 years ago, but of which some are even older, are positive evidence of this and are the earliest records of natural history observations. They document the existence of contemporary faunas and illustrate species long gone from the areas in question. Some of them are now extinct. An impressive mammalian fauna is portrayed, including horses, Mammoth, *Mammuthus primigenius*, Woolly Rhinoceros, *Coelodonta antiquitatis*, Aurochs, *Bos primigenius*, Red Deer, *Cervus elephas*, Bison, *Bison uniformis*, Ibex, *Capra ibex*, Cave Lion, *Panthera spelaea*, and a few others, with occasional representatives of other groups such as Snowy Owl, *Nyctea scandiaca*, and salmonid fishes. Palaeolithic cave paintings may have had magical or religious significance, but the artists were often careful observers, whose paintings are sometimes so accurate that we can recognise the species portrayed.

The animals depicted were often used as food and this is clearly why one invertebrate found its way into an ancient gallery. On the wall of a rock shelter, probably of Mesolithic age, bees are shown attacking someone who has been lowered down a cliff to collect honey. Moreover, the bees are merely schematic and can only be identified from the context of the scene. However, in another rock shelter, a picture of a spider apparently catching flies can only reflect pure curiosity and a positive interest in the workings of nature.

Early animal art was not restricted to cave walls. Bone and ivory were often engraved. For example, a piece of rib bone from Robin Hood's Cave, Creswell Crags, Derbyshire was decorated with the head and forequarters of a horse some 12,000 years ago and, like an antler engraved with Reindeer and Salmon, was surely produced by someone not only familiar with these animals but genuinely interested in them. Otherwise, why were they engraved?

Early Illustrations of Animals and Plants: Their Value to Natural History

From Palaeolithic times onwards, man has been sufficiently interested in animals, and to a lesser extent plants, to have produced illustrations and carvings in vast numbers. Often these were doubtless inspired by the simple attractiveness of animals but some, like a crude Neolithic outline of a flamingo in characteristic feeding posture, show that attention was paid to habits. Others provide records of contemporary faunas. In a famous frieze of geese dating from *c* 2700 BC, perhaps the oldest Egyptian mural painting, the White-fronted and Red-breasted Goose, (*Anser albifrons* and *Branta ruficollis* respectively), can be specifically identified. A third species, conceivably the Bean Goose, *Anser fabialis*, but more probably the Greylag, *A. anser*, is also depicted. This suggests that the Red-breasted Goose may then have wintered in Egypt, which is not the case today, and that the Greylag may also have been a winter visitor. Illustrations of the Papyrus plant, *Cyperus papyrus*, and Hippopotamus likewise record their former presence in Lower Egypt. Whole communities of plants and animals, terrestrial and aquatic, were illustrated in ancient Egypt. One low relief of a Hippopotamus hunt dated between 2400 and 2250 BC, shows many other animals – Crocodile, Mongoose, various birds and numerous fishes – and two small frogs hidden among vegetation on which sit two grasshoppers. Grasshoppers have attracted attention in various places and times and are among the most frequently illustrated invertebrates. Two paintings from Thebes, dated about 1400 BC, which show birds of various species being hunted, include several butterflies, possibly the earliest representations of these insects. One also appears to show dragonflies in flight. Other invertebrates including scarabaeid beetles and even tabanid flies are also illustrated in various media and contexts.

Particularly impressive are communities of Nilotic fishes whose identity is readily apparent. *Oreochromis*, *Clarias*, *Lates*, *Synodontis*, *Mormyrus* and others are depicted in remarkable detail. Fishing scenes show how they were exploited. Particularly noteworthy as revealing familiarity with habits is that the mochokid catfish *Synodontis batensoda*, which swims inverted, is so illustrated in one low relief, carved some 4500 years ago.

Among many Egyptian illustrations of birds, and perhaps even earlier than the frieze of geese, is a particularly beautiful low relief of a flock of cranes – apparently domesticated. Most of these are excellent representations of the Common Crane, *Grus grus*, now only a passage migrant in Egypt, but three individuals display tufts behind the head not present in this species, and one has some adornment of the breast. These are suggestive of the Demoiselle Crane, *Anthropoides virgo*, a species that today neither breeds nor winters in Egypt nor, apparently, occurs there on passage but is known as a rare straggler. Here too may be a clue to a change in distribution or migration routes during the last five millenia.

Of particular interest to students of the Crustacea are Assyrian reliefs of *c* 700 BC that, as incidentals to historical events, show Mesopotamian cyprinid fishes and freshwater crabs and include examples of fishes being seized by crabs, assuredly the earliest record of crustacean feeding habits. Examples are to be seen in the Assyrian gallery of the British Museum, where there are also superb portrayals of lions being hunted from horse-drawn chariots – again a record of a former distribution as the Lion, *Panthera leo*, is now extinct in that area. Here too reliefs from the 7th and 8th centuries BC portray other members of the contemporary fauna – deer, gazelles, hare, wild boar, a sow with piglets, wild asses, horses, camels, a vulture, numerous fishes and others.

These and other representations show that although science (and philosophy, from which it was not then separated) is generally regarded as having developed in Greece in the early 6th century BC, it was long pre-dated by an interest in the natural world, and by accurate observation, an essential element in science. Natural history is indeed one of the oldest of man's cultural activities, and the base from which much of his science sprang.

Because, throughout history, man has portrayed animals, and to a lesser degree plants, either accurately or as decorative motifs, and in many different media, this does not necessarily mean that the artists were always naturalists. Some of them, however, must have studied living animals very carefully in order to produce some of the masterpieces that have come down to us. They were clearly inspired by the beauty and diversity of nature and, in some cases, perhaps by genuine scientific curiosity. A Greek coin (actually from the Greek city of Akragas in Sicily) of *c* 408 BC, for example, shows two magnificent eagles on a hare and, as a bonus, a fine grasshopper; it is just one of the many Greek coins that show eagles, owls, swans, dolphins, lions, goats, bulls, crabs and other creatures that are often depicted with great care in this difficult medium. Such accurate illustrations have played a part in the development of scientific natural history. Their diversity also casts doubt on the view expressed by Hall (1983) that the origins of natural history were anthropocentric, being concerned with plants and animals related in some way with man's welfare. Many of the animals illustrated throughout history fulfil no such role.

Our Anglo-Saxon forebears made scant contributions to recorded natural history, though the Venerable Bede (*c* 673-735), who begins his *History* with an account of the land of Britain and Ireland, makes brief reference to several elements of the fauna and even gives what now seems to us a fanciful reason for the supposed absence of reptiles from Ireland. Entries in the *Anglo-Saxon Chronicle* also show that happenings in nature did not go unnoticed. Of 671, it is recorded, "In this year there was the great mortality of birds", a tantalisingly simple statement with no amplification. For 685, one version records, "In this year in Britain it rained blood, and milk and butter were turned into blood", events which have a biological explanation but which were then doubtless viewed as supernatural (as they have been much more recently). Following their conversion to Christianity, the Anglo-Saxons made much use of vine scrolls on their stone crosses and these were often inhabited by birds, and sometimes other animals. Squirrels appear on the great Bewcastle cross. They also used zoomorphic and sometimes plant designs on clasps, buckles and other items, designs derived from birds' heads being favourites. Even invertebrates received notice, but whoever illustrated spiders in a herbal of *c* 1050 was not a good observer, for these, which are labelled so we know what they are supposed to be, were given what appear to be wings!

Herbals and Bestiaries

Herbals remind us that plants too have long attracted man's interest but, while often easier to portray than animals, have been less often illustrated. Plants appear on Egyptian and Assyrian reliefs and murals but, as elsewhere, are overshadowed by zoological subjects. Knowledge and lore of plants was, however, long ago gathered into herbals. While they had considerably older precursors in Egypt, Sumer and China, the origin of herbals in Western civilisation can be traced to the writings of Theophrastus in the 4th century BC. These were probably illustrated, but no illustrations survive. Probably in the 1st century AD, Dioscorides produced a botanical work, *De materia medica*, of which a splendidly illustrated copy made in about 512 AD, the *Codex Vindobonensis*, still survives.

Herbals were practical manuals and were copied and recopied, some illustrations having lifespans of many centuries that even continued as they were transformed into woodcuts in printed herbals from the 15th century onwards. While a printed German herbal of 1485, the *Gart der Gesundheit* (also called *Herbarius zu Teutsch* and various other names) included woodcuts that achieved a considerable degree of realism, and in this respect is indeed a landmark in the development of natural history, illustrations often became extremely crude and debased during the process of copying. Those in printed herbals were sometimes so bad and conventional in character that the same woodcut was used for more than one plant in the same book. For example, in a French work, *Le Grant Herbier* of 1486-8, one woodcut does duty both for the Cherry and the Deadly Nightshade but, as Arber (1953) reassures us, such double usage was unlikely to have led to fatalities as the illustration bears not the slightest resemblance to either plant. In fact Arber was not quite correct on this point. She applied her remarks to *The Grete Herball* of 1526 – which is the Englished version of the French work – in which the block that purports to illustrate the Cherry does duty also, not for the Deadly Nightshade, but for the Tormentil!

Botanical iconography is now treated in various fine books, but one thing deserves emphasis: in the 16th century the examination and delineation of plants, that had by then sadly degenerated, was transformed, not by botanists but by artists who illustrated certain early printed books. The first such was Hans Weiditz who illustrated a Latin herbal of Otto Brunfels, appropriately called *Herbarum vivae eicones* (Living portraits of plants), between 1530 and 1536. This was the first biological book with scientifically accurate illustrations, but the text was derivative, unremarkable, and sometimes erroneous. It was quickly followed by *De Historia stirpium* of Leonhart Fuchs (1542) which also had splendid woodcuts.

It is probably no accident that (although he had his own style), Weiditz was an associate of Albrecht Dürer, who a little earlier had made his detailed studies of clumps of vegetation that are not only meticulously rendered from nature but beautiful works of art. His 'Large piece of turf' was produced in 1503, not as a contribution to botany but because the assemblage interested him. He also produced water colours of several flowers that combine accuracy and beauty, and illustrated trees. By a remarkable coincidence, at that very time another genius, Leonardo da Vinci, was also combining meticulous observation and artistic skill in his portrayals of plants, some of which, such as his Marsh Marigold, *Caltha palustris*, and Wood Anemone, *Anemone nemorosa*, survive. There had in fact been an earlier revival in *c* 1419 when Benedetto Rinio produced a manuscript herbal illustrated by Andrea Amadio, whose excellent paintings are so different from contemporary and subsequent grotesques as to be truly astonishing. This herbal was in private hands and eventually found its way into a monastery so its influence was probably not great. Such illustrations bear two hallmarks of sound natural history, meticulous observation and accurate delineation. With them modern botanical illustration began.

In some ways the zoological equivalent of the herbal was the bestiary, whose ancestry can be traced to a manuscript work, the *Physiologus* (which can be translated as *The Naturalist*). A compilation from still earlier sources, that appeared in the 4th century AD or earlier, probably in Egypt, this collection of anecdotes on the habits of animals was immensely popular. Probably written originally in Greek, it was translated into many languages, including Anglo-Saxon. By the 12th century or thereabouts, it had become the Bestiary. Although bestiaries contained some genuine natural history, this is embedded in a mass of fable and fantasy. For example, while a 12th century example gives a creditable description of the distraction display of the Partridge, it reports with equal credulity how the Phoenix lives for more than 500 years, builds and ignites its own funeral pyre, and rises from the ashes. Bestiaries, which used animals as vehicles for putting over religious doctrines and as models of morality or of less desirable traits, were among the most popular books of their time and had a long history. Like herbals they were copied repeatedly, sometimes most attractively, but the illustrations were often made by those who had never seen the animals concerned and full rein was often given to the imagination – necessarily so in the case of non-existent creatures. Indeed, the symbolism of the animals seemed more important than their appearance, and compilers of bestiaries displayed less knowledge of living animals, and greater credulity, than did Aristotle in the 4th century BC. Notwithstanding recent claims to the contrary by two enthusiasts who have produced an attractive book on the subject (George & Yapp, 1991), bestiaries did not contribute much to the development of scientific natural history.

The Importance of Illustrations in the Development of Natural History

Just as the development of scientific botany was furthered by good illustrations, so was zoology. In Western Europe, where natural history as we know it eventually developed, many centuries were to elapse before illustrations reached the standards achieved by those of ancient civilizations. A few naturalistic illustrations appeared in the 13th century. Some, such as those in the Emperor Frederick II of Hohenstaufen's book on falconry (*De arte venandi cum avibus*), were concerned with genuine natural history: others of the 13th and 14th centuries were mostly decorative, though sometimes based on accurate observations.

The Italian Renaissance, inspired in part by observation of the real world, also stimulated renewed awareness of nature and a revival of lifelike illustrations, not necessarily by naturalists. For example, the so-called Bergamo Sketchbook, produced by various hands between *c* 1400 and 1450, includes several notable bird portraits. At about the same time, Antonio Pisanello (before 1395-1455) produced a number of paintings based on careful observation of living animals. His studies on the Jay, *Garrulus glandarius*, while somewhat wooden, reveal an interest in the bird for its own sake.

Splendid anatomical illustrations were made by Leonardo da Vinci (1452-1519), who studied a variety of animals, but his work was not generally available until long after his death. He also painted animals. His 'Lady with an Ermine', *c* 1483, is intriguing. The animal is not a Stoat, being too big, though this may be deliberate, and the face is not right; and he would not have easy access to a Stoat in ermine pelage in Italy, or indeed to a Stoat at all. A Ferret may have been his model for this symbol of his patron. Whether Hans Holbein was aware of this painting is an intriguing question, but his 'Lady with a pet Squirrel and a Starling' of *c* 1527 shows certain parallelisms, and his Squirrel is beautifully done. The Starling is less successful. Holbein may well have been influenced by Dürer, who was born less than 30 years earlier and who illustrated various animals with meticulous accuracy. His famous portrait of a Hare is an outstanding example, and his depictions of invertebrates, such as a crab and a delightful Stag Beetle, have come down to us. That he influenced others, to the advantage of natural history, is shown by a celebrated illustration of Red Squirrels that bears his monogram. This, however, apparently depends upon a lost prototype by him and was executed by Hans Hoffman (1530-1591/2) whose animal drawings, while unquestionably inspired by those of his great predecessor, reveal him as an accurate observer of nature in his own right. Hoffman is credited with making an important contribution to the flowering of the northern Renaissance: he also deserves credit for his contribution to the development of accurate illustrations in natural history and thus to its advance.

It was, however, Conrad Gesner (1516-1565) who really brought to the fore the importance of illustrations in biology. His huge *Historia Animalium*, begun in 1551, included several hundred woodcuts, many of which, however, were borrowed. Some of these were good, but even Gesner had not cast off all traces of medievalism, some of his illustrations of whales and crustaceans, for example, being extremely fanciful. Of these, some had originally embellished a map of 1539 by Olaus Magnus, whose North Atlantic sea monsters and animals of northern lands were also reproduced by Sebastian Münster in 1550; they give a good impression of how little was then known of such faunas and how imagination sometimes contributed more than observation to ideas of animal form.

That improvements in animal illustration were much needed at this time is shown by a German woodcut of 1556 (some 50 years later than Dürer's Stag Beetle) purporting to be an exact representation of locusts that invaded Europe that year. The number of legs is correct: otherwise the standard is similar to that of the Anglo-Saxon spider.

Accurate illustrations showing close observation sometimes appear in unexpected contexts. A Dutch work, 'The Hours of Catherine of Cleves' (*c* 1435) for example includes several well depicted butterflies in its borders. Even more surprising, the strange 'Garden of delights' of *c* 1500 shows Hieronymus Bosch to have been a close observer of nature. Although intermingled with other figures, and perhaps overshadowed by imaginary creatures, several birds are beautifully portrayed. These include a male and female Mallard, the male revealing that close attention was paid to its behaviour in life, Kingfisher, Robin and Goldfinch (all with deliberately exaggerated beaks), Hoopoe, Green Woodpecker and Tawny Owl, a Great Tit admirably displaying its acrobatic prowess, a pair each of White Storks and Spoonbills whose postures indicate careful observation of the behaviour of both species, others of their kind in the background, Hooded and Carrion Crow and a whole menagerie of birds and beasts, real and imaginary, fishes, frogs and human figures. There is also a butterfly that perhaps owes more to the Large than to the Small Tortoiseshell. To emphasise the enormous superiority of such illustrations – which made no claims to be contributions to natural history – not only over those that purported to do so but to some that were to follow, we need only compare them with those in Topsell's *The Fowles of Heauen or History of Birdes* (1613-14 but not published until 1972). Most of these were copied from the crude figures of Aldrovandi's *Ornithologiae* (1599-1603). Notwithstanding their description in the full title of the book as 'true and liuely figures', some are barely recognisable.

Why such crude and wooden illustrations should have been deemed adequate for such a book is difficult to understand, and it is a mystery why so many illustrations of that period were inferior to some of those of the ancients, even when the difficulty of transforming some of the originals into woodcuts is taken into account. It is a sobering thought that much better bird portraits were produced more than 4000 years earlier in Egypt and that, notwithstanding greater problems than those involved in making woodcuts, the eagles on a Greek coin made 2000 years earlier were also vastly superior. It has always been a mystery to me why, with a few exceptions, it took so long to re-achieve these standards in Western Europe. Topsell's illustrations were, however, particularly crude: much better ones were produced in his own century. For example, excellent studies of birds and mammals were made by the German artist Carl Ruthart (1630?-1703 or later), presumably in preparation for the hunting scenes and pictures of fighting animals of which he produced some notable examples. These not only revealed great artistic ability but were clearly based on prolonged and careful observations by a genuine explorer of nature.

Illustrations of newly discovered exotic plants and animals began to appear in the 16th century. Of such, John White's paintings (1585) of a wide range of North American animals, for example, were excellent, and enriched the corpus of natural history. These include the butterfly *Papilio glaucus* from which a crude woodcut was made for Mouffet's *Insectorum Theatrum* (actually by several authors, published 1634 but completed considerably earlier: English transl. 1658), the first English book on insects. Collections of seeds and bulbs enabled previously unknown plants to be grown in Europe, which furthered both botany and the cultivation of flowers and food plants. The recently rediscovered *Camerarius Florilegium* of *c* 1589 illustrates almost 500 such ornamental plants, many of them exotics. These, often beautifully painted by an unknown artist, admirably reveal the naturalism of some of Dürer's successors. In the 17th century, Dutch still life painters also produced some accurate and beautiful portraits of comestible crustaceans and, like painters of flower arrangements, often embellished their compositions with small but accurate butterflies, moths and other insects, or with lizards and such invertebrates as snails, a tradition carried into the next century. Some of these miniature masterpieces are better than illustrations in later textbooks.

Throughout the period when few advances were made, there were of course observant naturalists. Of those in this country about which something is known, much can be found in Raven's *English Naturalists from Neckam to Ray* (1947). Likewise, even in the days of crude illustrations in herbals and bestiaries, good representations, quite out of keeping with the general state of knowledge of natural history, provide evidence of accurate observations. The beautiful stone carvings of oak leaves with acorns, Hawthorn with berries, Buttercups with flowers, and of several other plants in the chapter house of Southwell Minster, which date from about 1290, provide an outstanding example. A remarkable boss at Exeter cathedral even shows six sphingid caterpillars browsing among flowering vegetation. The leaves of Southwell have a parallel in wood in a wonderfully preserved gittern (an ancestor of the guitar), now in the British Museum. Made in England between 1280 and 1330, this is elaborately and exquisitely carved with masses of foliage of minute dimensions – ivy, vine, oak leaves and acorns – and various animals, some being hunted – deer, hares and foraging pigs, as well as fabulous beasts.

Because the signs of the zodiac were often illustrated, and because one such symbol is Cancer, the Crab, crustaceans were portrayed more often than would otherwise have been the case. Some illustrations are grotesque; others remarkably good. At Amiens Cathedral a beautifully sculpted crab, readily recognisable as *Carcinus maenas*, must have been copied from a specimen by its 13th century carver. 'Crab' was interpreted broadly and, even earlier, at the end of the 12th century, a magnificent marble relief of a crayfish was sculpted at Ferrara Cathedral. Other good animal carvings are to be found in various places. For example, there is a squirrel, and an owl with a captured rat, as well as much foliage, on 14th century capitals in Carlisle Cathedral. The rat must have been modelled on the Black Rat, *Rattus rattus*, then the only species in Britain. Incidentally, we now know that this species was a member of the Yorkshire fauna several centuries earlier than had long been thought – its remains having been found in excavations of Roman York.

At a more rustic level, common animals were certainly observed. For example, at St. Agath's Church, Easby, a wall painting of *c* 1250 shows a man sowing corn accompanied by a lively, if not particularly accurate, black corvid, probably a Rook though the beak is not well done.

The importance of accurate illustrations in natural history has been stressed. They have played a key role in the development of modern biology and are still vital. Valuable as they are, photographs cannot compete with, for example, C. F. Tunnicliffe's detailed coloured drawings of birds as a means of recording general morphology, feathers, and other details. The same is true of the portrayal of anatomical details of animals in general, and drawings are far superior to photographs as a means of illustrating many insects (the Lepidoptera provide exceptions) and microscopic organisms. It is, however, a matter of reflection that even illustrations that are both technically and artistically good can be misleading. For example, a delightful plate in *British Butterflies* by Humphreys and Westwood (1841) shows Clouded and Pale Clouded Yellows resting on a Milk Thistle and the Giant Fescue Grass. The insects are portrayed with enviable accuracy – but the result is misleading. Without exception they are shown with outspread wings; yet species of *Colias* seldom bask in this way; when they settle they almost always close their wings. Thus, while for purposes of identification, and as a work of art, this plate is highly meritorious, as a guide to the behaviour of these butterflies it is misleading, as are plates of the Grayling and species of *Caenonympha* in the same work.

Preconceptions can also lead to errors. Even Leonardo da Vinci was so misled. He illustrated Galen's imaginary perforation in the inter-ventricular septum of the heart. Our Anglo-Saxon spider with wings is a grosser example. Insects and spiders were not then differentiated; insects (so it was probably thought) have wings, so these creatures were given such.

Scientific Natural History and the Discoveries of Naturalists

Natural history took on a truly scientific aspect in the 16th and 17th centuries. There is no easy answer to why this was so, but factors include the advent and rapid spread of printed books and their accompanying woodcuts and engravings; a growing realisation that, contrary to the long-held view, the ancients had not said the last word on the natural world, a change of outlook helped by acceptance of the heliocentric concept of Copernicus, which meant that we do not in fact live in a geocentric universe, and later by Kepler's demonstration of elliptical, not circular, planetary orbits; voyages of discovery that revealed previously unknown lands and brought back organisms unknown to classical authorities; the close attention that began to be given to plants and animals by those who illustrated them – and later by their describers; the advent of the microscope; the development of scientific academies, of which the Royal Society included a remarkably talented group of individuals in its early years; the innovation of the scientific journal – of which the *Philosophical Transactions*, first published in 1665, is the world's longest-running example – that enabled individual observations to be reported; and the general development of a more questioning outlook.

Early printed books and journals provide occasional glimpses of naturalists who must be typical of many who went unrecorded. One example suffices. The fairy shrimp, *Chirocephalus diaphanus*, a primitive and beautiful crustacean that inhabits temporary pools, was brought to notice by Petiver in 1709. In 1767 King, who provided some very crude illustrations, reported how it was found, in 1762, "by a poor man now dead, whose genius was very extraordinary and much superior to what is usually found in his rank. He was indefatigable in his searches after everything curious, and without ever having had any advantages of education, had acquired a degree of knowledge by no means contemptible". Unfortunately King did not deign to name this obviously excellent naturalist, who must be representative of others who have not achieved even this modest degree of recognition.

Throughout history, naturalists have made significant discoveries. It was a naturalist who first observed that seeds grow into new individuals of the plant that produced them. Now seemingly self-evident, it is not easy to appreciate what a tremendous achievement this thrice made discovery was, though it is put into perspective when we remember that a belief in spontaneous generation persisted in some circles until well into the 19th century. Its exploitation by those able to foresee its implications led, some 10,000 years ago, to the Neolithic revolution – the growing of crops. The discovery that enabled this momentous step to be taken must have been made as the result of curiosity – the driving force of natural history and of science as a whole.

Naturalists have made many other discoveries that have benefitted human welfare. They include the elucidation of sequences of strata in rocks; appreciation of the sexuality of flowers which; ancient practices of date-palm growers notwithstanding, was first suggested by Nehemiah Grew in 1682 and proved by R. J. Camerarius in 1694; the discovery of natural drugs and toxins; the principles of heredity (Mendel crossing his peas in a monastery garden and making fundamental discoveries thereby was a naturalist and his results were published in the journal of a natural history society); the discovery of minute organisms by Leeuwenhoek and other early microscopists, and the elucidation of their life cycles, which in some cases had important medical implications, and many others. These discoveries were made purely as a result of curiosity. Their implications could not be predicted. Natural history makes no claim to be an applied science but it is a reputable scientific discipline with a long and honourable record of fundamental discoveries.

Natural History in the mid-19th Century: Achievements and Obstacles

By the mid-19th century naturalists had accumulated an enormous amount of information and it is salutory to remember just how much was known in certain fields at that time; for example, William Smith had established his stratigraphical system on the basis of fossil content more than thirty years earlier; John Michell (1724-1793), while Rector of Thornhill, had also elucidated the succession of strata from the Coal Measures upward with remarkable accuracy by observing outcrops as he travelled between Yorkshire and London in the 18th century, though his findings were not made known until 1810; Lyell's *Principles of Geology* had passed through several editions and parts of it had metamorphosed into his *Elements of Geology*. We had considerable knowledge of the flora of Britain and at least a general idea of the distribution of higher plants, though many details remained to be worked out. The first flora of Yorkshire – that of Baines – was published in 1840, rather less than 300 years after the first reference to a Yorkshire plant by William Turner in *The Names of Herbes* (1548), who noted that the Yew "groweth in diuerse partes of Yorkeshyre". More local floras, even of fungi, had appeared even earlier than that of Baines: James Bolton's *An History of Funguses growing about Halifax* appeared in four volumes between 1788 and 1791. Various books on birds, mammals and invertebrates, especially insects, were available, and much was known about anatomy, naturalists probably being more conversant with the anatomy, at least of vertebrates, than is the case today. How many bird watchers know much about the mechanism of a woodpecker's tongue, for instance? – yet both its anatomy and movement had been studied by Leonardo da Vinci and several 16th, 17th and early 18th century investigators.

Nevertheless many things accepted as axiomatic today were unknown to mid 19th century naturalists, such as those who had already founded some of the societies that were to give rise to the Yorkshire Naturalists' Union (or as it was originally called, the West Riding Consolidated Naturalists' Society) in 1861. Among others, and very briefly, were the following.

The great age of the earth was not appreciated. Indeed, although geologists were by then advocating a much greater age than had long been accepted, and although Darwin's ideas seemed to demand such, during the second half of the century the influential physicist Lord Kelvin was suggesting successively shorter periods of earth history on the basis of his calculations of its alleged rate of cooling. For all their mathematical precision, however, these were erroneous because Kelvin was unaware of the existence of radio-activity and therefore of a means of heat generation in the earth's core that balanced the energy radiated into space. This is a classic example of the triumph of careful natural history observations over 'rigorous' mathematics, which is of course powerless to produce correct answers from erroneous data.

The phenomenon of plate tectonics – which inexorably changes the position of land masses and puts biogeography into a true perspective – was unknown. Here again naturalists, whose observations demanded such movements if certain geographical distributions were to make sense, were long thwarted by the views of those who deemed them impossible.

What we now know to be the work of ice in relatively recent times was usually attributed to 'diluvial' activities. Again, as Kendall and Wroot (1924) point out, mathematicians were happy to provide calculations relating to events that never happened.

The principles of heredity were unknown, as was the mechanism. At the cytological level even chromosomes remained unknown. Moreover, it was only just beginning to be appreciated that sperms were involved in the process of fertilization, and the belief that they had no material role was still strongly supported, as it was to be for some years longer by some; just as botanists explicitly denied that in flowering plants the pollen tube entered the embryo sac. The role of sperms in the transmission of characters of the male parent continued to be debated even longer. Laboratory-based physiologists believed that contact between egg and sperm was all that was necessary, penetration not being essential; this being in keeping with their desire to reduce biological phenomena to physical and chemical principles. Such workers barely considered how characters of the male parent were inherited, but to naturalists, familiar for example with hybrids, this was an important question. Here again accurate observations eventually triumphed over attempts to adhere rigidly to the principles of physics and chemistry.

Although evolutionary ideas had been mooted, no convincing mechanism had been put forward, nor was it to be (save in the scarcely noticed Darwin-Wallace paper of 1858), until the publication of Darwin's *On the Origin of Species* in 1859. This was of course a work whose major source of information was pure natural history.

The life cycles of various organisms, including whole groups such as bryophytes and ferns, were only just beginning to be elucidated, and those of many animals remained unknown.

It was not appreciated that various insects regularly migrate to this country. Even the idea that they might arrive as wind-blown individuals was ridiculed. Speaking of the capriciously occurring Camberwell Beauty, *Nymphalis antiopa*, had not the influential Haworth (1803) made the magisterial pronouncement that "to suppose they come from the Continent is an idle conjecture"? (He suggested that the eggs may lie dormant for several years until stimulated to hatch by "some extraordinary but undiscovered coincidences".)

Territoriality in animals was scarcely known. Some naturalists were probably aware of certain aspects of the phenomenon (as Johann von Pernow apparently was 150 years earlier, and Dovaston had just discovered), but its roles and significance were not appreciated.

Today's naturalist not only knows these and many other things unknown to his mid-19th century predecessors: he enjoys other advantages. He is, in general, more affluent and more mobile and has at his disposal binoculars, telescopes, microscopes, cameras, sound-recording equipment and other gadgets. If he is an ornithologist, he can ring birds both as young and as mist-netted or trapped adults and can employ coloured rings, wing tags or even radio-transmitters, as can students of mammals. The books at his disposal are such as his ancestors could scarcely conceive and include identification manuals of even esoteric groups, taxonomy in general being in better shape than it then was. A wider range of better maps is available.

A specific example shows how understanding has been transformed in one field. John Phillips, the second edition of whose book, *The Rivers, Mountains and Sea-coast of Yorkshire* was published in 1855, was fully aware that the blocks of granite that sometimes cap the summits of the Stainmore area were erratics that had been brought from Shap Fell in Westmorland by what he called "some uncommon natural force". As to the nature of that force, he could only "speculate on the power employed, and the ancient condition of land and sea which could render possible this almost miraculous transport across deep valleys and over lofty hills". Only later was it appreciated that they had been carried by ice that had also gouged out U-shaped valleys, deposited boulder clay, sculpted other landscape features, made striations on rocks, and polished rock bosses, which led to the concept of the 'Ice Age'. Later still, it was realised that there was not just one such episode, but a series of Pleistocene glaciations that alternated with warmer interludes, details of which are still being elucidated. Many of the methods used in this work and in the study of post-glacial changes – including identification of plant and animal remains in peat and other deposits, and the documentation of their stratigraphy – are those of natural history pure and simple and some of them were pioneered in Yorkshire, especially by Woodhead, whose account of the history of the vegetation of the Southern Pennines (1929) is still valuable today. Such events now provide a background against which problems relating to the ecology, distribution and dispersal of plants and animals can be considered.

Phillips does refer to Glacial and post-Glacial periods, but the concepts inferred were very different from those embraced by these terms today. While prepared to countenance the presence of glaciers in the uplands, like most contemporary geologists he thought that subsidence of the land had led to flooding by an ice-laden sea whose erosive activities produced the boulder clay later exposed when the land rose again. He also considered how Britain was colonised by plants and animals. This took into account the non-existent 'glacial ocean', of which he says there "seems reason to limit its height . . . to something less than 1500 feet", and he expected some survivals on the islands thus left. He also envisaged invasion from the continent during a time "when the bed of the German Ocean (which had been a glacial sea) was raised above the waters so as to constitute a dry-land communication with the east and south-east" – an interesting amalgam of error and correct supposition. That Phillips was so wrong is no reflection on his abilities, which were great. Indeed, although he continued to accept the submergence theory, he later came to appreciate some of the difficulties that it presented. Perhaps 150 years hence, some of our ideas will be just as outdated.

Changes in understanding were accompanied by changes in attitude. Consider, for example, what was described in *The Naturalist* (old series) for 1864 as "The second exhibition of objects of natural history" held by the Huddersfield Naturalists' Society in that year. At the opening ceremony various speakers gave addresses, one of them noting that entomologists were "not now looked upon with mistrust and suspicion as was formerly the case" – an interesting side-light on yet earlier times. The exhibition was open for eight days and visitors averaged nearly 1000 a day. In 1861, the population of the extensive township of Huddersfield was just under 35,000. Visitors approached a quarter of this number though some doubtless came from elsewhere. The exhibition hall measured 90 ft by 30 ft and its walls "were entirely hid to a considerable height by cases of birds, and below these a narrow table running round the room was covered with drawers of birds' nests and eggs, Coleoptera and Lepidoptera". Among a mass of other exhibits were cases of mammals and reptiles. The birds, provided by 36 exhibitors, numbered "upwards of 560 cases". No modern natural history exhibition would include a stuffed bird, unless it were to illustrate bygone attitudes, and the contrast between such an event and, for example, one of the Yorkshire Naturalists' Union's York Symposia, could hardly be greater. Note, however, the enthusiasm. Almost 1000 visitors a day for eight days is remarkable, even if not all shared the sentiments so ardently expressed in an address by Peter Inchbald "on the desirability of studying nature in a fair and candid spirit, and not being led away by specious theories without a rigid examination of their truth". These Victorian naturalists took their studies seriously!

Public reaction to the exhibition recalls even earlier enthusiasm for natural history. For example, Williamson (1896) records that in the 1830s, "the hills between Lancashire and Yorkshire swarmed with botanical and floricultural societies", run mostly by working men of limited means and with little free time. Such societies existed even in the previous century. Likewise, when the British Association met in Newcastle in 1838, daily attendance at the Geology section was between 1000 and 1500. Even more striking, what Herschel described unkindly as "colliers and rabble (mixed with a sprinkling of their employers)" and numbering about 3000, gathered on the seashore to listen to Adam Sedgewick. Today, enthusiasm for natural history is superficially enormous. Television films, made with great technical skill, sometimes attract audiences of millions, and popular conservation movements are enthusiastically supported, but as Roy Crossley (1986) so lucidly described, support for serious natural history societies has not kept pace. It is difficult to imagine a crowd of 3000 gathering out of doors to listen to a geologist today.

Modern Natural History

Dramatic changes in understanding and approach have taken place in the last 150 years or so, and continue at an ever-increasing pace, but the basic aims of natural history remain the same – and just as important. These are to elucidate the attributes of plants and animals, to ascertain where they live and why they live there, how their structure and habits fit them for life in particular places, how they interact with other plants and animals, the nature of their life cycles and dispersal mechanisms, their distribution and the factors that affect it, changes in their abundance, their variability, their taxonomic relationships, and their evolution. Some of these apply also to fossils, while the study of rocks, soils and geological processes provides essential background information to them all.

Highly significant is the continuity of observation throughout this recent period, *The Naturalist* being an important repository of records pertaining to Yorkshire. These, particularly of flowering plants, bryophytes, fungi, birds, and certain groups of insects, for which information is particularly abundant, are much more than lists of past and contemporary status: they often document dynamic situations and record changes in range and abundance. For example, they enabled John Mather (1986) to chronicle the history of the Oystercatcher, *Haematopus ostralegus* as a breeding bird in Yorkshire since it first nested at Spurn in 1888, became a scarce coastal breeder, then, since 1936, moved inland and began to colonise the western dales and subsequently spread somewhat to lower ground. Similar recording showed how several other species of birds have recently established or re-established breeding populations in Yorkshire and documented their subsequent progress. Likewise the demise or near demise as breeding species of several others has been recorded. Involving more than two dozen species, these are some of the more dramatic of the changes that have taken place in our avifauna during the past century and a half. Only extensive and persistent recording could have revealed this dynamic situation.

Botanical examples include changes in the lichen flora of the West Yorkshire conurbation that have received similar careful attention from Mark Seaward and his collaborators, who have shown how, following the loss of many species as a result of atmospheric pollution, a heartening number are re-colonising as levels of sulphur dioxide and other pollutants fall (references in Seaward & Henderson, 1991). Recording of changes over vastly longer periods of time by tracing changes in fossil faunas is exemplified by Bisat's elucidation of the succession of Carboniferous rocks in Yorkshire and Lancashire on the basis of the goniates present in component strata. This work, which brought renown to Bisat, was, incidentally, published largely in two local journals – the *Proceedings of the Yorkshire Geological Society* and *The Naturalist*.

Microscopy and the Discovery of Micro-Crustaceans

Man's accumulated knowledge of large animals extends back to the Palaeolithic, and probably beyond: the very existence of most small animals (say 2mm or less) remained unknown until the invention of the microscope, so knowledge of such organisms as protozoans, rotifers, small crustaceans and the smaller algae goes back only to the second half of the 17th century. Some small crustaceans, such as *Daphnia magna*, which is sometimes abundant in cattle ponds, and is visible to the naked eye, were doubtless noticed long ago, but pre-microscopic observations are of no moment. I believe that the earliest published mention of a freshwater microcrustacean was by a Yorkshire naturalist, Henry Power (1623-1668), who resided in Halifax and then at New Hall, Elland, whose book *Experimental Philosophy* (1664) dealt partly with microscopy, partly with other scientific matters. Pre-dating Hooke's more famous *Micrographia* by just one year, this was the first book on microscopy written in English. In it, under the heading 'Pond Mites', he describes, unfortunately without an illustration, which would have been invaluable, how "there are bred in most restagnant Waters, Pools and Fishponds, in *June* and *July*, an innumerable company of little whitish Animals, which move up and down the water with jerks and stops in their motion; in which animals we could discover two little horns and leggs". This can hardly refer to any animal other than *Daphnia*.

In 1669 Swammerdam produced a description and a readily-recognised illustration of *Daphnia*. Considering the originality of his observations these were excellent, though inevitably defective – but much less so than those of Bradley (1721) more than 50 years later who thought the head of *Daphnia* "was somewhat like that of a bird", that it had legs (he meant the post-abdomen) "like the claws of an eagle" and that the locomotory antennae "may be designed for suckling their young", for he was aware that *Daphnia* gave birth to living young. In 1753 Baker, wrongly, maintained that it had two eyes. These and other early accounts were, however, far eclipsed by Schaeffer whose publication of 1755 made what we would now call a quantum leap in our understanding not only of the anatomy of these animals, which he dissected, but of their ways of life. He also recognised that not all 'water fleas' belonged to one species and defined two categories as "the spined and unspined horned waterfleas' (transl.). These we now recognise as *Daphnia* and *Simocephalus*. Before the end of the 18th century, Otto Frederick Müller (1730-1784), who established the genus *Daphnia*, described several additional species, some of which are now assigned to other genera. Another landmark, greatly enhanced in value by the illustrations of his daughter, was Jurine's *Histoire des Monocles* of 1820, which advanced knowledge of the taxonomy, structure and habits of these so-called cladocerans, that actually belong to four distinct orders. In 1850 Baird gave the first comprehensive account of the British species then recognised. Subsequent work, including a superb monograph by Lilljeborg (1900), and many individual papers, has brought us to a stage where the taxonomy and general distribution of the European fauna is reasonably well known (though various problems remain), but much is yet to be learned of the ecology and habits of individual species, of which more than 80 occur in Britain.

A similar story unfolded for copepods. A cyclopoid copepod was briefly mentioned in 1688 by Blancardus, who gave a bad illustration, but the first real contribution was made by Leeuwenhoek (1699) who, via his draughtsman, gave a figure that, while incorrect in many respects, is clearly recognisable as a cyclopoid copepod. Five years later, an anonymous contributor to the *Philosophical Transactions of the Royal Society* (Anon., 1703) produced illustrations of both a freshwater cyclopoid and a calanoid copepod, the latter being the first such of a calanoid, and anticipated the finding of the first marine species by 67 years. Leeuwenhoek also made the important discovery that the eggs of copepods hatch as larvae – nauplii – that differ markedly from the adult, but his draughtsman was defeated in his attempts to portray them, as most of us would be today if we had to use his simple microscope. This discovery of the basic crustacean larva in a copepod was not confirmed until 1778 (by de Geer). In that very year, Martinus Slabber saw the nauplii of barnacles, which were not then recognised as crustaceans, for the first time but did not recognise them as the offspring of the parent. He might have done so had Leeuwenhoek been able to provide an illustration, and might also have resolved the crustacean nature of barnacles. A better example of the value of reliable illustrations could hardly be found. Even later, Müller, who never observed hatching himself, could not convince himself of the validity of the observations of Leeuwenhoek and de Geer. He saw copepod nauplii but thought they were a distinct type of organism, for which he established a genus, *Nauplius* – hence the present name. Further advances were made by many of the same individuals as increased our knowledge of 'cladocerans' – O. F. Müller (who coined the name *Cyclops*), Ramdohr and Jurine (both of whom confirmed the nature of the nauplius and followed the entire life cycle), Baird, Lilljeborg, Brady, G. O. Sars and others. By the 1930s Gurney was able to produce a splendid monograph of the British species that is still our standard work.

Users of such works may not always appreciate the gulf that separates them from the earliest observations and the enormous difficulties that had to be overcome by the early microscopists. These pioneers were not only confronted by entirely new types of organisms, but had to cope with primitive instruments. Those made and used by Leeuwenhoek seem extremely crude today; Swammerdam used a simple microscope and so probably did some 18th century investigators. The compound microscopes of their contemporaries suffered greatly from spherical and chromatic aberrations. Not until the early 19th century did instruments reasonably free from these defects become available. Not surprisingly, early microscopists sometimes drew wrong conclusions as a result of distortions caused by their lenses.

Taxonomic advances have been particularly rapid since the late 19th century. As recently as 1850 Baird assigned all cyclopoids to a single species. In Britain alone there are at least 36, in 10 or more genera according to the scheme followed, as well as 13 calanoids and 43 fresh and brackish water harpacticoids.

The Ecology and Habits of Small Crustaceans

These animals having become recognisable, study of their habits became possible. Like form, habits are exceedingly diverse. Even cyclopoid copepods which, superficially at least, appear rather similar to one another, have adopted many different ways of life. Some are planktonic, others live among vegetation, on the bottom, or in minute volumes of water. Although all seize their food with grasping, tearing, mouthparts, some feed on algae while others are formidable carnivores that often prey on animals much larger than themselves, such as oligochaete worms or chironomid larvae. Calanoid copepods have different habits; freshwater species generally frequent open water where most of them filter out fine particles; the minute, largely creeping, harpacticoids have yet other habits. Furthermore all these copepods begin life as nauplius larvae and gradually change to the adult stage, their habits, feeding mechanisms and microhabitat preferences changing with each successive moult.

Anomopods are much more diverse and occur in a wide range of situations. By no means all share *Daphnia*'s habit of persistent swimming. Species like *Peracantha truncata* and *Alonella exigua* display elaborate suites of beautifully co-ordinated morphological features that enable them to move efficiently over surfaces, collecting finely particulate food by complex mechanical devices as they do so. They also illuminate the evolutionary route followed by the super-specialised *Graptoleberis testudinaria* that glides over surfaces (usually of leaves) like a minute snail, scraping material from them with scrapers that are analagous to the gastropod radula but which operate on entirely different principles. Similar habits, using a mixture of similar and different devices, have been adopted by a member of another family, *Lathoneura rectirostris* – a striking example of evolutionary convergence. Other species are bottom dwellers. Some scuffle in detritus, others burrow in mud. The latter include species of *Ilyocryptus* that, as well as being specialised for burrowing and moving over muddy bottoms, can lay fair claims to be among the most perfect filter feeders in the animal kingdom. Yet others have colonised open water where they collect suspended particles, *Daphnia* being the most familiar genus. Some of its relatives, like *Simocephalus*, have turned to a more sedentary mode of life while still retaining the same basic filtering apparatus; others, such as *Scapholeberis*, have exploited the surface film from which they suspend themselves as they collect their particulate food.

These are but a few of our anomopods, of which even this brief glimpse highlights what I regard as one of the axioms of natural history – that much of the beauty of nature is revealed in the details. Similar adaptive radiation is shown by yet other freshwater crustaceans such as ostracods.

As well as requiring certain conditions - such as particular kinds of bottom, or vegetation – that determine exactly where they live in a particular water body, these animals are sensitive to different kinds of water. Some occur only at the warmer time of the year: others frequent cold springs. Some require alkaline conditions and water containing an abundance of dissolved minerals; others favour acidic, mineral-poor water. Because waters of different kinds are found in different areas, so too are these crustaceans. Thus in Yorkshire many species are restricted to 'rich' lowland waters and, except for certain areas of limestone upland, are generally confined to altitudes below as little as 500 ft. Others shun these places and live only in the acidic uplands and where similar conditions prevail on lowland heaths.

These patterns, which reflect differences in climate, geology and soils, lead naturally to maps. The first to suggest that maps might serve as more than guides to the geography of an area but might portray things of interest to the naturalist was Martin Lister, a pioneer investigator of molluscs and spiders, whose paper of 1684 bore the delightful and informative title, "An Ingenious proposal for a new sort of *Maps* of *Countrys*, together with *Tables of Sands and Clays*, such chiefly as are found in the *North* parts of *England*, drawn up about 10 years since". In this paper he noted that "The *Soil* might either be coloured, by variety of *Lines* or *Etchings*; but the great care must be, very exactly to note upon the *Map*, where such and such *Soiles* are bounded. As for example in *Yorkshire* (1) The *Woolds*, Chaulk, Flint and Pyrites, Etc (2) *Black moore*; Moors, Sandstone Etc (3) *Holderness*; Boggy, Turf, Clay, Sand, Etc (4) *Western Mountains*; Moores, Sand-stone, Coal, Iron-stone, Lead Ore, Sand, Clay Etc." The descendants of Lister's proposed map are those of the geology and soils of Yorkshire, and we now have maps that show rainfall and other climatic features, pollution levels and so on. A map showing aspects of water chemistry (pH and calcium content) in a representative series of Yorkshire waterbodies (Fryer 1993) provides a background against which we can consider the distribution patterns of crustaceans, and other freshwater organisms. And of course naturalists now use grids of different kinds that enable distributions to be plotted with ever-increasing exactitude.

Ecology, Diversity and the Naturalist

The diversity of structure and habits of living organisms have always attracted the naturalist. Ecologists too have recently re-discovered diversity. Such parallelisms are one reason for looking briefly at the relation of natural history to some of its offspring and to science in general. This is an appropriate venue for so doing for the Yorkshire Naturalists' Union has long been an amalgam of professional biologists and geologists and amateurs skilled in many branches of natural history. Each appreciates the knowledge and skills of the other and the complementary nature of the association. A few professionals, however, have spoken disparagingly about natural history; for example, after referring to the accumulation of observations, Toulmin (1960) says, "This is one of the things which the sophisticated scientist holds against natural history; it is 'mere bug-hunting' – a matter of collection rather than insight". This is a lamentable display of arrogance and ignorance. For example, Darwin and Wallace were great collectors, of facts and of material; the insights derived from the contemplation of these facts led to the concept of evolution by natural selection which ranks with the Copernican system and Newton's laws of motion and universal gravitation as one of the great landmarks of science.

Natural history involves far more than collecting; nor is it the purely descriptive branch of enquiry as which some would categorise it, though description is vital. As I understand it, modern physics believes there are no proofs, only better and better descriptions. Nor is natural history concerned only with observation – though accurate observation is an essential element of it, and often much more demanding than, for example, the counting involved in collecting the so-called 'hard' numerical data of ecologists, or the concoction of mathematical models, many of which simply don't work. But my aim is not to exchange insults, just to note the difference in approach to the exploration of nature and the value of the approach via natural history. To use small freshwater crustaceans as an example; the naturalist is interested in these for their own sake and seeks to elucidate the structure and habits of individual species and how these attributes are related. He tries to find out how they earn their livings, how related species differ, why they live in particular kinds of places that can sometimes be precisely defined, which are their enemies and how, if at all, they can avoid them, how they reproduce and disperse, and so on. The ecologist is interested in similar things, but often only in a general sort of way. He often seeks generalisations which, he believes, will help to explain how communities are structured, or populations are controlled. From personal experience I know that, even though they work with these animals, some ecologists are not interested in them as such, and openly admit it. As a result they sometimes display a lamentable lack of knowledge about things that fascinate the naturalist and which it is essential to understand before meaningful generalisations are possible.

Ecologists favour what they like to call a rigorous approach. Qualitative sampling is often despised, yet a quantitive sample of small crustaceans, taken for example from an area of bottom and the vegetation growing there, displaces these animals from what are often carefully selected living places and mixes creatures with very different habits and micro-habitat preferences – as different as those of ground-living and arboreal vertebrates. Likewise if quantitative plankton sampling ignores the behaviour of the organisms concerned it can, as Hardy (1956) records, be 'hopelessly misleading'. Early in his career he encountered 'patchiness' in plankton and young Herrings, *Clupea harengus*, which showed that the results obtained during several scientific cruises were 'quite valueless'.

Usually the ecologist preserves his samples on the spot. By so doing he misses key elements of behaviour. Animals are often counted, but categories are not always adequately discriminated. For example, to list 'cyclopoid copepods' embraces carnivores and herbivores, and to put all nauplii into one category, as sometimes happens, lumps representatives of two, sometimes three, orders! A curious psychological block allows some ecologists to lump microscopic animals in ways they would never do for birds or mammals. Naturalists are often good taxonomists; ecologists, some of whom are not, sometimes scorn taxonomic ability. Counts provide 'raw data' that can be subjected to manipulation, preferably by computer, and statistical tests are *de rigeur*. The results, presented with the requisite confidence limits, may look impressive, and even be valid, but sometimes the naturalist sees that they display an ignorance of facts that render them at best meaningless or, even worse, misleading. *Daphnia* has been counted *ad nauseam* but counters seldom appreciate its structure and even fewer know how it 'works'. Some counts embrace two or more species which of course renders laboriously produced results not just useless, but misleading. Because *Daphnia* filters suspended algae, experimenters have used elaborate techniques to measure the rate at which it reduces the density of such suspensions under different conditions. Not all have been aware that, having abstracted particles, it binds them into a bolus or 'sausage' with secretions before ingesting them. If particles are abundant, it collects more than it can readily ingest so material piles up behind the mouthparts. By a very elegant device employing hooks on the first pair of trunk limbs, and sometimes the post-abdominal claws, it then from time to time ejects a bound-up mass of algae that falls to the bottom, unnoticed by the experimenter who nevertheless notes their disappearance from suspension and assumes they have been eaten by the *Daphnia*.

Some ecological concepts also seem insecure. That optimal foraging is of general application must always have seemed dubious to the naturalist and has recently been severely mauled by ecologists too. The naturalist knows that animals are often opportunistic though under particular conditions they may well forage optimally. Models of this and other aspects of animal behaviour may bewitch by the elegance (or complexity) of the mathematics, but all too often the underlying assumptions are erroneous, some being so fatuous as to merit only ridicule. The naturalist, therefore, need not be overawed by the so-called rigorous approach or 'robust' theories of the ecologist or ethologist – who is sometimes, and sometimes unwisely, apeing the physicist. If basic assumptions are incorrect the rigour is misplaced and pointless.

Although this will probably elicit criticism as being unscientific, and anecdotal evidence certainly has to be treated with suspicion, it also seems to me that much effort is sometimes devoted by professional biologists to testing what seems obvious to the naturalist; for example, it is probably self-evident to most naturalists that food-begging by female birds not only strengthens the pair bond but has energetic benefits at a time when eggs have to be produced. One should not blur the distinction between observation and interpretation or make deductions that merely *seem* self-evident. Real evidence, which can be observational or comparative as well as experimental, is needed; but in this case experiments merely confirm the obvious.

Another example concerns the significance of aggregation by warningly-coloured prey. Gagliardo and Guilford (1993) claim to have demonstrated for the first time, by experiments using coloured crumbs fed to domestic chicks, that prey aggregation "may be an aposematic signalling strategy that enhances predator discriminative aversion learning", of which the naturalist was surely already aware but would have described more simply, but just as precisely, as a warning device more easily learned by predators than if the prey were widely dispersed. These authors also claim that aggregation works by enhancing the effectiveness of visual but not chemical defence. This is not convincing to a naturalist. In Africa, I encountered the millipede *Habrodesmus massai nyassae* which displays black and yellow transverse stripes not unlike those of the caterpillar of the Cinnabar moth, and has bright orange legs. This millipede wanders in open places, does not display the usual millipede defence reaction of rolling up, and emits a very marked odour of bitter almonds, suggesting the production of hydrocyanic acid, presumably from repugnatorial glands. Furthermore, it aggregates into compact groups of perhaps 500 individuals (Fryer, 1957 with photograph). This naturally concentrates the odour which, it is reasonable to suppose, will enhance its defensive properties.

Likewise studies such as those on the growth rates of fishes, while sometimes necessary when comparing populations from different areas, or living under different conditions, often merely confirm, or perhaps define a little more precisely, what the naturalist already knows. The discovery of some previously unknown habit, the elucidation of a life cycle, or some other qualitatively new finding, is surely a greater contribution to scientific knowledge, as well as being vastly more interesting, than the accumulation of such data.

Observation is essential, but naturalists are not 'mere' observers. They have for long tried to make sense of their observations and have asked how? and why? and proposed and tested hypotheses. Although it is as an observer that he is justly famous, Gilbert White (1789) provides examples. In 1776 he recorded how a French anatomist suggested that the Cuckoo does not brood its own eggs because its crop lies behind the sternum and would interfere with brooding. White procured a Cuckoo and confirmed the anatomical situation but was rightly aware that the test for the theory was whether any birds that do brood share this condition. He therefore obtained a Nightjar which, "from its habit and shape, we suspected might resemble the Cuckoo in its internal construction". As he says, "nor were our suspicions ill-grounded", for the same conditions prevailed, as they proved to do also in a Hen Harrier. He rightly concluded that the conjecture "seems to fall to the ground".

Another example was his reflection (1772) on why birds should flock in winter, as he put it, "in pursuit of sustenance at a time when it is most likely to fail"; behaviour for which he suggested sensible explanations. Although most famous for his work in a single parish, he was not averse to contemplating the wider world and was, for example, dismissive of a suggested trans-Atlantic land bridge as a means of explaining various faunal affinities (1769), which to him was "making use of a violent piece of machinery" – and this some two centuries before the reality of plate tectonics became established. And of course 'mere observation' enabled him to recognise the specific distinctness of the Willow Warbler, Chiff Chaff and Wood Warbler, initially by their songs, more than 200 years ago – an excellent achievement.

Observations are sometimes more informative than elaborate apparatus. Early this century it was supposedly proved by technical methods that bees are colour-blind, a conclusion surprising to the naturalist whose observations were in accord with work already done by Lubbock (summarised 1885) which indicated that they perceive colours. Notwithstanding the need to eliminate the possibility that bees only distinguish different degrees of brightness, and not colours, the possession of colour vision has since been amply confirmed by ingenious, but often simple, experiments, which also show that they do not perceive the colours of the spectrum just as we do. They cannot, for example, distinguish red, but recognise ultra-violet as a separate colour.

Incidentally, although it is often said that, to be significant, observations need to be prompted by some theory, and that the collection of facts alone is aimless and unscientific, this is not strictly true. Provided they are recorded, as in field notes in *The Naturalist*, even isolated observations may prove valuable as contributions to a hypothesis, or for the testing of theories, for which reliable facts and observations are always necessary.

Prediction in Natural History

Predictive ability is held to be the hallmark of the best science: natural history is a predictive enterprise. Few scientific demonstrations can be more impressive than the ability of Chance (1940) to watch the behaviour of a female Cuckoo, *Cuculus canorum*, and, at a particular time and place, to ask observers if they would like to see it lay an egg in a host's nest – which, with accompanying activities, it proceeded to do. As a student of the Cuckoo, Chance, incidentally, had a celebrated predecessor in Edward Jenner (1788) of vaccine fame, who made extensive observations on that bird and demonstrated the experimental side of natural history by putting eggs or nestlings into nests occupied by young Cuckoos of various ages and observing how behaviour changed with age.

Accurate predictions can sometimes be based on apparently slender evidence. Richard Owen's (1840) claim, based on a single piece of bone, that very large ostrich-like birds formerly occurred in New Zealand, later confirmed the discovery of complete skeletons of Moas, is an outstanding example of the predictive power of naturalists familiar with the structure and habits of animals. Good naturalists can often identify organisms from fragments or make helpful predictions about such things as the life cycles, feeding habits and habitat preferences of animals on the basis of very limited material.

The Limits of Generalisation and the Scope of The Naturalist

While prediction is sometimes possible, the diversity and abundance of facts, many of them specific to individual species, of which there are vast numbers, often makes generalisation dangerous in natural history – some mammals lay eggs; not all birds brood their own eggs; some fishes breathe air; some angiosperms lack chlorophyll, and even closely related animals may differ strikingly in habits and behaviour. Some biological laws are as all-embracing as those of physics, for example, like begets like, and the universal nature of the genetic code, but while in physics essentially simple laws, such as those of motion, are of universal application, there are no such that can define the requirements, habits, life cycles and diversity of structure of the inhabitants even of a small pond. Physical and mechanical principles certainly apply to the design and functioning of organisms but cannot 'explain' their multifarious activities. To elucidate such things is the task of the naturalist, whose approach to the exploration of nature is just as valid, and sometimes far more informative, than that of the quantitative ecologist or of those who seek to apply the principles of physics and chemistry in the analysis of the living world. Incidentally, while the computers much beloved of modern ecologists are remarkable number crunchers and can do all sorts of wonderful things, even super computers cannot 'see' reliably and lack what the computer-monger would probably call scene-analysis capability; that is, they are defective in the recognition of patterns that depend on previous knowledge – which is the basis of much good natural history.

Amid the welter of diversity that is one of the most awesome yet fascinating attributes of nature, naturalists continue to make new and striking advances. Relatively recent examples include the discoveries that many bird vocalisations are individually distinct, that earthworms often constitute the major item in the diet of the Badger, *Meles meles*, that acorns are toxic to the Red Squirrel, *Sciurus vulgaris*, but not to the Grey, *S. carolinensis*, and the remarkable revelation that male Stoats, *Mustela erminea*, mate with the still helpless, blind and unweaned females in the nest, a procedure that is followed by a delay of 9 or 10 months before implantation of the blastocyst. We can be confident that many more such discoveries remain to be made, especially in groups such as insects where the classic work of Fabre, of von Frisch on dancing bees, and recent studies on ants, show what the patient observer can reveal.

Observation remains supremely important. It was the observation that egg-breakage was a feature of the reduced breeding success of the Peregrine Falcon, *Falco peregrinus*, in the 1960s that led Ratcliffe to the discovery of eggshell thinning and, by brilliant deduction, to connect the phenomenon with the increased incidence of organochlorine residues in the environment and, in particular, in individual birds and their eggs. (Summary in Ratcliffe, 1980). This, one of the best correlations in modern ecology, later fully substantiated by experiments, which operated in reverse as organochlorines were withdrawn, is a triumphant vindication of the approach to an ecological problem via natural history.

New techniques open up new vistas. For example, the use of hides transformed our knowledge of the behaviour of birds at the nest and, with photography in mind, was pioneered at the turn of the present century by the Yorkshire naturalists Richard and Cherry Kearton. It is now easy to smile at Richard's bullock skin stretched over a wooden framework within which one of the brothers crouched – his legs appearing between the fore and rear legs of the ox. The camera, "fixed upon a little platform in the brisket", had its lens peering out of the breast (Kearton 1903). The whole hide could be carried on a man's shoulder. That this and other strategems were in fact unnecessary – a simple box is as effective as an ox – and that a simple brushwood-covered hide had in fact been used some 60 years earlier, does not negate the value of the idea. (Hunting peoples elsewhere in the world have evolved similar methods). By using such hides, the Keartons made valuable observations and produced some remarkably good photographs with what now seems archaic apparatus. More recently, high speed electronic flash photography enabled Hosking and Newberry (1949) to reveal the remarkable positions into which birds could throw their wings, tails and bodies, and to produce such stunning photographs as those that show how a Sand Martin puts on the brakes as it approaches its nest hole at high speed. Likewise, collaboration between naturalists and chemists (who can use gas chromatography to reveal the many components of such substances), is throwing new light on the nature and significance of scents in animals as different as mammals and butterflies, and naturalists are already finding applications for DNA fingerprinting. Other techniques, presently inconceivable, are sure to follow.

There is also still enormous scope for survey work. Of several valuable entomological surveys conducted in Yorkshire, that of Thorne Moors (Skidmore, Limbert & Eversham, 1987), provides an excellent example. Not only has the rich insect fauna of this raised mire (almost 2,500 recorded species) been documented, but the possibility of tracing its historical development by the investigation of sub-fossil remains in the peat has been demonstrated and partly exploited.

But there is another reason for pursuing natural history. It is immensely enjoyable. Its rewards are as diverse as nature itself. My own include such things as the elation and satisfaction that follows the finding of nests of Merlin and Hen Harrier in the heather, the thrill of watching Peregrine Falcons, or Badgers emerging from their sett, enjoying the spectacle of a Gannet colony, and, on a different scale, the exquisite beauty of butterflies, common as well as rare, or of collecting small crustaceans in delightful water bodies, and many more. One needs no other justification for being a naturalist than that one enjoys it. Bodies such as the Yorkshire Naturalists' Union not only encourage this enjoyment, they foster the spirit of enquiry that enhances it and makes natural history a continuing means of increasing natural knowledge.

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BOOK REVIEWS

The Hawkmoths of the Western Palaearctic by **A. R. Pittaway**. Pp. 240, including 20 colour plates, 60 text figures & 58 maps. Harley Books, Colchester. 1993. £55.00 hardback.

This is an exceptionally fine large format book with maps and beautiful illustrations. As its name suggests it takes in Northern and Western Europe, North African and the near Middle East. Although it is arranged in the same way as *Moths and Butterflies of Great Britain and Ireland* (1979, Vol. 9) edited by John Heath and A. Maitland Emmet, the latter only deals with the 17 hawkmoths which have occurred in the British Isles. In this book the author describes 86 species and sub-species.

Verbal description is kept to a minimum because as the author says in his preface "most adults are easily recognised from the illustrations". Much of the text is devoted to biology and behaviour of larvae and imagines. Of the 240 pages, 55 comprise the text, two are colour photographs of habitats, three are of larvae and pupae, and three show typical attitudes of living moths. At the end, there are 13 colour plates of drawings of larvae and set imagines, a systematic index, index of plants and a subject index. 90 pages contain the description of the species and distribution maps. There are 4 appendices: the first describes rearing of hawkmoths, the second is devoted to host plants, next is a gazetteer and finally a glossary.

Although we get a more detailed picture of our few British species' distribution from the 10km x 10km maps in *Moths and Butterflies of Great Britain* (*op. cit.*), in the volume under review the maps cover a much larger area, so one can see how our native and migratory species fit into the Palaearctic scene.

A unique feature is the inclusion of not only English and Latin names but in the case of widely distributed species, the names used in eight other languages.

A table of recorded papasitoids is a feature which will give more pleasure to the hymenopterist than the lepidopterist!

The writer was pleased to have this book to hand when a neighbour requested her to look at caterpillars in the middle of her garden pond. These proved to be *Deilephila elpenor* (L.) feeding on *Menyanthes trifoliata* (Bogbean), the first time she had seen it on that host plant.

A. R. Pitterway and Harley Books are to be congratulated on producing such a superb volume. At this high price the reviewer feels it may be snapped up for its aesthetic and investment value rather than as a working book. She therefore advises all students of butterflies and moths to obtain a copy before it is out of print!

JP

THE STATUS AND DISTRIBUTION OF THE OTTER (*LUTRA LUTRA* L.) IN NORTH YORKSHIRE

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ABSTRACT
From 1985-1990 a detailed survey of otter distribution was carried out on six rivers in North Yorkshire. Records of signs and otter sightings were also collected for other rivers in Yorkshire. In addition to data gathered using established survey techniques the study also incorporates hunting records for the region and information from a sprainting experiment. The area (1990 onwards) is now receiving introduced otters, providing a check on the earlier fieldwork which failed to find otters.

The overall conclusions are that the otter population in North Yorkshire, particularly the Derwent catchment, is fragmented and vulnerable. The situation appears to be similar throughout Yorkshire as reflected in the latest National Survey.

INTRODUCTION

The decline of the otter (*Lutra lutra* L) has been well documented (Anon 1969, 1974, 1977). Chanin and Jefferies (1978) made a detailed analysis of the otter hunt records from 15 active packs and found that the decline started in 1957-1958 and was severest in the south and east of England.

Information independent of that provided by hunting data was obtained by baseline national surveys of otter distribution in 1977-1979 (Lenton *et al.*, 1980) and in 1984-1986 (Strachan *et al.*, 1990). In these national surveys stretches of river (sites) were selected at 5km intervals along water courses and searched for otter signs such as footprints and faeces ("spraints") which animals deposit throughout their home range. The 1977-1979 and 1984-86 surveys showed that less than 6% and 9% respectively of all the sites surveyed yielded evidence of otters. While there is now a slight increase in the number of sites showing evidence of otters (Strachan *et al.*, 1990), the status of the otter over most of England remains precarious.

The methodology of the baseline surveys (Lenton *et al.*, 1980; Strachan *et al.*, 1990) meant that some important river systems, including the 1700km of waterways in the North York Moors National Park, were missed. None of the previous otter studies in Yorkshire (Clarke & Roebuck, 1881; Stephens, 1957; Sims, 1971; Howes, 1976, 1985; Thompson, 1977) give a very clear picture of the status of the species. This project aimed to fill the large gap in our knowledge of the otter distribution and status in North Yorkshire where habitats and agricultural practices are very different from other areas of England. The study differs from the national surveys by using a combination of hunting records, intensive surveying over a two year period and a sprainting experiment. The study rivers are now receiving introduced otters (1990-1993), thus providing a check on my earlier survey techniques.

STUDY AREA

The principal rivers in the Derwent and Ouse catchments for which otter hunting records were available are shown in Figs 1 and 2 respectively.

Thirty stretches of river (study sites) were selected for monthly surveying on six of the rivers in the North Yorkshire Moors National Park – the Esk, Dove, Seven, Seph, Rye and Upper Derwent from 1984-1987 (Fig 1). The Esk, in the northern section of the Park enters the North Sea at Whitby. All others are tributaries of the larger River Derwent system which flows into the Yorkshire Ouse.

Additional sites were regularly surveyed outside the National Park from 1987-1989; on 16km of the middle Derwent from Malton to Scrayingham (Fig 2); on the Seven at Brawby, 7km below Sinnington and at Amotherby, Butterwick and Ryton on the Rye

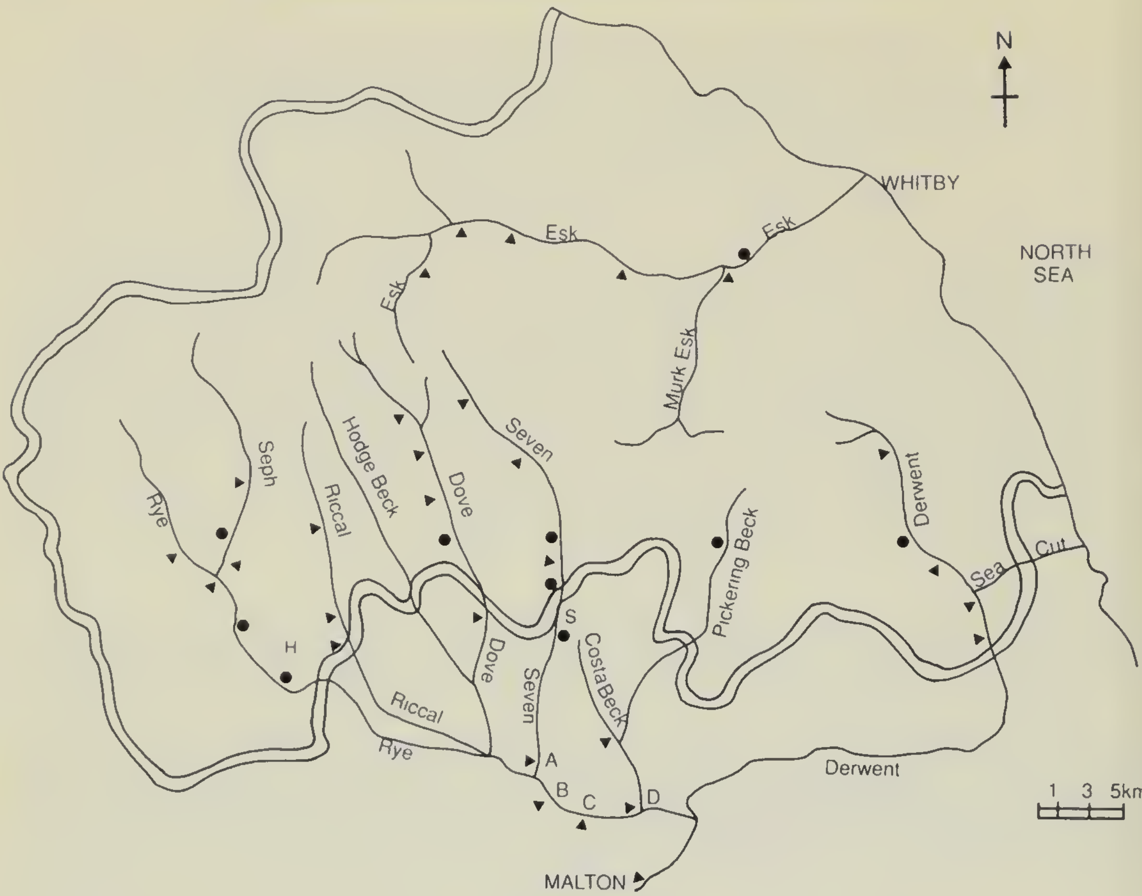


FIGURE 1

Principal rivers in the North Yorkshire Moors National Park. Positive otter signs from 1984-1986 ●. Survey sites 1984-1989 ▲. National Park Boundary □.
A = Brawby; B = Butterwick; C = Amotherby; D = Ryton; H = Helmsley; S = Sinnington.

14km downstream of Helmsley. One site on Costa Beck and 3km of the Riccal between the Park boundary and its upper reaches were also included (Fig 1).

Reliable records of otter presence provided by anglers, water bailiffs and The Vincent Wildlife Trust Otter Haven Project were collected for the Ure, Swale, Nidd, Wharfe, Burn and Ouse (Fig 2).

The River Derwent ranks as one of the cleanest lowland rivers in the country (River pollution survey of England and Wales, 1973), providing excellent fishing and a very important habitat for wildlife (Burnett *et al.*, 1978).

A biological water quality classification based on invertebrates and carried out by the National Rivers Authority (Yorkshire Biological Index – NRA internal document) on the Derwent catchment graded the study area as good (BIA) or quite good (BIB). All the survey sites on the River Esk were classified as BIA (Dr L. Chalk, pers comm).

Fish surveys of the River Derwent catchment in 1983, 1988 and 1989 showed the fish populations to be mainly brown trout (*Salmo trutta*), particularly numerous in the Rye; grayling (*Thymallus thymallus*) and pike (*Esox lucius*) were also relatively abundant in the Derwent. Other species recorded were bullheads (*Cottus gobio*), river lamprey (*Lampetra fluviatilis*), minnow (*Phoxinus phoxinus*), dace (*Lueciscus leuciscus*), rudd (*Scardinius erythrophthalmus*), chub (*Leuciscus cephalus*), stone loach (*Noemacheilus barbatulus*), eel (*Anguilla anguilla*), perch (*Perca fluviatilis*) and ruffe (*Gymnocephalus cernua*). Freshwater crayfish (*Austropotamobius pallipes*) are found in the Rye, Derwent, Nidd, Ure, Swale and Wharfe (D. G. Hopkins, pers. comm.).

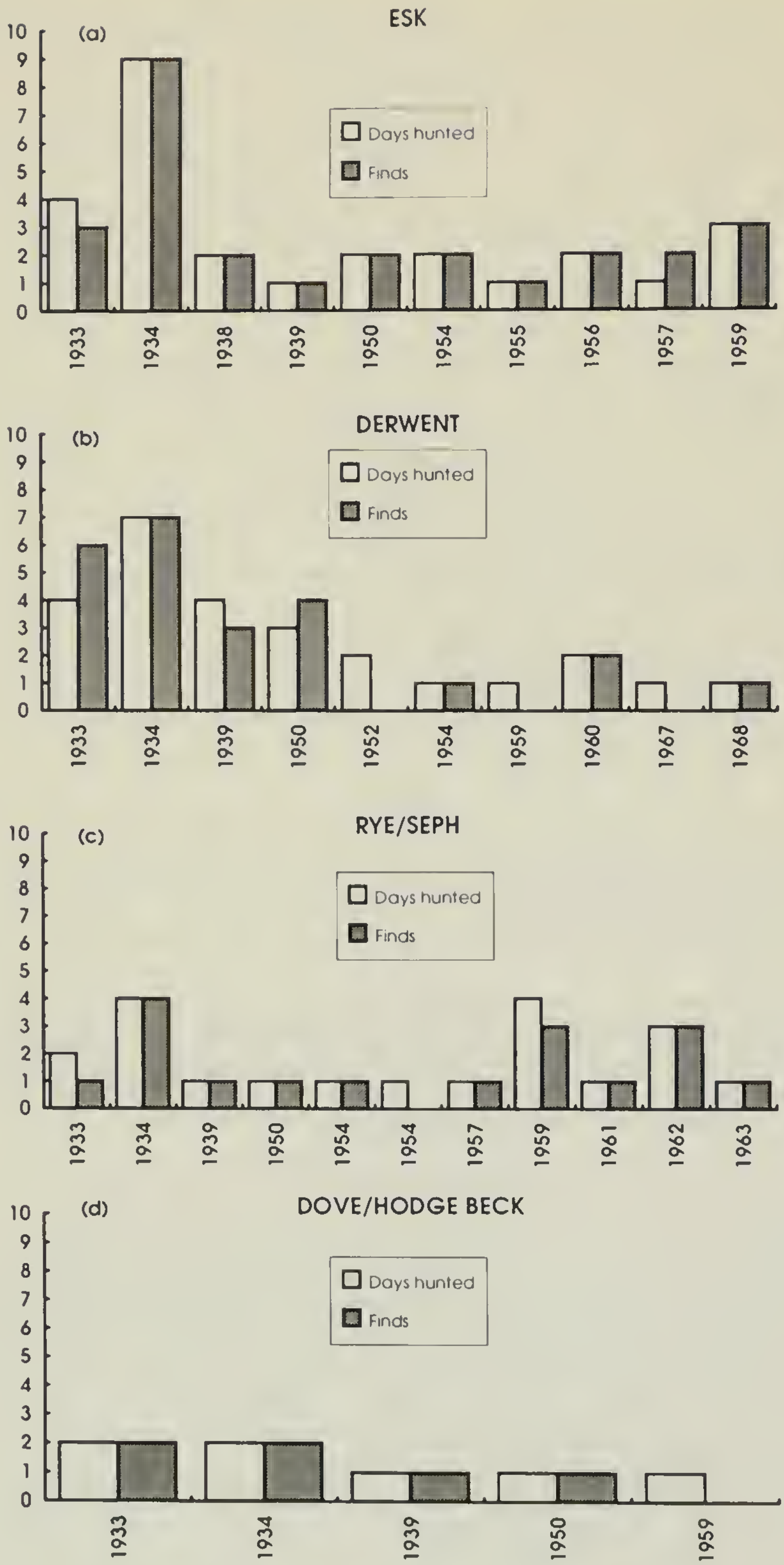
FIGURE 2
Otter distribution map for the Ouse and Derwent catchments based on reports and field signs between 1984-1990 ●. Extra survey sites on the middle Derwent from 1987-1989 ▲. E = Buckden; G = Boston; H = Harewood; M = Marske Bridge; S = Scrayingham

Methods

Yorkshire Hunting Records

All the main North Yorkshire rivers and tributaries were hunted by Malton and District Otter Hounds (MDOH), (F. S. H. Ward, pers. comm.); Northern Counties O.H. (NCOH) (T. Paisley, *pers. comm.*) and Kendal and District O.H. (KDOH) (J. Williams, *pers. comm.*). Data from these hunts, supplemented by newspaper reports, for the 1930s, 1950s and 1960s were analysed to answer the following questions:

1. Which were the most important otter rivers in North Yorkshire? These were used to ascertain how otters were faring in the three decades.
2. Where were the principal sections along the study rivers used by the hunt? These sites were then used for contemporary surveying.
3. Was there a change in hunting success, measured by the number of finds* per hundred days hunting (Chanin & Jefferies, 1978), providing evidence for a decline in otter numbers and, if so, which rivers were most affected? (*A 'find' is the term used when the hunt sees an otter: the otter may escape, be followed or be killed).


(a)
ESK
Days hunted
Finds
1933
1934
1938
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DERWENT
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1933
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RYE/SEPH
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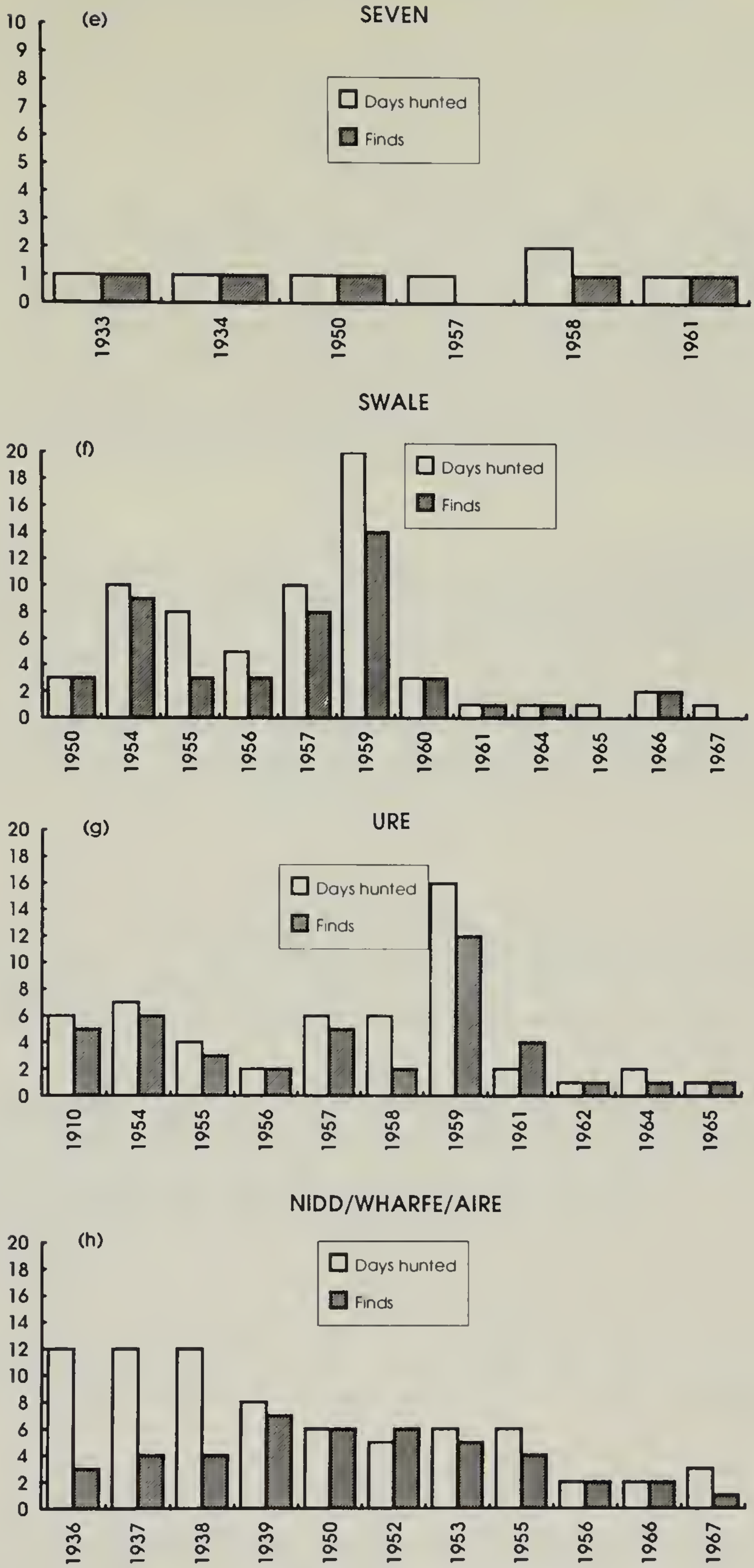


FIGURES 3a-3h (above and opposite)
Frequency of hunting and finds. Numbers of days hunted □.
Number of finds ▩.

4. Were the weights of the otters killed after World War II significantly different from those killed before? Jefferies (1989) found that the mean body weight of otters in the last 25 years was much lower than weights from earlier records. Mean body weights were calculated from the present hunting data for the periods 1910-1939 and 1950-1960.

Field Signs
Survey techniques used here followed those of the Nature Conservancy Council (now English Nature) and The Vincent Wildlife Trust in their national surveys (Lenton *et al.*, 1980; Strachan *et al.*,1990; Green & Green, 1980, 1987). Survey sites were selected at 2-5km intervals along the river and searched for otter footprints and spraints. This survey also differed from the national surveys in some important ways: the sites on six of the rivers in the National Park were visited and surveyed monthly for two years: 1985 and 1986; 600m on both banks was checked (national surveys only one bank) and once a year the whole length of the rivers Seph/Rye, Seven, Dove, Esk and Derwent within the National Park boundaries were walked. From 1987-1989 irregular checks were made at the same sites.

Sprainting Experiment
Otters can discriminate between the spraints from different individuals (Trowbridge, 1983) and have been seen to deposit faeces on existing spraint. I call this "countermarking". Working on the hypothesis that some spraints are used as signals to other otters (Gorman & Trowbridge, 1989) an experiment was designed to see if resident otters would "countermark" on spraints introduced at strategic points along the rivers in the study area. Fresh spraints were collected from Scotland and kept frozen (–20°C) until the time of the experiment. These spraints were placed at selected sites along 300m stretches on the Seven (1987, 1989, 1991) and on the Rye and Derwent (1989, 1991). The "spraint sites" were checked at least twice a week for a period of 3-5 weeks.

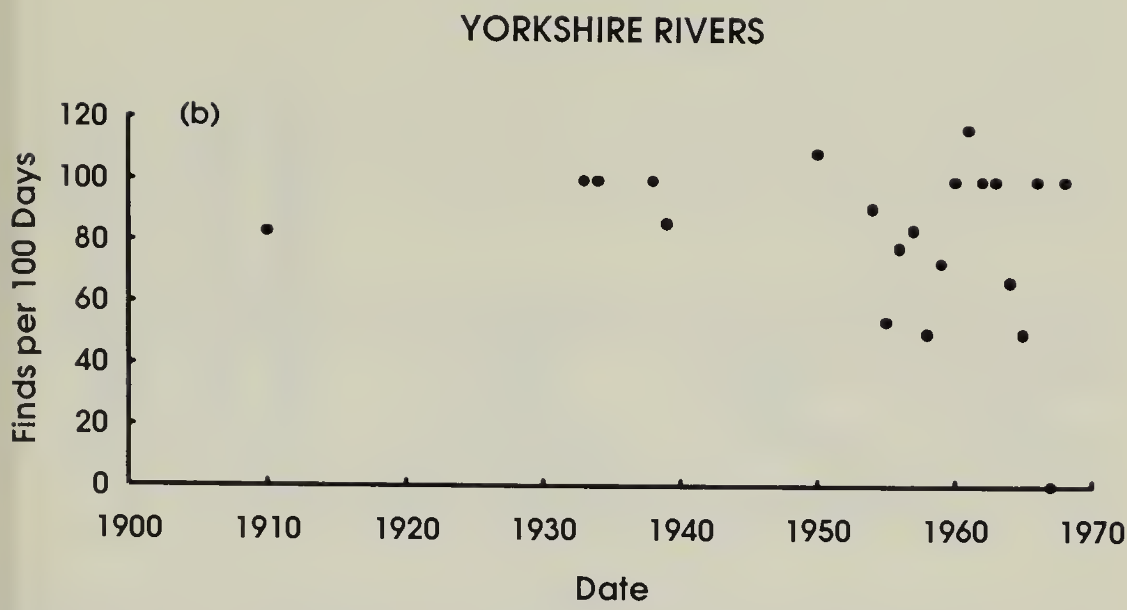
RESULTS

Hunting Records
Key otter areas revealed by hunting are summarised in Table 1. These indicate that there was no shortage of otter habitats or otters in the study area. Survey sites within the National Park as shown in Fig. 1 were sections of the rivers favoured by the otter hunts.

TABLE 1
Summary of hunting venues (meeting places) in the 1950s and 1960s on Yorkshire rivers from the diaries of the Northern Counties OH and Malton and District OH.

River	Number of hunting venues	Maximum length of river hunted (km)
Esk	5	29
Derwent	11	28
Seph/Rye	11	47
Seven	3	17
Dove/Hodge Beck	3	14
Ure	11	57
Swale	18	45

Figs 3(a)-(g) show the numbers of otters found and days hunted on the Yorkshire rivers between 1910-1968. As this area of Yorkshire is south of the main territory of the NCOH the frequency of hunting was low but it clearly dropped in the 1950s and 1960s. The Nidd/Aire/Wharfe were grouped together because data for the individual rivers were not available (Fig 3(h)).



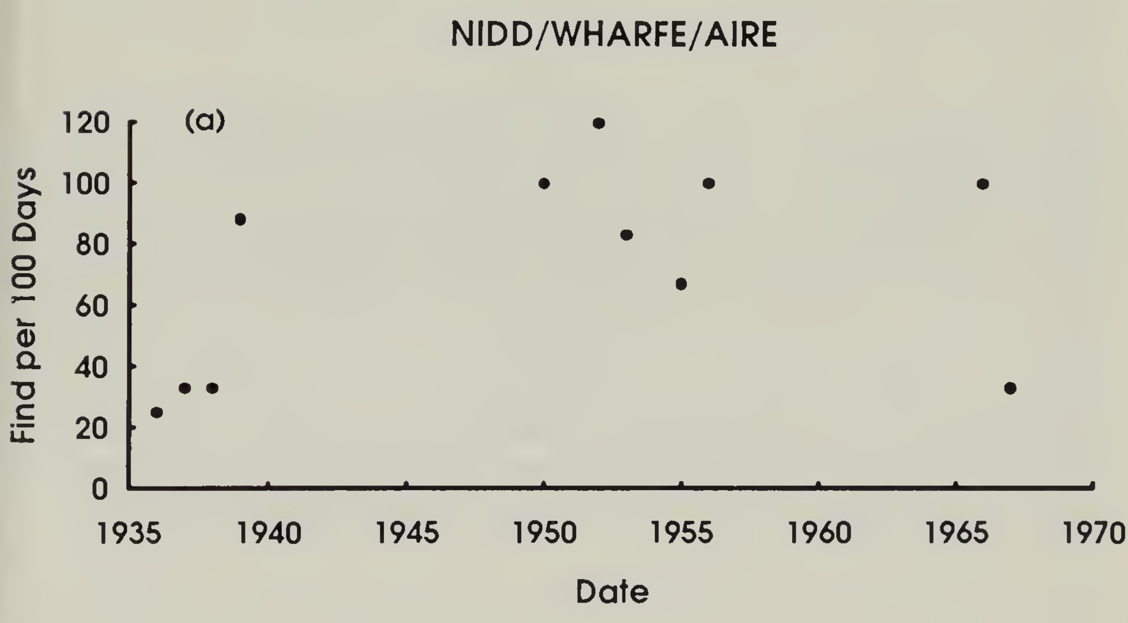


FIGURE 4
Hunting successes: plots of Finds per 100 day hunting (i.e. %): (a) Yorkshire rivers hunted by NCOH for the period 1910-1968 and (b) Nidd/Aire/Wharfe hunted by KDOH for the period 1936-1967 (see text for details).

Cumulative annual hunting successes for the Yorkshire rivers (excluding the Nidd/Aire/Wharfe) and the Nidd/Aire/Wharfe are illustrated in Figs 4(a) and 4(b).

A drastic decline in otter numbers might be expected to result in a drop in hunting success with time. A weighted, least squares regression analysis (Snedecar and Cochran, 1980) was used to investigate this prediction, where the weight for each data point is equal to the number of days hunted that year. The weights allow for the fact that the number of days hunted varies considerably and prevents proportions based on small number of days in the 1960s unduly influencing the regression shape. The fitted regression line for the NCOH data is negative ($y = 1.13 - 0.00565x$, $P>0.1$) but not significant (Fig 4a). The KDOH data, on the other hand, suggests an increase in hunting success ($y = -0.281 + 0.0196x$, $P>0.05$), but this is not quite significant (Fig 4b).

Analysis of Weight Data

The mean weights of otters killed in Yorkshire rivers for the periods 1910-1939 and 1950-1960 are given in Table 2. The differences are not significant, for either dog ($t_{39} = 0.217$, $P>0.05$) or bitch ($t_{26} = 0.334$, $P>0.05$).

TABLE 2

Mean weights of otters killed in 1910-1939 and 1950-1960.

	males		females	
	1910-1939	1950-1960	1910-1939	1950-1960
mean weight (kg)	9.93	9.65	6.98	7.07
SD	2.3	1.39	1.47	0.81
n	21	20	18	10

Signs of Otters

During the main study period (1984-1989) otter spraints were found only twice: on the upper Derwent (1985) and on its middle reaches in July 1989 (L. Winter, pers. comm.). At all other times signs of otters consisted solely of footprints and were found in spring, summer and autumn 1985 on the rivers Seven, Rye/Seph and Esk, and in the summer of 1985 on the Dove (Woodroffe 1989). In 1986, footprints were restricted to the Rye/Seph in June and October and the Esk in April and October (Fig 1). Strachan also reported otter tracks on the Esk in December 1986 during the English national survey (Strachan *et al.*, 1990).

While the number of footprints is no guide to the number of otters there is, nonetheless, a marked difference in the annual cumulative total of footprints in 1985 ($n = 74$) and 1986 ($n = 15$) (Fig 5) suggesting that the otter population was very small and declining. From 1987 to 1990 these sites on the National Park rivers were checked irregularly while the middle Derwent and lower reaches of the Rye and Seven were surveyed regularly by L. Winter. No evidence of otters was found.

Sprainting Experiment

Spraints were placed at prominent places on three rivers in 1986, 1989 and 1991 (Table 3). Countermarking was only found in 1991 after otters had been introduced in the general area of the experiment.

Otter Sightings and Other Evidence of Presence in Yorkshire and Humberside

Reliable reports of sighting and other evidence of otters in Yorkshire and Humberside are

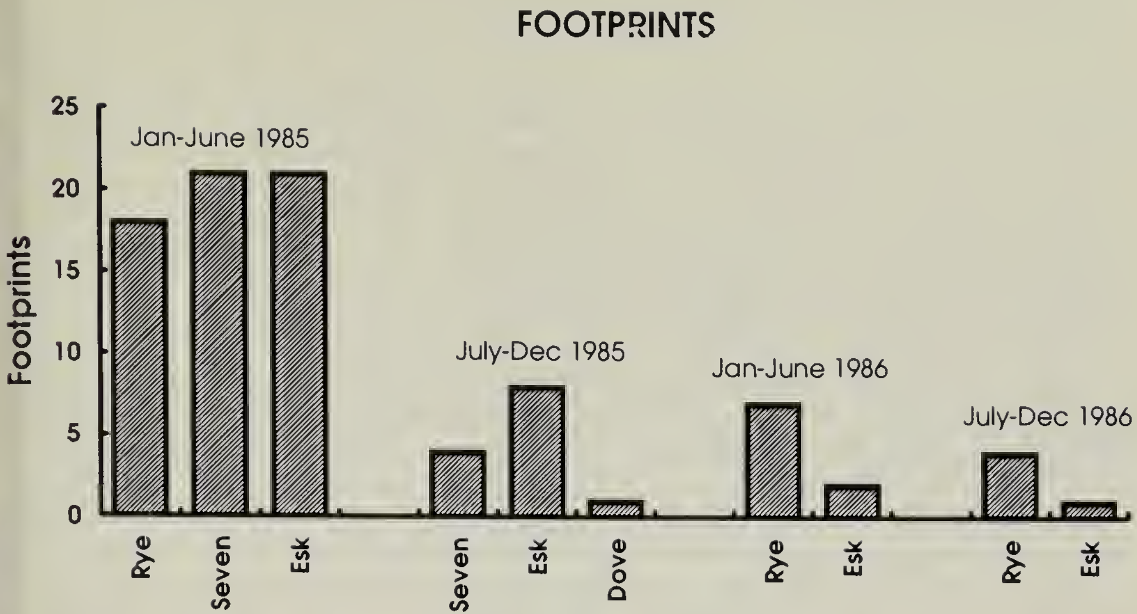


FIGURE 5
Cumulative totals of otter footprints found on 1.2km stretches of river banks on the rivers Esk, Rye/Seph, Dove, Seven and Upper Derwent for 6 monthly periods (see text for details) during 1985 and 1986.

incorporated in the distribution map (Fig 2). Of the rivers outside the National Park the most consistent records are from the middle reaches of the Ure; spraints were found there between 1985 and 1991 with breeding reported in 1990 (J. Graham, pers. comm.). Few reports come from the Swale which was, according to hunt records, one of the major otter rivers and still has good riparian habitat (Strachan *et al.* , 1990). Evidence that it still has an otter population is confined to sightings at Marske Bridge in 1985 and 1989 (H. Smith, pers. comm.). Reports for the Wharfe include a road casualty at Harewood (M. Barratt, pers. comm.), footprints at Boston Spa (1988-1989) and a sighting at Buckden (H. Smith, pers. comm.). There was a single sighting on the Nidd in 1988 where spraints were found in 1991 (Woodroffe & Winter, unpubl.). Strachan recorded one positive site on the Ouse (Strachan *et al.*, 1990).

The middle and lower Derwent are interesting. In spite of reported sightings in 1984 and 1986, regular surveying by L. Winter (unpubl.) from 1987-1989 at eight sites between Malton and Scrayingham found a single spraint. None of these areas on the Derwent produced any countermarking in the sprainting exercise. It must therefore be concluded that the Derwent population, like the others in North Yorkshire, was at best small and fragmented in the period 1984-1990.

Discussion

The detailed survey sites used in the present study, included all the best known former otter haunts revealed by hunting diaries. This was further confirmed when otters were reintroduced into the Derwent catchment in 1990-1992. Release sites were chosen for reasons of security and isolation. In most cases the author has observed that these were situated at least 10-15km from the historic hunting stretches but the released animals travelled to and frequented these former haunts. Prior to the reintroductions there was an almost total lack of sprainting but afterwards sprainting intensity was high and spraints relatively easy to find at these sites.

TABLE 3

Sprainting experiment: locations and distance on rivers where spraint was placed in 1986, 1989 and 1990.

Date	River	Location	(Grid Ref)	Length of River Used	Number of Spraints Placed	Results
June 1989	Seven	Sinnington	(SE 745863)	1 km	18	negative
November 1989	Derwent	Howsham Br	(SE 733625)	364 m	16	negative
November 1989	Derwent	Kirkham Abbey	(SE 734656)	140 m	6	negative
November 1989	Derwent	Menethorpe	(SE 764679)	192 m	9	negative
November 1989	Derwent	Malton Br	(SE 792715)	35 m	3	negative
November 1989	Seven	Sinnington	(SE 745863)	1 km	14	negative
November 1989	Rye	Helmsley	(SE 606826)	490 m	5	negative
Jan-March 1990	Derwent*	Church Br	(SE 758445	–	1	negative
		Thornton Ellers	(SE 724455)	–	1	negative
		Hagg Br	(SE 717451)	–	1	negative
		Wheldrake Ings	(SE 694444)	–	1	negative
		Bubwith	(SE 707365)	–	1	negative
July 1990	Derwent	Scrayingham	(SE 735608)	250 m	7	negative
July 1990	Derwent	Howsham Br	(SE 733625)	364 m	7	negative
July 1990	Derwent	Kirkham	(SE 734656)	140 m	9	negative
July 1990	Derwent	Howlbeck Br	(SE 764667)	5 m	1	negative
July 1990	Derwent	Menethorpe	(SE 734679)	140 m	6	negative
July 1990	Derwent	Minster Hill	(SE 766685)	90 m	1	negative
October 1991	Derwent	Hilla Green	(SE 945903)	500 m	15	5 positive

*Derwent Bridge checks

Sprainting experiment: locations and distances on rivers where spraint was placed in 1986, 1989 and 1990. "Negative" means no countersprainting; "positive" means counter-sprainting.

The use of spraints to monitor otter populations is not straightforward (Kruuk *et al.*,1986; Kruuk & Conroy 1987; Conroy & French 1987; Mason & MacDonald 1987; Jefferies 1987). Conroy and French (1989) found that many otters defaecate mostly in the water and that the absence of spraints does not mean that there are no otters. They also counted up to five times more spraints over 200km of coast in winter than in the summer. Higher sprainting activity in winter was also observed by Erlinge (1968) in Sweden and by MacDonald and Mason (1987) on the River Severn. Males appear to spraint more often at sprainting places than females (MacDonald & Mason, 1986; Jenkins, 1986). Green *et al.*, (1984) calculated that the females' sprainting intensity was 5.5 times less than that of the male although this was based on a small sample of 3 animals.

Because footprints but no spraints were found on all the rivers in 1984-1986, the present study appears to support the conclusions of Conroy and French (1986) that otters can be present without signs of spraints. Differences in seasonal sprainting intensity would not explain their absence, as monthly surveys were carried out for two years and then irregularly for the following four years.

If sprainting is a means of communication between otters (Green *et al.*, 1984), either signalling priority in the use of resources to other group members (Kruuk, 1991) or if it has a sexual function (Conroy & French, 1991) then it is feasible that otters only spraint at conspicuous places along rivers when their densities rise sufficiently for communication between animals to become important. The sprainting experiment on the Derwent partly supports this hypothesis because it was only after animals had been reintroduced that there was some counterspfrainting. In general, however, the failure to find spraints suggests that otter numbers were at best very low.

Chanin and Jefferies (1978) found that hunting returns for the combined NCOH territories (chiefly Northumberland and Teesside) indicated a steady rate of decline in hunting success from the late 1950s to the mid 1960s, with an even sharper decline after 1960. With so little hunting in Yorkshire during the 1960s, dividing the data between individual rivers leaves very little that can be analysed statistically, but even when the NCOH Yorkshire data are pooled the decrease in hunting success is not significant in the period 1910-1967. The slight (non-significant) increase in the KDOH data was most likely caused by replacing the master by a more experienced otter huntsman after World War II (J. Williams, pers. comm.). The first suggestion of a decline in otter populations in North Yorkshire was in 1964 when the NCOH failed to find otters in all the "well known otter haunts" (Paisley, 1964). From this it might be inferred that the decline in North Yorkshire probably started in the mid 1960s and was almost complete on the rivers covered by the time of the 1977-78 survey (Lenton *et al.*, 1980).

There is no evidence that otter hunting was responsible for any decline. Jefferies (1989) hypothesised that otters killed after World War II were much lower in weight than those from earlier records and that the population was highly stressed with an age structure tending towards juveniles before 1957. This is not supported by Yorkshire hunt data.

The drop in hunting activity was mainly due to loss of huntable water particularly on the Dove, Seven, Esk and Rye because of increased fishing interests (F. Ward, pers. comm.), canalising of river banks by Drainage Boards (Rippingille 1963) and destruction of some good habitats. There was little hunting during the early 1960s and it had completely stopped 10 years before it was made illegal in England and Wales in 1978. Canalisation and loss of some good habitats occurred principally outside the National Park on the lower reaches of the Dove, Seven and Rye. The river courses were changed, the banks cleared and raised to prevent flooding. Nonetheless the current otter release programme (Woodroffe & Winter unpubl.) indicates that the Derwent catchment is well able to support a viable otter population.

There is no simple explanation why otters should remain so rare and indeed may still be declining in North Yorkshire. Elsewhere the decline has been linked to the use organochlorine pesticides, notably dieldrin and aldrin (Chanin & Jefferies, 1978) or PCBs (Mason *et al.*, 1986). Information on the use of these chemicals in Yorkshire is not available but with such different cropping patterns from those in the south and east (M. R. Thomas, *pers.* comm.) it is unlikely that there were any significant agricultural applications in North Yorkshire. Substantial amounts of dieldrin were however used in sheep dips (Leech & Macrae, 1970) and this would have resulted in river pollution. While the water and biological quality of the Esk and Derwent catchments are good it is possible that this improvement in quality is relatively recent and that pollution from agricultural chemicals and dairy farming may have initiated the otter's decline; however, this is pure speculation.

Trapping and gamekeeping may have had a larger impact in North Yorkshire than is generally realised (Chanin & Jefferies, 1978; Green, 1991). There was a market for pelts in the 1960s and otters were not tolerated by fishing interests (Ward, 1969). Gamekeepers and water bailiffs confirmed that otters were shot in Bilsdale in the 1960s; and thirteen were known to have been trapped in the north west region during a twelve week period in 1964 (J.Paisley, *pers. comm.*). Such activity might compound natural demographic processes in small populations. For example, if the otter population was already stressed, declining or fragmented, any action which increased any of these factors could be critical for the long term viability of isolated populations.

In summary, lack of sprainting activity along the rivers suggest that the otter population of North Yorkshire is fragmented with few viable breeding groups. The reasons for this are unclear but most likely due to a combination of factors such as intensive farming, pollution and high disturbance in some of its former strongholds. Trapping during the sixties is thought to have made a significant contribution to the continued decline.

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BOOK REVIEWS

British Freshwater Crustacea. Malacostraca: a key with ecological notes by **T. Gledhill, D. W. Sutcliffe** and **W. D. Williams** Pp. 173. Freshwater Biological Association, Ambleside, 1993. £12 paperback.

The first edition of this work (1960, 36 pages, 3 shillings = 15p.) suffered from textual deficiencies and contained some poor, even grotesque illustrations. The second, revised by the present authors (1976, 72 pages, £1), was a great improvement. Some of the worst figures were replaced, but a bad illustration of *Palaemonetes varians* was added. The present work (1993, 173 pages, £12) is again bigger and better. Still incorporating a key, it deals with fewer species – brackish water amphipods of the genus *Gammarus* are excluded – and it has become a mini-monograph. The bad figures have gone: *P. varians* now looks like that species instead of some unknown animal, and an adequate illustration of *Corophium curvispinum* replaces a misleading predecessor.

Beginners are aided by eleven illustrations of representatives of the major groups, which are repeated in the keys. Although we have only one native crayfish, keys are provided to seven as European and N. American species are now sometimes encountered as a result of much to be deplored introductions. Thirty-five pages, new to this edition, are devoted to the taxonomy, distribution, ecology, physiology and breeding habits of the various species and condense an enormous amount of information documented by over 600 references. Statements are usually explicit but it was tantalising to read that the evolutionary significance of mate-guarding in *Gammarus* has recently received much attention (16 references are cited) but to be given no indication what its significance is.

Now providing not only a means of identifying British fresh-water malacostrocans but also a valuable source of information on their biology, this useful work is unfortunately over-priced. Sponsored as it is by the National Rivers Authority, it could surely have been sold more cheaply and would then have reached a wider audience.

GF

Hoverflies by **Francis S. Gilbert**. Naturalists' Handbooks 5. Richmond Publishing Co., Slough. Revised edition, 1993. £13.00 hardback, £7.95 paperback.

This book is a second edition of that first published in 1986 by Cambridge University Press. It is an excellent introduction to the hoverflies, with keys to the common species and many ideas for investigations. In the second edition mistakes in the first edition are corrected and information on recent discoveries included. The excellent plates by Steven Falk are reprinted although perhaps with slight loss of colour intensity.

MEA

Self Made Man and His Undoing by **Jonathan Kingdon**. Pp. 368, with numerous illustrations, maps, black and white photos, line drawings. Simon & Schuster, 1993. £20.00 hardback.

In his previous and widely acclaimed volume *Island Africa*, Jonathan Kingdon dealt with those "islands" of speciation and genetic diversity that lie within the vast "seas" of that continent, as forests, savannas and deserts. Now, in this superb work, he draws on his wide knowledge of his native continent in all its manifestations to develop his latest and most vital theme, the evolution of man, the "self made" technologist, out of African Eden. With his intimate and scholarly knowledge of African primates, and a childhood background which included regular picnics in the Olduvai Gorge, there can be no-one better qualified to draw up the threads from so many disciplines and weave them into a coherent whole. He describes and illustrates our closest living species, the Bonobo, or pygmy chimpanzee, whose anatomy, social structure and sexual appetites place it near to us. His argument that climatic change forced our primate ancestors out of the jungles and onto the plains is compelling.

He reviews the fossil and genetic evidence from the latest research, and constructs his "pagoda tree" of hominid evolution, from the early Lucy, through the Handyman grade to the Moderns.

Whether discussing cave art, sickle cell protection from malaria, the construction of fish traps or the location of Eve in East Africa, Kingdon knows his material. He brings it together in a cogent plea that we recognise our dangerously opportunistic nature, and learn to control it before time runs out. This is a wonderful book, well written, beautifully illustrated, and of great significance. At £20 it is a bargain.

RAE

BATS AND THEIR ROOSTS IN CLEVELAND AND NORTH EAST YORKSHIRE III: THE NOCTULE BAT

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In a previous account of bat distribution in Cleveland and north east Yorkshire (Wardhaugh 1992), it was stated that the noctule bat (*Nyctalus noctula*) can be seen regularly in the study area during summer months. The purpose of this note is to report recent sightings and occasional records of this species (see Figure 1).

Only five certain records of the noctule are known for the period 1969 to 1993 in this area. Two individuals were caught unintentionally in bird ringers' mist nets at Saltholme Pools, Cleveland (GR 45/504224) on 1st September, 1969 and one was found in a moribund condition at Hartlepool Headland (GR 45/531341) on 23rd April, 1971 (R. T. McAndrew, *pers. comm.*). More recently, an exhausted female was found near Carlton-in-Cleveland, on 17th August, 1992 (GR 45/512030). This animal was cared for and when fully recovered it was released at the site of origin on 19th August, 1992. Lastly, a moribund male was found near Yarm (GR 45/413106) on 25th May, 1993.

Sightings indicated in Figure 1 refer to one or more bats seen in flight, often on several occasions, at dusk in summer, mostly at riparian sites. They have been identified as noctules on the basis of size, flight pattern and call.

The noctule is one of the largest bats occurring in the British Isles and it is the only large species known to occur within the study area (Howes & Thompson 1985, Stebbings & Griffith 1986, Corbet & Harris 1991). Compared with the other six smaller species known from the area (Wardhaugh 1992), its flight is high, fast and quite distinctive (Whitaker 1906, Racey 1991). In many cases the bats were found to emit ultrasound for echo-location at a peak in frequency of 20 to 25 KHz, recorded on QMC Mini and Mini 2 bat detectors. This frequency peak is characteristic of the noctule and lower than that of other British bat

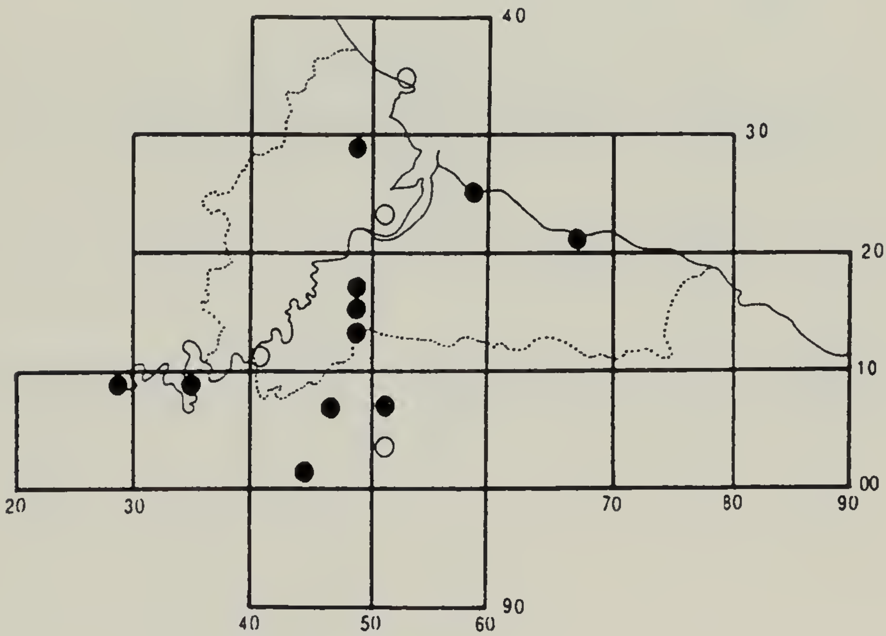

FIGURE 1
Tetrad distribution map for the noctule bat in Cleveland and north-east Yorkshire.
River Tees and Cleveland county boundary (dotted line) also shown.
○ = records of individuals ● = sightings

species known to occur in the area (Stebbings 1986). Furthermore, the lower frequencies of these calls (around 19 KHz) are clearly audible to young people with keen hearing (Racey 1991), a feature noted on many occasions by B. S. Wardhaugh in the sightings reported here. For this combination of reasons, there is no doubt that all of these sightings refer to the noctule bat, even though animals were not identified in the hand.

Taken as a whole, the fifteen records presented in Figure 1 indicate a possible association with altitude since fourteen of the sites lie at less than 100m above sea level (chi squared = 8.03 $P<0.01$, an estimated 56.8% of land in the study area being below 100m). This accords with records for the pipistrelle (*Pipistrellus pipistrellus*) and the brown long-eared bat (*Plecotus auritus*) in this area (Wardhaugh 1993). However, the noctule can travel several kilometres from roosts to feeding areas (Howes 1974) and hence caution should be applied to any conclusion drawn from this finding.

The noctule occurs throughout England and Wales, reaching the northern limit of its distribution in Scotland (Racey 1991). In Durham county (vice county 66), Jackson and Hinchcliffe (1986) reported thirteen noctule roosts, whilst previously published records for Watsonian Yorkshire show a southerly bias (Howes 1985). Taking these facts into account, the records presented here serve to fill a gap in the known distribution of the noctule and although no roost sites have been located, it seems very likely that it is a resident, breeding species in the study area.

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I am grateful to members of Cleveland Bat Group, both past and present, for their help in providing data included in this paper.

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BOTANICAL REPORTS FOR 1991 FLOWERING PLANTS AND FERNS

Compiled by J. E. DUNCAN

The recorders thank all those who have sent in records. The names of contributors are given in full the first time they occur in each report and initials are used thereafter. Nomenclature of species is according to Dandy, J. E. (1958) with some amendments. The figures indicate 10 km grid squares on the ordnance survey maps. In each case the first number (meaning 100 km grid) is represented on maps by letters as follows 35 = NY; 45 = NZ; 34 = SD; 44 = SE; 54 = TA; 43 = SK.

East Yorkshire (VC 61) (F. E. Crackles)

Ranunculus lingua L. Howden Marsh 44/73, 1990; J. & R. Hunt.
Coronopus didymus (L.) Sm. River bank, North Ferriby 44/92, 1990; F. Bannister.
Stellaria neglecta Weithe Breighton 44/73; M. Hunter.
Trifolium fragiferum L. Howden Marsh 44/73; J. Hu & R. Hu.
Vicia tetrasperma (L.) Schreb. Car park, Hessle Country Park 54/02; F. E. Crackles.
Myriophyllum verticillatum L. Leven Canal 54/14 (formerly recorded for the canal in 54/04); F.E.C.
M. alerniflorum DC. Pond, Thornton Ellers 44/74, 1990; D. R. Grant.
Rumex maritimus L. Howden Marsh 44/73, 1990; J. H. & R. H.
Hyoscyamus niger L. One plant in field of Kale, Rudston 54/16; M. Gatenby.
Linaria repens (L.) Mill. x *L. vulgaris* Mill. = *L.* x *sepium* Allman Kiplingcotes Quarry 44/84, 1990; R. Hewer.
Filago vulgaris Lam. Sancton Wold 44/94; A. J. Horne.
Centaurea cyanus L. Fifty plants still at Bursea 44/83; J. Killingbeck.
Butomus umbellatus L. About forty plants in pond, Roos Carrs 54/22; P. Cook.
Platanthera chlorantha (Custer) Reichb. Two plants, Bratt Wood 44/95, 1987; M. & J. Stringer.
Orchis morio L. Forty plants near Fimber 44/86, 1990; M. Clark.
Dactylorhiza maculata (L.) Sóo Meadow, Withernwick 54/23; F.E.C.
D. purpurella (T. & T. A. Steph.) Sóo Withernsea 54/32; P.C.
Eliogiton fluitans (L.) Link Black Drain, Thornton Ellers 44/74, 1990; T. E. Dixon.
Carex divulsa subsp. *leersii* (Kneuker) Walo Koch, Near Bentley 54/03, 1990; J. Dews, herb. C.G.E., conf. R. W. David.
C. dioica L. Tophill Low 54/04, 1990; A. Marshall.
Catabrosa aquatica (L.) Beauv. South Newbald 44/93; English Nature.
Spartina anglica C. E. Hubbard On shore. Hessle 54/02; M. Fuller.

North-East Yorkshire (VC 62) (T. F. Medd)

Dryopteris carthusiana (Vill.) H. P. Fuchs Kildale 45/60; Rev. G. G. Graham; Eston Moor 45/51 and Gerrick 45/71; I. C. Lawrence.
Nymphaea alba L. Claxton 44/65; A. Weston.
Cochlearia danica L. Skinningrove 45/72; I.C.L.
Trifolium striatum L. Teesport 45/52; I.C.L.
Crataegus laevigata (Poir.) D.C. Waupley Moor 45/71 and Skinningrove 45/72; I.C.L.
Pimpinella major (L.) Huds. Skinningrove 45/72; I.C.L.
Parietaria judiaca L. Wilton 45/51; I.C.L.
Salix triandra L. Near Guisborough 45/51; I.C.L.
Hottonia palustris L. Claxton 44/65; A.W.
Petasites hybridus (L.) Gaertn., Mey. & Scherb. (female plants) Near Kirkbymoorside 44/68; Miss H. L. Wyett per (Mrs N. Sykes).
Serratula tinctoria L. Waupley Moor 45/71; I.C.L.

Allium scorodoprasum L. Near Kirkbymoorside 44/68; H. J. Killick.
Dactylorhiza fuchsii (Druce) Sóo x *D. incarnata* (L.) Sóo ssp. *pulchella* (Druce) Sóo Dalby Forest 44/88; F.Horsman. First record involving this subspecies.
D. praetermissa (Druce) Sóo Stape 44/79; N.S. det. F.H. Previously mistaken for *D. purpurella* and probably the only extant locality for the species.
D. purpurella (T. & T. A. Stephenson) Sóo var. *crassifolia* Sledgate 45/90; F.H. First record for this variety.
Eleocharis multicaulis (Sm.) Sm. Eston Moor 45/51; I.C.L.
Carex pseudocyperus L. Claxton 44/65; A.W.

South Yorkshire (VC 63) (D. R. Grant)
Hypericum maculatum Crantz Hexthorpe 44/50; D. R. Grant.
Myosoton aquaticum (L.) Moench Near Clayton, Doncaster 44/40; D.R.G.
Stellaria neglecta Weithe Norwood, near Maltby 43/59; D.R.G.
Ornithopus perpusillus L. Old railway, Normanton 44/32; D. Proctor.
Pyrus communis L. Stainforth 44/61; T. Schofield.
Rubus ulmifolius Schott Earlsheaton 44/22; D.R.G.
Crataegus oxyacanthoides Thuill. Tankersly 44/39; J. Lunn.
Umbilicus rupestris (Salisb.) Dandy Near Foster Clough, Mytholmroyd 44/02; G. Barker.
Foeniculum vulgare Mill. Dudfleet, Horbury 44/31, D.R.G.
Daucus carota L. Old railway, Notton 44/31; T.S.
Bryonia dioica Jacq. Hatfield 44/31; E. Thompson
Rumex hydrolapathum Huds. Rossington 43/69; D.R.G.
Salix pentandra L. Near Steeton 44/04; D.R.G.
Scrophularia umbrosa Dumort. River Aire, Steeton 44/04; D.R.G. Woodlesford 44/32; D.Walls.
Mimulus moschatus Dougl. ex Lindl. Shaw, Oxenhope 44/03; T.S.
Veronica catenata Pennel Sprotbrough 44/50; T.S.
Campanula glomerata L. Warmsworth, 44/50; T.S.
Inula conyza DC. Womersley 44/51; E.T.
Picris echioides L. Blacktoft 44/82; C. Braham.
Juncus compressus Jacq. Skellow Cross 44/51; T.S.
Allium oleraceum L. Near Sprotbrough 44/50; D. Bramley
Ophrys apifera Huds. Old railway, Normanton 44/32; D.P.
Acorus calamus L. Canal. Horbury 44/21; D.R.G.
Carex rostrata Stokes Widdop 34/93; D.R.G.
C. acuta L. Cottingley Bridge 44/13; D.R.G.
C. pendula Huds. Whitley Woods Mirfield 44/21; E.T.
Poa compressa L. Old colliery site, Cadeby 43/59; T.S.

Mid-West Yorkshire (VC 64) (L. Magee)
This year records were received from eleven field workers, covering many of the remoter parts of the Vice-County. Records of unusual interest were from the Craven area of the Dales as well as from the YNU field and section meetings in VC64.

Unfortunately only a fraction of the records can be published and the recorder sincerely thanks all who contributed.

* = New 10km square records.

Ranunculus hederaceus L. West End 45/15; FWBS field meeting.
Ranunculus aquatilis L. Barden reservoir, 45/05; L. Magee.
**Ranunculus penicillatus* (Dumort) Bab. *ssp. pseudofluitans* (Syme) S. Webster. R. Aire Buck Mill 44/13; L.M.
Nuphar lutea (L) Sm. R. Wharfe, Newton Kyme, 44/44; D. Grant.
Euonymus europaeus L. Common Scar, 34/76. Confirmation of old record; D.G.

Ceratophyllum demersum L. Plumpton Rocks Lake, 44/35; D.G.

Genista anglica L. Newby Moor Bridge 34/77, Deepdale Field 34/85, Langber 34/94: J. Allison.

Astragalus glycyphyllos L. Old Quarry Towton 44/44; C. Hartley.

Chrysosplenium alternifolium L. Banks Gill 44/05, Lobwood Gill 44/05, Clifford Wood 34/67, Old Wood 34/67, Carr Beck Wood 34/76, Watery Lane, 34/86; J.A. River Laver Nr Rippon, 44/37; D.G.

Myriophyllum spicatum L. River Aire, Bank Newton 34/95; D.G. Redcar Reservoir, Keighley 44/04; L.M.

Hippuris vulgaris L. Plumpton Rocks Lake 44/35; D.G.

Silaum silaus (L) Schinz & Thell. Church Fenton 44/5136; E. Thompson.

Anagallis tenella (L.) 10km square 34/76, in five locations; J.A.

Gentianella amarella (L.) Boerner *ssp. septentrionalis.* (Druce) N. Pritch Kidstones Pass 34/76; J. & S. Hartley.

Menyanthes trifoliata L. Pond, Meagill Lane 44/15. 'Probably introduced'; L.M.

Myosotis stolonifera (DC.) Gay ex Leresche & Levier. Barden Reservoir 44/05; L.M.

Mimulus luteus L. River Nidd, Birstwith 44/25; L.M.

Melampyrum pratense L. West of Giggleswick 34/76; M. Sanderson per J.A.

Veronica scutellata L. Barden 44/05; FWBS Field meeting.

Mentha spicata L. R. Nidd, Birstwith 44/25; L.M. R. Wharfe, Barden 44/05; L.M.

Chaerophyllum temulum L. River Wharfe, Ilkley 44/14; Flowering Plant Section field meeting.

**Campanula trachelium* L. Grass Wood 34/96 'Adventive'; M. T. Hanson.

Senecio fluviatilis Wallr. Giggleswick Quarry 34/86; D.G.

Clinopodium vulgare L. R. Wharfe, Ilkley 44/14; FPS field meeting.

Littorella uniflora (L) Aschers. Fish pond, Barden 44/05; L.M.

**Baldellia ranunculoides* (L) Parl. Pond at Arthington Hall 44/24; L.M.

Butomus umbellatus L. Canal, Kildwick 34/04. Confirmation of old record; J.A.

Potamogeton alpinus Balb. Newby Moor 34/76; P. Abbott and T. Rich.

Potamogeton berchtoldii Fieb. Pond near Scarcroft, Leeds 44/34; D.G.

**Zannichellia palustris* L. Harry's Dam, West End 44/15; FWBS field meeting.

Groenlandia densa (L) Fourr. R. Aire, Bank Newton 34/95; D.G.

Juncus subnodulus Schrank. Austwick Moss 34/76, Pan Beck Flush 34/85, Langber 34/94; J.A.

Scirpus maritimus L. Ben Rhydding gravel pit. 44/14; FPS field meeting.

Schoenicus nigricans L. Austwick Moss 34/76, confirmation of old record: Deepdale Field and Pan Beck 34/85; J.A.

**Eleogiton fluitans* (L.) Link. Mill Goit, West End 44/15; FWBS field meeting.

Carex pendula L. Hob Moor 44/54; J. Lambert, Punch Bowl Wood 34/66, Old Wood 34/67, River Dove, Kirby Mills 44/78; L.M.

Carex elata All. Crane Field, 34/85, Coniston 34/85; J.A.

Carex paniculata L. Cunliffe Bog, Esholt, SE44/14. Confirmation of old record; D. G. Arnford 34/85, Mansell Beck Fen 34/85; J.A.

Eleocharis uniglumis (Link) Schult. Deep Gill 34/66, Swinden 34/85, Flambers Laithe 34/85; J.A.

Eleocharis quinqueflora (F. X. Hartmann) O. Scharz. Gill Beck 34/66, Newby Moor 34/76, Swinden 34/85, Huntsworth 34/86; J.A.

Punccinellia distans (L.) Parl. Newton Kyme 44/44; D.G.

Poa compressa L. Old railway Broughton 34/95, Settle railway yard 34/86.

NORTH-WEST YORKSHIRE (VC 65) (T. F. MEDD)

Ophioglossum vulgatum L. Low Newstead 44/18; Dr. J. Allinson.

Ranunculus circinatus Sibth. Bolton-on-Swale 44/29; L. Magee.

R. penicillatus (Dumort.) Bab. var. vertumnus Richmond 45/10; C. J. Bruxner det. Dr. S. Webster.

Hippuris vulgaris L. Hornby 44/29; J.A.
Silaum silaus (L.) Schinz & Thell. Disused railway, Moulton 45/20; J.A.
Andromeda polifolia L. Two sites in Coverdale 44/07; C.J.B.
Pedicularis palustris L. Kexwith 45/00; J.A.
Valerianella locusta (L.) Betcke Whitcliffe Scar 45/10; J.A.
Pulicaria dysteneriса (L.) Bernh. Bolton-on-Swale 44/29; L.M.
Serratula tinctoria L. Wood End 44/09; J.A.
Alisma plantago-aquatica L. Harmby 44/18, Forcett Park and Eppleby 45/11 and Croft Grange 45/20; J. A.
Zannichellina palustris L. Bolton-on-Swale 44/29; L.M.
Juncus subnodulosus Schrank Leyburn 44/18, Harmby Moor 44/19 and Eryholme 45/30; J.A.
Dactylorhiza incarnata ssp. *pulchella* Sóo Coombe Scar 34/68; F. Horsman. Second vice-county record.
D. traunsteineri (Sauter) Sóo Carperby 44/09; F.H.
Scirpus fluitans L. Catterick 44/29; J.A.
Schoenus nigricans L. Bellerby 44/19; J.A.
Carex vesicaria L. Thornton Steward 44/18, Newton-le-Willows 44/28 and near Eppleby 45/11; J.A.
C. pallescens L. Wood End 44/09; J.A.
C. elata All. Spennithorne 44/18 and Newton-le-Willows 44/28; J. A.
C. acuta L. Thornton Steward 44/18; J.A.
C. paniculata L. Forcett Park 45/11; J.A.
C. disticha Huds. Newton-le-Willows 44/26 and Uckerby 45/20; J.A.
C. spicata Huds. Leyburn 44/18 and near Eppleby 45/11; J.A.
Calamagrostis canescens (Weber) Roth Jervaulx 44/18; J.A.

CASUALS AND ADVENTIVES (E. CHICKEN)

During 1991, there were 69 records received from 13 individuals from 53 taxa. Records of plants growing in aquatic situations have been prominent this year due to the activity of the Freshwater Biology Section. It would seem that many of those records are of delilberate introductions, though it is not always possible to be sure about this. Certainly one wonders how *Nuphar pumila* could otherwise arrive in Otley, so far from its usual locations in the north of Scotland and in Wales.

It is always a problem to know which trees to list in this report rather than in those of the VC Recorders. This can be seen by considering holly, native and spreading readily; sycamore, alien and seeding readily; and the London plane, alien and more likely to be planted than otherwise spread. The last of these has been included in this report.

All records sent in are entered on the card indexes. The contributor is assumed to be the determiner unless otherwise stated.

Ranunculus lingua L. (64) Gallows Hill pond, Otley 4424; L. Magee.
Nuphar pumila (Timm) DC. (64) Gallows Hill pond, Otley 44/24; L.M.
Cardaria draba (L.) Desv. (63) Ravensthorpe 44/22; E. Thompson per D. R. Grant.
Impatiens parviflora DC. (63) Under trees on golf course, Holmfirth 44/10; Mrs J. Lucas, and Netheroyd Hill, Huddersfield 44/11; J.L. per D.R.G.
Medicago sativa L. (63) Roadside, Colne Bridge, Huddersfield 44/11; J.L.
Robinia pseudoacacia L. (63) Bank of R. Colne, Upper Heaton, Huddersfield 44/11; J.L.
Lathyrus latifolius (L.) (63) Tankersley 44/39; T. Schofield per D.R.G.
Elaeagnus umbellata Thunb. (62) Small enclosure between fields, Hackness Estate, Suffield 44/99; E. Chicken.
Bupleurum falcatum L. (64) Bolton Abbey 44/05; Wharfedale Naturalists' Society, per Mrs J. E. Duncan.
Euphorbia cyparissias L. (63) Old railway sidings, Normanton 44/32; D. Proctor per D.R.G.

Platanus x *hybrida* Brot. (63) Bank of R. Colne, Upper Heaton, Huddersfield 44/11; J.L.
Buddleja davidii Franch. (63) Old pit site, Cadeby 43/59; T.S. per D.R.G.
Dipsacus pilosus L. (64) Grass Wood 34/96; J.E.D. and two sites at Bolton Abbey 44/05 & four sites in the Washburn Valley 44/15; W.N.S. per J.E.D.
Senecio cineraria DC. s.l. (62) Ravenscar 45/90; Miss L. Dudley per T. F. Medd.
Conyza canadensis (L.) Cronq. (61) Set-aside field, Potter Brompton 44/97; B. S. Pashby

RECENT OCCURRENCES IN YORKSHIRE OF SEA LAMPREYS *PETROMYZON MARINUS* (PETROMYZONITDAE)

P. A. FREAR
National Rivers Authority, Clifton Moor, York YO3 4UZ
and
J. C. SHANNON
National Rivers Authority, Gelderd Road, Leeds LS12 6DD

On the evening of 29th June 1993, the authors observed several adult sea lampreys, *P. marinus* (Linnaeus, 1758), excavating redds in the River Swale at Fawdington (Grid Ref. 44 /437728). The fish were in fast flowing water, 0.4m-0.6m deep. On closer inspection of a 25m length of river, a total of seven redds were observed, all but one occupied by a single lamprey. The redds were approximately 0.6m in diameter with most of the excavated material deposited slightly downstream, giving an overall 'pear-shape' appearance. Each lamprey positioned itself at the downstream side of the redd and remained in this location by attaching its oral sucker to a single large pebble. The lampreys varied in length from *c*.0.7-1.0m.

A further visit to the river on 5th July 1993 indicated that the lampreys had left their spawning site but the redds were still clearly visible.

Following these observations, three further reports of sea lampreys were received at the National Rivers Authority office in York. The first, on 1st July 1993, reported several sea lampreys spawning in the River Ure at Boroughbridge (D Shillcock, *pers. comm.*). The other two reports were of individual sea lampreys swimming near the surface in a downstream direction, one in the River Ouse at Acaster Malbis on 2 July 1993, observed by the second author, and one in the River Nidd at Skip Bridge on 13th July 1993 (Cole, pers. comm.).

Sea lampreys have rarely been recorded in the Ouse system in recent years, although a single seaward migrating young adult, 157 mm in length, was recovered from Moor Monkton water intake screens on 11th January 1991 (Frear & Axford, 1991). Prior to this capture sea lamprey records in Yorkshire have been very scarce. They were recorded in the middle and upper reaches of the River Derwent in the 1940s (Clegg, 1977) but their numbers declined soon after, along with salmon, mainly as a result of gross industrial pollution of the lower River Ouse.

Adult sea lampreys have recently been observed attached to boat hulls in the North Sea (D Whittaker, *pers. comm.*).

It is interesting to note that, like salmon, sea lampreys are apparently returning to the main tributaries of the River Ouse.

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OBITUARY

R. J. RHODES
(1925-1993)

In May 1993, it became known that R. J. Rhodes – 'Reg' to his many friends and acquaintances – was seriously ill in Doncaster Royal Infirmary. With his death, on 5th June, Doncaster ornithology lost its veteran researcher and Yorkshire ornithology one of its post-war paladins. Throughout his life, RJR had an enduring commitment to ornithology at both local and county level. The eldest son of a coal miner, he was born at Rossington, near Doncaster, in 1925. He entered Rossington Colliery in 1939, leaving in 1950 to begin a succession of other local jobs. In 1984 he retired from full-time work, having been employed for many years as a crane driver at the Doncaster railway plant.

RJR was a leading supporter of the idea to form the Doncaster & District Ornithological Society in 1955. Although he always modestly disclaimed any credit for the formation of the Society, his longer term commitment was unequalled, and at his death he was the only founder member still retaining membership. He was associated with the DDOS Executive Committee for many years, and became the Society's first Treasurer (1956-57). He held the Presidency in 1958, acted as Secretary in 1960, and edited numbers 5-7 of the DDOS journal *Lapwing* (1970-72). But it was as a Recorder and Joint-Recorder that he made the greatest impression, being closely associated with editing and producing many of the Society's annual reports between 1957-89. RJR joined the Yorkshire Naturalists' Union in 1959, and became actively interested in the Ornithological Section. He was invited by Ralph Chislett to sit on the Section's General Committee in 1962-63, and later became V.C. 63 Recorder, being involved with the records of 1970-73.

A bird ringer for a number of years, RJR served as Chairman of the DDOS Ringing Sub-committee from 1957-65. He was instrumental in establishing the Adwick-le-Street Ringing Station in 1962, and eventually wrote a short history of it, a condensed version of which was published in John Mather's *The Birds of Yorkshire* (1986). In RJR's more general birdwatching around Doncaster, he gained a wide knowledge of local sites. Some, like Hangthwaite, Almholme 'Dugout' (Thorpe Marsh) and Potteric Carr, he 'discovered' as modern ornithological sites, and at others – including Wath Ings, Denaby Ings and Sprotbrough Flash – he was amongst the first to visit them. With R. D. Mitchell, he 'opened up' Thorne Moors to Doncaster district birdwatchers. This field experience proved invaluable in developing his interest in research derived from local bird recording. His research was undertaken on personal initiative and as a coordinator of DDOS endeavour. The fieldwork on Thorne Moors culminated in co-authorship of the booklet *Thorne Moors: Birds and Man* (1986). His other papers, reports and notes appeared in both *Lapwing* and *The Naturalist*.

In 1957, RJR began to research more widely into aspects of Doncaster ornithology, sometimes presenting the resultant work to DDOS audiences at meetings. His mind was already turning to the possibility of publishing a Doncaster avifauna, which he increasingly saw as an essential focus of longer-term DDOS activity. In 1967 the DDOS published his book *The Birds of the Doncaster District*, which was well received, being described by one reviewer as an 'absolute model'. Following its publication, RJR's interest in encompassing the entire gamut of Doncaster ornithology was, if anything, keener than before. In October 1977, he presented a paper, 'Status changes of some birds in the Doncaster District since 1965', which updated his earlier book to the end of 1975. In 1978 it was published as a supplement to *Lapwing* **10**; however, at that time he was already planning another full review of Doncaster birds. Progress increased following retirement, and *Birds in the Doncaster District* appeared at the end of 1988; it received justifiable appreciation from reviewers, and much praise from birdwatchers. Sadly his plan to publish a detailed summary of the results of Doncaster bird ringing had eventually to be abandoned a few months before his death.

RJR and his wife travelled widely in the British Isles and northern Spain in search of birds, but it was Doncaster which always formed the focus of his birding life: his ornithology was tempered by a strong sense of place. This dedication was recognized in 1980, on the occasion of the DDOS Silver Jubilee, when RJR was made the first Honorary Life Member of the Society. He felt genuinely honoured, as his speech of acceptance (*Lapwing* **13**: 6) revealed. RJR is posthumously accorded a detailed appreciation in the *Doncaster Bird Report 1992* (7-12), and his surviving unpublished scripts are to appear as a memorial volume in the *DDOS Occasional Series*.

RJR was the epitome of a good society member: committed, productive, proud of his chosen organisation, and held in esteem. His contribution to local and regional ornithology was remarkable, and his example was being emulated long before his death. There have been many expressions of regret at the loss of a fine mentor and friend; we offer sympathy to his brother and sisters for their greater loss.

Martin Limbert

SNUFFED OUT FOR SNUFF: *MEUM ATHAMANTICUM* IN THE ROBERTS LEYLAND HERBARIUM

J. R. EDMONDSON

National Museums & Galleries on Merseyside, Liverpool Museum, William Brown Street, Liverpool L3 8EN

The herbarium of Roberts Leyland (1784-1847), a printer and naturalist of Halifax, Yorkshire was formerly kept at the Belle View Museum in Halifax, but was reported by Desmond (1977) to have been destroyed. Kent and Allen (1984) state that the herbarium of Edward Akeroyd (1810-1887) may have included the remains of the herbarium of Roberts Leyland; as Akeroyd was responsible for donating the Leyland herbarium to the Museum

(Crump & Crossland 1904) it appears that he may have distributed duplicates to other collectors.

I was interested, therefore, to discover a specimen bearing a printed label "Ex herbario R. Leyland, Halifax" among a collection of plants which was recently acquired by Liverpool Museum from the Chelsea Physic Garden, London. It is a sheet of *Meum athamanticum* Jacq. (Apiaceae) collected "in the 2nd lane after you pass the Booth Wood Inn on the road from Ripponden to Oldham, July 1837". This locality is cited exactly as stated, but without the date and recorder's name, in Baines (1840, p. 45). The specimen was found in a collection of mainly British flowering plants known as the G. W. Robinson herbarium (Edmondson 1994).

The specimen is mounted on a pale blue paper 204 x 327 mm, watermarked "R W & H Nicholls 1834". On closer examination, the label was seen to bear an inscription on the reverse side, this having been thickly attached with adhesive to the mounting paper so as to make the information inaccessible. The sheet was therefore taken to the Museum's Paper Conservation laboratory, where Donna Hughes carefully removed the label and cleaned the adhesive from the paper. This was a glutinous water-soluble adhesive similar in appearance to animal glue. The following additional information was revealed: "An old locality. The plant is however nearly destroyed, not by the rapacity of Botanists but by the Snuff takers in the neighbourhood of the place where it grows who dig up the roots for the purpose of scenting! their snuff."

The specimen and its associated data are therefore interesting on at least two counts. Firstly, they represent a surviving fragment of a long-lost herbarium of a major Halifax botanist who was active in a period (1814-1843) of growing environmental pressures caused by industrial developments. Secondly, they come from a location (Grid Ref. *c.* 44/0317) where the species is now extinct, and provide an intriguing explanation for the plant's extinction.

According to Crump and Crossland (1904), the plant was last recorded in the Halifax area in 1844 at Booth Dean, "the only specimen to be found, the ground being planted with potatoes, where it used to grow". This suggests that agricultural activities may have contributed to its final decline; no reference is made here to the use of its roots as a perfume, although an earlier record for the year 1840 by Leyland is cited "at the Booth in Rushworth, formerly plentiful, now nearly eradicated" (Crump & Crossland 1904, p. 49).

ACKNOWLEDGMENTS

Thanks are due to Ruth Stungo (Chelsea Physic Garden) for facilitating the transfer of the G. W. Robinson herbarium to Liverpool Museum, and to Donna Hughes and Sally Ann Yates for carrying out the conservation work on the specimen of *Meum*.

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MARSH TIT

Photo: Richard Vaughan

In Farndale, where this photograph was taken, the Marsh Tit *Parus palustris* is common and the Willow Tit seldom, if ever, seen. Sunflower seeds are a favourite winter food of the Marsh Tit which, however, often prefers to bury a seed in the ground anything up to a hundred yards away from the feeding station and then return at once for another. Here the seeds were placed in a hollow in an apple tree.

BOOK REVIEWS

The Life and Death of a Pool by **John Struthers**. Pp. 136, including 201 colour plates. Swan Hill Press, Shrewsbury. 1993. £19.95.

For six weeks John Struthers watched the animal life around a small pool in the Savanna of Zimbabwe. His observations extended over much of September and October, a period which started with the pool well supplied with water and ended with it drying out. In this photo-narrative (with the excellent colour plates occupying more space than the text) the author simultaneously and continuously records his observations in text and photograph. Initially faunal utilisation of the pool is rich and frequent. This included many antelope such as impala (up to 3000), nyali, kudu and bushbuck as well as elephant, zebra and warthog. Their visitations and foibles are carefully described as are their abundance, arrival and dispersal. At this time the faunal dynamics about the pool were quite considerable.

However, as the pool dried up, thick, cracked mud made the water more difficult of access and less potable. The difficulties and struggles the animals then encountered are well recorded by the author's camera. Appropriately, human activities and intrusions during the watch are included. This is a light readable account dominated by its large photographic input; well suited to the coffee table.

MJD

Aspects of Tropical Mycology edited by **Susan Isaac, Juliet C. Frankland, Roy Watling** and **Anthony J. S. Whalley**. Pp. ix + 325, including numerous b/w plates, line drawings & tables. Cambridge University Press, 1993. £50.00.

Although tropical mycology has only been widely recognized by scientists relatively recently, this volume bears testimony not only to the importance of the discipline but also to the very considerable development of our knowledge in the past decade.

As the editors state in their Preface, they hope "to stimulate interest in mycobiota of tropical sites, the attributes of these fungi and how they react to particular condition". This they have done with remarkable success by covering the broader issues of ecology, taxonomy, experimentation these are and commercial interest in 14 chapters; these are complemented by a personal and captivating introduction to tropical mycology by E. J. H. Corner and a thought-provoking concluding chapter by D. L. Hawksworth which examines in considerable detail the extent of fungal biota (with probably 1 million undescribed fungi on tropical plants alone!), the resource base, the pertinence and the future of the subject. Other chapters deal with such wide-ranging topics as litter-trapping, nutrient cycling, marine fungi, desert interactions, biodiversity, mycorrhizae, pathogens, molecular genetics and commercial potential.

All in all, a rewarding and fitting record of the British Mycological Society's Symposium on the subject held at Liverpool University in 1992. Rather pricey, but recommended reading for mycologists and an important addition to the academic library bookshelf.

MRDS

Upland Britain. A natural history by **Margaret Atherden**. Pp. xvi + 224 (including numerous b/w plates, line drawings & maps), plus 8 pages of colour plates. 1992. Manchester University Press. £45.00 hardback, £12.95 paperback.

Margaret Atherden is no stranger to readers of *The Naturalist*, being a regular contributor to it, besides being an active member of the Yorkshire Naturalists' Union. She is also more widely known for her palynological studies based on detailed investigations of the North Yorkshire Moors over many years. In *Upland Britain* she marshals all these interests to present a fascinating insight into the plant and animal communities to be found at higher altitudes, drawing heavily on her own firsthand observations. As well as covering the physical and biological aspects of the various upland habitats, she highlights the interaction of ecological processes, paying particular attention to human pressures on these often fragile ecosystems and to the measures being taken (or otherwise) to conserve them. One particularly interesting chapter concerned with 'boundaries and highways' emphasises not only their disruptive effects on wildlife continuity but also their role as wildlife corridors.

This book is a worthy successor to W. H. Pearsall's remarkable but now rather dated work on *Mountains and Moorlands* (Collins New Naturalist series) which inspired countless naturalists since its first appearance in 1950. The successor is well written and well presented, and is strongly recommended.

MRDS

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