SCIENTIFIC ILLUSTRATION IN THE EIGHTEENTH CENTURY

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Illustration emerges from complex and diverse motives. The portrayal of an objective reality may seem to lie at its heart, but there are other subtle factors at work. Preconception guides many an illustrator's hand. A wish to project known realities onto nascent concepts distorts reality in its own ways, and the process of transmuting the subtle realism of nature into an engraver's line imposes constraints and conventions of its own.

There is a general principle in artwork, often unrecognised: the culture of each era dictates its own arbitrary realities. Our experience of this is largely intuitive, but it explains why a specific image (a saint from a thirteenth-century psalter, or the countenance of the Statue of Liberty) is easier to relate to the time it was produced, than to the identity of the artist or the name of the subject. In just this way, a scientific illustration is a mirror of contemporaneous preoccupations, and a clue to current prejudice. It is more than a didactic symbol. Some illustrations create, and then perpetuate, icons which transcend reality and provide a synthesized convention which passes from one generation of books to the next. These icons are created for textbooks, and they populate their pages as decorative features which do little to reveal reality.

FOONOTE

Discussions on the relationship between reality and interpretation are found in: Ford, Brian J., *Images of Science, a History of Scientific Illustration,* London: British Library; New York: Oxford University Press (1992); also in the author's Images Imperfect, the Legacy of Scientific Illustration, *Yearbook of Science and the Future*: 134-157, Chicago: Encyclopedia Britannica (1996).

Early in the century, François Legaut's *Voyages et Aventures* (1708) featured a rhinoceros with a second horn projecting forward from its brow. This structure is never found in life. Why should it feature in an eighteenth-century illustrated textbook? The first published study of a rhinoceros (made by Albrecht Dürer in 1515), though powerful and realistic, boasts a small secondary horn on the shoulders, which projects forward. The image was repeatedly plagiarised and - with each generation of copying - this imaginary forward-projecting second horn increased in size. By the time it was included in Legaut's book the imaginary horn was equal in size to the real one.

For the technician, keen to capture scientific imagery, some notion of 'realism' is the declared aim. Yet cultural interpretations of this term vary considerably. European conventions aimed at conveying the right proportions, the correct number of scales, the alignment of petals in precise order. Eastern illustrators portrayed nature with less absolute accuracy, but with more style and panache. A Japanese illustrator, faced with the precision of a picture from a Western encyclopaedia of ichthyology, observed: 'Yes, but I don't find it appetising.'

Representing three-dimensional, subtle realism on a flat sheet with lines and bands of colour took time to mature. Each new convention bestowed its terms of reference on the generation which followed, and they nurtured the paradigm, improved it, honed and refined it for their own contemporaneous audience. Representational illustration became a hall-mark of eighteenth century reference books, and we can glimpse flashes of inspirational realism in earlier centuries on which this tradition was founded.

Earlier examples are the photo-real *Viola odorata* portrayed for Jacopo Filipo of Padua in the 1390s, followed by the brilliant rendering of *Mandragora autumnalis* by Giacomo Ligozzi around 1480, and the clump of turf of Albrecht Dürer's *Das Große Raßenstück* of 1503.

FOONOTE

Reference is made to: Hastings Hours manuscript (<1480) [London: British Library, Additional 4787 f49], and to Jacopo, Filipo (1390) *Viola odorata*, [London: British Library, Egerton 2020 [94]. The original of Dürer is preserved as: Dürer, Albrecht (1503), *Das Große Raßenstück*, Vienna: Albertina collection, and the Ligozzi, Giacomo (c1480) *Mandragora autumnalis* is at Florence: Uffizi Gallery, Gabinetto Disegnis.

There remained no method of duplicating these vivid images, which could not find publication as scientific illustrations in mass-produced works. Most earlier published scientific illustrations were of poor quality, and the crude woodcut of a horse skeleton by Ferrari in 1560 (as an example) shows little more than a half-decayed and distorted corpse with little attempt at realism. Others were far more attentive to detail. Carlo Ruini produced well-observed studies of the horse skeleton as early as 1598, and his work was still being used as a reference by Snape in 1683.

As the eighteenth century dawned, new philosophies were emerging in a cascade of intellectual renewal. Locke and Spinoza, Leeuwenhoek and Leibniz, Descartes and Newton were publishing revelations in an unending stream. The techniques of graphical representation were more fully understood, and accepted conventions could now be applied to the whole panoply of natural philosophy. After centuries of haphazard block-making and essentially crude drawing, an era of representational scientific illustration was suddenly to emerge. Now that artists were aware of the way to apply their craft, and natural philosophers were identifying the realities that surrounded them, lucid

illustrations suddenly began to become commonplace. A flowering banana was portrayed, for the first time in scientific history, as clearly as you would expect to find it in a present-day text-book or a botanical home page on the world wide web. The horse skeleton was beautifully embodied in engravings of the highest quality, transcending anything that went before, and better than most illustrations available today. Majestic images of the heavens, and detailed drawings of the intricate communities of ponds and hedgerows were suddenly laid before an enthusiastic audience. As an era of science began to mature, the illustration of its findings came to a state of representational perfection which sometimes exceeded the standards in modern reference sources.

Representational realism as a routine had begun to appear in previous centuries, though not usually in academic texts. The many herbals, for example, frequently featured hideously distorted and exaggerated versions of medicinal plants. To the tyro, their value as a guide to identification was slight. Herbalists, of course, knew perfectly well what was portrayed. No, to seek the best portrayals of nature we need to turn to the religious artist. The most available source would be the Books of Hours perfected by the Flemish illustrators of the fifteenth and sixteenth centuries. One example, the *Hasting Hours* painted prior to 1480, is a perfect small tortoiseshell butterfly sitting on a primrose. The painters were content to set down images of nature as an aid to worship, and had no need to distort or falsify.

Why, then, do we find unrecognisable images of plants in the specialist herbals? The reason lies in a wish to dignify the trivial through obscurantism. Herbalists did not wish to have the public *au fait* with their art, and the purpose of the imagery was to keep outsiders at bay. In modern science we find the equivalent, when false-colour transmission electron micrographs are used to decorate articles for the public, and when complex terminologies are used to designate the simplest of concepts. There is a phenomenon in which patients clench their molars and rub them together whilst asleep. It is known to doctors as tooth-grinding - but only amongst themselves. Once the topic is likely to receive a wider audience, it becomes transmuted into temperomandibular joint syndrome. In just the same way, a white cell remains a white cell amongst the scientists in a haematology laboratory. If an outsider comes into the room, these cells become polymorphonuclear granulocytes, and they remain polymorphonuclear granulocytes until the visitor has left.

A desire to keep specialisms special, and to prevent non-academics from gaining undue insights into fields which authorities like to keep for themselves, has often guided the *rapporteurs* of scientific progress. In the field of scientific illustration we find resonances of the same ideal. The modern world is replete with images of twisting spirals of nucleic acid, seductive impressions of black holes in the deep recesses of outer space, meaningless vistas of integrated circuits animated in a choreographed sequence in a television commercial - images designed to impress the public with a sense of unattainable complexity, rather than to illuminate a simple and assimilable truth. Atoms are still illustrated as though comprised of billiard balls, even though this concept has

not been applicable since the post-quantum era of the 1930's.

In the eighteenth century we had a respite. The clumsy caution of the earliest illustrators was maturing into a full appreciation of the wonder of reality, and the present-day tendency to distort and impress was still to arise. In this singular century we saw the new currency of scientific honesty beginning to emerge. It bequeathed to us a legacy of vivid and striking pictures, capturing for the first time the extent of human discovery. Science began to emerge as a recognisable discipline, and its illustrators served it well. Great voyages of discovery were bringing back collections of natural history, plant specimens and geological samples. They were using artists to record their finds and were servicing collectors on their return. The era of scientific exploration was under way.

When the century was born, work on a great illustrated work was only beginning. Maria Sibylle Merian (1647-1717) had just returned to Amsterdam from Surinam, laden with drawings and collections of plant and insect material from that South American colony. She came from a family with long-established connections with this field. Her father, Mathäus Merian the Elder, had inherited the *Florilegium Novum* of his father-in-law Johann Theodor de Bry, and published a new edition of this work in 1641. After his death a few years later, Maria's mother married Jacob Marrell, a painter of floral arrangements, and Maria in turn married one of her step-father's pupils from Nuremberg, Johann Graff. Some years afterwards she left her husband for religious reasons, and travelled to Surinam in 1698 to study, collect and draw. The results appeared in a beautifully illustrated work, *Metamorphosibus Insectorum Surinamensium* (1705) with an enlarged second edition, containing additional plates made by her daughter Joanna, in 1714. These editions are illustrated with fine engravings, each painstakingly hand coloured, and provide an interesting exemplar of the transitional period between the partly imaginary corpus of earlier illustrations, and the move towards representationalism. The illustrations have an exaggerated quality, with salient features distorted to suit the view of the engraver. Some of the aspects (and several of the species) are imaginary, and some have anatomical details in the wrong order. Her cashew nut, for instance, is drawn upside down in relation to its stem.

FOOTNOTE

See: Theodor de Bry, Johann (1611) *Florilegium Novum*, Frankfurt. Merian, Maria Sibylle (1705) *Metamorphosibus Insectorum Surinamensium*, Amsterdam was published in a second edition, with additional plates, in 1714. Rudolph Ackerman published *Thirty Studies from Nature*, Munich (1812), an example of publishing in which teams of colourists were employed to embellish engraved plates.

Joseph Pitton de Tournefort (1656-1708), Professor of Botany at the Jardin Royal in Paris, first published his *Élémens de Botanique* in Paris in

1694. It became well known for its much-revised English edition, *The Compleat Herbal*, published in two volumes (1719 & 1730). He catalogued 8846 vascular plants in this book, which was illustrated with some 500 engravings on copper. As Maria Sibylle Merian had explored the New World, de Tournefort took leave from his post in Paris and set off to explore the Middle East. He was accompanied by Andreas Gundelscheimer, a physician, close friend and naturalist, and a noted apothecary and illustrator, Claude Aubriet. They set sail from Marseilles in 1700, and headed for Crete where they botanised for three months. After exploring the islands of the Aegean they travelled on to Turkey, spending time in Armenian and Kurdish communities en route to Georgia, discovering many species new to western botanists. Tournefort published an account of the journey and their findings in a book illustrated by Aubriet, the *Voyage au Levant* of 1718. The engravings are recognisable, but are unsubtle and done without grace. As in the case of Sybille Merian's publications of the same era, there are detectable resonances of the herbals and other illustrated books of an earlier age. However, in the *Élémens de Botanique* he had produced the first comprehensive treatise on botany, and the work of later taxonomists (Linnaeus, for example) should be considered in conjunction with this work.

FOOTNOTE

Joseph Pitton de Tournefort, published *Voyage au Levant*, Paris (1718) and *The compleat Herbal*, London (1719, 1730). The quality of engraving was not always high, but the large number of species described set in train the work by taxonomists such as Linnaeus.

Aubriet himself illustrated several works on botany. His studies were stylised, too, but the vigour of his vernacular enhanced, rather than detracted from, the vivid realism with which he portrayed his subjects. The great work in England was published by John Ray (1627-1705), the son of a blacksmith *cum* herbalist from Essex. With the support of Francis Willughby (1635-72) Ray toured Europe between 1663 and 1665. Many of Ray's other publications appeared during the seventeenth century, but his greatest work appeared in the eighteenth. Publication of the great *Historia generalis plantarum* was completed in 1704. Although a greater work than Joseph Pitton de Tournefort's *Élémens de Botanique* (Ray describes 18,600 plant species in a work of almost 3,000 pages) it was unillustrated. There was a growing belief that the student of high science needed no pictures to enlighten the mind. This concept persisted well into the twentieth century. Today's senior British botanists know Clapham, Tutin and Warburg's *Excursion Flora of the British Isles*, for example, which contains no illustration of any of the species it describes.

A close friend of John Ray's, Mark Catesby (1683-1749) - a self-taught artist - was inspired to visit the Americas to document what had recently been discovered in the territories still new to natural philosophy. He visited the Carolinas, Virginia, and the Bahamas and published a *Natural history of*

Carolina, Florida and the Bahama islands in 1731-43. Catesby had an urge to drawn everything he could see, and his books were well illustrated. There are resonances of an earlier era, for some of his illustrations lack a certain realism. Many are imbued with a caricature-like quality which is not truly representational, but reflects his self-taught status. In a later era, cartoon-like resonances can be detected in some of the drawings by Edward Lear where birds are given almost anthropomorphic expressions. For all the stylistic oddities, Catesby is rightly celebrated as the pioneering great naturalist to work in America.

George Edwards (1694-1773), who travelled widely in Europe in his time as an apprentice, undertook to publish much of Catesby's output, and wrote a number of published natural history books. The *Natural history of birds* was published as a three volume set (1743-50) and was subsequently produced in a French edition. His greatest work was published in four volumes, as *The Natural history of uncommon Birds, and some other rarer undescribed Animals*. It appeared between 1743 and 1751 and was followed by *Gleanings of Natural History* (three volumes, 1758-64).

The vigour of Catesby's illustrations can be compared with those of Griffith Hughes, whose *Natural History of Barbados* (1750) fulfils the need of the book collector, rather than the naturalist. The marine invertebrates he figures are faithfully portrayed, and represent study in the field, but each is set with mathematical precision on a plate faithfully dedicated to its particular sponsor. The result is a dull book, pandering to the wealthy patrons, but doing little to entice readers with the exuberance of discovery in the New World. Catesby deserves his reputation as an innovative naturalist of the Americas, but he was not the first natural philosopher to illustrate the species of the New World. Charles Plumier (1666-1706) had visited the Americas between 1689 and 1695. He published several illustrated works, including the *Nova Plantarum Americanarum Genera* of 1703 and the *Traité des Fougères de l'Amerique* published in 1705. Both books feature detailed illustrations of the genera he studied, and the 170 plates on American ferns (engraved on copper by Plumier from his own specimen drawings) became a standard work. Here too the images are slightly stylised, yet they come close to the modern ideal of a line drawing. Plumier died on a journey to Peru in his fortieth year, and his final book was published posthumously. This was *Plantum Americanum . . .* edited by Johannes Burmann. Plumier left a legacy of inspiration, too, for it was his late seventeenth-century travels to the New World which had inspired Maria Sibylle Merian to set out and explore for herself. Catesby was followed by William Bartram (1739-1823) who was the first great American naturalist, and a fine artist. He has also been called 'America's first ecologist' (a title perhaps more correctly bestowed upon Henry Chandler Cowles (1869-1939) whose publication, *Vegetation of the Sand Dunes of Lake Michigan* was published in 1899). Bartram, the son of King George III's botanist in America, certainly understood that there were subtle interactions between plant and animal communities, and his great work was published as *Travels through*

North and South Carolina, Georgia, east and West Florida, etc, in 1791.

Carl Linnaeus (1707-78) of Råshult, Sweden, was the great systematist who brought an enduring order to the taxonomy of the natural world. The most innovative of his pioneering books was *Systema naturæ regnum vegetabile*, first published in 1735, but his *Genera plantarum* (1737) soon followed, and was itself succeeded in 1751 by the *Philosophia Botanica* and in 1753 by *Species Plantarum*, in which the binomial convention appeared for the first time. Linnaeus is commemorated as the person who popularised the system of nomenclature which we have inherited today. It is interesting to note that the drive towards this simplicity was not the result of scientific clarity, but in order to economise on paper. Linnaeus felt that too much space was devoted to the lengthy Latinised descriptions of plants which were then current. By reducing the description to genus and species (one word for each) he reduced his printing costs. His work gave a considerable impetus to the development of illustrated botanical books. Pulls of many of the plates used in his own books were used as wall-paper in Linnaeus's country home at Hammarby, and survive there in their original condition to this day.

One of those inspired by the output of Linnaeus was Carl Peter Thunberg (1743-1828), who set off from Sweden in 1700 for a journey through Japan, Java, the Cape and Ceylon. He documented about 2,000 new species of plants and they appear in his 293 publications on natural history and medicine. His many books were influential for generations of botanists who came in their wake.

FOONOTE

The principle botanical volumes are as follows:

Thunberg, Carl Peter (1784) *Flora Japonica*, Leipzig.

Thunberg, Carl Peter, (1788-93) *Sera uti Europa, Africa, Asia förätad ären 1770-79*, Uppsala.

Thunberg, Carl Peter (1807) *Flora Capensis*, Uppsala.

Thunberg, Carl Peter (1794-1800) *Prodromus plantarum Capensium [etc]*, Uppsala.

Michel Adanson (1727-1806) of Aix-en-Provence, France, was one of those inspired by these works. He explored Senegal in 1749 collecting specimens. Adanson's *Histoire naturelle du Sénégal* [etc] (1757) was published in Paris, appearing in English in volume 16 of J. Pinkerton's *General collection of . . . voyages [etc]* (1814) London. Adanson's extensive two-volume *Familles des Plantes* (1763, 1764) was published in Paris. The engravings, taken from specimens collected on the way, are vivid and realistic. Interestingly, his plates on conchology show specimen shells with the apex downwards, a convention followed by French publishers at variance with traditions elsewhere in European illustration.

The eclipse of the traditional woodcut was marked in the eighteenth century, when H. L. Duhamel de Monceau published his *Traité des arbres et*

des arbustes (1755). All the illustrations were old woodcut blocks. As this book was published, the young Georg Dionysius Ehret (1708-1770) was already demonstrating the use to which fine and detailed copper engraving could be put. Although a vogue for exploration and discovery provided a hall-mark for eighteenth century biologists, Ehret did not travel the globe. He spent all his life in Europe, yet produced some of the most memorable and accomplished illustrations in the history of botany. Born in Heidelberg, Germany, Ehret was the son of a gardener. His father died young, but not before he had painstakingly taught the young Ehret to draw from nature. His early years were not a success. He worked as a gardener for Karl III of Baden in Karlsruhe who was impressed by his art and invited him to paint some botanical studies. Ehret's status as a favourite caused problems with his fellow gardeners, and by 1726 matters had become so strained that he moved to live in Vienna. An apothecary named J. W. Weinman commissioned Ehret to produce 1,000 botanical studies, but after he had produced the first half Weinman felt dissatisfied, paid him half a year's salary, and the contract was terminated. Some of the Ehret engravings appeared in Weinman's *Phytanthozoa Iconographia.* However, this book also contains many imaginary organisms and thus has more in common with a work from a previous century.

During a period working for a Regensburg banker, Ehret was befriended by Johann Ambrosius Beuer, a trainee apothecary and keen amateur botanist, who introduced him to his uncle. This was a crucial event for the young Ehret. The uncle was Christophe Jacob Trew of Nuremberg, who became Ehret's most successful patron and an enduring friend. Trew encouraged Ehret in his work. A collection of 600 of Ehret's botanical watercolours was sold in 1732 for 200 thalers (Trew had been paid only 20 thalers for his contract with Weinman). The collection, known as *Herbarium Vivum Pictum,* may be the otherwise unidentified collection of water-colour studies now in the library of the Earl of Derby at Knowsley Hall, England.

FOOTNOTE:
Reference may be made to:
Trew, Christophe Jacob (1750-1792) *Hortus Nitidissimus*, Nuremberg.
Trew, Christophe Jacob (1750-73) *Plantae Selectae*, Nuremberg.

This was his first commercial success, and Ehret spent time during the following years to travel in Europe, visiting botanic gardens and studying as widely as he could. His many flower paintings were sent back to Trew, who added them to his collections and cared for them. Ehret's pictures were always identified both by name of specimen, and often with details such as where and how the plants were grown. Ehret made visits to England, where he became friendly with George Clifford, a Netherlands banker whose gardening assistant and physician was the young Linnaeus. Linnaeus published a description of the rare plants in Clifford's gardens, and it was illustrated by twenty plates by Ehret. The plates were engraved by Jan Wandelaar, and the finished product

appeared under the title *Hortus Cliffordianus* (1737). The beautiful illustrations marked the move towards scientific accuracy in delineation of detail. Since the sexual characteristics of angiosperms were considered crucial to classification by Linnaeus, Ehret featured many of these details, painstakingly dissected out, in his illustrations. At the Chelsea Physic Garden, he was befriended by the curator and horticulturist Philip Miller, whose sister-in-law Ehret married. Miller had kept notes on many remarkable plants at the Garden, and published *Figures of the most Beautiful, Useful and Uncommon Plants* between 1755 and 1760. The illustrations were all by Ehret.

By this time he was beginning to engrave his own copper plates. He set himself a project which was published as *Plantae et Papiliones Rariores* (1748-59). Though the plants are confidently engraved, the butterflies are not identified by the artist and serve merely as embellishments to his floral compositions. Some of the plates show dissected details of floral structures, and each book was painstakingly hand-coloured. Meanwhile Trew was compiling his own books for publication, using engravings of Ehret's fine watercolours as illustrations. Trew published the ten-part *Plantae Selectae* between 1750 and 1773 and a book on garden plants, *Hortus Nitidissimus* between 1750 and 1792.

His illustrations were included in other books, such as a fine engraving of *Pinus pinaster* which illustrates the *Description of the genus Pinus* (1803-24) written by Aylmer Bourke Lambert. He worked for an unsuccessful year as curator of the Oxford Botanic Garden, but quarrelled with Humphrey Sibthorp, Professor of Botany, and was then given patronage by the Duchess of Portland. She was a keen horticulturist and collector, and asked Ehret to train her daughters in botanical illustration. Though Ehret did not produce any major works devoted to his work, he served as a great teacher and an inspiration to the botanical illustrators who were to follow. In the next few years, botanical illustration was to reach the height of observational accuracy.

Humphrey Sibthorp himself visited Vienna in 1785, to study the manuscripts which recorded the ancient teachings of Dioscorides. Here he became friendly with Ferdinand Bauer, a young and promising botanical painter, and the two embarked upon one of the greatest floral books ever published. Together they toured Greece in 1786 and 1794, the findings of which were immortalised in the *Flora Graeca*, which Sibthorp wrote with J. E. Smith. The illustrations are of high quality, in the form of copper engravings water-coloured by hand, and by the time the finished work appeared (1806-1840) it represented the best of eighteenth-century botanical illustration. Ehret was the finest plant illustrator in Europe until Franz Bauer (1758-1840) came to Kew Gardens at the invitation of Sir Joseph Banks. The two Bauer brothers, Franz and Ferdinand, became a formidable pair of talents who brought illustration to a pitch of perfection that has not been exceeded.

The most famous botanical artist of the period was the Belgian Pierre-Joseph Redouté (1759-1840) born at St Hubert in the Ardennes. His greatest

influence, as a young man, was Charles Louis L'Héritier de Brutelle (1746-1800) who commissioned Redouté to illustrate his *Stirpes Novae aut Minus Cognitae* (1764-85). Some of the plates were printed in colour *à la poupée*. In this technique, coloured inks are used on differing parts of the engraved plate, producing a full-colour printed image. The engravers began working on plants collected from the Spanish colonies when, in 1786, they were instructed to return them to the Spanish Ambassador in Paris. Realising what a valuable property they held, Redouté and L'Héritier had the collection shipped urgently to London, where they were cared for by Sir Joseph Banks. Redouté was thus introduced to many members of English scientific society, whilst L'Héritier (who returned to Paris) was murdered in the streets in 1800. Redouté gained an additional reputation through his rôle as *protégé* of Josephine Bonaparte, and illustrated books by Augustin de Candolle and Philippe la Peyrouse. As the century closed, he was working on his *Liliacées*, published in Paris between 1802-16, which some have claimed as the greatest illustrated work in the history of botanical science.

The production of botanical illustrations was a labour of considerable magnitude. The drawings themselves took time, but the painstaking rendering of each anatomical feature as fine scratches on a copper sheet proved to be an arduous task. As in sculpture, the removal or indentation of the raw material had to be done with care. Mistakes during the engraving process were not easy to repair.

Robert Thornton (1768-1837) planned to publish *A New illustration of the sexual system of Carolus Linnaeus.* The first part appeared in 1799 and Thornton found he could no longer bear the cost of production. He appealed to parliamentarian friends, who prepared an Act of Parliament which would allow him to hold a national lottery to pay for publication. Though further portions of the great work appeared up to 1807, the lottery was insufficient to pay for the project and Thornton ended his career as a publisher of scientific illustrations a ruined man.

Other projects never came close to completion. Sir Joseph Banks had embarked upon a grandiose publication of a folio work, the *Florilegium*. Massive copper plates were engraved of the new plant species from Australasia, the intention being to print them in full colour *à la poupée*. The cost proved to be unbearable, and although some pages were published inked with black ink only, the great set of engraved plates was wrapped in paper and placed stored away. They were rediscovered, in near perfect condition, in store in London and were published by Editions Alecto in 1990. The editors had the plates meticulously polished and plated, and they were then inked with contemporaneous pigments and the pages produced with a nineteenth century printing press. The original engraving had been carried out in 1770. It thus took more than two centuries for the final work to appear. It should be noted that prolonged delays in publication are not unique in the field of scientific illustration. Eustachio's *Tabulae Anatomicae Viri* took 162 years to pass from completion of the engraved plates to publication of the completed work (p000).

Mankind's fascination with the dynamics of the animal world, an organic rival to human existence, had for centuries given rise to countless fanciful descriptions of demons, dragons and denizens of the deep. To illustrators unaccustomed to unfamiliar forms of animal life, the stories brought back by travellers from far-off lands were hard to interpret as images on paper. Thus, the one-horned mystery of the hippopotamus was portrayed as a unicorn and the first images of elephants were like hogs with an elongated snout. Plagiarism was rife. The process of rendering a three-dimensional animal as an illustration is more complex than the portrayal of a plant: collections of pressed animals are not available, as are herbarium specimens. For this reason, images were often re-engraved from already-published illustrations. Some eighteenth-century authors acknowledged their sources (as Henry Baker paid homage to van Leeuwenhoek, whose images he copies in his own books), whilst most others protested that the work of others was all their own, and continued to plagiarise the work of earlier illustrators since that was far easier that creating an image *de novo.* It has been observed that the exaggerated protestation of unprecedented novelty and originality in the introduction to an illustrated book is usually a sure sign that the images were derivative, and not original. The publisher who feels the need to insist that the reader should never imagine he has borrowed someone else's inspiration must, on deconstruction, to have felt the need to disclaim responsibility. In some cases the results are amusing, as in the example of the Great Auk, which was vividly portrayed by the Danish naturalist and collector Ole Worm in the *Museum Wormianum* of 1655. His own Great Auk was a house-trained pet which he regularly took for walks. Naturally, it wore a collar of silk, and the engraver who portrayed it in the great book figured the silken band around the bird's neck. For centuries thereafter, the Great Auk was shown with a pale collar around its neck, as though this were a feature of the plumage of that species. Rarely was plagiarism so fittingly traced to its origins. In the modern era, published images are often used by scientific illustrators as points of reference for a new piece of artwork. The use of a photograph, or a published plate, as a reference is now being recognised in the commercial world of scientific publishing. The fees for the use of a picture as a reference are becoming comparable to standard reproduction charges.

During the eighteenth century, the flora and fauna of Southeast Asia remained unknown to the West until they were recorded by Georg Eberhardt Rumpf (1627-1702). His works were published posthumously. The *D'Amboinsche Rariteitkamer* (1705) contains over sixty plates featuring molluscs and crustaceans, and his seven-volume *Herbarium Amboinense* (1741-55) is also richly illustrated with discoveries new to science. Early eighteenth century zoological illustration was marred by a host of books containing mythical creatures like those from two or three centuries earlier. François Valentijn published *Oud en Nieuw Oost-Indien* between 1724-26, filling the book with extraordinary images of sea-creatures allegedly drawn from life. These did little to celebrate the wondrous realities of nature, for they were grotesque versions of distorted and unreal creatures already published by

Louis Renard in his *Poissons, Écrevisses et Crabes* (1719). The book, published in Amsterdam and dedicated to the King of England, is filled with hand-coloured illustrations of a lurid and unreal nature. They have always been dismissed as figments of a vivid imagination. However, a scholarly investigation by Theodore W. Pietsch published in 1995 has shown how most of the figures can be related to existing species. In this analysis, the comical images published by Renard were based on real studies after all. The artist imposed such artificialities on the drawings brought back from afar as to make the images grossly distorted and, at first, unrecognisable. Pietsch may have done much to rehabilitate an illustrator previously held to have invented more than he observed.

FOOTNOTE [IF PAGINATION PERMITS, PUT WITH NEXT]
Published as: Pietsch, Theodore W. (1995) *Fishes, Crayfishes and Crabs*, Baltimore: Johns Hopkins University Press.

In the field of ichthyology, of economic importance as well as a burgeoning field of pure scientific study, the trend towards representational accuracy makes the eighteenth century the crucial period of refinement. Some of the most attractive illustrations of fish appeared in Japan at this time, where natural history illustrations were beginning to acquire increasing importance. The eastern cultures embodied more cultural resonances than the strictly representational illustrators of the west. The spiritual elevation of the eel, for instance, gave these fish the status of objects of desire in China and Japan, whereas they were traditionally reviled in the west; the national iconographies reflect these distinctions. Examples surveyed by Aramata (1989) clearly exemplify the difference.

FOOTNOTE [IF PAGINATION PERMITS, PUT WITH PREVIOUS]
Aramata, Hiroshi (1989) *Fish of the World*, Tokyo: Heribonsha, includes some artwork from Eastern sources. Conventional histories rely upon a tradition of Eurocentrism which this wide-ranging book serves to correct.

In Europe between 1785-94, Carl von Meidinger published *Icones Piscium*, with vivid hand-coloured engravings. The technique of illustrating fish species reached its heights with perhaps the most attractive and appealing illustrated work on fish ever to be published, compiled by Marcus Elieser Bloch (1723-99) and published under the title *Icthyologie, ou Histoire Naturelle Générale et Particulière* (1785-97). It is a work of stunning beauty and impressive size. The large folio pages are decorated with striking and confident engravings of fish species from around the world. The images are hand-coloured, and silver paint is frequently used to convey a sense of realism to the fish.

Elsewhere in zoology, the refinement of illustration was being harnessed to recording the new realism that was seen in science. Butterflies, always a

popular subject (frequently seen in religious paintings and Books of Hours, *q.v.*), were well represented by the engraver's art. Eleazar Albin (1713-59) prepared many beautiful studies which were published as hand-coloured engravings. As was common at the time, the name of the sponsor of each plate featured as a dedication prominently displayed below each image. The *Natural History of English Insects* (1720) featured a series of well-observed studies, and was followed by many others, including a small pocket-book, *Natural History of English Song Birds* (1737) with plain engraved plates which the owners would embellish with colouring of their own. Albin was not above plagiarism. The frontispiece of his *Natural History of Spiders, and other Curious Insects* (1736) shows a fine engraving of the author himself, seated on horseback, and surrounded by arthropods of various shapes and sizes. The most prominent feature is an 'original' study of a mite, which is in reality copied line by line from Robert Hooke's celebrated *Micrographia,* which had originally appeared in 1665. Butterflies and moths were meticulously portrayed in *The Aurelian* (1766) by Moses Harris, who seems to have provided the inspiration for a book by Jacob L'Admiral entitled *Nauwkeurige Waarnemingen omtrent de Veranderingen van Veele Insekten* (1774), in which the illustrations are somewhat less reliable. Images of great charm, and in hand-painted plates of Technicolor vividness, were published by J. C. Sepp in *Beschouwing der Wonderen Gods* (1762-1860). Symmetrical patterns of butterflies and moths appear in Benjamin Wilkes's *Twelve New Designs of English Butterflies* published in 1742. The plates in most surviving copies are printed in black ink, though some of the rare hand-coloured edition are also in library holdings. By the turn of the century, some of the most beautiful books on the lepidoptera were in print. James Edward Smith published his *Natural History of the Rarer Lepidopterous Insects of Georgia, from the Observations of John Abbott* in 1797, and the wondrous variety of insect life featured in books such as Dru Drury's *Illustrations of Natural History, wherein are Exhibited Figures of Exotic Insects* (1770-82) which shows how appealing hand-coloured copper engraved images can be. The peak of perfection in insect illustration must be Edward Donovan's *Epitome of the Natural History of the Insects of India,* engraved and richly coloured in the closing years of the century and released to an adoring public in 1800.

Roesel von Rosenhof, originally a painter of miniatures (and a good microscopist) published *Historia Naturalis Ranarum* in 1759, filled with richly detailed hand-coloured illustrations of amphibia and occasional reptiles in their natural habitats. Though the drawings have a certain stylistic boldness, they are of unmistakable realism. The frontispiece, showing salamanders and frogs clustered around an engraved plaque, is one of the most vivid and memorable in the history of scientific illustration. The shells of the mollusca became popular objects for collectors, and many books were published on onchology, corals, and the like. 1742 marked the publication of two works with striking folio plates: a book by Antoine-Joseph Dezallier d'Argenville entitled *Le Lithologie et la Conchyliologie* (1742) and Niccolo Gualtieri's *Index Testarum*

Conchyliorum. John Ellis published an *Essay towards a Natural History of the Corallines* (1755), followed by *History of the Zoophytes* (1786), both illustrated with engraved plates. Among the finest books on conchology were those with hand-coloured plates. Thomas Martyn published *The Universal Conchologist* in four volumes between 1743-78, and they contain so many remarkable images that few copies survive with all the 160 plates intact.

FOONOTE
Published as: Martyn, Thomas (1743-78) *The Universal Conchologist*, 4 vols, London.

The largest coloured illustrations in any book on shells appear in the *Choix de Coquillages et des Crustaces* (1758), the images here being markedly more accurate that those in the *Neues Systematisches Conchylien-Cabinet* (1769-95) by F. H. W. Martini and J. H. Chemintz. These are such impressive and magnificent tomes that they must have acted as a stimulus to the endeavours of the natural philosopher. Here was colour publishing available on a grand scale for the first time in history. The results are as vivid as anything available today, but this was in as era where the public had never seen anything so beautiful and captivating before. Within a generation, realism and vivid colour had become widespread.

Not all biological illustration required vivid colours to convey its message. The development of animal anatomy during the eighteen century was perfectly paralleled by a maturation in the engraving technique of the scientific illustrators. The exemplar is George Stubbs (1724-1806), whose painstaking dissections and diligent studies raised the anatomy of the horse to a peak of perfection that is lyrical in its beauty, and impressive in its accuracy. Stubbs was born in Liverpool, the son of a leather-dresser, who encouraged the young George to study the anatomy of the animal carcases he saw. George Stubbs took an apprenticeship at Knowsley Hall, engraving pictures from the Earl of Derby's collections, but found it uncongenial and resolved to study on his own, rather than through formal channels. He therefore set out to 'study from nature herself, and consult and study her only,' and in this frame of mind became a painter in Leeds, mostly painting portraits. He studied anatomy under a surgeon in York, and began giving lectures on the subject to medical students. In 1754 he visited Italy, but soon returned to set up home Lincolnshire. There he resolved to complete a major undertaking, later published as *The Anatomy of the Horse* (1776).

Stubbs lived and worked in a deserted Lincolnshire farmhouse with his partner, Mary Spencer, who was euphemistically described on different occasions as his 'aunt' and his 'niece'. He worked continually, painstakingly removing the hide, then the muscle layers, finally the sinews and on down to the bones. The odour of decay was heavy and oppressive, bringing complaints from neighbours many miles downwind. Stubbs, a man of great physical strength, used to carry the cadaver of a horse up several flights of stairs to his

attic dissection room. The specimen was suspended on wires and ropes in a life-like attitude, whilst Stubbs worked his way down through the layers and meticulously recorded each detail of what he observed. He made each engraved plate himself. In some of the illustrations he portrayed the specimen as seen, adding a second plate in which an outline diagram of great delicacy of line bore the annotations by which the figure was interpreted. His engravings run in sequences, so that - by turning the pages - the reader is presented with a time-lapse voyage of discovery from the surface layers to the internal anatomy, stage by stage. The book, when published, was enough to recommend Stubbs to a wider audience. Joshua Reynolds was among his patrons at that time. George Stubbs spent the rest of his life engaged in the painting of pictures, mostly of famous horses.

As the eighteenth century began, the ancient teachings of the much-revered anatomists still lingered. They had been much modified by Andreas Vesalius (1514-64) whose *De Humani Corporis Fabrica* (1543) contained 600 woodcut illustrations, yet was published when the author was only 28 years old. It remained a popular source in the early eighteenth century. Curiously, one of the great eighteenth century illustrated works on human anatomy was written by a contemporary of Vesalius. This was the *Tabulae Anatomicae Viri of Bartolomeo Eustachio* (1524-74). Its is rich in striking copper-plate engravings. This work was completed by 1552, but was not published until 1714 when the plates were found in store in Rome - the gap of over one and a half centuries exceeded only by the delay of two centuries in the publication of the *Florilegium*. Its appearance almost coincided with the publication of William Cheselden's *Anatomy of the Humane Body* (1712), and this sudden flurry of new publications served to stimulate research, so that within the next decades the standards of anatomical illustration increased dramatically. The studies in Cheselden's first work were extended and improved upon in his *Osteographia* (1733) and this became a standard work of reference. The images are good, though lacking in fine detail. Some of them show the human body in action, occasionally as two forms in combat. They were inspiring images in their time, and were plagiarised by Sir Charles Bell a century later when he came to compile his own work on skeletal anatomy.

One seminal new illustrated work on human anatomy was the *Tabulae Sceleti* (1747) by Bernhard Albinus, replete with strikingly stylised engravings with a three-dimensional appearance, each dissected human body standing in a scene of classical splendour. Some of the muscular figures were portrayed in a magnificent garden setting, or against a work of sculpture; some were set in juxtaposition with a grazing rhinoceros and, when the skeletal subject was reversed to show the opposing aspect, the rhinoceros also turns its back. This work was followed by William Smellie's fine studies. His *Sett of Anatomical Tables* (1754) takes a further step towards photo-realism. The drawings were made from his dissections by Jan van Rymsdyk and engraved on copper by Grignion. Van Rymsdyk used his years with Smellie as a training period for his greatest creative period as an illustrator, for he went on to work for the

celebrated anatomist William Hunter (1718-83). William and his young brother John (1728-93) revolutionised the documentation of medicine in many respects. William Hunter studied medicine at the University of Glasgow, graduating in 1750, and moved to London where he was joined by his younger brother. John, who did not attend medical school, went to London in 1748 where he assisted his brother in the dissecting room. He studied surgery under Cheselden (supra) and his dexterity as a surgeon became renowned. He was subsequently elected Master of Anatomy at Surgeon's Hall.

William Hunter, meanwhile, specialised in obstetrics from 1756 and began to establish the science as a branch of formal medicine, rather than the concern only of the midwife. With Jan van Rymsdyk at his side, William made detailed studies of the human uterus in pregnancy and childbirth. He published three works, the results of his obstetrical anatomical studies appearing in *The Anatomy of the Human Gravid Uterus* (1774). This is a marvellous work, replete with rich and precise illustrations with a luminous quality of vivid realism. His work was followed, at the turn of the century, by the *Museum Anatomicum* of Eduard Sandifort (1793-1835). This fine book, which features bold - if stylised - engravings of human anatomy was not superseded until Henry Gray published his celebrated *Anatomy* in 1858. To this day, *Gray's Anatomy* is a standard teaching text, and reproductions of some of the original plates have appeared in editions published as the late twentieth century merged into the twenty-first.

The impact of the magnified image left its mark on eighteenth century scientific illustration, though not to the extent one might imagine. In the late seventeenth century, Antony van Leeuwenhoek (1632-1723) had launched the concept of a microbial universe upon the world of natural philosophy, and many of his letters to the Royal Society of London were published in volume form during the early part of the eighteenth century. The published illustrations are testimony to the technical limitations of the era, for they convey only a crude impression of the vital quality that exists in the original red crayon drawings Leeuwenhoek regularly sent to London. Interestingly, Leeuwenhoek never drew; he employed a limner to capture images of his observations and directed the artist as to how to finish the study. On occasion, he records, he had to tell the appointed draughtsmen to hurry up with the work, for they tended to spend time looking in wonderment at the new sights Leeuwenhoek's home-made microscopes revealed.

FOONOTE

Most of Leeuwenhoek's volumes appeared during the late sixteenth century, but those appearing after 1700 are as follows:

Leeuwenhoek, Antony van (1702) *Sevende Vervolg der Brieven*, Delft.
Leeuwenhoek, Antony van (1708) *Arcana Naturae Detecta* [third edition], Lugduni Batavorum.

Leeuwenhoek, Antony van (1708) *Arcana Naturae Detecta* [fourth edition], Lugduni Batavorum.
Leeuwenhoek, Antony van (1722) *Continuato Arcanorum Naturae . . .* [reprint of 1697 edition], Lugduni Batavorum.
Leeuwenhoek, Antony van (1715) *Continuato Epistolarum* [third edition], Lugduni Batavorum.
Leeuwenhoek, Antony van (1718) *Send-Brieven, zoo aan de Hoog-edele Heeren van de Koninklyke Societet te Londen,* Delft.
Leeuwenhoek, Antony van (1718) *Brieven seu Werken No 19,* Delft.
Leeuwenhoek, Antony van (1719) *Epistolae ad Societatem Regiam Anglicam,* Lugduni Batavorum.
Leeuwenhoek, Antony van (1719) *Epistolae Physiologicae Super compluribus Naturae Arcanis,* [reissue of of 1718 edition], Lugduni Batavorum.
Leeuwenhoek, Antony van (1722) *Anatomia Seu Interiora Rerum,* [retranslation of 1687 edition], Lugduni Batavorum.
Leeuwenhoek, Antony van (1722) *Omnia Opera, seu Arcana Naturae,* Lugduni Batavorum.
Leeuwenhoek, Antony van (1730) *Continuato Epistolarum* [fourth edition], Lugduni Batavorum.
Reference can also be made to the author's *Single lens, Story of the Simple Microscope*, London: Heinemann and New York: Harper & Row (1981); and *The Leeuwenhoek Legacy*, London: Farrand and Bristol: Biopress (1991),

His young compatriot Jan Swammerdam (1637-80) lived a tortured and turbulent life, which ended at the age of 43 when he took up a fanatical religious asceticism. He studied insects in minute detail, using injections of mercury to emphasise the course of vessels within the dissected insect body, and recording his observations in illustrations made with meticulous accuracy. After his death the papers eventually found their way into the hands of Herman Boerhaave. He wrote a biography of this lost genius, the true founder of anatomical illustration in the arthropod world, and had the illustrations published at his own expense in a grand folio volume. The book appeared as *Bybel der Natuure* in two volumes (1737-38) and became a standard reference work in its field. Although it took over 60 years to appear in print, the book was still considered advanced in its time. The engravings reveal the extent to which a gifted observer could discern detail using the simplest of optical apparatus.

One of the books to popularise microscopy after Leeuwenhoek's time was Henry Baker's *The Microscope Made Easy* (1743). Baker refers to Leeuwenhoek, and reproduces several of the Leeuwenhoek figures, in a re-engraved and somewhat degraded form. He shows particular interest in Leeuwenhoek's observations of *Hydra viridis*, devoting a book published in 1743 to this interesting organism. He did little advance our knowledge of these freshwater polyps, however, and the scientific study of *Hydra* was not further advanced until it came to the attention of Abraham Trembley (1710-1784), a

Swiss-born teacher who used *Hydra* as a topic for the teaching of children in the Netherlands during his work as a private tutor. He published illustrations of his experiments in the form of stipple engravings which, notwithstanding a certain artificiality of line, convey a powerful impression of the organisms in their living state. Baker's hydroids, by comparison, look moribund and distorted.

The aspects of Trembley's work of interest to the student of the history of scientific illustration concern the great delicacy of line employed in producing his plates. *Hydra* has tenuous tentacles, and they unravel into the surrounding aquatic environment as fine, undulating structures. This is all well conveyed in the plates. The remarkable analysis by Lenhoff and Lenhoff (1986) includes a full facsimile of the original, complete with folding plates where appropriate.

FOOTNOTE

See: Trembley, Abraham (1744) *Mémoires d'un genre des polypes d'eau douce*, Geneva. Reproduced in annotated facsimile by Lenhoff, S., & Lenhoff, H. (1986) *Hydra and the Birth of Experimental Biology*, Pacific Grove, CA: Boxwood.

The transparency of a glass vessel (Plate 3) is carefully conveyed through the use of the finest engraved lines in the plate. In the Trembley plates, note should be made of the judicious use of stipple in the engraver's technique. This allows the most subtly graded shading, but only if done by a master of the craft. Plate 5 shows stipple used to convey an impression of a living *Hydra.* Rarely has it been used to greater effect. The illustrations for *The Universal Conchologist* were also printed from stippled plates. Great subtlety of texture can be conveyed by this exacting technique.

Glassware came to be more frequently portrayed in engravings as chemical experiments came to the fore. The research which led to Joseph Priestley's discovery of the gas Antoine Lavoisier called oxygen is clearly illustrated in his *Experiments and Observations on Different Kinds of Air* (1744-77). The glassware is neatly engraved in copper plates, though comparatively little attention is paid to the need to convey the refractive clarity of the glass. In France, when the essential nature of oxygen was recognised by Lavoisier, it was his wife who prepared the drawings which illustrated his published papers. She was Marie-Anne Paulze, a diligent technical artist who paid attention to the correct assembly of apparatus and recorded it faithfully in her scientific illustrations. The engraver, D. Lizars, conveys the details of the experiments in plates which, though sometimes distorted in the interests of clarity, make the nature of the experiments plain.

The move from woodcuts to metal plate engraving brought with it a significant increase in the details it was possible to convey. In the chemical and physical sciences, as in astronomy and mathematics, line diagrams were the stock in trade of the scientific illustrator, and copper engraved plates provided

the ideal medium for graphs and maps, charts and circuits. Perhaps the most vivid of the new earth sciences harnessed the new techniques and exploited them to the full: geological science. Jean Étienne Guettard (1715-1786) recognised that several key features of the geology of France were volcanic in origin. His concept was extended by Nicholas Desmarest (1725-1815) and the resulting impetus attracted great interest in the newly expanding science of geology.

Meanwhile an English canal-builder, William Smith, was making copious notes as he travelled the length and breadth of Britain, from which he compiled the most detailed geological maps of the era. His work, published early in the nineteenth century, took the form of coloured engraved sheets, and laid the groundwork on which today's geological maps are based.

FOOTNOTE

See: Guettard, Jean Étienne (1780) *Atlas et Description Minéralogiques de la France*, Paris; also Desmarest, Nicholas (1774) *Histoire de l'Académie Royale des Sciences*, Paris; and Smith, William (1815) *A Delineation of the Strata of England and Wales with part of Scotland*, London.

By the end of the century, the standard of scientific illustration had reached a level rarely exceeded in present-day volumes. Earlier wood-cuts had been progressively superseded by higher quality engravings on copper, some of them inked with different pigments *à la poupée*, thus allowing the publisher to mass-produce engraved plates in colour for the first time. Volumes rich in hand-coloured illustrations became available, and by the end of the century lithography had appeared.

The lithographic printing process was invented by Alois Senefelder (1771-1834) at the age of 26, through pure chance. In 1796 Senefelder, an unsuccessful copper engraver, jotted down a shopping-list in wax crayon on a piece of smooth Bavarian limestone. It occurred to him that the wax might resist an etchant with which he could remove surrounding stone. As his experiments proceeded, he realised that the wax itself would attract ink which would not mark the stone if it was moistened with water. Eventually, his process was based on the production of a wax image on a stone surface which was wetted with water prior to printing. When a thin coating of oil-soluble ink was rolled across the image, the ink adhered to the wax whilst being repelled by the water. A sheet of paper applied to the inked surface would thus pick up an ink copy of the original wax image. The concept was soon applied to scientific illustration, the first lithographic work of botanical illustration appearing in 1812. The first zoological book on ornithology appeared in 1818.

Senefelder's definitive account, a *Comprehensive Course in Lithography*, was also published in 1818. His work in the late eighteenth century led to present-day lithographic printing, where a polymer sheet is used in place of a limestone block. Senefelder was awarded a life pension for his work by the Bavarian royal family, and his inspiration is extant in almost every

illustrated science book of the modern era. Thus, in terms of scientific illustrators' methods, the eighteenth century bridges the gap between the earliest woodcuts and the foundations of today's printing technology.

FOONOTE

The work that set out the principles of lithography was: Senefelder,Alois (1818) *Vollständiges Lehrbuch der Steindruckerey*, Munich, and the first illustrated work in zoology to be produced by lithographic printing was a modest volume: Schmidt, Karl (1818) *Beschreibung der Vögel*, Munich.

END

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