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Until the nineteenth century, the investigation of natural phenomena, plants and animals was considered either the preserve of elite scholars or a pastime for the leisured upper classes. As increasing academic rigour and systematisation was brought to the study of 'natural history', its subdisciplines were adopted into university curricula, and learned societies (such as the Royal Horticultural Society, founded in 1804) were established to support research in these areas. A related development was strong enthusiasm for exotic garden plants, which resulted in plant collecting expeditions to every corner of the globe, sometimes with tragic consequences. This series includes accounts of some of those expeditions, detailed reference works on the flora of different regions, and practical advice for amateur and professional gardeners.

Selected Papers, 1821–38

Professor of botany from 1825 until his death, John Stevens Henslow (1796–1861) revived and greatly advanced the study of plants at Cambridge. His influence helped to make the University Botanic Garden an important centre for teaching and research. Originally published over seventeen years, and now reissued here together, these thirteen papers reveal the impressive breadth of Henslow's scientific knowledge. The first two items, from 1821, address the geology of the Isle of Man and Anglesey respectively, preceding his five-year tenure of the chair of mineralogy at Cambridge from 1822. The rest of the papers, dating from 1829 to 1838, address botanical topics. John S. Parker, Director of Cambridge University Botanic Garden (1996–2010), has provided a foreword that traces Henslow's developing interests and contextualises the items in this collection. Several of Henslow's other publications, including his *Catalogue of British Plants* (1829), are reissued separately in this series.

Selected Papers, 1821–38

John Stevens Henslow

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Foreword: The Science of John Stevens Henslow

John S. Parker
Director, Cambridge University Botanic Garden (1996–2010)

In the received history of modern evolutionary theory, Cambridge University's Professor John Stevens Henslow (1796–1861) has been awarded a small but highly significant role. He is remembered as the man who recommended Charles Darwin to be the companion of Captain Robert FitzRoy and act as a naturalist during the voyage of H.M.S. *Beagle.* Henslow wrote to Darwin in August 1831 indicating that he regarded Darwin as being 'amply qualified for collecting, observing and noting anything worthy to be noted in natural history', although, with a fine appreciation of his own role as teacher and mentor, he gave the admonishment that Darwin was not yet a 'finished naturalist'.

In his letter to Leonard Jenyns, included in the *Memoir* that Jenyns published after Henslow's death, Darwin says of Henslow that 'his accurate powers of observation, sound sense and cautious judgement seem predominant … drawing conclusions from minute observations … [he also] shows his capacity for extended observations and broad views' (Jenyns, 1862). Darwin, however, prefers at this time, soon after Henslow's death, to remember his lifelong friend above all for his gentle, courteous demeanour, rather than emphasising the quality of his intellect and his contribution to science. Darwin's great friend Sir Joseph Hooker, the eminent botanist and Director of the Royal Botanic Gardens, Kew, from his perspective as Henslow's son-in-law, gives his own poignant view of Henslow's life. Hooker's eulogy of his father-in-law records the passing of a great scientist, but one whose character outshone even his scientific brilliance. His death 'is like gouging a piece out of the face of the country … I miss his knowledge [of] Botany and loads of kindred subjects'. More, he was one of 'those friends formed … to be a lamp unto our path whom we never go ahead of' (Huxley, 1918).

The conventional interpretation of Henslow's influence on Darwin's intellectual development at Cambridge and on his subsequent life is partial, and indeed misleading in its brevity and simplicity. In Henslow, Darwin found a guide to the natural world who expanded his horizons from that of a collector with an obsession for beetles to a brilliant and insightful field naturalist versed in geology, zoology and botany, capable of making profound judgements about his environment from observation alone. This volume in the Cambridge Library Collection presents a selection of Henslow's papers over a seventeen-year period, which together demonstrate the breadth of his scientific research and thinking, and which qualified him to be regarded by Darwin as someone 'of whom we were all awe-struck with the amount of his knowledge … he knew everything'.

Early Life of John Stevens Henslow: 1796–1823

Henslow was born in Rochester, Kent, in 1796. His paternal grandfather, also John Henslow, had moved from the south coast to Somerset House in London when he became Chief Surveyor of the Navy, and was later knighted for his energetic commissioning of naval ships which subsequently saw service in the war with France. He married a Kentish woman when based at the Royal Naval Dockyard at Chatham. Their son, John Prentis Henslow, was initially a lawyer in Enfield, and then joined a relative as a wine merchant in Rochester (Walters and Stow, 2001).

From his riverside home at Frindsbury, on the banks of the River Medway opposite Rochester, young John Stevens would have seen on each side the swelling uplift of the North Downs with their chalky fields and hangers rich in a diversity of plants, animals and fossils. The family recorded how he was an ardent collector from his earliest years, staggering back from country walks under loads of curious stones and fascinating sticks which took his eye. He also had an early talent for drawing

and painting, which he employed throughout his career for recording his scientific observations and in teaching.

Henslow's maternal grandfather was Thomas Stevens, a wealthy brewer in Rochester, and John was named for him. Thomas built a house called Gads Hill, high among the rolling downs in a wooded area a few miles to the south-west of Rochester. Henslow visited his grandfather frequently, even when he was a Cambridge professor with a wife and children, finding this biologically rich countryside very appealing and intriguing. He discovered and collected here many rare plants and animals, which were very different from those found in the river valley of the Medway Gap and the coastal salt marshes below the hills.

After a few years' education in Rochester, Henslow was sent in 1805 to Wilson's Grammar School at Camberwell, then a village in rolling countryside to the south of London, to continue his education up to university entrance under the headmastership of Rev. W. Jephson. Here he was particularly influenced by the art master George Samuel, whose hobby was entomology. Henslow learnt the techniques of art from him, through drawing and painting the butterflies and other insects which they collected around the village. Samuel was friendly with the noted young zoologist William Elford Leach, appointed Assistant Curator of the British Museum in 1813, and the famous entomologist James Stephens, and the enthusiastic schoolboy Henslow was introduced to these two influential men by him. Later, while at Cambridge, he helped Leach at the British Museum during vacations and submitted specimens, particularly of marine organisms, for incorporation into the British Museum collections. Henslow developed into a knowledgeable entomologist, becoming one of Stephens's friends and carrying on a long correspondence with him about the British fauna.

Rev. Jephson had been educated at St John's College, Cambridge, where his brother was a fellow, and so it was natural for Henslow to be admitted there as an undergraduate in October 1814, aged eighteen. He opted to read mathematics, and was regularly among the top prizemen at the college in each year of study. He graduated in 1818 as a wrangler, placed sixteenth in the University list. He would perhaps have finished even higher in mathematics if he had not devoted a lot of his energy to enthusiastically absorbing a whole spectrum of the natural sciences during his undergraduate career. For example, Henslow developed an interest in molluscs and devised a net for extracting tiny shells from the muddy bottoms of the rivers of the Fens, an early example of specific ecological instrumentation. One of the bivalves he collected was new to science, and was named for him by Leonard Jenyns as *Pisidium henslowanum*. He presented one of his marine specimens from Devon, collected in 1817, to the British Museum and it was also named after him: 'Henslow's swimming crab', *Polybius henslowii*. Proposed by his friends William Leach and James Stephens, he was elected a fellow of the Linnean Society of London for his entomological and other zoological knowledge in February 1818, a month after he graduated in mathematics.

One of the great attractions at Cambridge in the first two decades of the century was the lecture course of Edward Clarke of Jesus College, for whom the Chair of Mineralogy was created in 1808. Although their science content was rather slight, each lecture was a tour de force owing to his flamboyant style and eclectic experiences gained on a trip round Europe, the Levant and Egypt (Otter, 1824). The lectures attracted many attendees, including Henslow, who absorbed from them knowledge of mineralogy, and more importantly crystallography.

Henslow was also introduced, when an undergraduate, to Adam Sedgwick, who was ten years older and already a fellow of Trinity College. Together they developed their interest in the young science of geology, and both joined the hub of this new science, the Geological Society of London. In 1818, Sedgwick became Professor of Geology at Cambridge, despite confessing his relative ignorance of the science, and acknowledging the equal expertise of his young friend Henslow, who attended Sedgwick's first course of public lectures given in Lent Term of 1819. After this the pair

departed in the Easter vacation for a geological tour of the Isle of Wight to gain the field experience which both men lacked (Jenyns, 1862).

After their walking tour exploring the geological diversity of the Isle of Wight, Henslow now felt confident in his abilities in field geology and immediately followed this up in the summer of 1819 by leading a party of undergraduates on an exploration of the Isle of Man. Here his prime role was to give instruction to the students in preparation for their examination, but he also collected plants and studied the geology of the island. His geological results did not agree with interpretations given in a previous geological survey, so he prepared a paper, including beautifully drawn sketches and maps, which was published in the *Transactions of the Geological Society of London* in 1821. This was Henslow's first scientific paper (see the first item in this volume).

A very different outcome of the Isle of Wight tour was a proposal by the two friends to promote the cause of science at Cambridge through a society for discussion and debate on scientific matters within the university. With support from Professor Clarke, Sedgwick and Henslow spread this idea among the dons, and many eminent scholars supported them (Hall, 1969). After a public meeting in 1819, the Cambridge Philosophical Society was formally set up in 1821; it flourishes still. Henslow and Sedgwick were founding signators, and Henslow acted as secretary from its inception until 1839, when he resigned on his move from Cambridge to a rural parish at Hitcham in Suffolk.

On his graduation in 1818, Henslow had not performed well enough to be made a fellow of St John's College. Since his father, John Prentis Henslow, was rather unsuccessful in both the law and as a wine merchant, John had no independent income and so had to find ways to support himself if he wished to remain in Cambridge. One way to raise funds was to tutor undergraduates for examinations as he had done on his Isle of Man trip, but he found another and became demonstrator to the Professor of Chemistry, James Cumming. Cumming was particularly interested in electrochemistry, on the borders of what we would now regard as chemistry and physics, so Henslow expanded his scientific knowledge to encompass these sciences too.

Henslow's job was to carry out experiments at the front of the lecture theatre under Cumming's direction, for the benefit of the undergraduate audience. Later, one of Henslow's revolutions in Cambridge teaching was to get students personally involved in practical science. His experience as a demonstrator clearly showed him the unsatisfactory nature of practical science training at the time – observing others rather than through personal investigation. He addressed this deficit when he was able.

Henslow's interest in zoology continued to grow, and it becomes clear at this time that his fascination was not taxonomy but processes – physiology and anatomy allied to morphology. For example, he made minutely detailed drawings of his dissections of snails, in which he linked the organs he displayed to the recent terminology introduced by French anatomists. Unfortunately, he left this early work unpublished (see drawings in the Bath Royal Literary and Scientific Institution archive).

In the summer of 1820, Henslow furthered his interest in the geology of islands with a visit to Anglesey. Again, he was accompanied by undergraduates whom he instructed in the Cambridge examination syllabus. His prime objective, however, was to make a geological survey and to map the strata of the island. He collected about a thousand rock specimens. Back in Cambridge he annotated and arranged them for Sedgwick and the developing geological museum. By studying his contributions to the University Herbarium, we know that he also spent a part of most days on this trip in collecting plants.

By late 1821, his study of Anglesey was complete, and he read his long and detailed paper to meetings of the Philosophical Society. It was then published in the first volume of the *Transactions of the Cambridge Philosophical Society* and is a massive work of nearly one hundred pages,

accompanied by a superb colour map summarising his findings and many sketches (see the second item in this volume). It is clear that Darwin's own attempt at a major geological field analysis of the Falkland Islands in 1834 was modelled exactly on Henslow's paper on Anglesey. From the detailed commentary in his notes, Darwin must have had the paper with him on the *Beagle* voyage (Darwin, n.d.). In his letter to Jenyns for the *Memoir* in 1862, Darwin singles out Henslow's 'admirable memoir on the geology of Anglesea' for particular praise.

Although most of the early records of Henslow's biological enthusiasms concern animals, it is clear that he gave his attention to botany too. His oldest surviving herbarium specimens were collected in 1816. One of these was the rare British herb from which woad is obtained, *Isatis tinctoria*. Another is a herbarium sheet displaying 'monstrous' (fasciated) forms of *Plantago major*, illustrating this developmental abnormality. The phenomenon of monstrosity fascinated Henslow and was the subject of several later papers. The unusual nature of these sheets suggests perhaps that Henslow collected many more herbarium specimens but disposed of the commoner ones when the systematic preparation of a British herbarium became one of his top priorities from 1821 onwards. Several interesting plants also survive from his 1819 Isle of Man visit, and over one hundred from Anglesey.

In 1820, Henslow was introduced to Leonard Jenyns, an undergraduate at St John's College and one of the few people in Cambridge at that time who shared his interest in zoology. This acquaintance grew to become a lifelong friendship, and was further sealed three years later by Henslow's marriage to Jenyns' sister Harriet. In the *Memoir* published after Henslow's death, Jenyns records that in 1820 they decided together to make a collection of the whole British flora as dried specimens on herbarium sheets (Jenyns, 1862).

Henslow started his plant collection with enthusiasm in March 1821 and collected about two hundred flowering plant specimens in this first year. Jenyns was primarily a zoologist and proved only intermittently committed to their botanical project, although he frequently accompanied Henslow on collecting trips around Cambridge, and also contributed interesting plants whenever he came across them. From the outset, however, it is clear that Henslow's object in making collections was distinctive and unique – he collected not simply to have specimens of all species, as a taxonomist would, but to explore the patterns of variation in nature in order to define the species by that means. Thus his earliest herbarium sheet was of the tiny moss *Weissia lanceolata*, from the Gog Magog Hills to the south of Cambridge, collected on 29 March 1821. It displays a meticulous and beautiful arrangement of fifteen individual moss plants, in ascending order of size.

Professor of Mineralogy: 1822–7

In 1822, Professor Clarke died and the Chair of Mineralogy became vacant. Henslow applied for it and was elected, at the young age of twenty-six. He was clearly regarded in the University as the most appropriate candidate because of his wide scientific background and the esteem in which he was held both as a result of the publication of his two important geological papers and for his position as secretary of the Cambridge Philosophical Society.

Henslow immediately began the process of devising a new syllabus for his course of mineralogy lectures. These he based on completely different principles to those of his predecessor. Henslow was inspired by the work of the Abbé Haüy, the French crystallographer. Haüy had, around the turn of the nineteenth century, found a way of describing the structure of crystals by applying mathematical principles, and any newly discovered crystal could be ascribed to its place within mathematically defined families – order was produced out of chaos for this facet of the natural world. The syllabus Henslow published for his lecture course has a long introduction, in which he argues the case for the Haüy system (Henslow, 1823). By contrast, Clarke's lectures had had no philosophical basis, but consisted of a series of topics, many of them economic.

Only one research paper emerged from Henslow's tenure of the Chair of Mineralogy: 'On the Crystallization of Gold', published in the first volume of the *Magazine of Natural History* in 1828. Indeed, Henslow's scientific publication record between 1822 and 1828 is rather sparse, but he was far from idle during this time. He busied himself with teaching his mineralogy course each year, by getting married in 1823 and starting a family in 1825, by taking holy orders in 1823 and carrying out duties as curate of Little St Mary's Church in Cambridge, and – more significantly for science – by collecting and mounting in his herbarium thousands of plants which he obtained from innumerable field excursions around Cambridge (and occasionally around Rochester when visiting his family).

To increase his British herbarium still further, Henslow began to build up a massive network of collectors across the whole country. There were fellow professors, such as Hooker at Glasgow University and Graham and Balfour at Edinburgh, but he profited particularly from a huge number of knowledgeable amateurs – his own close relatives, his friends and acquaintances, as well as known botanical enthusiasts identified through the Linnean Society of London. With these amateur collaborators, he exchanged lists of his requirements, his 'desiderata', in a reciprocal way. Thus, Cambridge specialities, particularly fen plants, were incorporated into herbaria across Britain. The number of his acquisitions reached a peak in 1826, when he added more than 800 plants to his collection.

Professor of Botany: 1825 onwards

In the first two decades of the nineteenth century, botany was a moribund subject at Cambridge. The Chair of Botany had been founded in 1727 and the third holder, Thomas Martyn, was appointed in 1762. Martyn was initially very active, involving himself vigorously with the establishment and financing of a Botanic Garden in the centre of the city, giving lectures, and writing extensively about his subject (Walters, 1981). His enthusiasm, however, had waned by the 1790s and he moved permanently to his parish in Bedfordshire. He retained his chair but in a dormant state, so that for about thirty years no botanical lectures were given in the University, while the Botanic Garden began to slide into decay. He eventually died in 1825 at the age of eighty-nine, and John Henslow successfully applied for his position. So, by the age of twenty-nine, Henslow held two chairs at Cambridge, and in very different subjects. His great love, however, was botany, and after two years of holding both positions he resigned from the professorship of mineralogy. He retained the Chair of Botany until his death in 1861 and, despite failing health, he taught his summer course every year up to 1860.

As with mineralogy three years earlier, Henslow immediately began the preparation of his botanical lecture course. He spent the first three months of 1827 working intensively using his artistic skills to produce about seventy large (20x26 inches) watercolour illustrations of botanical subjects for display during his lectures. The course itself began in May 1827, and the lectures were the first in the English universities to be illustrated. William Darwin Fox was so enthusiastic about Henslow's first course that he told his cousin Charles that it was not to be missed. Darwin himself said that 'His lectures on botany were universally popular, and as clear as daylight'. So accurate and clear were Henslow's 1827 teaching diagrams that they continued to be used in the Botany School at Cambridge for undergraduate lectures until the 1960s.

Henslow's botany course was revolutionary in many ways. As well as the novelty of illustration during lectures, he provided each student with equipment such as needles, scalpels, dissecting tiles and microscopes. Each week, he gathered plants from the Botanic Garden and from nature for the students to investigate for themselves – the first practical science for all, with Henslow giving training in detailed observation of natural phenomena.

A number of excursions were timetabled during the five-week botanical course. Henslow took his students into the field to examine the different habitats around Cambridge. Lists of the plants seen were then printed and distributed after each field trip. At the same time, his friend Sedgwick was running field excursions in geology for his students, sometimes covering great sweeps of country on horseback. Henslow's progresses were rather more sedate – on foot through the fens and over the Gog Magog Hills; by barge down the Cam to Baits Bite Lock; and by coach to an unusual, rich, acid-soil heath at Gamlingay to the west of Cambridge. While attempting to collect the water plant *Utricularia* for Professor Henslow on this boggy heath at Gamlingay, Darwin slid gracefully underwater in a ditch, to the great amusement of his fellow students. Darwin, however, emerged triumphantly clutching his prize.

Henslow's Botanical Studies

Although Henslow had become an active botanist by 1821, the results of his studies emerged as publications after a long delay due to his other preoccupations. In 1827, however, his resignation from the Chair of Mineralogy enabled him to devote all his energies to his beloved plants, and *A Catalogue of British Plants* was ready for use by his students during his third annual botanical course in 1829. This list was revolutionary as it was not based on the work of Linnaeus but on the 'natural system' favoured by the French school led by A.P. de Candolle. Henslow's knowledge of species came from his own remarkable, unique British herbarium. Even today the University Herbarium at Cambridge holds 3,654 Henslow sheets carrying over 10,000 plants, and this still represents 89 per cent of the 1,200 or so species recognised by him in his *Catalogue* (Henslow, 1829).

For Henslow, the focus of his herbarium studies was not taxonomic. He was not concerned with the classification of plants in a 'methodical manner, according to some … of various methods or systems [of classification]'. His interests lay in 'Physiological Botany, as this subject possesses more general interest, owing to the numerous and striking phenomena … which it enables us to explain' (Henslow, 1836). Henslow was thus an experimentalist interested in how to 'connect the numerous facts … and laws which regulate the functions performed by the living vegetable'. He viewed his collection of dried specimens as a tool to address the most important question of the day in botany – the laws that regulate the *variation of species*.

To address this species question, Henslow assembled his herbarium sheets by a process he called 'collation' (Kohn et al., 2005). A collated sheet contains several plants (a maximum of thirty-two) showing aspects of variation (height, for example) arranged in distinctive patterns. We would today recognise these patterns as representing bell curves, or ascending or descending series. Henslow the mathematician is revealed here. By compiling collated herbarium sheets using the range of specimens he had, Henslow was seeking what he called the 'limits' of each species. These results he then presented in his *Catalogue*. Remarkably, then, Henslow was arguing that species, and the variation within each species, could be subject to experimental investigation. And the stimulus for this view of species can be seen in the work of Abbé Haüy on crystallography. Henslow wrote in 1836 that, after the discovery of the laws of crystallography, 'a single crystal at once puts the mineralogist in possession of … the species, and he can calculate "à priori" the possible forms under which it may occur' (Henslow, 1837). The act of collation was an attempt to transfer Haüy's ideas from the geological to the botanical world, and so resolve disputes about what constitutes a species.

Henslow was fully committed to the idea of the creation of immutable species at some distant time in the past, the orthodoxy among the scientists of his day. However, he developed a fine appreciation of the nature of species during the 1820s – exploring the extent and importance of variation, trying to understand the role of 'monstrosity' as a key to understanding the (developmental) laws that govern plant growth and differentiation, and establishing the importance of hybridisation as an

experimental method of determining the *limits* of species. Many of Henslow's subsequent botanical papers emerge from this appreciation of species.

Importantly, Henslow's most favoured student, Charles Darwin, was instructed in these fundamentals during his innumerable interactions with him. Darwin's understanding of the importance of variation and species, of populations, and the problems presented by monstrosities, enabled him to evaluate his own observations and experiences as he circumnavigated the globe on the *Beagle*, and subsequently as he pondered them on his return. Using Henslow's approach, however, he reached radically different conclusions, and the stable species became unstable.

Most of Henslow's botanical investigations emerged from observations he made during his innumerable collecting trips into the countryside around Cambridge, often alone, with friends such as Jenyns, or later with his students. His 'experimental' approach to the species problem necessitated close observation of living plants to detect patterns of variation. Thus he noticed the fringed edge of the leaves of the tiny bog orchid *Malaxis* (now *Hammarbya*) *paludosa* (see item 3 in this volume). Microscopic observation revealed to Henslow that the minute outgrowths were vegetative propagules or gemmae, and he illustrated this with his own drawings. His pencil sketches are still held in the University Herbarium.

Henslow also realised that spatial considerations were important to an understanding of botany, and so he meticulously recorded the locations of all the plants he collected. This probably reflects his interest in the broader, world-scale patterns of plant distribution which were emerging at the time, the study of which we now call 'biogeography'. Thus his papers on 'monstrosities' of the flowers of common mignonette (1835; see item 9) and *Adoxa* (1837; see item 11) arose from chance observations of aberrant individuals he found on his rambles near Cambridge and whose localities he specifies. He clearly had an exceptional eye for developmental variants. For example, his herbarium contains two aberrant forms of *Linaria vulgaris*, the yellow toadflax, found around Cambridge. In one, the standard bilateral flower with a single nectar spur takes on a radial symmetry with five spurs (a *peloric* form), while the other lacks the spurs completely (form *ecalcarata*).

Henslow clearly developed a sense of the concept of populations, and his herbarium specimens reveal this. For example, he collected seven flowering individuals of *Orchis fusca* (now *O. purpurea*) from Boxley Wood, near his grandfather's house in Kent, on a single visit in May 1827. One is extremely tall and robust, others are small and spindly, some have many-flowered spikes and some few-flowered. He clearly mounted them on sheets to illustrate the variation occurring within this single population.

One of the most remarkable of Henslow's papers, however, concerns a single population of the rare lily-like herb *Paris quadrifolia*, which he discovered in a new and isolated site in a wood at Coton, about three miles west of Cambridge. Henslow noticed that individuals of this species differed in the numbers of their vegetative and floral parts, so over a three-year period he collected information from 1,500 plants in this population on Whitwell Farm. From each individual he recorded five numerical parameters – numbers of leaves in the sub-floral whorls, numbers of sepals, petals, stamens and styles within flowers. He also recorded and illustrated all the aberrations of stamen morphology he encountered. As far as I am aware, this is the first modern study of a biological population, and is a compilation of 7,500 bits of data. In this mammoth task, he was helped by two undergraduate students from his botany course, Charles Babington (who later succeeded him as Professor of Botany) and John Downes (who supplied Henslow with plants showing variation from near his home in Northamptonshire).

In his paper on the varieties of *Paris* in the Whitwell population (see item 7), Henslow demonstrates his mathematical background in his logical presentation, in tabular form, of this complex

multivariate data. He also uses further tables to explore the '*limits*' (his italics) within which the observed variation occurs. He then considers his observations in a wider context. He considers the related genus *Trillium,* in which the floral parts are strictly in threes, and proposes from its variation that *Paris* is 'ever struggling to become double in all its parts'. Henslow's capacity for combining such detailed observation with broad speculation, as shown here, was referred to by Darwin in his eulogy in Jenyns' *Memoir* of 1862. Interestingly, one of Darwin's numerous enquires of Henslow was to ask whether populations at the edge of a range could still show variation despite their isolation and their inevitably small numbers of founders. Variation is clearly necessary for evolution to occur at the edge of a range. A manuscript in the Darwin Papers at Cambridge University Library is annotated with a word from Henslow associated with this question – '*Paris*'.

In considerations of the nature of species throughout the nineteenth century, the genus *Primula* played a highly significant role. Darwin's *The Different Forms of Flowers on Plants of the Same Species* (1877) is primarily a record of experiments he carried out to reveal the consequences of cross- and self-fertilisation, using the 'pin' and 'thrum' forms of primroses (*P. vulgaris*) and cowslips (*P. veris*). Darwin uses this breeding evidence as support for the theories on the significance of sexual reproduction that he had advanced in *On the Origin of Species* (1859). Henslow, in 1830, while Darwin was his student, debated the nature of species and the necessity for experimentation to resolve issues in his paper 'On the Specific Identity of the Primrose, Oxlip, Cowslip and Polyanthus' (see item 4). As a result of observations of populations of *Primula* he found at Westhoe, near Cambridge, combined with experiments in his own garden, Henslow began to doubt the existence of separate species in this genus, contrary to the thinking of 'modern botanists'. He concludes that the view of Linnaeus eighty years previously, that the different forms are varieties of a single species, was indeed correct.

Hybridity is clearly an important consideration for Henslow in his thinking about the definition of species, and in the *Primula* paper he calls for rigorous experimentation on hybrids in many different genera to underpin observation. He also urges botanists to tabulate their experiments, and not ignore failures and 'unsatisfactory' results. In a paper published in the same year, he uses the fact of segregation of different forms of offspring from a single capsule of *Anagallis* to refute the existence of two species based on flower colour – *A. arvensis* and *A. coerulea* – in favour of them being two varieties of the one species *A. arvensis* (see items 5). Thus hybridity and segregation together provided Henslow with a definitive test of species distinction. Indeed, he later went further and proposed that if observations on a hundred different hybrids and their parents could be collected, then the laws of heredity could be elucidated.

Henslow understood that hybrids are formed in nature as well as being produced by direct intervention. When an unusual *Digitalis* (foxglove) arose in his own garden in Cambridge, Henslow quickly realised its hybrid origin, and followed its development throughout its flowering and fruiting life since it provided him with 'curious and important physiological facts' (see item 6). His detailed description of the developmental progress of the hybrid and its two parents is masterly, and is one of the most important early contributions to this area of research, although he modestly considers he had 'thrown so little light … upon the great questions connected with the phenomenon of hybridity'. What he had done, however, was to set the stage for future considerations of the nature of species, through his influence over his students, and particularly by imbuing Charles Darwin with this unique understanding.

Darwin came to Cambridge in 1828 as a failed medical student from Edinburgh University. He was to read for an Ordinary Degree, which would qualify him for a comfortable career as a parson in the Church of England. At Cambridge, Darwin was pointed towards Professor Henslow by his cousin, William Darwin Fox, who had attended Henslow's inaugural botany course. Darwin found

Henslow inspiring, and attended the botany course in 1829, 1830 and 1831. He also took full advantage of Henslow's generous, open and novel pedagogy, notably attending Henslow's Friday evening soirées at which the great men of Cambridge assembled to discuss science. Indeed, Darwin spent so much time with his mentor that he became known to the dons as 'the man who walks with Henslow'. Henslow's ultimate act of generosity came when he recommended Darwin for the position of gentleman companion to Captain Robert FitzRoy on the circumnavigation of the globe by H.M.S. *Beagle*.

At Cambridge, Henslow received all the material collected by Darwin on the voyage, and dealt with it. Darwin made a particular point of collecting the kinds of plant material he thought would be most acceptable to Henslow, including population samples. As it turned out, Henslow the experimental botanist was inadequate to attempt a full taxonomic analysis of these plants, although he mounted beautifully more than 2,000 specimens and meticulously labelled them. However, he did describe and name two of the endemic species of *Opuntia* from the Galápagos archipelago in 1837 (see item 12), and he compiled a short flora (a *florula*) of the native plants of the Keeling Islands the following year (see item 13).

It later fell to Joseph Hooker to address the taxonomy of Darwin's Galápagos specimens and give a definitive account of the remarkable endemism shown by the plants of this remote archipelago. The botany of isolated islands was as intriguing to Henslow, who lectured on biogeography, as it was to Darwin. Henslow the scientist was at pains to urge his fellow botanists to distinguish between introduced plants and those that were indigenous to an area when compiling floras and plant lists, in order to 'arrive at a knowledge of the laws which regulate the geographical distribution of species'. In his own *Catalogue of British Plants* (1829) he printed in italics all species not so far met with in Cambridgeshire.

Henslow's views on the science of botany can be gleaned from the syllabus of his first lecture course of 1828 and its subsequent editions (Henslow, 1828). The substance of these early lectures was later brought together in book form as *The Principles of Descriptive and Physiological Botany*, published in 1836 in Dionysius Lardner's 'Cabinet Cyclopædia' series and reissued in the Cambridge Library Collection in 2009. One of the great influences on Henslow's own thinking was the work of the French-speaking botanist A.P. de Candolle. Their common thinking on modern botany and the importance of physiology (non-taxonomic botany) is evident in Henslow's 48-page review, published in the *Foreign Quarterly Review,* of de Candolle's 1832 three-volume work *Physiologie végétale* (see item 8). Henslow uses this review to consider his own philosophical position, although, curiously, he presents the review anonymously.

During the 1830s, Henslow became increasingly involved with national scientific developments and the dissemination of knowledge throughout the country and at all levels in society. He was a staunch supporter of the British Association for the Advancement of Science from 1831, organising the third of its annual meetings at Cambridge (Morrell and Thackray, 1881), and was a founder member of the Royal Agricultural Society of England (Goddard, 1988). He was also intimately involved in the rise of the Mechanics' Institute movement, which sought to spread education among working men – his membership card for the Cambridge Mechanics' Institute bears the number 2.

Alongside his increasing national position as an academic, Henslow advanced in his clerical career and received the living of Cholsey-cum-Moulsford in Berkshire in 1832. In 1837, he was offered a more prestigious, and much more financially rewarding, parish at Hitcham in rural Suffolk. After two years as an absentee rector, Henslow made the momentous decision to move his family to this rather remote agricultural parish (Russell-Gebbett, 1977). From then on, he focused his scientific endeavours on agriculture and its improvement on a rational basis, publishing papers

on such subjects as wheat and its diseases, potatoes and clover, and manuring and plant nutrition. However, he maintained his Cambridge connections and returned from Suffolk every summer to give his botanical lecture course until a year before his death in 1861.

References

Darwin, C.R. (n.d.) 'Geological Diary'. Cambridge University Library, DAR33.217–222.

Goddard, N. (1988) *Harvests of Change: History of the Royal Agricultural Society of England*. Quiller Press, Fakenham.

Hall, A.R. (1969) *The Cambridge Philosophical Society: A History 1819–1969*. Cambridge Philosophical Society, Cambridge.

Henslow, J.S. (1823) *A Syllabus of a Course of Lectures on Mineralogy*. James Hodson, Cambridge. [Reissued by CUP – ISBN 9781108002011]

Henslow, J.S. (1828) *Syllabus of a Course of Botanical Lectures*. James Hodson, Cambridge.

Henslow, J.S. (1829) *A Catalogue of British Plants Arranged According to the Natural System*. James Hodson, Cambridge.

Henslow, J.S. (1836) *The Principles of Descriptive and Physiological Botany*. Longman, London. [Reissued by CUP – ISBN 9781108001861]

Henslow, J.S. (1837) 'On the Requisites Necessary for the Advance of Botany'. *Magazine of Zoology and Botany*, 1, 113–125.

Huxley, L. (1918) *Life and Letters of Sir Joseph Dalton Hooker*. John Murray, London. [Reissued by CUP – ISBN 9781108031028]

Jenyns, L. (1862) *Memoir of the Rev. John Stevens Henslow*. John van Voorst, London. [Reissued by CUP – ISBN 9781108035200]

Kohn, D., Murrell, G., Parker, J., and Whitehorn, M. (2005) 'What Henslow Taught Darwin'. *Nature*, 436, 643–645.

Morrell, J. and Thackray, A. (1981) *Gentlemen of Science: Early Years of the British Association for the Advancement of Science*. Oxford University Press, Oxford.

Otter, W. (1824) *Life and Remains of Edward Daniel Clarke*. J.F. Dove, London.

Russell-Gebbett, J. (1977) *Henslow of Hitcham: Botanist, Educationalist and Cleryman*. Terence Dalton, Lavenham.

Walters, S.M. (1981) *The Shaping of Cambridge Botany*. Cambridge University Press, Cambridge. [Reissued by CUP – ISBN 9781108002301]

Walters, S.M. and Snow, E.A. (2001) *Darwin's Mentor: John Stevens Henslow, 1796–1861*. Cambridge University Press, Cambridge. [Reissued by CUP – ISBN 9780521117999]

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Quod si cui mortalium cordi et curæ sit, non tantum inventis hærere, atque iis uti, sed ad ulteriora penetrare; atque non disputando adversarium, sed opere naturam vincere; denique non belle et probabiliter opinari, sed certo et ostensive scire; tales, tanquam veri scientiarum filii, nobis (si videbitur) se adjungant.

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