

Charles Darwin (1809 - 1882)



Down House

Section 3

Description of the nominated World Heritage Property

3.a Location

Country

United Kingdom

Region

London Borough of Bromley, England

Name of Property

Darwin's Landscape Laboratory

Geographical coordinates to the nearest second

Darwin's Landscape Laboratory is situated in the London Borough of Bromley in southeast Greater London

The centre of the nominated World Heritage Property, Down House is at:

Latitude: 51 19' 50" N

Longitude: 0 03' 4"

3.b Boundaries and map

1. The boundary of the proposed World Heritage Property has been set to conform to landscape features and roads. It excludes the main areas of housing developed since Darwin's death, at Holwood, north of Downe, at Luxted and Single Street, which have been placed in the buffer zone

2. The setting of the Property is the environment or surroundings around the World Heritage Property. It includes those sites, monuments, buildings and landscape components that provide additional historical context and a physical space in which events could affect the

visual appreciation of the World Heritage Property. The immediate setting of the World Heritage Property and important views are strongly protected by planning designations, particularly London's Green Belt while most of the Property is defined by the ridge lines of the two valleys which form a natural visual barrier. The buffer zone completes this visual barrier. The World Heritage Property and its setting are both managed appropriately and a buffer zone has been proposed to complete protection for the visual envelope of the Property. The relationship between the World Heritage Property and its setting is an important concept in the World Heritage Convention. The UK government has also made it clear that the concept of setting is a material consideration in cultural heritage planning policy. National guidance is contained within PPG15: Planning and the Historic Environment, which is currently being revised at the moment and the draft World Heritage Site circular (2008). These documents support the concept of setting and require the relevant Regional and Local Planning Authorities to formulate policies to protect the Property and setting from damaging development which could impact on the outstanding universal value of the Property, its authenticity, integrity and significance.

Area of nominated Property

721 hectares.

Area of buffer zone

567 hectares

Area of nominated Property and buffer zone

1288 hectares

3.c Description of Property

3.c i Introduction

1. The nominated World Heritage Property is the farmed landscape of the Downe and Cudham valleys, either side of Down House and grounds, all used by Charles Darwin to develop and demonstrate his theory of evolution through the study of plants and animals in natural settings and under human management. He lived at Down House from 1842 to 1882, using his surroundings and home as his scientific research station. The Property comprises of two valleys bridged by high ground which was and is today an intimate farmed landscape.

2. The nominated Property was Darwin's workplace and field study area during the forty years of his greatest productivity, including his main investigational work on the theory of evolution and his historic contribution to the understanding of plant life. It was an essential part of his scientific approach to base as much of his work as he could on his own observations of natural life and to use experiment wherever possible to explore, test and demonstrate aspects that were not immediately obvious. The nominated Property preserves the evidence of his research to a remarkable degree of completeness.

3. The valley landscape with its two steep wooded chalk valleys to the east and west, arable fields, grassland and meadows in the valleys bottom and on high ground between them, and woodland on the upper slopes, provided Darwin with a wide range of habitats, as did the promontory of heath, bog, woodland and parkland to the north. The underlying geology of the area supported a wide range of habitats for observation which could be easily accessed by footpaths and lanes from Down House. The many varied habitats that Darwin studied and still exist today include: chalk grassland; acid grassland; acid bog; acid heathland; clay pond; gravel streams; laid hedges; ancient woodland; coppiced woodland; plantations; ploughed land; pasture; and hay meadows.

4. The area is sewn together with the footpaths and lanes which were regularly used by Darwin to access his landscape resource for his science and observations in the surrounding landscape.

5. The Property includes Down House his home and part of his landscape laboratory for over 40 years, his experimental garden and his estate. These were all modified and adapted by Darwin to allow him to daily undertake observations and experiments.

I think I was never in a more perfectly quiet country. ... Between us and the escarpment there is not a village or gentleman's house, but only great woods and arable fields ... so that we are absolutely at the extreme verge of the world.

Darwin to W D Fox, 28 March 1843

From September 1854 onwards, I devoted my time to arranging my huge pile of notes, to observing, and to experimenting in relation to the transmutation of species.

Darwin, 'Autobiography' in Life and Letters (1887) p. 71

6. One of the main reasons why Darwin moved to Downe in 1842 was to find an area with access to a wide range of habitats to enable him to answer his "Question and Experiments" – a list that he wrote in London in 1839 of fieldwork and other enquiries he wanted to undertake but was unable to in London's built up area. Many of his most productive lines of research at Downe on birds, insects and plants were anticipated in the 'Questions and Experiments'. (Down House is spelt without the final 'e' in the village name, in accordance with an earlier spelling of the village name).

Experimentise on primrose seeds - it really is an important case - cross with cowslip pollen as these are wild varieties. Is any intermediate form found wild?

Darwin, 'Questions and Experiments', 1839-1842

7. On arrival at Downe with his wife Emma and their first two children, the grounds and garden were modified to better enable observation and experimentation for his science. His initial survey of the landscape, which he headed 'General Aspect', is reproduced in Annex 1. He spent most of the following forty years at Downe and carried out almost all of his scientific work during that period in the landscape close around, at Down House, in the garden and the grounds. One important sequence of his field investigations for The Origin of Species is recorded in a notebook he opened in 1855 and labelled 'Experiment Book'.



Cudham Valley to the east of Darwin's home

In most countries the roads and footpaths ascend along the bottoms of valleys, but here this scarcely ever the case. All the villages and most the ancient houses are on the platform or narrow strips of flat land between the parallel valleys. Is this owing to the summits having existed from the most ancient time as open down and the valleys having been filled up with brushwood? I have no evidence of this, but it is certain that most of the farm-houses on the flat land are very ancient. There is one peculiarity, which would help to determine the foot paths to run along the summits, instead of the bottoms of the valleys, in that these latter in the middle are generally covered, even far more thickly than the general surface, with broken flints.

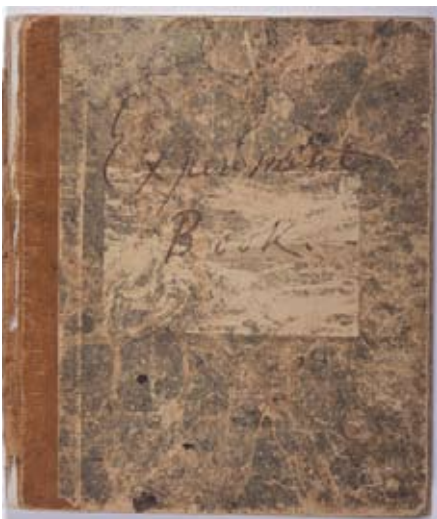
Darwin, 'General Aspect', 1843

1856: Jan 23rd. Put two half ounces [of soil] separately from shaw [wood bank] by Sandwalk, from a shady place, where ground in most part covered with ivy but in parts bare. Earth taken from close to surface but not the actual surface. There were many earthworm casts. Put this earth on well-burnt earth under glass in my study. Feb 10th. Threw away earth; before which two dicotyledonous plants had sprung up near each other in the one glass.

Darwin, 'Experiment Book', 1856

1857: July 2nd. In Larch Wood removed pollen from four flowers, some top, some bottom and middle on four plants of Bee orchis, and put on pollen masses from other plants (marked pods with white worsted and broke branches near them). There were other pods swelling on some plants. All killed by cows.

Darwin, 'Experiment Book', 1857



Darwin's Experiment Book 1856 - 1868

8. The wider landscape and its many habitats and the garden and grounds of Down House were of critical importance for his scientific work for the fundamental reason that his subject was the processes and patterns of natural life which required close continual observation and full, detailed recording over long periods of time to provide the base evidence for his theories. Darwin used his study at Down House for work with his microscope on specimens from the Beagle voyage and his collecting in the grounds and countryside, and also for many plant experiments. The garden was modified to provide shelter from the north winds by raising earth banks and a greenhouse was built in order to be able to carry out a wide range of observations and experiments on flowers, vegetables and fruit under cultivation in temperate to tropical conditions, and to experiment with wild plants that he had found in the countryside.

9. The description of the nominated Property covers the rural farmed landscape that provided the natural features that were important for Darwin in his work before describing Down House and its grounds, where he carried out many of his experiments. For each these is a description followed by an examination of how the setting proved invaluable to Darwin's scientific work.

10. The following summary table (pages 20-21) of features shows how many aspects of his achievement as a scientist can be appreciated today by seeing the living things he observed at Downe in the settings in which he studied them and the relevant publication associated with the experiments and observations. In almost every case the setting is close if not identical to how it was in his time.

Places around the Property where Darwin studied natural life



Features of Down House estate used by Darwin in his scientific work



Key locations for Darwin's science, observations and research

Location	Darwin's science, observation and research	Significant Species still present	Relevant Publication
Rural Farmed Landscape and Access	Throughout the nominated Property. Effects of human farming practice on natural elements in a managed landscape seen by Darwin using the network of lanes and paths (photo 1)		The Variation of Animals and Plants under Domestication (1868)
Cudham Valley	Collection of specimens of <i>Verbascum thapsus</i> and <i>V. lychnitis</i> , and <i>Anagallis arvensis</i> and <i>A. caerulea</i> for study of variation and hybridisation in plant communities in the wild. (photo 2)	Anagallis arvensis and <i>A. caerulea</i> (scarlet & blue pimpernel) Verbascum thapsus and <i>V. lychnitis</i> (great & white mullein)	Different forms of Flowers (1877)
Downe Valley	Identification of male, hermaphrodite and female flowers and investigation of fecundity in community of <i>Euonymus europaeus</i> ; study of wild communities of <i>Primula veris</i> and <i>vulgaris</i> for work on species, varieties and hybridisation; observation of insect pollinating and orchid, <i>Dactylorhiza fuchsia</i> . (photo 3)	Aceras anthropophorum (Man Orchid) Gentianella amarella (Gentian) Euonymus europaeus (Spindle)	Different Forms of Flowers (1877) The Origin of Species (1859)
Woodlands and Hedgerows	Hangrove Ancient beech woodland in which Darwin collected <i>Oxalis acetosella</i> for examination of forms of flower, and studied <i>Euonymus europaeus</i> for comparison with observations in Great Pucklands Study of <i>Viola canina</i> and <i>Bombus hortorum</i> attempts to obtain nectar Study of native climbing plants. Holwood Park Observations of 'superfecundity' in nature and mechanisms for cross-fertilisation in Horse chestnut blossom.	<i>Euonymus europaeus</i> <i>Oxalis acetosella</i> (wood sorrel) <i>Viola canina</i> and <i>Bombus hortorum</i> (Bumble Bee) Climbing plants still growing in hedgerows Horse Chestnut	Different forms of Flowers (1877) Climbing Plants (1875) The Power of Movement in Plants (1880) The Origin of Species (1859)



Location	Darwin's science, observation and research	Significant Species still present	Relevant Publication
Grassland and Meadows	Orchis Bank Study of pollination of orchids by insects as a supreme example of evolutionary co-adaption; the inspiration for the 'entangled bank' Darwin envisaged in the conclusion of The Origin of Species.	9 Native Orchids species	The Various Contrivances by which Orchids are Fertilised by Insects (1862) The Origin of Species (1859)
	High Elms Estate Observations of wildlife. Study of native Orchid species – looking at fertilisation Lubbock's study on Collembola (springtails) and Cloeon dimidiata (mayfly)	10 Native Orchid species	The Origin of Species (1859)
	Keston Common Heath and acid grassland habitats in which Darwin studied where earthworms were active;	Heather	The Origin of Species (1859)
Wetlands	Cudham School Pond Cultivation of plant seeds from samples of mud in woodland pond to establish that birds may transport plant-life in mud on their feet, explaining uniformity of life in isolated bodies of fresh water.	Plant seeds in mud	The Origin of Species (1859)
	River Ravensbourne and Keston Bog Acid bog habitat in which Darwin collected <i>Drosera rotundifolia</i> for investigation of plant's adaptations to catch and digest insects. (photo 4)	Management of valley mire in place to encourage return of <i>Drosera</i> species	The Origin of Species (1859)
Down House	Study Microscopic examination of specimens for taxonomy and physiology; indoor experiments on plant physiology and earthworms; scientific reading and writing with books, periodicals and working papers.		The Origin of Species (1859)
	Drawing Room Indoor experiments on earthworms; use of ornamental plants for experiments.		The Power of Movement in Plants (1880) The Formation of Vegetable Mould through the Action of Worms (1881)
Down House Garden	Garden frontage of house Study of climbing plants under cultivation. (photo 5)	Climbing species on trellises	Climbing Plants (1875) The Power of Movement in Plants (1880)
	Flower Garden Study of floral mechanisms for cross-fertilisation; experimental installation for detecting long-term effects of earthworm activity on soil; experiments on plant diversity in grass habitat and mental capacities of earthworms. Worm-stone set in the lawn to detect subsidence of soil due to burrowing (photo 6)	<i>Lobelia fulgens</i> <i>Rhododendron thomsonii</i> Earthworms	The Origin of Species (1859)

Location	Darwin's science, observation and research	Significant Species still present	Relevant Publication
Down House Garden (cont'd)	Orchard Study of varieties of fruit developed by human selection; experiment on survival of plant seedlings for insight into struggle for existence. (photo 7)		The Origin of Species (1859) The Variation of Animals and Plants under Domestication (1868)
	Kitchen Garden Study of varieties of vegetables developed by human selection; 'experimental beds' for major investigations of cultivated and wild plants under controlled conditions. (photo 8)	<i>Primula veris and vulgaris</i> <i>Lythrum salicaria</i> <i>Linaria vulgaris</i>	The Variation of Animals and Plants under Domestication (1868)
	Greenhouse Cultivation of exotic plants, orchids, insectivorous plants, climbers and sensitive plants for global comparisons; plant experiments requiring special controls & monitoring. (photo 9)	<i>Angraecum sesquipedale</i> (Commet Orchid) <i>Bignonia capreolata</i> (swamp climbing plant) <i>Dionaea muscipula</i> (Venus Fly Trap) <i>Drosera rotundifolia</i>	Insectivorous Plants (1875)
	Garden Laboratory Laboratory building for planned experiments on sensitivity of growing plants to light.		The Power of Movement in Plants (1880) The Origin of Species (1859)
Down House Estate	Great House Meadow Long term experiment on soil development by earthworms; field observation of flight patterns of mating bumblebees; study of ecological links between clover, bumblebees, field mice and cats.		The Formation of Vegetable Mould through the Action of Worms (1881) The Origin of Species (1859)
	Sand-walk copse Experiments showing the existence of a natural 'seed bank' in woodland soil; hedgerow planted by Darwin in which he studied the development of plant diversity over decades; Darwin's 'thinking path' for scientific reflection. (photo 10)	<i>Lathraea squamaria</i> (Toothwort)	The Power of Movement in Plants (1880)
	Great Pucklands Historic survey of plant biodiversity in defined area of uniform habitat. Study of Earthworms	The diversity of the plant population is now as high as it was when Darwin made his first count	The Origin of Species (1859) Natural Selection (1858)



For locations, refer to the table above

3.c ii Rural Farmed Landscape and Access

Description:

11. The landscape is characterised by a pattern of dispersed settlements and farmsteads in a largely enclosed terrain of arable fields, pasture and woodland. It has been farmed continually through the six thousand years since humans first settled it. The landscape that Darwin discovered and used was comparatively prosperous and shaped by small scale mixed farming.

12. Some parts of the landscape have changed but taken as a whole, the two quiet valleys and the high land between are still fully recognisable as the setting in which Darwin worked and there are many specific places within the area where the wildlife and plants that he studied are still present and can be observed today just as he studied them.

13. Two south-north valleys have been formed in the high land, with chalk slopes and deposits of alluvium in their lower parts. The high ground between the two valleys slopes gently northwards into a west-east valley. There is a promontory of higher ground at Keston Common in the northwest part of the Property.

14. The Cretaceous chalk was laid down between 146 and 65 million years ago when a shallow sea covered much of western and central Europe. In the early Tertiary era, which followed, movements of the earth's crust raised the North Downs on which Downe is situated and led to the excavation of the Weald of Kent to the south. The extensive view from the North Downs escarpment out over the Weald was important for Darwin. He described it in *The Origin of Species* when he needed to explain the immensity of geological time, an essential point for understanding how evolution by natural selection has taken place.



Arable farming is still practised in parts of the nominated Property.

The consideration of [the time-scale of geological formations] impresses my mind almost in the same manner as does the vain endeavour to grapple with the idea of eternity. ... It is an admirable lesson to stand on the North Downs and to look at the distant South Downs; for, remembering that at no great distance to the west the northern and southern escarpments meet and close, one can safely picture to oneself the great dome of rocks which must have covered up the Weald within so limited a period as since that latter part of the Chalk formation. ... I have made these few remarks because it is highly important for us to gain some notion, however imperfect, of the lapse of years. During each of these years, over the whole world, the land and the water have been peopled by hosts of living forms. What an infinite number of generations, which the mind cannot grasp, must have succeeded each other in the long roll of years!

Darwin, *The Origin of Species* (1859) p. 296

How Darwin used the landscape:

15. Many of the features of the wildlife of the area that Darwin examined reflected long-term adaptations by natural species to farming practices, as for instance with the insectivorous plants in the wetlands and the native orchids and their insect pollinators. He also had a pioneering understanding of the effects of human farming practice on natural elements in a managed landscape. His awareness of those effects was an element in his recognition of the importance of human impacts on natural systems and the value of studying those impacts and their after-effects in order to understand the dynamics of the natural processes involved. He made use of what he knew about the recent history of the landscape in a number of his investigations in the nominated Property, including those into buried viable seed, the working of the soil by earthworms, ecological succession in hedgerows and the comparison of plant diversity in different areas (see Annex 2).

16. Darwin made almost all his recorded scientific observations during the forty years he spent at Downe in his grounds and within the immediately surrounding landscape of the nominated Property. His observations in the natural and semi-natural settings of the countryside around were of fundamental importance for his science; his work on plants under cultivation in his garden was often only supplementary to his examination of natural phenomena.

17. Darwin's range as a field naturalist was confined by his poor health and he seldom ventured further than the distance he could cover in a two or three-hour outing. Despite those limits, the area met his scientific needs for three reasons. First, it contained a diverse flora and fauna in a range of semi-natural and man-managed habitats including unimproved chalk grassland, unimproved and improved neutral grassland, water-meadow, arable land, semi-natural and coppiced woodland, coniferous plantation, ancient wood banks and hedgerows, acid heath, bog and surface-water ponds. Second, all the different habitats were easily accessible for Darwin along the many lanes and pathways in the neighbourhood, allowing him to study plants and animals within the context of the natural communities in which they occurred, and to make repeated observations when required for his research. Third, the unchanging patterns of management in some areas, together with the alterations in others when land use was changed according to market demands, enabled him to investigate and compare natural life in situations of both continuity and flux, and to explore the dynamics of ecological processes through time, both essential aspects of his global theory. The long history of geological change and human settlement that Darwin was able to read in the countryside around him enabled him to trace the processes of natural change and development in an ancient landscape, fundamental influences that it is part of the Outstanding Universal Value of his theory to explain. Those features of the neighbourhood all survive in the nominated Property today.

After several fruitless searches in Surrey and elsewhere, we found [Down] house and purchased it. I was pleased with the diversified appearance of vegetation proper to a chalk district, and so unlike what I had been accustomed to in the Midland counties.

Darwin, 'Autobiography' in Life and Letters (1887) p. 78



Darwin on his horse Tommy in the 1870s

In England any person fond of natural history enjoys in his walks a great advantage, by always having something to attract his attention.

Darwin, Journal of Researches (1839), Chapter 2

Up to ten or twelve years [before his death], his tall figure, seated upon a favourite old black cob, was a familiar object in the lanes round about. ... it was observed that he was rarely seen in the village or met on the roads, preferring, as he did, to take his way generally southward by the footpaths through the woods and meadows. Little children, who have a quick instinct for a kind and gentle nature, would run to open a gate when they saw Mr Darwin coming, encouraged thereto by a smile and a kind word. Downe folk, by whom he was much beloved, like now to dwell upon these trifles, and to speak of his considerate kindness to all about him.

Daily News, 24 April 1882

My memory goes back to my first sight of this great man. ... I had crossed the corner of Keston Common, and my horse was slowly walking up that steep hill that leads into the Village of Down. The road is rough and narrow. An elderly man was walking slowly down. Seeing me he turned aside and stood as I moved along the road, with his back to me, studying the face of the chalk quarry in the hill, from which the road material of chalk and flints had been dug. The action was that of a shy and nervous man, and I looked curiously at him as I passed. I saw, in side view, a slender and somewhat bowed man, with a "drawn face", heavy white eyebrows and beard, under a soft black hat. He wore black clothes and a cape, with a grey plaid shawl wrapped round his shoulders. There was something familiar in the general outline. Suddenly recognition came to me. It was the pictures of the author of the "Origin of Species", the original of which I had passed, looking at the chalk quarry on the road to Down.

Wallis Nash, A Lawyer's Life on Two Continents, 1890

I had been bird's nesting in some woods not far from Down House when suddenly I found myself confronted by a very tall man with a grey beard, wearing a black cloak and a flat, wide-brimmed hat rather like the ones clergymen wore. I was terrified at first, but he spoke very kindly to me and showed me a place where a wren had built her nest. There were three eggs in it and I wanted to take one of them, but he told me I mustn't. In spite of this, he went on to tell me how to blow eggs so as to preserve them, which I thought was very funny. When I returned home to Cudham my father told me who



View looking south in Cudham Valley to Orchis Bank

the old man was and said he probably knew more about birds' eggs than any person living.

J Bunting of Cudham about a childhood meeting with Darwin in 1871

3.c. iii Access, paths and lanes

Description:

18. The extensive network of lanes, paths and bridleways was important for Darwin for the access it gave him to every part of the neighbourhood and to the surrounding farmed landscape.

Darwin's use:

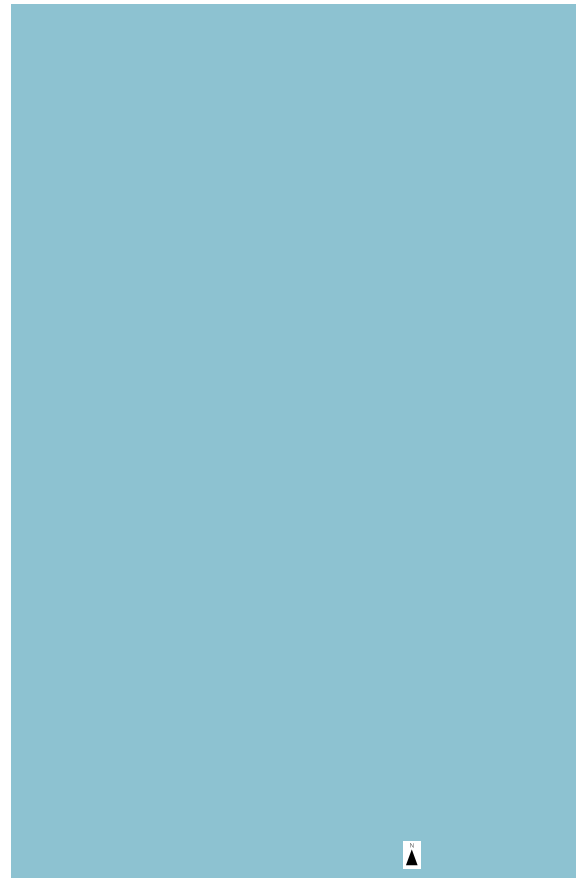
19. Darwin rarely walked for more than half an hour from Down House, partly due to illness and partly because the landscape offered him most of the opportunities to conduct his science. The paths that Darwin would have used are still in use today. He was frequently to be seen on the quieter back routes rather than the main roads

The country is extraordinarily rural and quiet with narrow lanes and high hedges and hardly any ruts. It is really surprising to think London is only sixteen miles off. ... The charm of the place to me is that almost every field is intersected ... by one or more footpaths - I never saw so many walks in any other country.

Darwin to his sister Catherine, July 1842

3.c. iv Cudham Valley

Description:



Aerial photograph of fields in Cudham Valley with 1868 Ordnance Survey map overlaid

20. Cudham Valley is a steep-sided chalk valley with wooded sides and enclosed fields along its base, a quarter of a mile to the east of Down House and very similar to Downe Valley in scale and character. Starting in the south from smaller tributary valleys, Cudham Valley runs northwards until it leaves the nominated Property as the narrow valley broadens and widens before it meets the settlement of Green St Green. There was in Darwin's time an intricate pattern of fields, each marked by hedgerows with many paths and lanes to enable easy access. These features can still be seen today. The valley contains key sites, such as Hangrove and Orchis Bank which are described in more detail later.

Darwin's use:

21. Darwin studied wild plants growing in the fields in the lower parts of Cudham Valley, and collected specimens which he then cultivated in his experimental beds for his research on species, varieties and hybridisation. Two pairs of plants that he worked on in this way and still grow in the fields are *Anagallis arvensis*

and *A. caerulea*, scarlet and blue pimpernel, and *Verbascum thapsus* and *V. lychnitis*, great and white mullein.

Have you any white and yellow varieties of Verbascum which you could give me or propagate for me or lend me for a year? I have resolved to try Gaertner's wonderful and repeated statement, that pollen of white and yellow varieties, whether used on the varieties or on distinct species, has different potency. I do not think any experiment can be more important on Origin of Species; for if he is correct, we certainly have what Huxley calls new species arising.

Darwin to Hooker, September 1861

Here is a fact which may possibly interest you. In a field here I find many Verbascum thapsus & lychnitis; & lots of varieties making an almost perfect series between those two distinct forms. I am sure many species have been run together on less perfect evidence. But lo and behold every one of these intermediate forms are absolutely sterile! and no doubt are natural hybrids. I found 33 of these hybrids in one field!!!

Darwin to Hooker, October 1862

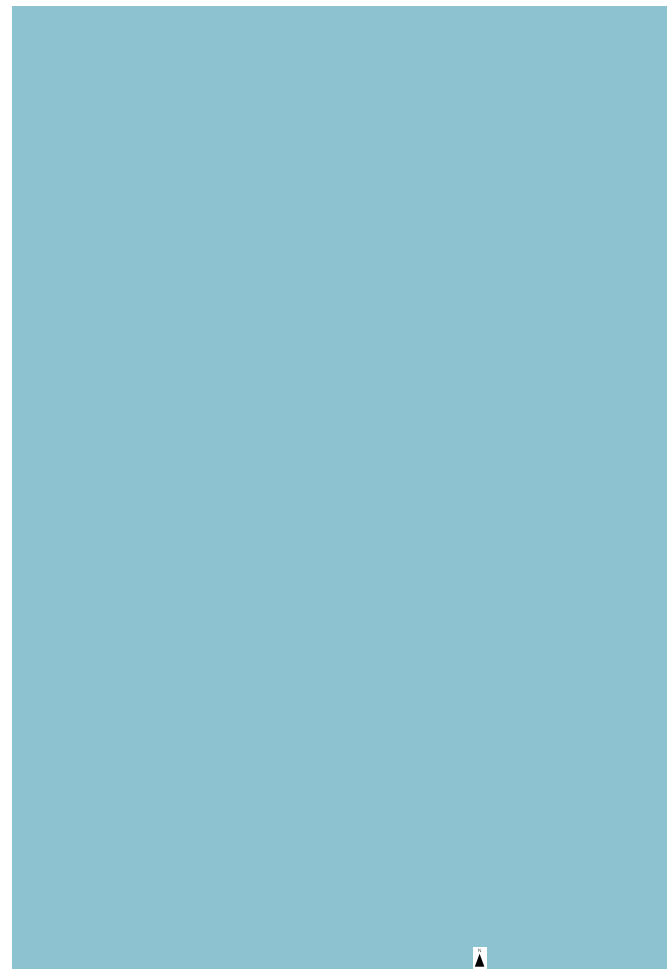
Oct 16th I went to Cudham field and gathered two capsules from eleven plants not observed before; (I shd say I examined altogether about nine before) and all these capsules contained abortive ovule; where Verbascum lychnitis, contained fine young seed. It cannot be time of year, on account of plant in Kitchen Garden — One fine plant was very woolly and I think hybrid from branched stem and open flowers; this has now been transplanted into Kitchen Garden.

Darwin, scientific papers, 1862

3.c v Downe Valley

Description:

22. Downe Valley lies immediately to the west of the Sand walk, Great Pucklands and Down House. Running from north to south, it has extensive areas of semi-natural woodland including the 'Big Woods', unimproved grassland slopes including Green Hill and improved grassland levels along its length. The chalk grassland at Green Hill on the eastern side of the valley is described more fully later. The lower parts with their rich soil have been pasture or arable since the medieval period at least. The less fertile slopes have mostly been woodland and pasture. As in Darwin's time there are few dwellings in the valley and it has only one small road. The main addition since has been the development of a golf course which uses the natural slopes as features; the golf course



Downe Valley showing nominated Property and buffer zone

has been placed in the buffer zone. Lying deep between the uplands on either side with the wooded ridges as its high horizon, the valley had and still keeps a special sense of quietness. The closeness of Down House to this private domain where he would be able to walk and observe natural life whenever he wanted, was a factor in Darwin's decision to come to Downe.

[The Sand-walk] was separated from a neighbouring grass field by a low quickset hedge, over which you could look at what view there was, a quiet little valley losing itself in the upland country towards the edge of the Westerham hill, with hazel coppice and larch wood, the remnants of what was once a large wood, stretching away to the Westerham road. I have heard my father say that the charm of this simple little valley helped to make him settle at Down.

Francis Darwin, Life and Letters (1887) p. 115



Downe Valley

Darwin's use:

23. Darwin and his wife often walked along the paths in the valley and he made many observations of plants and insects in the wooded and open grassland areas. In the 1850s Darwin collected local specimens for a wide-ranging comparison with other wild and domesticated varieties in Europe, Asia and the Caribbean, for his treatment of variation and speciation in *The Origin of Species*. One plant that Darwin studied in the Downe Valley wood bank bordering Great Pucklands and which still grows there now is *Euonymus europaeus*, the Spindle tree. Darwin identified male, female and hermaphrodite forms of the flower and noted the relative fertility of the different unions they made in the wild for his study of the development of sexual differences in plant species.

Thirteen bushes growing near one another in a hedge consisted of eight females quite destitute of pollen and of five hermaphrodites with well-developed anthers. In the autumn the eight females were well covered with fruit, excepting one, which bore only a moderate number. Of the five hermaphrodites, one bore a dozen or two fruits, and the remaining four bushes several dozen; but their number was as nothing compared with those on the female bushes, for a single branch, between two and three feet in length, from one of the latter, yielded more than any one of the hermaphrodite bushes.

Darwin, *Different Forms of Flowers* (1877) p. 290

It was a sure sign of my father's feeling pretty well that he ventured from his safe 'Sand-walk', down a pleasant field at the end of the kitchen garden, over a stile, and then along a grassy terrace, looking across the quiet green valley on to the woods beyond. The terrace was sheltered from the north-east by a rough shaw of beeches and an undergrowth of sloes, traveller's joy, service-trees and hawthorn, and this bank was particularly gay with the flowers that love a chalk soil - little yellow rock-rose, milkwort, orchises, ladies' fingers, hare-bells, coronilla, scabious and gentian. My father would pace to and fro, and my mother would



Female *Euonymus* flower



Male *Euonymus* flower

sometimes sit on the dry chalky bank waiting for him, and be pulled by him up the little steep pitch on the way home.

Henrietta Litchfield, Emma Darwin, *A Century of Family Letters* (1915) 2.268

24. During Darwin's first summer after arriving at Downe, he observed double flowers of *Gentianella amarella*, the autumn gentian, in the grassland in Downe Valley, and found in them a possible answer to one of the questions he had posed in his 'Questions and Experiments' for his work on the theory of evolution. He reported his observation in a letter to a leading botanist and the letter was published in the botanist's periodical under the heading 'Double flowers - their origin'. Darwin and his family called the open area 'the terrace' and it became one of his favourite places for walking with his wife and enjoying their view over the valley to the woods on the western side.

The enclosed specimens appear to me curious, as in some degree connected with the origin of double flowers. They consist of plants of the Gentiana amarella, found in a wild state, covered with abortive buds, or rather minute double flowers. ... By examining these, a series can be shown, by which the stamens are seen to become deformed, and gradually to pass into small petals and scales. The pistil also can be traced, becoming more and more foliaceous. The change in the pistil has been effected in several flowers, whilst the stamens have remained nearly perfect. In the same manner I have observed in double Violets and some other garden flowers, that the pistil, contrary to the general rule, is metamorphosed before the stamens. ... The plants of the Gentiana in both states grow mingled together on a very hard, dry, bare chalk bank; but those with the abortive flowers grow on rather the barest spots, where it was surprising that anything could grow. You state in your "Theory of Horticulture," that the origin of double flowers is not well understood. Some have attributed it to excess of food; but the dry chalk bank surely was not too rich a soil; and I may mention that late last autumn, I found on an adjoining field of wretchedly sterile clay, great numbers of the Ranunculus repens, producing semi-double flowers, some having three, some additional rows of petals.

Darwin, letter to John Lindley published in The Gardeners' Chronicle, 8 September 1843.

25. Among the flowers of Downe Valley, *Dactylorhiza fuchsii*, the common spotted orchid, grew in the open areas and still does today. In 1862 Darwin's son George kept a group of plants under close observation and observed two species of fly visiting and cross-pollinating them. He showed his father specimens of the fly with the pollen sacs attached to their probosces, and Darwin himself later observed the act of pollination.

We often used to go out with [our father] on his mid-day walk, generally down the hill to Cudham Lodge Woods, the 'big woods', and do a little collecting as we walked. He seemed to know nearly all the beetles and was immensely interested when any of the rarer sort were found. ... He used to take long walks of three or four miles before breakfast, starting frequently in the dark. I have heard him say that sometimes in the dusk of the morning in the woods he would walk very slowly, just quietly putting down his foot and then waiting before the next step – a habit, he said, which he had practised in the tropical forests of Brazil.

George Darwin about his father, 1892

June 20 1862. George watched Orchis maculata in big woods today and in a hour caught six Flies (Empis livida named by Mr. Walker) with long hard proboscis, inserting proboscis into the nectaries. These all had pollinia attached to one or both spherical and rough eyes. ... I saw the large fly inserting proboscis.

Darwin, scientific papers, 1862

26. One of the footpaths used by the Darwins in an open part of the valley runs along an ancient woodland boundary which may be medieval and is possibly more than a thousand years old. The hand-dug bank served originally as a barrier to prevent animals grazing below from straying into the valuable woodland above. The ground flora with *Anemone nemorosa* (wood anemone) and *Ranunculus ficaria* (celandine) is a pointer to former woodland nearby that has been cleared. There are communities of *Primula vulgaris* (primrose) and *Primula veris* (cowslip) in the open grassland areas between the woods, just as the two plants grew there with the hybrid between them (false oxlip) in Darwin's time.

27. Darwin observed them and collected specimens to grow in the kitchen garden for his experiments on species, varieties and hybridisation.

April 27 1862. I have just compared the oxlips in corner of big wood whence I got the seeds last year now coming up in the K. garden, with the Bardfield Oxlip. ... Has very different appearance. ... There was a group of five or six plants, long and short-styled (slightly different in tint and size); [I] have seedlings from some neighbouring plant - Both cowslips and primroses grow mingled in this open bit of wood.

Darwin, Experiment Book, 1862

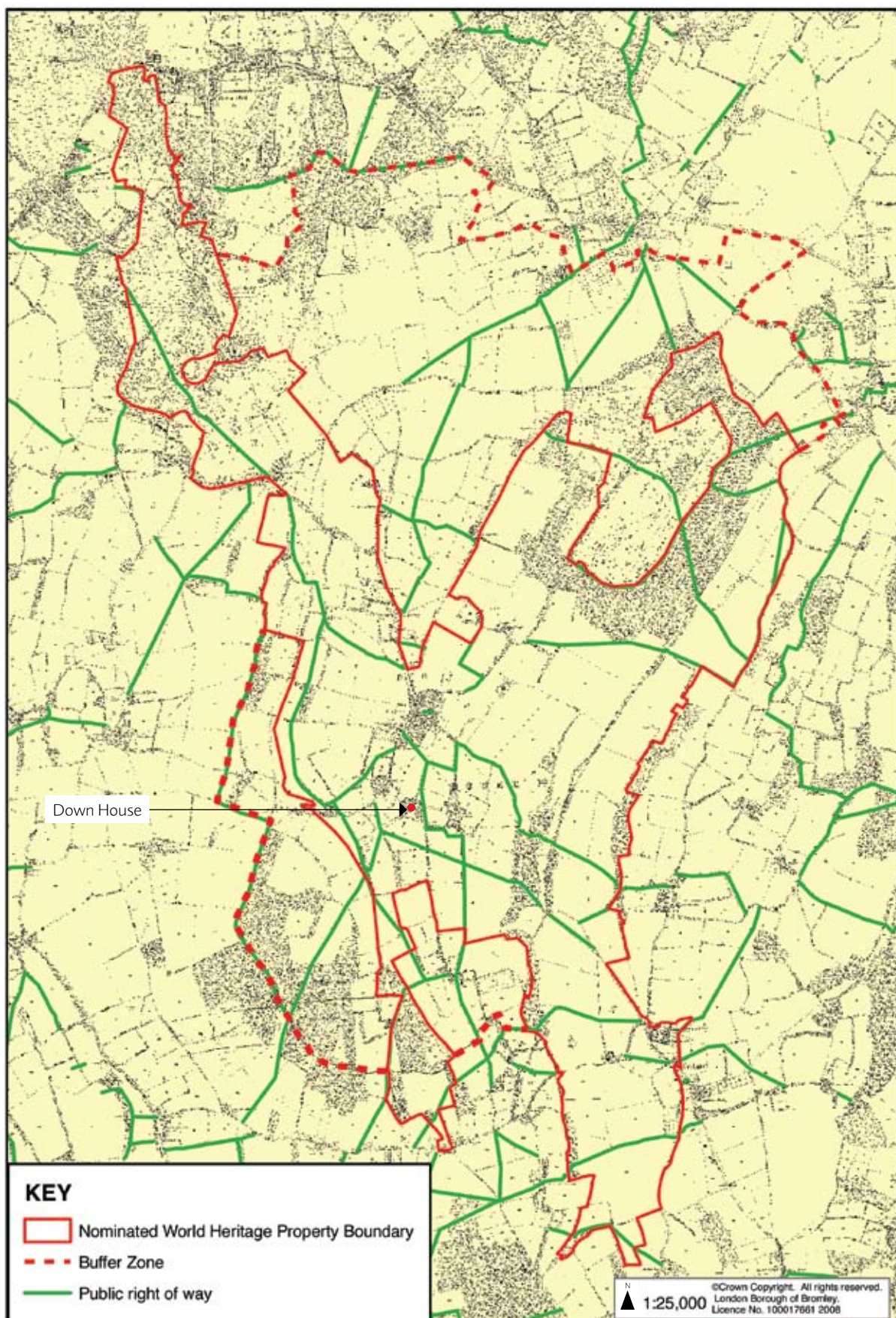
3.c vi Woodlands and Hedgerows

Description:

28. Woodland occurs on the clay-with-flint soils, which historically would have been more difficult to cultivate. The high demand for arable land had seen some of these woodlands cleared before Darwin arrived, leaving thinner strips of woodland or shaws, often running along the tops of the valleys. As land had been cleared, hedgerows of native trees and bushes were created or planted so that most lanes and fields were demarked by them. In other areas, plantations of beech and softwoods can still be seen

Retracing Darwin's Footsteps

The 1868 Ordnance Survey map with present-day Rights of Way, routes well known to Darwin



that were established on open farmland in Darwin's time, partly to produce timber but also as landscaping for the High Elms and Holwood estates. Thus a mosaic of woodland structure in the nominated Property was and is still maintained including high forest, coppice with standard trees through to secondary woodland.

There are large tracts of woodland, cut about once every ten years; some of these enclosures seem to be very ancient; On the south side of Cudham Wood a beech hedge has grown to Brobdignagian size, with several of the huge branches crossing each other and firmly grafted together.

Darwin, 'General Aspect', 1843

Life in the coppices of our southern counties differs much from year to year. When the copse is first cut there is a wonderful outburst of wild woodflowers, anemones, primroses, cowslips, bluebells, stitchwort, bugle, yellow archangel, woodspurge and many others. Attached to this phase are many butterflies, moths and other insects, but there is not yet enough corn for birds, or shelter for their nests. They begin to increase about their third year of the cycle. The flowers become taller, and are less numerous, still the Copse is at the height of its interest and beauty. Nightingales, blackcaps, titmice, willow wrens and other warblers find convenient nesting places. Year by year the beech and hazel and ash shoots grow longer, the sunlight is more and more excluded and gives place to a soft gloom. The flowers become fewer, paler and weedier; the small birds draw off to the edges of the wood ... Then come the woodcutters and the cycle begins again.

Sir John Lubbock IV, note for a lecture

29. In Downe Valley there is Sow Wood, Ladies Wood, Snotsdale Wood, Leasons Wood and Spencers Grove containing areas of ancient woodland and hazel coppicing which are surviving parts of the extensive woodland called by Darwin 'the big woods', which he often explored on his daily walks. There are wild rabbits, *Oryctolagus cuniculus*, in the woods and were used by Darwin in his work.



A coppiced beech tree in Cudham Wood

30. There are many surviving traces of woodland features in the existing boundaries showing boundary trees, hedgerows, wood banks and narrow strips of woodland known locally as 'shaws'. There are twelve kilometres of ancient wood banks in the nominated Property and buffer zones. There are hedges today on the line of ancient boundaries, for example parish boundaries that are over 1,000 years old. Most of the field boundaries, road edges and paths are marked by hedgerows which have been in place since Darwin's time.

31. There were and still remain plantation woodland at Holwood and High Elms whilst they have been joined by new plantation just to the east of Downe and in the Big Woods.

Darwin's use:

32. Darwin used the woodlands in both Valleys and these are detailed elsewhere in the sections on Hangrove, Holwood, High Elms and Keston Common. He became well acquainted with the woodland wildlife on his frequent visits whilst his observations on the hedgerows supported his work on twining plants and their mechanisms to affect growth rates and their response to light.

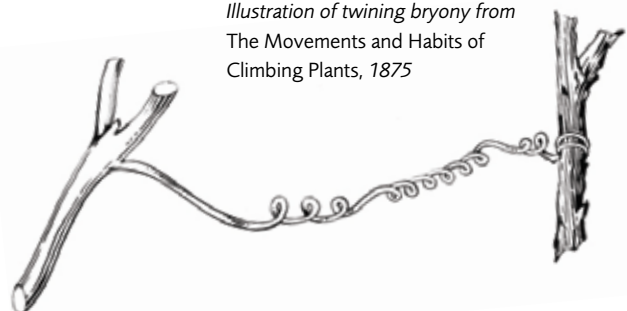
We often used to go out with [our father] on his mid-day walk, generally down the hill to Cudham Lodge Woods, the 'big woods', and do a little collecting as we walked. He seemed to know nearly all the beetles and was immensely interested when any of the rarer sort were found. ... He used to take long walks of three or four miles before breakfast, starting frequently in the dark. I have heard him say that sometimes in the dusk of the morning in the woods he would walk very slowly, just quietly putting down his foot and then waiting before the next step – a habit, he said, which he had practised in the tropical forests of Brazil.

George Darwin about his father, 1892

The number of different kinds of bushes in the hedgerows, entwined by Traveller's joy and the two bryonies, is conspicuous, compared with the hedges of the northern counties.

Darwin, 'General Aspect', 1843

Illustration of twining bryony from
The Movements and Habits of
Climbing Plants, 1875





Hangrove Wood today

Hangrove

Description:

33. Downe Bank is an area with ancient woodland and hazel coppice, chalk grassland and scrub, on the west flank of Cudham Valley, quarter of a mile across the high ground from Down House. It has two parts, both of which were important for Darwin - an area of ancient woodland called Hangrove, and an open area named Rough Pell, part of which Darwin called 'Orchis Bank' and often walked to with his family. It is notable for the diversity of plant species that occur there, especially the many kinds of native orchid and other plants that Darwin studied in the woodland and open areas.

34. Hangrove was recorded as woodland in a detailed survey of the parish in 1840; it was woodland in the 1869 twenty five inch Ordnance Survey and its ancient beeches still stand along the shoulder of the Cudham Valley. There was hazel coppice under storey in Darwin's time, and the coppicing is being maintained today on a similar cycle.

Hangrove ... had been one of the [Darwin family's] favourite near walks in old days - a wood, with hazel undergrowth cut down periodically, and in the hedges gnarled old beeches good for children to climb. It was carpeted with primroses, anemones and bluebells, and birds-nest orchis also grew in this wood.

Henrietta Litchfield, Emma Darwin, A Century of Family Letters (1904) 2.279

Darwin's use:

35. Darwin carried out many observations of woodland and woodland edge plants in the area. One that he observed there and is present there now is *Euonymus europaeus*. He continued the research on which he had started in the wood bank bordering Great Pucklands with observations on another group of trees in Hangrove that showed a similar mixture of sexes in their flowers.

I now determined to observe more carefully during successive seasons some bushes growing in another place about a mile distant. As the female bushes were so highly productive, I marked only two of them with the letters A and B, and five polleniferous bushes with the letters C to G. ... We thus see that the female bushes differ somewhat in their degree of fertility, and the polleniferous ones in the most marked manner. ... This case appears to me very interesting, as showing how gradually an hermaphrodite plant may be converted into a dioecious one.

Darwin, Different Forms of Flowers (1877), p. 290

Aerial photograph of Hangrove and Orchis Bank with 1869 Ordnance Survey map overlaid

36. Another woodland plant that Darwin obtained from Hangrove and is growing there still is *Oxalis acetosella*, wood sorrel. He made use of the plant in three separate lines of research, into the different forms of flowers in certain species, mechanisms for self-fertilisation, and *Oxalis*'s dual leaf movements during day and at night.

April 25 1862. George brought me 17 flowers (Oxalis) from so many plants near Hangrove.
Darwin, scientific papers, 1862.

With respect to Oxalis acetosella, Hildebrand says that in all the many specimens examined by him the pistil exceeded the longer stamens in length. ... In one lot of 17 flowers from the same wood, the stigmas in every flower projected fully as much above the upper anthers as these stood above the lower anthers. So that these plants might fairly be compared with the long-styled form of a heterostyled species; and I at first thought that O. acetosella was trimorphic. But the case is one merely of great variability.

Darwin, Different Forms of Flowers (1877) p. 182

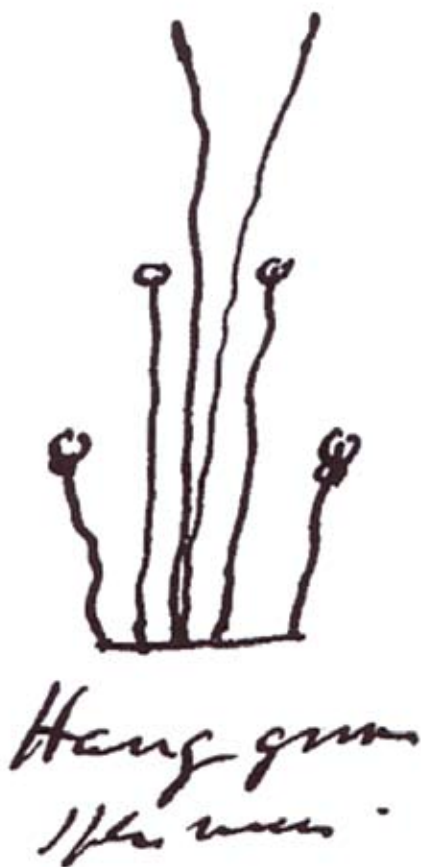


Oxalis acetosella at Hangrove

37. A third plant that Darwin studied in Hangrove still found there is *Viola canina* on which he observed the bumble-bee *Bombus hortorum* biting holes in the flowers' nectaries to obtain the nectar. His note of his observations shows how he marked plants in the countryside outside his property to help in his scientific observations. *Bombus hortorum* is also still present in the woodland.

April 15 1863 Viola canina (true) Hangrove - saw Bombus hortorum sucking multitude of flowers, and biting holes in nectary ... Marked six flowers sucked by black thread and each by stick at twig end of layered birch trees, where cut down flat wood, rises into wooded slope - 25 yards on sort of path from gap in hedge into grass-field. It is near where Cephalanthera grew. Where so many primroses have grown this spring.

Darwin, scientific papers, 1863



Darwin's diagram of an *Oxalis acetosella* specimen from Hangrove 1862

3.c vii Grassland and Meadows

Orchis Bank

Another favourite place [for Darwin] was 'Orchis Bank' above the quiet Cudham Valley, where fly and musk orchis grew among the junipers, and Cephalanthera and Neottia under the beech boughs; the little wood, Hangrove, just above this, he was also fond of, and here I remember him collecting grasses.

Francis Darwin, Life and Letters of Charles Darwin (1887) 1.116

Description:

38. Orchis Bank is a narrow area of grass and scrub on the chalk grassland slope immediately below Hangrove. It was a favourite place for the Darwin family to picnic and although the field's name on maps was Rough Pell, the Darwins called their picnic place 'Orchis Bank' because of the many wild orchids that grew there. The field had been arable in the 1840 Tithe Reapportionment Survey of the Parish, but was recorded as 'arable, rough pasture &c' in the survey carried out for the twenty five inch Ordnance Survey map of 1869, and was probably sheep-grazed during Darwin's time. Some areas have since become scrub and woodland. When the Kent Wildlife Trust acquired the land in 1963, they started to cut it and in 2000 they reintroduced sheep grazing.

Just on the other side of the narrow steep little lane leading to the village of Cudham, perched high above the valley, was 'Orchis Bank' where bee, fly, musk and butterfly orchises grew. This was a grassy terrace under one of the shaws of old beeches, and with a quiet view across the valley, the shingled spire of Cudham church shewing above its old yews. The view was strongly characteristic of the country, and had the somewhat melancholy charm of our chalk landscape - the waterless, uninhabited valley, the rolling contour of the country, yews in the hedges, and here and there a white chalk-pit.

Henrietta Litchfield, Emma Darwin, A Century of Family Letters (1904) 2.279

39. Orchis Bank now has nine of the British native orchids including *Gymnadenia conopsea* (Fragrant orchid) - not found at High Elms, *Listera ovata* (common twayblade) and *Anacamptis pyramidalis* (Pyramidal orchid). The combined total for the neighbourhood of twelve, with nine here, two additional species at High Elms and one on another site in Cudham Valley, matches the count of thirteen species which Darwin



Pyramidal orchid

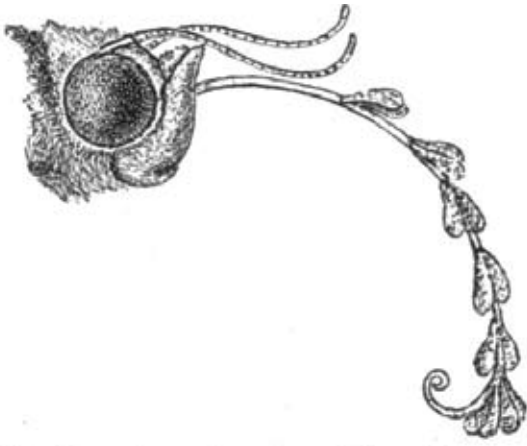
knew to be growing in the neighbourhood in his time. This high figure for native wild orchids in a small area of countryside so close to London is one clear measure of the survival of the flora Darwin knew at Downe.

Kent appears to be the most favourable county in England for the order [of Orchids], and within a mile of my house nine genera, including thirteen species, grow.

Darwin, Various Contrivances by which Orchids are Fertilised by Insects (1862) p. 279

Darwin's use:

40. The pyramidal orchid, which Darwin studied below Orchis Bank, was of great importance for Darwin's science as he recognised it to be one of the supreme examples of evolutionary co-adaptation between plant and animal in the natural world. Darwin wrote in *The Various Contrivances by which Orchids are Fertilised by Insects* (1862) about the 'almost endless diversity of beautiful adaptations' shown by the orchid family, and analysed how parts which originally served for one purpose had been modified 'by slow changes for widely different purposes'. The native orchids which can now be observed growing on Orchis Bank and High Elms are among the main examples of evolutionary adaptation that Darwin studied in Britain following his observation of the special process of adaptive radiation by finches on the Galapagos Islands.



Head and proboscis of *Acontia luctuosa* with seven pair of pollinia of *Orchis pyramidalis* attached to the proboscis.

Illustration by G B Sowerby for Darwin's book on the Fertilisation of Orchids, 1862

I have been examining Orchis pyramidalis, and it almost equals, perhaps even beats, your Listera case; the sticky glands are congenitally united into a saddle-shaped organ, which has great power of movement, and seizes hold of a bristle (or proboscis) in an admirable manner, and then another movement takes place in the pollen masses, by which they are beautifully adapted to leave pollen on the two lateral stigmatic surfaces. I never saw anything so beautiful.

Darwin to Hooker, July 1860.

In no other plant, or indeed in hardly any animal, can adaptations of one part to another, and of the whole to other organised beings widely remote in the scale of nature, be named more perfect than those presented by ... Orchis [pyramidalis].

Darwin, Various Contrivances by which Orchids are Fertilised by Insects (1862) p. 28

41. Another plant now growing on Orchis Bank which Darwin studied there is the fragrant orchid, *Gymnadenia conopsea*. Darwin's son George identified the moths that pollinated the orchid by catching a number of specimens with the orchid's pollen sacs attached to their probosces.

Mr. George Darwin went at night to a bank where this species grows plentifully, and soon caught Plusia chrysitis with six pollinia, P. gamma with three, Anaitis plagiata with five, and Triphonapronuba with seven pollinia attached to their proboscides.

Darwin, 'Notes on the fertilization of orchids', Annals and Magazine of Natural History, 1869

'It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent upon each other in so complex a manner, have all been produced by laws acting around us. ... There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved.'

Darwin, *The Origin of Species* 1859

42. With its rich habitats of plants, insects, birds and animals, Darwin's Orchis Bank is a clear and full realisation of the 'entangled bank' that he envisaged in the concluding lines of *The Origin of Species*, one of the most eloquent and famous passages in all writing about science and the natural world.

Keston Common and Ravensbourne

Description:

43. Keston Common is an area on the dry infertile acid soils of the Blackheath Beds with an open common land habitat of a kind which has become rare in Greater London. It includes areas of heathland and valley mire with a notable gradation from dry acid grassland to wet neutral grassland alongside the meadows which border the river Ravensbourne as it flows north from its source close to Holwood Park. Around 6,000 years ago, groups of hunter-gatherers were present in the area and established camps at a number of locations around the common. Much of the area remained wooded until the Iron Age when it was cleared and the land was enclosed within earth banks and ditches. The earthworks known as Caesar's Camp from which the Thames Estuary and its lowlands can be seen to the north, dominated the landscape. With more intensive farming in later periods, parts of the heath became rough pasture. In the nineteenth and twentieth centuries the open areas were used by local people for grazing sheep and cows. As grazing declined in the twentieth century, young woodland spread over parts of the heath and conifers were planted in other areas. The area today is a mixture of lowland heath, valley mire, meadow, scrub and coniferous woodland reflecting this complex history.



Keston top pond

Keston Common adjoins Hayes Common (past the windmill and village smithy). A most choice resort for the botanist and the lover of primeval nature.

The Saturday Half-holiday Guide ... The London Microscopist's Collecting-grounds (1873)

Darwin's use:

44. Darwin examined adjoining areas of heath and acid grassland in the drier parts of the common to determine whether earthworms frequented either kind of habitat. Again, areas with both habitats can be found next to each other on the common today.

I walked carefully over this place and pulled up the heath and looked among the roots, saw no trace of worms. The Holwood path divides the lower part of this bit of common into two regions, the S[outh] being chiefly gorse and fern with grass and having worm castings, the north region being the pure heath and lichen region. There is grass on both borders of the path in this part, and worm castings on both borders. But higher up the heath, vegetation is on both sides of the path and here there are no worms on the grass edging.

Darwin, scientific papers, 1880

Green Hill

Description:

45. Green Hill is an area of rough pasture on the eastern side of the Downe valley. It was and remains mainly chalk grassland on the steep valley side. It is only a few hundred yards from Down House and was adjacent to Great Pucklands, part of his estate.

Darwin's use:

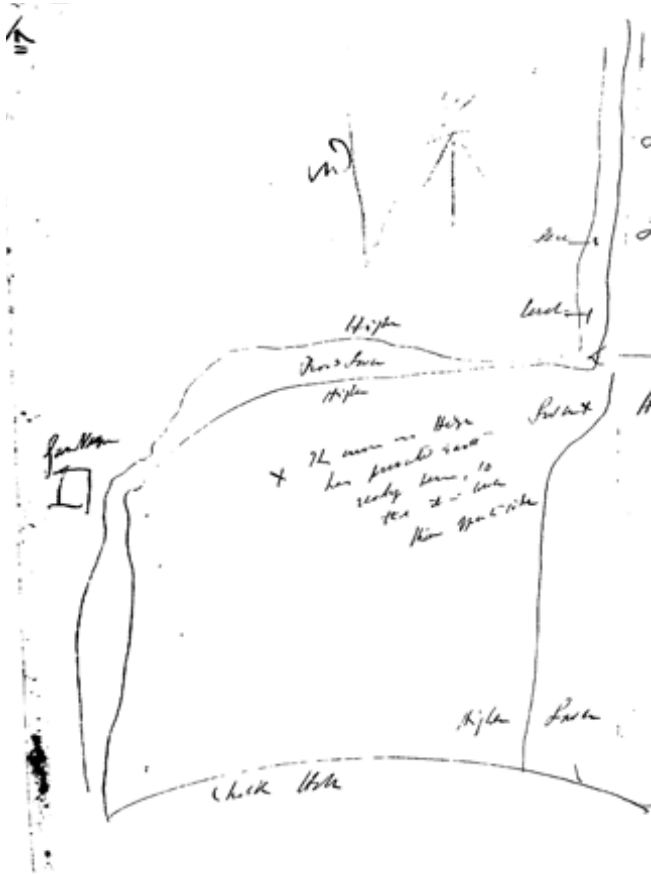
46. Darwin observed relations between different species by watching honey- bees feeding on *Viola hirta* (named *hirsuta* in his time). A sloping field at the base of Green Hill is also one of two places where Darwin once studied earthworm casts after a winter storm in order to gauge the effects of wind and rain on their dispersal in the soil, and to assess the contribution of earthworms' ceaseless excavations to landscape erosion. In his final book which dealt with the action of earthworms in the soil, he showed how the simple process he had identified in this investigation could be a factor in major transformations of the landscape over hundreds of thousands of years. Worm casts and the flow of earth from them can be observed in the same place today when similar conditions occur.

*April 1st [1863] I watched 1000s of wild flowers; at last saw on Green Hill one Hive-Bee visiting and sucking several. Marked 6 flowers of [*Viola*] *hirsuta* with black thread, which I saw sucked. [Later addition: In one of these 6, 2 set five pods and some others seemed to have been injured.] Second field, Green Hill, 70 yd beyond gap into, there is little thorn close to path, and 2 yards beyond this, the marked flowers are a yard along on bank.*

Darwin, scientific papers, 1863



Green Hill in Downe Valley



Darwin's plan of soil levels in fields below Green Hill in 1872

After some heavy storms of rain (Jan. 25, 1872) two rather steeply inclined fields near Down, which had formerly been ploughed and were now rather sparsely clothed with poor grass, were visited, and many castings extended down the slopes for a length of 5 inches, which was twice or thrice the usual diameter of the castings thrown up on the level parts of these same fields.

Darwin, *The Formation of Vegetable Mould* (1881) pp.265-266

3.c viii Wetlands

Description:

47. Being in an area with chalk geology there is little surface water. The sole stream which forms the River Ravensbourne starts from a spring on Keston Common and runs to the north out of the Property. Small surface-water ponds were a feature of the landscape in Darwin's time, some dug near roads to drain water from the roadway, others forming naturally in poorly drained places. Of those that Darwin knew, all but one, in the village of Downe are still there.

Darwin's use:

48. Darwin had taken a special interest in the distribution of fresh water species ever since noticing, while he was collecting specimens during the Beagle voyage, how uniform they were in comparison with land species, while they might have been expected to be varied from their isolation in separate bodies of water between land barriers. He suggested a possible evolutionary answer in *The Origin of Species* that only organisms adapted for transport from one body of water to another would survive the frequent drying out of many ponds. When he found surface-water ponds in the countryside around Downe and Cudham, he took the opportunity to test his idea in a number of them.

... this power in fresh-water productions of ranging widely, though so unexpected, can, I think, in most cases be explained by their having become fitted, in a manner highly useful to them, for short and frequent migrations from pond to pond, or from stream to stream; and liability to wide dispersal would follow from this capacity as an almost necessary consequence.

Darwin, *Origin of Species* (1859) p. 383

Cudham School Pond

Description:

49. Cudham School Pond is a pond in a small ancient semi-natural wood which belongs to Cudham Primary School, a mile's walk from Down House south over the high ground between the two valleys. The pond is unaltered since Darwin's lifetime when it was one of the few small areas of standing water in the dry chalk landscape.

Darwin's use:

50. When Darwin was working on the dispersal, survival and germination of plant seeds for the important section of *The Origin of Species* on geographical distribution of

April 6th Got some ^{fetid} mud from two spots, under decaying leaves & roots of water plants, 4 or 5 inches from margin, & 3 or 4 inches under water; & a little red clayey mud from margin chiefly in another spot; ~~By measurement about 2 oz.~~ Little Pond of Cudham School.

Darwin, 'Experiment Book', 1856

plants and animals, he visited the pond, collected samples of mud from its margins and germinated plant seeds present in them in his study at Down House in the first of a series of experiments to test his tentative explanation of the means by which fresh-water flora and fauna were distributed across land and sea.

April 6th. Got some fetid mud from two spots under decaying leaves and roots of water plants, 4 or 5 inches from margin and 3 or 4 inches under water; and a little red clayey mud from margin chiefly in another spot. By weight about 2 oz. Little Pond by Cudham School. ... This mud with fibrous Matter was divided into 2 portions; in one weighing when damp about 2 1/4 oz. 27 Monocot and Dicot. came up making 29 plants. In the other lot, weighing when damp 1 1/2 oz. 14 Monocot. came up and 10 Dicot. making 24. plants. So that in under 1/4 lb of damp mud 51 plants came up. (May 10th).

Darwin, Experiment Book, 1856.

River Ravensbourne and Keston Bog

Description:

51. The pebbly, sandy soil of much of Keston Common and Holwood Estate allows surface water to quickly drain through. There is an underlying layer of clay which gathers this water and where the clay is close to the surface then the water emerges to form the start of the River Ravensbourne at Caesar's Well. A series of ponds, made in the 18th century are immediately situated as the river runs to the north. The Clay also lines a smaller tributary and this helps form a small area of wet bog.

Darwin's use:

52. Darwin made use of the River Ravensbourne and one of the ponds which it forms on Keston Common, as sources of seed-bearing mud for two follow-up experiments after his sampling of the mud from Cudham School Pond. In his eventual treatment of the transportation of seeds in *The Origin of Species* (1859), he gave the results from the pond on Keston Common. The pond and the banks of the Ravensbourne are both,

as far as can be determined, similar to how they were when Darwin collected the samples.

I do not believe that botanists are aware how charged the mud of ponds is with seeds: I have tried several little experiments, but will here give only the most striking case: I took in February three table-spoonfuls of mud from three different points, beneath water, on the edge of a little pond; this mud when dry weighed only 6 3/4 ounces; I kept it covered up in my study for six months, pulling up and counting each plant as it grew; the plants were of many kinds, and were altogether 537 in number; and yet the viscid mud was all contained in a breakfast cup! Considering these facts, I think it would be an inexplicable circumstance if water-birds did not transport the seeds of fresh-water plants to vast distances, and if consequently the range of these plants was not very great.

Darwin, *Origin of Species* (1859) p. 377

53. Keston Bog was especially important for Darwin as his main local source for specimens of the insect-eating *Drosera rotundifolia* (Sundew) which he studied for many years in the longest and most searching investigation he carried out on any single species of either plant or animal. The basis for Darwin's interest lay in the plant's adaptation to catch and digest insects in order to survive in nitrogen-poor 'valley mire' habitats like the acid sphagnum bog in which he found it. In his time, the plant was abundant among the sphagnum on



Keston Bog



Keston ponds

the common, but it is no longer present there because of changes in the level of the water table and light that followed alterations in the management of the common during the last twenty years. The sphagnum bog survives, though, and action is in hand to restore the habitat so that *Drosera rotundifolia* can be reintroduced from a nearby location.

I will and must finish my Drosera MS which will take me a week, for at this moment I care more about Drosera than the origin of all the species in the world. But I will not publish on Drosera till next year, for I am frightened and astounded at my results. ... Is it not curious that a plant should be far more sensitive to a touch than any nerve in the human body! Yet I am perfectly sure that this is true.

Darwin to Lyell, November 1860

*My father had been accustomed in his business as pharmaceutical chemist to supply Mr Darwin with nearly all his requirements in the shape of drugs and chemicals for his experiments on plants. ... Being fond of botany ... I was attracted by some experiments Mr Darwin was then making with *Drosera rotundifolia* (the Sundew), which is a flesh-eating plant and easily obtained from the sphagnum-moss bed near Keston Ponds. So one day I went up there with my vasculum to get specimens and was busy collecting the plant when I espied a shaggy pony wandering about, and instantly I thought Mr Darwin must be there! Not seeing him, however, I went on with my job. Presently I was conscious of someone standing over me and a quiet voice said, "Well, young man, what are you doing here?" I got up and there facing me was the grand old man, wrapped in his well-known cape. After recovering myself I replied, "I am collecting some *Drosera* to reproduce some of your experiments,*

*Mr Darwin. Mr Darwin then asked me what I was doing with the *Drosera* and I told him I was not feeding it on flies, &c., but on sulphur and poisonous alkaloids. I told him I found it absorbed sulphur. "How interesting," he remarked, "for that corroborates my experience; but I envy you your access to that mysterious cupboard you have, full of interesting poisons." I told him that of course we could send him any he might wish for. "I know! I know!" he said, "but I should like to try everything." After a few words of encouragement, and some enquiries about my examinations, he shook hands with me, caught his pony and rode away.*

William Baxter, Bromley and District Times, 13 September 1929

3.c ix High Elms Estate

Description:

54. The High Elms Estate is an extensive area of pasture and arable farmland, landscaped park, ancient semi-natural woodland, forestry plantation and grassland for golf and other recreational uses, which is now owned by the London Borough of Bromley and managed as a country park for public access. In Darwin's time the estate was owned and managed by Sir John Lubbock III and IV for agriculture, forestry and recreation, including for golf and horse racing. The present day course is located in the buffer zone whilst the other habitats are in the nominated Property. Today, areas of meadow and semi-natural woodland on the estate are managed with traditional methods and provide a range of habitats for ten of Britain's native orchid species that were studied by Darwin, *Aceras anthropophorum* (Man orchid), *Cephalanthera damasonium* (White helleborine), *Dactylorhiza fuchsii* (Common spotted orchid), *Epipactis helleborine* (Broad-leaved helleborine), *Listera ovata* (Common twayblade), *Neottia nidus-avis* (Bird's nest orchid), *Ophrys apifera* (Bee orchid), *Ophrys insectifera* (Fly orchid), *Platanthera chlorantha* (Greater butterfly orchid) and *Anacamptis pyramidalis* (Pyramidal orchid).

Darwin's use:

55. Darwin was able to use the High Elms Estate for observations of wildlife because of his friendship with Sir John Lubbock III and IV which stemmed in Sir John Lubbock III's case from their acquaintance with each other in London scientific circles (Sir John III was an astronomer and mathematician as well as a banker), and in Sir John IV's case from the encouragement and help Darwin gave him in his first years as a naturalist. When Sir John IV was a boy at High Elms, Darwin guided him in his collecting, dissecting and describing specimens, and reading in natural history. Darwin encouraged him



Sir John Lubbock IV in 1867

to study marine invertebrates and fresh water micro-organisms, and gave him specimens from his Beagle collection to work on. A coloured drawing made by Lubbock when he was seventeen shows thirteen fresh water micro-organisms probably collected in or around High Elms together with a marine specimen from the Cape of Good Hope probably provided by Darwin from his Beagle collection (he had sailed round the Cape of Good Hope in June 1836 on HMS Beagle's return voyage to England). Darwin studied many of the native British orchids which grew on Lubbock's land in the course of his research on orchid fertilisation.

In his later years, Sir John Lubbock IV became a leading expert on insect taxonomy, development and behaviour, and used his collections and observations at High Elms in a number of important contributions to entomology which were of value for Darwin because they were made from a Darwinian point of view and had implications for his theory. The estate is the taxonomic 'type locality' for a number of species of the primitive insects called Collembola or springtails, because it was there that Lubbock did much of his field research for the first comprehensive taxonomy of the order which he produced in 1873, and many of the species he first identified there are still present. Lubbock had a particular interest in the metamorphoses that insects undergo during their development, phenomena of sudden change which posed problems for Darwin's theory of evolution with its emphasis on gradualism and continuity. Lubbock's work on the mayfly *Cloeon dimidiata* which was and is still common in the neighbourhood, with his discovery that it undergoes its final metamorphosis from larva to adult through many small stages, was referred to by Darwin in *The Origin of Species*. The present communities of ants, bees and wasps around the property are the local successors of those which Lubbock observed and experimented on for his groundbreaking studies of insect behaviour which confirmed Darwin's



Sir John Lubbock IV's coloured drawing of fresh water and marine micro-organisms from 1852

insights into the importance of co-operative instincts in the development of insect societies.

Order, Thysanura.—The members of this lowly organised order are wingless, dull coloured, minute insects, with ugly, almost misshapen heads and bodies. Their sexes do not differ, but they are interesting as shewing us that the males pay sedulous court to the females even low down in the animal scale. Sir J. Lubbock says: "It is very amusing to see these little creatures (*Smynturus luteus*) coquetting together. The male, which is much smaller than the female, runs round her, and they butt one another, standing face to face and moving backward and forward like two playful lambs. Then the female pretends to run away and the male runs after her with a queer appearance of anger, gets in front and stands facing her again; then she turns coyly round, but he, quicker and more active, scuttles round too, and seems to whip her with his antennæ; then for a bit they stand face to face, play with their antennæ, and seem to be all in all to one another.

Darwin quoting Lubbock, *Descent of Man* (1874) p. 279



High Elms Mansion, the home of Sir John Lubbock III and IV, in the early twentieth century



Frontispiece of Sir John Lubbock's book *Ants, Bees and Wasps* (1882)

Development and Embryology ... is one of the most important subjects in the whole round of natural history. The metamorphoses of insects, with which every one is familiar, are generally effected abruptly by a few stages; but the transformations are in reality numerous and gradual, though concealed. A certain ephemeral insect (Chlöeon) during its development, moults, as shown by Sir J. Lubbock, above twenty times, and each time undergoes a certain amount of change; and in this case we see the act of metamorphosis performed in a primary and gradual manner.

Darwin, *Origin of Species* (1872) pp. 386-387

of *Species*, he was paying close attention to the horse chestnut's arrangement for cross-fertilisation through a form of sexual separation, recognising that the way in which the male and female parts of the same flower mature at different times has major implications for the processes of out breeding and natural selection. His comments on wasted male flowers and insects caught on the tree's sticky buds also reflected his preoccupation with the metaphysical implications of imperfection and excess fertility in the natural world.

3.c x Holwood Park

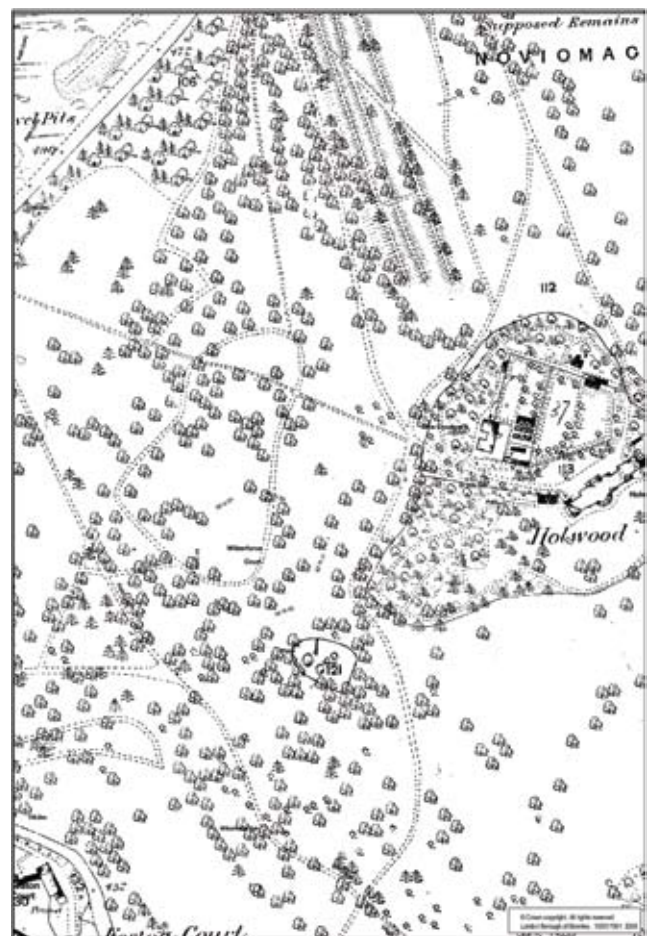
Description:

56. Holwood Park is an historic park around Holwood House which was owned during Darwin's time by Lord Cranworth, the Lord High Chancellor of England, and occupied for a time by the Earl of Derby. The estate was the largest land-holding in the area, and the house and parkland are prominent features in the landscape which in Darwin's time expressed the owner's social and economic pre-eminence in the neighbourhood. The park had been laid out by the landscape architect Humphrey Repton in the 1790s for William Pitt the Younger who then owned the property.

Use:

57. The Darwins often visited Lord Cranworth and the Earl of Derby at Holwood House, and were allowed to walk in the park. Darwin made a number of observations on plants and invertebrates in the parkland, and collected specimens there for his botanical experiments.

58. One species of tree in Holwood Park in which Darwin took a particular interest and of which there are a number still surviving from his time is the horse chestnut. His notes of his field observations in the park show that six months after the publication of *The Origin*



Map of Holwood in 1868

I think I shall make out good case of want of perfection in Horse-chestnut ... I might put it, "why should we wonder at thousands of wasted male flowers, when we see such waste of flowers of all kinds?" I have also somewhere got some notes on the prodigious waste of insect life, by the sticky scales on the buds, by the thousands, and all uselessly killed.

Darwin to Hooker, May 1860

A well-known feature of Holwood Park is the Wilberforce Oak of which remnants survive after damage in a storm in 1987. The tree and the nearby commemorative seat are preserved as a memorial to William Wilberforce (1759-1833), the campaigner against slavery, who in 1787 made a historic declaration there to Pitt, of his resolve to call in the British Parliament for the abolition of slavery (Pitt was then Prime Minister). Darwin's grandfather, Josiah Wedgwood the master-potter, played a prominent part in the campaign and Darwin was a passionate supporter of the anti-slavery cause.

3.c. xi Down House

Description:

59. Down House is an eighteenth century country brick and render villa with a slate tiled roof with nineteenth century additions set in a 16-acre estate on the edge of the village of Downe. It is now owned by English Heritage and the house and grounds are open to the public. Darwin bought the property in 1842; he adapted the house and grounds to form a family home and his workplace, and he lived and worked there until his death in 1882. The layout and appearance of the house and grounds are close to how they were in the last years of his life according to contemporary accounts, photographic evidence and documentary research carried out by English Heritage for their restoration of the property in 1996.

60. The house that survives is the building as Darwin acquired it in 1842 with the four additions he made - a three-storey bay on the garden front in 1843, a new drawing room in 1858, a veranda in 1872 and a new study in 1876. In Darwin's time the house provided accommodation for his family of between four and ten and from five to ten servants. It was briefly used as a school from 1907 to 1927 but was then purchased by the British Association for the Advancement of Science and converted into a museum. The property has been open to the public since 1929 with the main living rooms on the ground floor now furnished and decorated as they were in Darwin's time. On the basis of meticulous research using original documentary evidence and early

photographs supplemented by archaeological material including wallpaper and paint scrapes the study now appears how Darwin would have known it in the 1860s and 1870s.

Darwin's use:

61. Down House was an essential aspect of Darwin's scientific work that he was able to carry it out in his domestic surroundings and he achieved many of his most valuable insights in the work settings he created in and around his home. The forty years he spent at Down covered the span of his major research and writing after the voyage of HMS Beagle and his five years in London during which he published his account of the voyage and first developed his conjecture about evolution by natural selection.

I live in the country about 16 miles from London, in a good large house, in a very solitary part of the country: we do not see much company, excepting relations; & I work very steadily at Natural History.

Darwin to P G King, February 1854

a) Old Study

Description:

62. The room is furnished and arranged as it was when Darwin wrote *The Origin of Species* there in the late 1850s. Many of the scientific instruments, pictures, books and furnishings are his originals. The ensemble was reassembled in 1929 according to its arrangement in a historic photograph taken by Darwin's son Leonard; it provides a unique insight into the work setting in which one of the most influential books in human history was conceived and written.

Darwin's use:

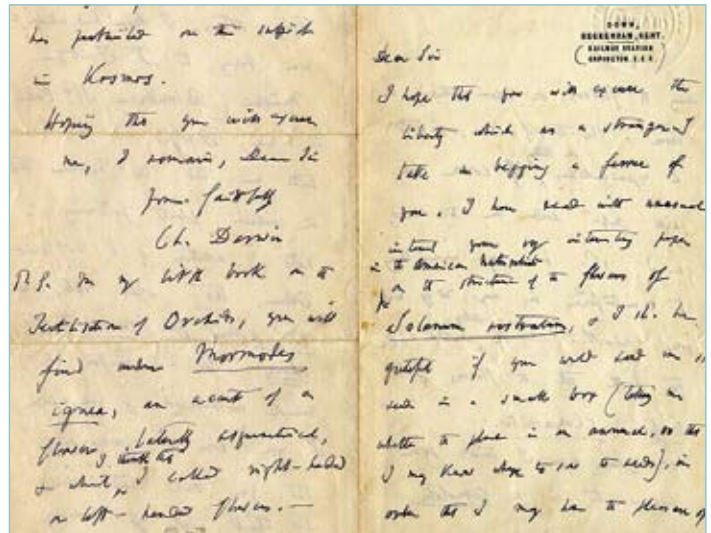
63. The Old Study is where Darwin carried out almost all of his scientific reading and writing, his correspondence with scientific colleagues around the world, his anatomical dissections, his microscopic investigations and his indoor plant experiments between 1843 and 1876. (In the last six years of his life, he used a new study at the northern end of the house.) The study was also where, in preparation for writing up his theory, he had spent eight years working on a comprehensive anatomical survey of the living and fossil barnacles of the world. After the publication of *The Origin of Species*, Darwin used the table and windowsills for many of his most meticulous observations of plant growth and movement in response to light and other stimuli.



A photograph of the study in the 1860s



The Old Study today



Letter Darwin wrote from Down to Professor James Todd in Iowa with a botanical inquiry

The movement [of *Echinocystis lobata* shoots] goes on all day and all early night. It has no relation to light, for the plant stands in my window and twists from the light as quickly as towards it. ... A clever gardener, my neighbour, who saw the plant on my table last night, said: "I believe, Sir, the tendrils can see, for wherever I put a plant it finds out any stick near enough." I believe the above is the explanation, viz. that it sweeps slowly round and round.

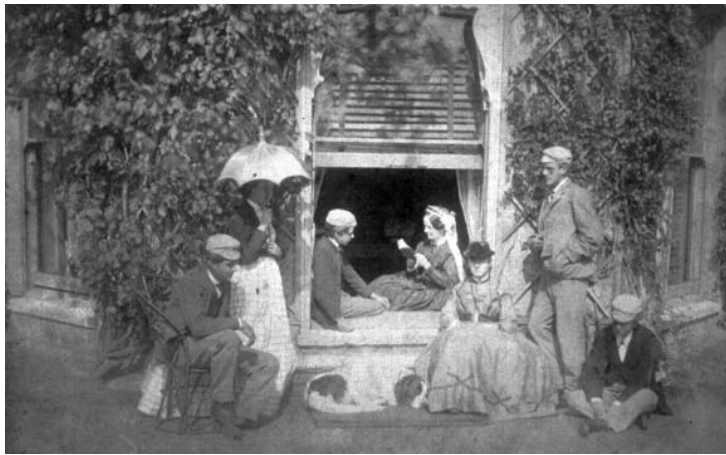
Darwin to Hooker, June 1863

EVOLUTION BY NATURAL SELECTION

Darwin's theory explains how all different species of living organisms have developed from common ancestors by a natural process of descent with modification. Darwin saw that all organisms have to compete for the means of life in order to survive and reproduce.

There are always differences between individuals within a species, and some randomly appearing traits are inherited. When, in the struggle for existence, an inherited trait enables those who have it to survive and leave more off-spring than those without it, that trait becomes more common in later generations and is said to be adaptive. A group of organisms with the trait may in time become a distinct variety of the species, and eventually, in certain circumstances, a new species.

64. Darwin's study has special significance, as it was the centre of the global network of scientific contacts he built up through his correspondence to gather facts from all continents, test his theories and give them global reach. Around 13,500 letters survive from his years at Downe and are being published in a comprehensive scholarly edition, *The Correspondence of Charles Darwin* (1985- present day). The letters he wrote and received in the study, including many to and from Africa, the Americas, Asia, Europe and the Southern Hemisphere, together forms one of the farthest-reaching and greatest personal exchanges of information for knowledge and understanding in the history of humanity. The unique value of that exchange was brought out in Darwin's published works which have been translated and read more widely around the world than those of any other scientist in the modern age.



Emma Darwin with sons, a daughter and friends

DARWIN AND HIS FAMILY

Darwin's wife Emma helped him in many ways with his scientific work though she did not accept the implications of his ideas for her religious beliefs. She bore him ten children, seven of whom survived to adulthood. They all helped Darwin in his experiments, collecting plants, observing insects, making drawings, taking photographs and in many other ways.

b) Drawing Room

Description:

65. The Drawing room was part of a two storey addition to the house built in 1857 by Darwin, originally intended as a new dining room. This room was eventually used as a family room where Emma and the family would play the piano and relax. The window looks out to the veranda and flower garden. The furniture and furnishings are mainly items which were used by Darwin in this room and which were given to Down House by members of the family when the house was first opened to the public in 1929.

The focal point of the room is Emma Darwin's grand piano, which has been conserved and placed in the Drawing Room in the same position it occupied 140 years ago.

Darwin's use:

66. Darwin did not confine his scientific work to his study, and even the drawing room, while primarily a family room, was used by him for experiments. Among the plants in the flower containers now are azaleas and *Deutzia gracilis* which were grown there in the 1870s in a plant-case obtained by Darwin for cultivation of scientific specimens. He observed the plants' movements and wrote about them in *The Power of Movement in Plants* (1880). When during his investigation of the mental capacities of earthworms, he wanted to test their sense of hearing and vibration, he put a number in a flowerpot on the lid of the grand piano and his wife Emma played it for them.

People always want others to see their own flowers so I wish I could show you our case in the drawing room, a beautiful pink azalea flanked by a delicate white Deutzia on each side and trimmed up with ferns and moss.

Emma Darwin to Fanny Allen, March 1873

Deutzia gracilis (Saxifrageae, Fam. 77). —A shoot on a bush about 18 inches in height was observed. The bead changed its course greatly eleven times in the course of 10 h. 30 m. (Fig. 75), and there could be no doubt about the circumnutation of the stem.

Darwin, *The Power of Movement in Plants* (1880) p. 205

Worms do not possess any sense of hearing. They took not the least notice of the shrill notes from a metal whistle, which was repeatedly sounded near them; nor did they of the deepest and loudest tones of a bassoon. ... Although they are indifferent to undulations in the air audible by us, they are extremely sensitive to vibrations in any solid object.

When the pots containing two worms, which had remained quite indifferent to the sound of the piano, were placed on this instrument, and the note C in the bass clef was struck, both instantly retreated into their burrows. After a time they emerged, and when G above the line in the treble clef was struck they again retreated. Under similar circumstances on another night one worm dashed into its burrow on a very high note being struck only once, and the other worm when C in the treble clef was struck.

Darwin, *Formation of Vegetable Mould through the Action of Worms* (1881) pp. 26-27

c) Down House Garden

Description:

67. Down House has a flower garden, kitchen garden, three-compartment greenhouse, orchard, meadow and copse with a circuit path, all of which Darwin used in his scientific research. When he acquired the property, the grounds had been neglected for some time and he reshaped and planted them for his scientific purposes

and his family's wants. Many of the features are characteristic of a modest 'gentry villa' of the nineteenth century, with the pleasure grounds for floral display and recreation, the kitchen garden for vegetables, fruit and flowers, the orchard for fruit, the meadow for the household's horses and cows, and the copse for coppiced wood for the garden. The form of the garden remains now as it was in Darwin's time; plants which are ephemeral in nature have been replaced using meticulous research based on Darwin's own archive of notes

Darwin's use:

68. Darwin used each of these features in his scientific work. Other features such as the 'experimental beds', the greenhouse, the garden laboratory and the 'worm-stone' installation in the lawn, were created for Darwin's science alone. Taken as a whole, Darwin's grounds at Down House formed an 'experimental garden', one of the most important of the small number created by individual botanists in the eighteenth and nineteenth centuries for major advances in the understanding of plant reproduction and physiology before the development of the two subjects into a laboratory science in the eighteenth and seventies. (Among the others in the sequence were those created by the Reverend Stephen Hales in Teddington in the 1720s, Joseph Gottlob Kölreuter at the Botanic Garden in Karlsruhe in the 1760s, Joseph Gärtner in Württemberg in the 1770s, Kurt Sprengel in Spandau in the 1780s, Thomas Andrew Knight at Downton Castle, Herefordshire, in the 1800s and Gregor Mendel at the Abbey of St Thomas, Brno in the 1850s.)

69. In Darwin's case the garden had a fourfold importance - first for his work on cultivated plants, second for experimenting on wild plants found in the neighbourhood, third for work with exotic species obtained from Kew and contacts, and fourth for comparing those different kinds of plants to give his findings reach over the whole range. A number of ash, yew, spanish chestnut, evergreen oak, mulberry and other trees survive from his time, and plantings by him have been reproduced from the detailed information that survives in the extensive records for the household and Darwin's full records of his scientific work in the grounds.

In the soft spring morning about sunrise I looked out of my bedroom window and saw Darwin in his garden, inspecting his flowers. His grey head was bent to each bush as if bidding it good morning.

Moncure Daniel Conway remembering a visit to Downe in April 1881

DARWIN'S PLANTS

At Downe, Darwin worked on birds, mammals and invertebrates but spent most time with plants because he could control their fertilisation, their offspring grew quickly, and he could study specimens easily.

In regard to plants, there is another means of observing the accumulated effects of selection—namely, by comparing the diversity of flowers in the different varieties of the same species in the flower-garden; the diversity of leaves, pods, or tubers, or whatever part is valued, in the kitchen-garden, in comparison with the flowers of the same varieties; and the diversity of fruit of the same species in the orchard, in comparison with the leaves and flowers of the same set of varieties. See how different the leaves of the cabbage are, and how extremely alike the flowers; how unlike the flowers of the heartsease are, and how alike the leaves; how much the fruit of the different kinds of gooseberries differ in size, colour, shape, and hairiness, and yet the flowers present very slight differences. ... as a general rule, I cannot doubt that the continued selection of slight variations, either in the leaves, the flowers, or the fruit, will produce races differing from each other chiefly in these characters.

Darwin, Origin of Species (1859) p. 33

d) External House Walls and Veranda

Description:

70. Darwin fixed trellises on the southwest brick wall of the house, which was rendered, to support the clematis, grape vines, ivy and Virginia creeper he grew there and used for his botanical researches. In the 1870s he added a veranda outside the drawing room.

Darwin's use:

71. The plants growing on the trellises and veranda structure now exhibit a number of evolutionary adaptations for climbing which Darwin identified in the plants he studied there for his investigation of climbing plants and plant movement.

The drawing room opens onto a veranda, under which there are rocking-chairs and easy-chairs. Climbing plants and creepers wind around the pillars and roof of the veranda; they are the self-same lianas on which Darwin made his wonderful observations about twining and climbing plants.

Professor Ferdinand Cohn, account of visit to Down House in 1876.

It is ... an interesting fact that intermediate states between organs fitted for widely different functions, may be observed on the same individual plant of ... the common vine; and these cases illustrate in a striking manner the principle of the gradual evolution of species. ... Flower-tendrils ... sometimes produce a few flower-buds. For instance, on a vine growing against my house, there were thirteen and twenty-two flower-buds respectively on two flower-tendrils, which still retained their characteristic qualities of sensitiveness and spontaneous movement, but in a somewhat lessened degree. ... If the genus Vitis had been unknown, the boldest believer in the modification of species would never have surmised that the same individual plant, at the same period of growth, would have yielded every possible gradation between ordinary flower-stalks for the support of the flowers and fruit, and tendrils used exclusively for climbing. But the vine clearly gives us such a case; and it seems to me as striking and curious an instance of transition as can well be conceived.

Darwin, Climbing Plants (1875)
pp. 6, 143

e) Flower Garden

Description:

72. The flower garden south west of the house consists of a lawn with a herbaceous border, four flower beds near the veranda and a shrubbery on a raised earth bank created by Darwin when he first shaped the garden in the early 1840s, to provide shelter from the cold north winds. Emma Darwin managed the garden and shrubberies and a range of the plants she is known to have grown in the flower-beds are cultivated there now.

Darwin's use:

73. Darwin carried out many scientific observations and experiments on natural life in the garden. When he was breeding fancy pigeons for his research on artificial selection for the first chapter of *The Origin of Species*, he kept his many birds in a wooden pigeon house and flight next to the well, close to the mulberry tree. (The structure was moved when he completed the work but the well-shaft is still there.) Among other features of the garden now in which points that he observed can be seen today are the *Lobelia fulgens* in the flower beds in which he studied the mechanisms the plant has evolved to prevent self-pollination, a *Rhododendron thomsonii* cultivated from a specimen brought back by his close friend Joseph Hooker, later Director of the Royal Botanic Gardens, Kew, from his historic plant-collecting expedition to the Himalayas in 1847-1851, the turf of

the lawn in which Darwin made a key observation on the diversity of plant forms, the earthworms in the soil whose behaviour he studied over many years, and the 'worm-stone' set in the lawn to detect the gradual subsidence of the soil due to the earthworms' ceaseless burrowing.

The truth of the principle, that the greatest amount of life can be supported by great diversification of structure, is seen under many natural circumstances. In an extremely small area, especially if freely open to immigration, and where the contest between individual and individual must be severe, we always find great diversity in its inhabitants. For instance, I found that a piece of turf, three feet by four in size, which had been exposed for many years to exactly the same conditions, supported twenty species of plants, and these belonged to eighteen genera and to eight orders, which shows how much these plants differed from each other.

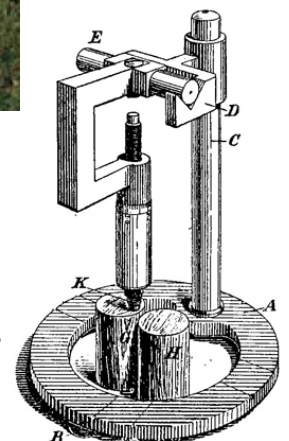
Darwin, *Origin of Species* (1859) p. 157

*I have also lately been re-observing daily *Lobelia fulgens* – this in my garden is never visited by insects, and never sets seeds, without pollen be put on the stigma (whereas the small blue *Lobelia* is visited by bees and does set seed); I mention this because there are such beautiful contrivances to prevent the stigma ever getting its own pollen; which seems only explicable on the doctrine of the advantage of crosses.*

Darwin to Asa Gray, [...] September 1857



Darwin's son Horace devised the 'worm-stone' to measure earthworms' undermining of the soil



The measuring device for the worm-stone, made by Horace Darwin in 1878

CROSS AND SELF-FERTILISATION

Darwin studied sexual reproduction and paid special attention to the mechanisms plant species have evolved to ensure that individual plants are always or sometimes fertilised by pollen from another plant, not their own. Darwin saw these mechanisms as important evidence for his argument that evolution depends on adaptive traits present in a population becoming more common through interbreeding and natural selection.

Worms usually work near the surface, but I have noticed that at certain seasons pale-coloured earth is brought up from beneath the outlying blackish mould on my lawn; but from what depth I cannot say. That some must be brought up from a depth of four or five or six feet is certain, as the worms retire to this depth during very dry and very cold weather. As worms devour greedily raw flesh and dead worms, they could devour dead larvae, eggs, etc., etc., in the soil, and thus they might locally add to the amount of nitrogen in the soil, though not of course if the whole country is considered.

Darwin to Joseph Gilbert, January 1882

With plants there is a vast destruction of seeds, but, from some observations which I have made, I believe that it is the seedlings which suffer most from germinating in ground already thickly stocked with other plants. Seedlings, also, are destroyed in vast numbers by various enemies; for instance, on a piece of ground three feet long and two wide, dug and cleared, and where there could be no choking from other plants, I marked all the seedlings of our native weeds as they came up, and out of 357 no less than 295 were destroyed, chiefly by slugs and insects.

Darwin, Origin of Species (1859) p. 120

g) Kitchen Garden

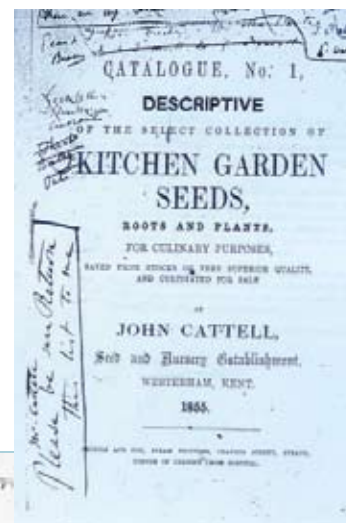
Description:

76. Darwin created the long kitchen garden which stretches from the western end of the flower garden along the northern side of the meadow on what had been before then a 'detestable slip' of stony ground, to grow fruit and vegetables for the household and provide an area for his scientific investigations of cultivated and wild plants.

Darwin's Use

77. Darwin created a special area close to the greenhouse for his outdoor plant experiments, and called it his 'experimental beds'. The beds now contain rows of *Primula veris* and *vulgaris* (cowslip and primrose), *Lythrum salicaria* (purple loosestrife) and *Linaria vulgaris* (common toadflax), all being cultivated as he grew them there for important experiments on fertilisation recorded in his scientific papers and described

A local nurseryman's seed catalogue for 1855 with Darwin's notes for experiments on cultivated varieties of vegetable



f) Orchard

Description:

74. The orchard northwest of the house is a replanting by English Heritage of the orchard which Darwin had first established there in 1843 to provide fruit for the household but later adapted for use in his scientific research.

Darwin's Use

75. In the course of his research into species and varieties for *The Origin of Species* (1859) and *The Variation of Animals and Plants under Domestication* (1868), Darwin planted a number of varieties of apple, pear and plum trees for comparison, and his planting has been recreated from his surviving record of it. An experiment he conducted in the orchard to test an important point about the struggle for existence for *The Origin of Species* has been repeated there on the basis of his scientific notes and can be seen in progress on the ground.



The Orchard has been replanted using Darwin's original plan of tree species (right)

in his published works. He also used the other parts of the kitchen garden for extensive plantings of cultivated varieties of pea, cabbage, bean, gooseberry and other vegetables and fruit, for his research on species and varieties. Many of the kinds that he grew there are being cultivated there now to show the processes and range of variation that he was studying.

The varieties of the common garden-pea are numerous and differ considerably from one another. For comparison I planted at the same time forty-one English and French varieties. They differed greatly in height, - namely from between 6 and 12 inches to 8 feet, - in manner of growth, and in period of maturity.

Darwin, Variation of Animals and Plants under Domestication (1868) p. 347.

SPECIES, VARIETY AND HYBRID

Darwin did much research on differences between species, varieties of a species and hybrids between species. His aim was to determine what makes a species different, whether and how a variety may develop into a separate species, and what hybrids tell us about the nature of species and their distinctness

In the Gooseberry Growers' Register for 1862 I find that 243 distinct varieties have won prizes at various periods, so that a vast number must have been exhibited. I cultivated fifty-four varieties, and considering how greatly the fruit differs, it was curious how closely similar the flowers were in all these kinds.

Darwin, Variation of Animals and Plants under Domestication (1868) pp. 376-7

h) Greenhouse

Description:

78. The greenhouse along the northern wall of the kitchen garden is the original and main part of the range built by Darwin between 1855 and the 1870s for his botanical researches into plants needing warmer and more humid conditions than the outdoor climate of Downe, and for experiments that needed protection for the plants or apparatus. The brick walls and heating system have been established by archaeological research to be original; the timber frame and glazing were renewed around 1900 as required after their expected lifetime.

Darwin's Use

79. The hothouse compartment had special importance for Darwin as it enabled him to cultivate and study tropical plants and so achieve a global perspective in his investigations. One exotic plant being grown there now is *Angraecum sesquipedale*, the comet orchid from Madagascar, a specimen of which was provided to Darwin shortly after the plant was first brought to England so that he could examine its remarkable mechanism for cross-pollination which he predicted correctly would require a moth with a thirty centimetre-long proboscis to act as pollinator. Among other plants from around the world that Darwin studied in the greenhouse and which are growing there now are *Bignonia capreolata*, a climbing plant from the swamp forests of the Southern United States, *Nepenthes*, the Asian pitcher plants which Darwin studied both as insect-eaters and as climbers with their leaf tips, and *Dionaea muscipula*, the Venus fly-trap. Darwin also used the greenhouse for his historic investigation of the movements and digestive powers of the insect-eating *Drosera rotundifolia*. The plant grew wild nearby on Keston Common but Darwin had to bring specimens from there to grow in the protection of his greenhouse in order to be able to carry out the delicate experiments and close examinations required for his long-running research.



Insectivorous plants in the greenhouse today



The greenhouse illustrated in The Century Magazine (1883)

In the garden behind the house was the greenhouse with a mixed collection of the plants familiar to the world. Their habits were studied. Changed modes of growth in the face of natural and artificial obstacles; their insect friends and enemies; influences on growth of light and moisture; retarded or quickened life; self and cross-fertilisation; changes of colour, form, flower; influences of chemistry on plant foods - on all such lines was research progressing. And the infinite patience of it all, never hastening, never discouraged.

Wallis Nash, *A Lawyer's Life on Two Continents* (1890)

i) Garden Laboratory

Description:

80. The building is a small rectangular brick structure at the back of the greenhouse. The garden laboratory was built to Darwin's specification in the last months before he died for experiments he planned to carry out on the effects of different light conditions on plant growth and movement.

Darwin's use:

81. The research was to be a continuation of the investigation into the fundamental laws of plant development and movement that he had proposed in *The Power of Movement in Plants* (1880). In the event, he was not able to carry out the experiments because of his declining health, but the building stands as a testament to his continuing commitment to experimental research even as he approached the end of his life.

82. An observatory beehive has been recently constructed in the building for a replication of the experiments on honey-bees' instincts for comb-building that Darwin carried out in his garden in 1858 for *The Origin of Species*. The experiments enabled him to explain how the bees' instinctive method of building combs with regular cells that became hexagonal probably evolved by natural selection from a simpler instinct to build circular cells shared with other species of bee and wasp. His explanation was an important part of his answer to criticisms of his theory on the grounds that honey-bees' perfect geometry could only be explained in terms of 'intelligent design' by a Divine creator.

I came here with all the children on Saturday leaving poor Papa at home (as he was too busy with bees' cells to endure to come) ... Only think how bold Papa has become; he hived a swarm of bees all himself. He and Mr Innes go about, wonderful figures in their bee dresses with white veils on their hats.

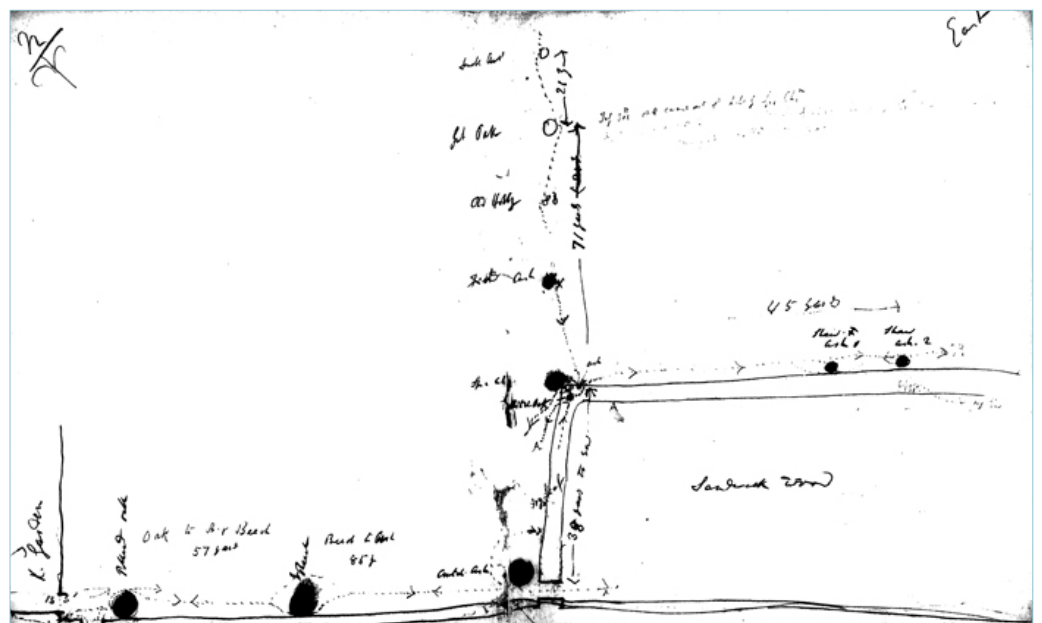
Emma Darwin to their son William, June 1858



Honey Bee



Repetition of Darwin's experiment on honey-bees' comb-building



Darwin's map of bumble-bees' flight paths traced with help from his children



Great House Meadow looking towards Down House

j) Great House Meadow

Description:

83. Darwin's meadow, adjacent and easily accessible from his home is a fifteen-acre field on the clay-with-flints which caps the ridge on which Down House is situated. It is still managed in a traditional routine of winter grazing following a hay cut.

Darwin's use:

84. On acquiring the property, he made immediate use of the field to start a long-term scientific experiment on the working of soil by earthworms, scattering a quantity of broken chalk over an area so that he would be able to excavate it many years later to see how far it had sunk each year as a result of the earthworms' workings. He made the excavation twenty-nine years later and found that during the intervening period the material had sunk. A layer of cinders scattered shortly after the chalk is still identifiable deep in the soil as a trace of Darwin's first field experiment at Downe.

A quantity of broken chalk was spread, on December 20, 1842, over a part of a field near my house, which had existed as pasture certainly for 30, probably for twice or thrice as many years. The chalk was laid on the land for the sake of observing at some future period to what depth it would become buried. At the end of November 1871, that is after an interval of 29 years, a trench was dug across this part of the field; and a line of white nodules could be traced on both sides of the trench, at a depth of 7 inches from the surface. The mould, therefore, (excluding the turf) had here been thrown up at an average rate of .22 inch per year.

Darwin, The Formation of Vegetable Mould through the Action of Worms, 1881

The consideration of [the time-scale of geological formations] impresses my mind almost in the same manner as does the vain endeavour to grapple with the idea of eternity. ... It is an admirable lesson to stand on the North Downs and to look at the distant South Downs; for, remembering that at no great distance to the west the northern and southern escarpments meet and close, one can safely picture to oneself the great dome of rocks which must have covered up the Weald within so limited a period as since that latter part of the Chalk formation. ... I have made these few remarks because it is highly important for us to gain some notion, however imperfect, of the lapse of years. During each of these years, over the whole world, the land and the water have been peopled by hosts of living forms. What an infinite number of generations, which the mind cannot grasp, must have succeeded each other in the long roll of years!

Darwin, The Origin of Species (1859) p. 296

85. The meadow was already being cultivated for hay when Darwin acquired the property, and he continued to fertilise it for an annual hay crop and grazing for the household's two cows and two horses. He used the meadow for many observations and experiments in the agriculturally improved neutral grassland habitat, and among features of its natural life that he observed and can still be seen there today are the dominance of coarse grasses in the greensward, bumble-bees whose regular flight paths he identified and traced with his children's help, and the red clover, field mice and cats as he described them with the bumble-bees in his classic account in The Origin of Species of the 'web of complex relations' between living creatures in the natural world.

My observations, though on so infinitely a small scale, on the struggle for existence, begin to make me a little clearer how the fight goes on: out of sixteen kinds of seed sown in my meadow, fifteen have germinated, but now they are perishing at such a rate that I doubt whether more than one will flower. Here we have choking, which has taken place likewise on great scale with plant not seedlings in a bit of my lawn allowed to grow up. ... What a wondrous problem it is - what a play of forces, determining the kinds and proportions of each plant in a square yard of turf! It is to my mind truly wonderful. And yet we are pleased to wonder when some animal or plant becomes extinct.

Darwin to Hooker, June 1857



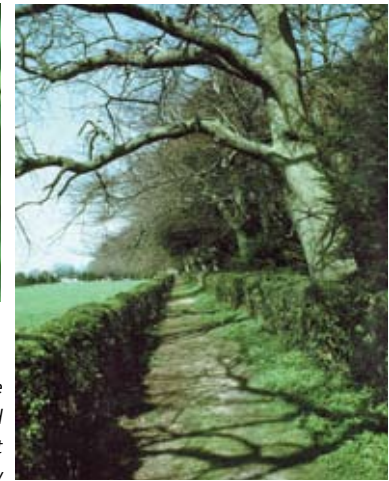
Darwin noted the ecological links between cats, field mice, bumble-bees and red clover



Field mouse



A bumble-bee pollinating red clover



The Sand-walk Copse where Darwin noted the growth of new plant species in his hedgerow

*I am tempted to give one more instance showing how plants and animals, remote in the scale of nature, are bound together by a web of complex relations. ... I have ... found that the visits of bees are necessary for the fertilisation of some kinds of clover. ... 100 heads of red clover (*Trifolium pratense*) produced 2,700 seeds, but the same number of protected heads produced not a single seed. Humble-bees alone visit red clover, as other bees cannot reach the nectar. ... Hence we may infer as highly probable that, if the whole genus of humble-bees became extinct or very rare in England, the ... red clover would become very rare, or wholly disappear. The number of humble-bees in any district depends in a great measure upon the number of field-mice, which destroy their combs and nests. ... Now the number of mice is largely dependent, as every one knows, on the number of cats. ... Hence it is quite credible that the presence of a feline animal in large numbers in a district might determine, through the intervention first of mice and then of bees, the frequency of certain flowers in that district!*

Darwin, Origin of Species (1859) pp. 124-125

carried out a series of experiments which established that the seed must have been buried and remained fertile for many years. His publication about 'Vitality of Seeds' (1855) was the first to draw attention to the existence of natural seed banks in the soil, an important underlying resource in many habitats, giving them the ability to generate new life after any change in the balance of natural forces. Another plant which he observed and still grows abundantly in the copse is the parasitic plant *Lathraea squamaria* (toothwort) whose first shoots show remarkable strength in pushing their way up out of the soil. A hedgerow he planted in the 1840s and studied many years later to see what other plants had become established in it in the course of ecological succession, still stands along the path showing the species he planted, and many others that have joined them over the years.

Your father and I never discussed scientific questions except for the half hour after breakfast ... At other times we had long chats by which I profited enormously, especially during the forenoon and afternoon 'sand walks', for which he invariably summoned me.

Sir Joseph Hooker to Darwin's son Francis after Darwin's death

July 18 1855 - In Sand-walk Wood thorns pulled up this Spring when leaves just budding - Now charlock growing for thickly entangled with weeds - Now in 3 places down very little larger than palm of hand, I find [in] one 6 plants, in another 3 and another 1-3 (because only 1 old). Now field was in cultivation about 15 years ago; but I broke up this part in [1846] and planted it, and by end of autumn became a thick entangled mass. Wood surrounded by meadow except at one narrow end.

Darwin, scientific papers, 1855

k) Sand-walk Copse

Description:

86. Darwin created the Sand-walk copse on the south western side of Great House Meadow and he laid his famous 'thinking path', the Sand-walk, round it for his daily walks and scientific reflection in the solitude of the Downe countryside. The copse adjoins an ancient wood bank and includes an area of hazel coppice which Darwin maintained alongside his plantation.

Darwin's use:

87. Darwin used the habitats for a range of observations and experiments including an important discovery about the vitality of buried seed. He noticed *Sinapis arvensis* (charlock) growing in an area of soil that had been disturbed when a plant had been dug out, and he

The flower-stem of the parasitic Lathraea squamaria, which is destitute of true leaves, breaks through the ground as an arch. ... The passage of the flower-stem of the Lathraea through the ground cannot fail to be greatly facilitated by the extraordinary quantity of water secreted at this period of the year by the subterranean scale-like leaves; not that there is any reason to suppose that the secretion is a special adaptation for this purpose: it probably follows from the great quantity of sap absorbed in the early spring by the parasitic roots.

Darwin, *The Power of Movement in Plants* (1880) pp. 85-86

Hedgerow in sand-walk planted by self years ago when I hired field ... had been left as pasture ... The following now sprung up in hedge – presum[ably] the seeds having been brought by birds, Crab-apple, Plum, Yew, Arum, Cherry, Maple, Holly, Privet, Sycamore, Honeysuckle, Ivy, Hornbeam, Elm, Euonymus, Gooseberry, Clematis vitalba, nuts, several, transported, I suppose by Rodents. Rosa, Beech. Birds alighting on clipped hedge will cause more seed in dung to be dropped than those on open field, but may must dropped there and are destroyed by cattle. – The thorn, though profiting by its thorns and thus escaping being browsed, suffers from protecting other plants, for instance, which by their growth will soon annihilate their nurse.

Darwin, scientific papers, 1880-1881

I) Great Pucklands Meadow

Description:

88. Great Pucklands Meadow is a thirteen-acre pasture adjoining Darwin's Sand-walk copse, It is situated mainly on acidic clay with flints, with a smaller area located on top of the chalk. The meadow has been maintained as pasture since the 1850s and still continues to be managed by grazing and hay cutting.



Great Pucklands Meadow

BIODIVERSITY AND THE PRINCIPLE OF DIVERGENCE

Darwin saw that the number and diversity of all forms of life is a primary feature of the natural world that needs to be explained. He suggested that the ceaseless pressure of competition for survival ensures that any fresh opportunities for obtaining the means of life that emerge at any time may be seized by species that are able to evolve special adaptations for the purpose. He named that process the principle of divergence and showed that it was the key to the global phenomenon of biological diversity.

Darwin's use:

89. The meadow has outstanding importance because it was there in 1855 that Darwin made the first focused survey of every plant species in a defined area within a single habitat in order to assess the biodiversity of the habitat. In the months beforehand he had identified the principle of divergence as a necessary factor for his theory of evolution, and his survey of the plant diversity of Great Pucklands was his first recorded test of the idea in the field. The results confirmed his expectation about the phenomenon and formed part of the basis for his treatment of the principle in his first long draft of *The Origin of Species*. A recent botanical survey has shown that the diversity of the plant population is now as high as it was when Darwin made his count.

To show the degree of diversity in our British plants on a small plot, I may mention, that I selected a field, in Kent, of 13.5 acres, which had been thrown out of cultivation for 15 years and had been thinly planted with small trees most of which had failed: the field all consisted of heavy very bad clay, but one side sloped and was drier; there was no water or marsh. 142 phanerogamic plants were here collected by a friend during the course of a year; these belonged to 108 genera, and to 32 orders out of the 86 orders into which the plants of Britain have been classed.

Charles Darwin, *Natural Selection* (1856-1858) p. 230



Dr J. Vogel (left) from the Natural History Museum examining buttercups with Randal Keynes (right) during the 2005 botanical survey of Great Pucklands

90. Darwin also studied the earthworms that were present in the soil in great numbers, and are still now. He continued the studies he had begun in Great House Meadow (2.a.84) in Great Pucklands, to show how over the thirty years after it had been left as a stone-strewn slope, the surface of the field had been transformed by the earthworms' unceasing activity into compact turf with increased vegetable mould. Since Darwin's time, the gradual accumulation of material that he was able to detect has reached a point of balance with other factors, and the layered composition of the soil now stands as an example of the imperceptible but unceasing workings of natural processes that it was part of Darwin's achievement to identify and explain.

3.d History and Development

i) Landscape

91. When Darwin first surveyed the landscape, he guessed that the two north-sloping dry chalk valleys on either side of the Downe ridge were 'ancient sea bays', but later, when he learnt about geologists' developing understanding of surface erosion by rain and surface water, he came to see how the two valleys had been carved by river action during the recent Ice Ages. He understood how the sea had advanced and retreated over the land and how during extreme climatic changes a pattern of Quaternary deposits had been left on the high ground and alluvium along the valley bottoms. From around 500,000 to 35,000 years ago small groups of early humans, *Homo heidelbergensis* and *Homo neanderthalensis*, hunted and scavenged in the area. During the climatic downturns arctic animals such as woolly rhinoceroses and mammoths and musk ox ranged over the landscape whilst deer, rhinoceros and elephant lived there during the warmer periods. Early human artefacts and fossil remains of the animals hunted or scavenged with them have been found in the neighbourhood, and Darwin was intrigued when he was told about discoveries.

Here I live on a chalk platform gently sloping down from the edge of the escarpment to the south (which is about 800 feet in height) to beneath the Tertiary beds to the north. The beds of the large and broad valleys (and only of these) are covered with an immense mass of closely packed broken and angular flints; in which mass the skull of the musk-ox



Mammoth tusk found at Green Street Green in 1862, Bromley Museum (68.26.47)

and woolly elephant have been found. This great accumulation of unworn flints must therefore have been made when the climate was cold, and I believe it can be accounted for by the larger valleys having been filled up to a great depth during a large part of the year with drifted frozen snow, over which rubbish from the upper parts of the platforms was washed by the summer rains, sometimes along one line and sometimes along another, or in channels cut through the snow all along the main course of the broad valleys.

Darwin to Professor James Geikie, July 1880

Herbert Norman found the other day a very perfect Celt [prehistoric implement] near Cudham: and a grand mammoth's tusk has just been found at Green Street Green.

Darwin to his son William, October 1862

92. Ever since the first human settlements in the area, the landscape around Downe has been shaped and reshaped by its human inhabitants. Modern humans have been present in the neighbourhood since around 35,000 years ago. The first part of this period was one of extreme cold and at its greatest intensity, around 18,000 years ago, the area was a harsh arctic wasteland. Subsequent warmer episodes led to the formation of soils and vegetation and by 9,000 years ago a succession of woodlands had developed, first of juniper and willow, then birch and pine and finally hazel, oak, lime, elm and ash. From that time, small groups of hunter-gatherers camped near the source of the River Ravensbourne on Keston Common in the northern part of the nominated Property and they exploited the natural resources of the surrounding area. The overall range of uses has remained broadly similar since the development of farming around 6,000 years ago, but there has been much change over the centuries with a major enclosed settlement in the Iron Age (around 200 BC), Roman settlements with arable farming during the Roman occupation of Britain, and Saxon settlements preceding the settlements in the twelfth to fourteenth centuries from which the pattern of use since then has developed.

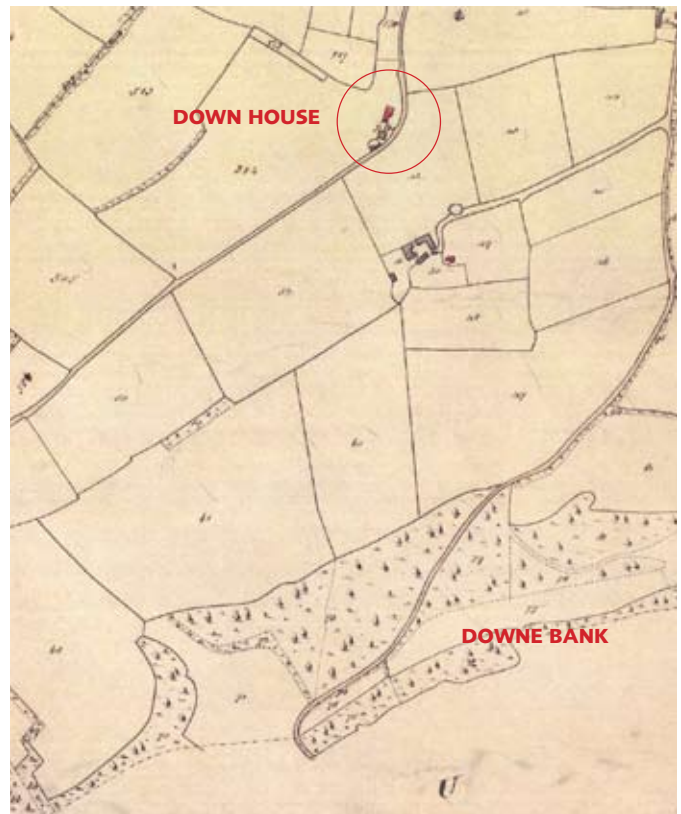
93. During the later Saxon period when the area around Downe was probably managed woodland shared by the surrounding estates, seasonal feeding was probably provided for pigs and other animals, and wood was probably obtained by coppicing. Much of the area was cleared for farming in the following centuries but the woodland recovered, particularly on more marginal land, when the pressures for cultivation decreased. The woodland was intensively managed again from the fifteenth century when the supply of timber and underwood products for London became an important part of the area's economy. Trees were coppiced for poles or left to grow as timber for building. Earth banks

marked out individual holdings within the wood and the boundaries with the open arable and pasture fields were marked with more substantial earthworks. During the early nineteenth century, some areas of woodland were cleared for arable farmland and pasture. The clearances left some former woodland boundaries in open ground and the earth banks can be seen today in a number of places. Semi-natural ancient woodland survives in a number of parts of the nominated Property today, with the combination of high forest for timber and a coppiced under storey that was characteristic of woods that Darwin knew.

94. There have been significant changes over the years in the balance of land uses, with wheat and sheep farming dominant and peaks of arable in the early fourteenth and nineteenth centuries. The first peak came with the increasing demand for grain crops as populations grew, both in the locality and in London to the north. The land north of Downe was brought into communal cultivation with the 'open field' system of medieval agriculture, and marginal land on the steep sides of the chalk valley north of Cudham was also ploughed. The land was managed in large communal fields, with common pasture for grazing and small areas of surviving woodland. The farming community lived in grouped settlements at Cudham, Downe and Berry's Green or in dispersed farmsteads across the landscape.

95. Famine and subsequent outbreaks of plague devastated the local population during the fourteenth century and led to widespread changes in the landscape. As the demand for arable farming decreased, marginal land was abandoned and woodland quickly regenerated. With a growing demand for fuel and timber for London, areas of managed woodland were bounded and divided by earthworks marking ownership of the resource, a number of which are still visible as field boundaries around the nominated Property today. Around the same time, the open fields north of Downe were enclosed with boundaries and hedges, some of which preserved the outlines of the medieval strip fields and were still in place when Darwin lived in the area. Farms were built within the newly consolidated land-holdings, creating the pattern of dispersed settlement that characterises the landscape today.

96. The period from 1700 to 1900 was one of general farming expansion which contributed significantly to the national economy. The agricultural land in the nominated Property was already enclosed, allowing farmers to change their crops to satisfy developing markets. In the early 1800s, harvests improved but prices fell from the high levels during the Napoleonic wars. This led to a historic peak of arable farming around the time when Darwin moved to Downe, as farmers brought more land into cultivation to maintain their incomes. The well-managed woods to the west and south of the



nominated Property were cleared, as shown by place names and the presence of woodland banks in now open areas. The pattern of long fields and hedgerows north of Downe survived into Darwin's time but some fields were enlarged again towards the end of the century.

I forgot whether I ever described this place: it is a good, very ugly house with 18 acres, situated on a chalk flat, 560 feet above sea. There are peeps of far distant country and the scenery is moderately pretty: its chief merit is its extreme rurality. I think I was never in a more perfectly quiet country. Three miles south of us the great chalk escarpment quite cuts us off from the low country of Kent, and between us and the escarpment there is not a village or gentleman's house, but only great woods and arable field, the later in sadly preponderant numbers course of the broad valleys....

Darwin to W D Fox, March 1843

Nearly all the land is ploughed, and is often left fallow, which gives the country a naked red look, or not unfrequently white, from a covering of chalk laid on by the farmers. Nobody seems at all aware on what principle fresh chalk laid on land abounding with lime does it any good. This, however, is said to have been the practice of the country ever since the period of the Romans, and at present the many white pits on the hill sides, which so frequently afford a picturesque contrast with the overhanging yew trees, are all quarried for this purpose.

Darwin, 'General Aspect', 1843



Local farming has a long history of crop and livestock production



Wheat-growing today in Cudham Valley

97. When Darwin moved to Downe in 1842, some of the less profitable fields on the valley slopes and other poor land were being turned back to pasture or plantation, and the trend continued during his time at Downe. New practices in estate management were also making their mark on the landscape and the two adjoining estates of Holwood Park and High Elms in the north part of the nominated Property were both modified extensively for their wealthy owners' profit and amenity, with agricultural improvements and landscaping for game and 'prospects' creating a continuous tract of parkland, woodland, arable farmland and pasture characteristic of large landed properties in nineteenth century lowland England. The Holwood Estate, which had been wooded until the middle of the eighteenth century, was cleared and landscaped by successive owners. The High Elms Estate was purchased by the Lubbock family, London bankers, in 1808 and a programme of landscaping and tree planting was initiated. In the 1840s Sir John Lubbock III (1803-1865) established extensive plantations on what had been arable land. Further landscaping was undertaken by Sir John Lubbock IV, later Lord Avebury (1834-1913). In the 1880s, a small golf course was laid out in the grounds. The southern parts of the two valleys including the areas in which Darwin spent most time were not affected by these changes because of their distance from the two great houses, their remoteness from other human activity and the steepness of their wooded valley sides.

Yesterday I drove to Keston to see Mrs Wright and walked back through Holwood Park – it was looking lovely – but seemed too full of memories, and I thought how you all used to race down the pretty green slope at the end – I was glad to think that I walked through it with your father not so very long ago – we used generally to finish a drive with that charming bit of walking.

Emma Darwin to her son William in 1883, after Darwin's death

98. In the 1860s and 70s, Keston Common in the north west part of the nominated Property became well known

to London naturalists as a place where they could come out from the city to collect rare plants, insects and fresh water organisms. Guidebooks for weekend 'excursionists' offered walks through Downe and many came to explore the unspoilt countryside. On a number of occasions in the 1870s Darwin and his wife gave tea to visiting groups from a Working Men's College in north London. The groups of naturalists who visit the area today continue that long tradition.

Several times after my marriage my father and mother invited the party to Downe. The first time was in the summer of 1873. These invitations gave great pleasure and there was a large attendance, often as many as sixty or seventy. My father's and mother's gracious welcome, an excellent tea on the lawn, wandering in the garden and singing under the lime-trees made a delightful day, ending with a drive home to Orpington Station for the ladies of the party.

Henrietta Litchfield, Emma Darwin, a Century of Family Letters, (1915) 2. 213

99. In the early twentieth century, with the development of the London suburbs, cheap public transport and the granting of more leisure time for working people through Parliamentary action led by Sir John Lubbock IV, a leading Liberal politician, people from the South London suburbs and nearby towns such as Bromley made increasing use of parts of the rural landscape around Downe for walking and other leisure pursuits. In the 1920s a part of Downe Valley that had been arable farmland before was laid out as a golf course, and at High Elms, a golf course initially laid out by John Lubbock in the mid 1880s was extended in 1968. In the 1930s, a number of camp sites were established in the nominated Property for children from London.

100. There have been some changes in the use of the land since Darwin's death and there have been a few losses of historic features, but the overall consequences have been limited. The changes are set out as follows: first, changes in the overall pattern of land uses; second, reduction of particular habitats and losses of particular

species; and third, changes in the general character of the landscape.

101. The changes in the overall pattern of land uses since the 1840s when Darwin came to Downe have been explained above. When Downe and Cudham Parishes were surveyed in 1840 for the reapportionment of Church tithes, the main use of land outside the villages was for agriculture. 65% of the land in the nominated Property was arable farmland; 20% was pasture, and 15% was woodland. The figure of 65% for arable farmland was the historic peak after the Napoleonic Wars. A trend back to pasture started in the 1840s and when the two parishes were surveyed again in 1868-9 for the Ordnance Survey's 25-inch map, the figures for land use had changed to 40% arable, 25% pasture, 20% woodland and 15% amenity. In the 1870s after a series of poor harvests, grain dealers started importing large quantities of cheap grain from the United States and elsewhere, and wheat acreages were again reduced. Between 1868 and 1898 the wheat acreage in the whole of Kent was halved and permanent pasture increased by a third. Since then, the amount of arable farming in the nominated Property has remained around the same, and the proportion at the present time is 25% arable, 35% pasture, 25% woodland and 15% amenity. With the general intensification of agricultural production in the last thirty years, farmers have been using more fertilisers and insecticides on arable land but recent changes in agricultural subsidies have changed the pattern of incentives, and farmers in the nominated Property are now making increasing use of schemes including environmental measures that favour conservation over monoculture.

102. Historically, the main use of pasture on the North Downs has been sheep production for meat and wool. Dairy farming continued through the nineteenth century depressions, partly due to the demand from the expanding London population, and pasture was also used for feeding horses. Much of the grassland in

the nominated Property was agriculturally improved in Darwin's time through fertilisation, drainage and cultivation, although some areas of rough pasture were left unimproved. The pasture today is used for grazing sheep and horses, and production of hay, fodder and silage. Since the Second World War, some areas of grassland on the steep valley sides have been allowed to revert naturally to scrub and woodland.

103. Since the early 1800s, the woodland in the nominated Property has been a mixture of semi-natural ancient woodland with coppicing and plantations. Elsewhere in lowland England there has been an overall reduction of woodland for timber production but the area in the nominated Property has been increased to its present figure of 25% through the plantings for landscape amenity and game shooting which began in the nineteenth century. In general, the increasing amenity use of the whole landscape has favoured the retention and extension of the historic woodland.

104. All the habitats that Darwin studied at Downe are still represented in the nominated Property, but in just two cases there have been reductions of the area covered. First, the area of heath, acid grassland and bog on Keston Common where Darwin studied earthworms and collected *Drosera rotundifolia* has been reduced from 37 acres to 7 acres with the reversion of large areas of the common to scrub and woodland following the cessation of grazing on the common land in the 1940s. Funding has been secured for plans to restore and provide interpretation for these historic habitats. Second, in the period up until the 1990s the area of unimproved chalk grassland, the characteristic floral diversity of which was important to Darwin was reduced from an estimated 200 acres to 100 acres through agricultural improvement and conversion to arable. Recent management of areas in Cudham Valley has resulted in the conversion of over 70 acres back from arable to chalk grassland, reseeding with locally collected wildflower and grass seed. Action



Arable farming in Cudham Valley



Sheep grazing on Downe Bank

is under way to restore more areas of former chalk grassland and to link isolated sites to form wildlife corridors along the valley.

105. Of over 50 plant species that Darwin collected and studied in the nominated Property only three are not now found in the same area: *Drosera rotundifolia* which he collected on Keston Common, *Orchis morio* which he noted was abundant in the area, and *Herminium monorchis* which he found in Cudham Valley. Plans to restore the bog habitat on Keston Common and reintroduce *Drosera rotundifolia* are underway. Two other orchids that Darwin studied in the neighbourhood, *Platanthera chlorantha* and *Neottia nidus-avis*, are no longer found in the places where he found them (the Orchis bank and Hangrove) but are present in similar habitats elsewhere on the nominated Property.

106. The general character of the landscape today is broadly similar to its character in Darwin's time in that it is still based on mixed farming in small units with hedges, wood banks and woodland in a quiet rural setting. The two wooded valleys and the open high ground between that were the key features of the landscape for Darwin, are still clearly present. Most settlement, roads and human activity are on the high ground, and the quiet wooded landscape in the two valleys still has a special sense of remoteness and privacy in a natural setting under tree-lined horizons. The quiet character of the two valleys in Darwin's time is partially preserved in Downe Valley, and fully preserved in Cudham Valley. The greens, fairways and roughs of the West Kent and High Elms Golf Courses are new elements but with the nature and pace of the game of golf, they are not seriously obtrusive in the wooded landscape and they do not have a significantly adverse effect on the area.

3.d ii) Down and Cudham villages

107. The villages of Cudham and Downe have remained largely the same size through the nineteenth and twentieth centuries. There are a few new buildings while some old ones have extensions and other minor modifications. Outside the villages, there have been only two significant extensions of the built area since Darwin's time. One small housing estate was built north of Downe and there has been ribbon development along parts of the road south of Down House. Since 1938 both developments have been limited by the Green Belt legislation and policies. The two areas have been excluded from the nominated Property, are located in the buffer zone and neither area is visible from any sensitive part of it.

108. The nominated Property includes the Parish of Downe and part of the neighbouring Parish of Cudham. Both villages still have their nucleated form dating from the medieval period. The many buildings in the two Parishes that date back to Darwin's time and before reflect the historic patterns of settlement in the area, land ownership and use, and show the social setting in which Darwin lived with his family and carried out his scientific investigations as a gentleman of independent means. A number of the buildings have significant associations with members of the local community who helped him in his scientific work, and with other aspects of his life in the neighbourhood including his commitment to education and social support for the working people of the two villages. These links are important for the World Heritage Nomination because Darwin saw clear ties between his scientific understanding of patterns of cooperation in natural societies and social values for civil life, and the way his theories influenced social philosophy and wider human thinking is an important aspect of their Outstanding Universal Value.

109. Downe Parish Church was first built in the 1290s. Parts of the structure are enlargements of the fourteenth and fifteenth centuries and its present condition and decoration are the results of an extensive refurbishment by the vicar, the Reverend George Ffinden, in 1871-1879, to which Darwin and his wife contributed as wealthy parishioners. There is now a sundial dedicated to Darwin on the south wall of the church tower. The yew tree, which dominates the churchyard, was already many hundreds of years old when the Darwins came to the village in 1842. In Darwin's first years at Down House he attended church services regularly with his family. He supported the church and was an active member of the Parish Vestry, which oversaw charitable support for the poor, the village school, and the maintenance of the roads, but he ceased to attend services after he gave up his Christian faith in the 1850s. His wife remained a



Gravestone of Darwin's brother Erasmus and his wife Emma



Downe Village Hall

devout Christian; she was pained by his scientific views and continued to attend church with their children. The stone tomb next to the west door of the church was built for the Darwins when they came to Downe, and they intended it to be their family's burial place. Two of Darwin's children who died at Downe in their infancy from the lethal diseases that often swept through the neighbourhood are buried there. Darwin expected to be interred with them in the family grave but after his death, leading politicians and churchmen decided to honour him with a funeral and burial in Westminster Abbey. Emma Darwin, who lived on at Down House during her fourteen-year widowhood, was eventually laid to rest in a second family tomb in the churchyard. There are also gravestones for Darwin's butler, one of his gardeners and a number of the villagers whom Darwin and his family knew.

110. The George and Dragon Inn facing the church dates from the seventeenth century and parts of the present building are eighteenth century, though the timbered frontage is of the 1930s. Darwin stayed at the inn on his first visit to Down House in 1842 and it was the meeting place for the Down Friendly Society, a provident society for the labouring poor of the village formed in 1850 at Darwin's prompting because he believed strongly in self-help and mutual support for social improvement. He served as the Society's Treasurer and played a guiding role at its regular meetings at the inn until the last years of his life. The George and Dragon still functions as one of the village's two pubs.

111. Downe Village Hall which stands next to the George and Dragon Inn, was built in 1855 by the squire of the parish, Sir John Lubbock III, as an elementary school for the village children. The interior is now a single raftered space as it was in the 1860s when Darwin, a strong supporter of Lubbock's aim to provide education for all children of the village without exclusions on religious grounds, was a member of the school's Governing Committee and paid the fees for a number of pupils. The school would not have been built had it not been for Darwin's support, as the scheme

nearly foundered because of a quarrel between Sir John Lubbock and the curate about the curate's role in its management. Darwin saved the plan by broking a compromise between them. Botany was taught at the school in the 1870s from a primer on botany written by Darwin's friend Joseph Hooker, then Director of the Royal Botanic Gardens, Kew. Hooker's Botany was the first school textbook to emphasize the value of an evolutionary approach to the origin of species.

When the school moved to larger premises, the Lubbock family gave the building to the village, and it is now used as the village hall.

Origin of species: - There are two methods of accounting for this; one, that of independent creation, that species were created under their present forms, singly or in pairs or in numbers: the other, that of evolution, that all are the descendants of one or a few originally created simpler forms. The first method is purely speculative, incapable from its very nature of proof. ... The other, whether true wholly or in part only, is gaining adherents rapidly, because most of the phenomena of plant life may be explained by it; ... because it has suggested a multitude of prolific enquiries, and because it has directed many investigators to the discovery of new facts in all departments of botany.

Hooker, Science Primer, Botany (1878) pp. 110-111

112. Many of the modest residential buildings in the village of Downe date from long before the Darwins came to the neighbourhood. Walnut Tree House and Cottage in the centre of the village are a fifteenth century Kentish Wealden Hall House in origin, and were occupied in Darwin's time by the village builder, John Lewis, who carried out many of the building works for Darwin at Down House, including the construction of his garden laboratory (2a.xi, i) 80). The flint and mortar walls of Snows Cottages (1737) and Yew Tree Cottages (early nineteenth century) show the geology of the neighbourhood as the flint was quarried from the deep chalk deposits on which the whole landscape lies.

"I had been told to look up Mr John Lewis in the village, who used to do all the carpentry and joining work for the house. ... "I made that dark house for him, for experimenting with plants, but he died before he did anything with it. I was sorry; I'd ha' liked to seen his performance in there. ..."

An Evening News reporter reporting on Downe for the centenary of Darwin's death, Evening News, Friday 12 February 1909.



Walnut Tree House and Cottage

113. Holwood House which commands the landscape of the northern part of the nominated Property, is a classical mansion designed by the architect Decimus Burton (1800-1881) and built in 1823-7 to replace the house built by William Pitt the Younger at the centre of the park laid out for him by Humphrey Repton (1752-1818) (2.a.x.56). Darwin and his wife often visited the two successive occupiers in their time, Lord Cranworth and the Earl of Derby. Lord Cranworth sent regular contributions to the charities for Downe villagers for which Darwin acted as treasurer.

114. High Elms was a large country mansion built for Sir John Lubbock III shortly before the Darwins came to Downe. The Darwins were frequent visitors to the house. Sir John Lubbock IV became one of Darwin's leading supporters in British scientific circles in the 1860s to 1880s and inspired by his guidance, made historic contributions to the archaeology of early man, as well as entomology as noted in 2.a.ix above. In his work *Pre-historic Times* (1865) he first explained the connexion between the earliest humans and the geological past that Darwin's theory had pointed towards. His identification and naming of the Palaeolithic and Neolithic eras provided an essential part of the framework for modern archaeology's understanding of human development from our pre-human origins. One feature of Lubbock's approach to archaeology was his interest in ethnographic findings about human groups still living in ways comparable to those of early humans. He arranged the main hall of High Elms with a remarkable collection he had formed of archaeological and ethnographic material showing the links between the two groups of specimens and the light present-day artefacts and practices could throw on the traces of human prehistory. He commissioned a series of paintings of scenes from pre-history which is one of the first portrayals of early humans based on an accurate understanding both of their archaeology and of the animals they hunted and the habitats they hunted them in. One of the paintings shows a group of hunters attacking a mammoth in an Ice Age landscape, echoing the finds of a stone implement and a mammoth tusk in Lubbock and Darwin's neighbourhood a few years before, and what



Holwood House

they understood about the climate and vegetation of the time. The paintings and other parts of the collection are now on display in the Bromley Museum in Orpington, just outside the nominated Property. Other items are in the British Museum. Sir John Lubbock IV was also a figure of great importance in the history of the valuing and protection of cultural heritage, with his pioneering legislation for the protection of ancient monuments (1882). The mansion building was destroyed by fire in 1967; it is the only large building in the area that was known to Darwin but is no longer standing. The gatehouse, boundary walls, ice well, coach houses and stables survive to show the grandeur of the property and the scale of agricultural operations on the estate during Sir John Lubbock III and IV's time.

115. There are a number of farm dwellings, barns and buildings for livestock that survive from Darwin's time and show the nature and scale of the farming activity in the neighbourhood with which he was familiar. It was a mixture of arable, pasture and livestock rearing, adjusted to the changing demands of local and London markets. Darwin had a number of scientific interests in the breeding of livestock and the cultivation of crops, and the farm buildings that survive from his time reflect the patterns of farming that he knew. Orange Court is an eighteenth century farmhouse with a barn dated 1779 and incorporating medieval timbers. Clockhouse Farm has a nineteenth century raised timber grain store with a pony gin below for pumping water. The old tithe barn for the parish of Cudham (a barn built to store the produce villagers had to provide every year for the parish church and clergy) survives in a conversion at Bottom Barn Farm.

116. Darwin's home at Downe is one of a number of country houses and villas in the neighbourhood that were occupied in his time by gentry with income from sources other than land in the vicinity, and were a feature of the parish and others like it in rural areas easily accessible from large cities. Petleys is a flint and red brick house with origins in the sixteenth century, which was lived in during Darwin's time by his Aunt Sarah Wedgwood, daughter of Josiah Wedgwood and herself a long-standing supporter of the anti-slavery campaign

and other liberal causes. Trowmers, parts of which date from 1717, was occupied in Darwin's time by another philanthropic spinster cousin, Elizabeth Wedgwood. The two ladies came to live in Downe in order to be near Emma Darwin, Sarah's niece and Elizabeth's sister, and the Darwins were frequent visitors to both households. The Rookery, a stuccoed building of the early nineteenth century, was occupied in Darwin's time by a racehorse-owner, George Henry Turnbull, whose highly skilled gardener, John Horwood, provided considerable help to Darwin in his research on exotic orchids and plant hybridisation. Downe Hall is a yellow stock brick house built in the 1820s. During Darwin's time it was occupied by the parish curate, John Brodie Innes, who supported village charities with Darwin, kept honey-bees and helped Darwin in his experimental investigation of their comb-making instincts on which he reported in the chapter of *The Origin of Species* on the main 'difficulties on the theory'.

117. Cudham Church of England School on Jail Lane between Cudham and Biggin Hill is the building erected for the village school when it was founded in 1850 at the instigation of Earl Stanhope, a local landowner, for the children of Cudham parish. Darwin, who was a strong supporter of education for local children, contributed to the building fund and paid an annual subscription for running costs. The school is now one of the two state primary schools for children of the neighbourhood.

Losses and Alterations

118. Of all the buildings in the nominated Property that were significant for Darwin for different reasons, only one is no longer standing. The mansion at High Elms where Sir John Lubbock III and IV lived and which Darwin visited frequently was destroyed by fire in 1967. The appearance of one other building that Darwin visited regularly has been changed. The George and Dragon Inn was given a timbered frontage in the 1930s.



Petleys



Cudham School is still the village school for 5-11 year olds

Additions

119. Between 1900 and 1939, 120 houses were built along part of Luxted Road and Single Street, on the upland half a mile south of Down House. Since the imposition of Green Belt controls in 1938, no more land has been built on, although some houses have been replaced. As the area was not part of the landscape which Darwin used for natural history, and as the buildings in it are screened from the nominated Property by woodland, trees and hedgerows, it has been excluded from the Property.

120. Between 1918 and 1939 a housing estate of 100 households was built on a 7 acre plot on North End Lane, just north of the village of Downe. It is known as the North End Lane housing estate. The imposition of Green Belt controls in 1938 prevented further development and new building is limited to replacement of existing buildings within their footprint. The housing estate is only visible from the nearby village recreation ground and an adjoining field. It has been excluded from the nominated Property.

121. In 1930 the field called Little Pucklands north of Great Pucklands was acquired by Sir George Buckston Browne who presented it to the Royal College of Surgeons for use as an experimental medical research farm which was called Buckston Browne Farm. A residential building designed by Eustace Corrie Frere in an 'Arts and Crafts' style was built in 1931 for people working at the research farm, and laboratory premises were erected behind. The research farm was closed in 1986.

122. In the 1970s the Holwood Estate was acquired by an international oil exploration company for its headquarters. Holwood House was used by the company and a large building was constructed in a wooded part of the estate for offices and other installations. The premises were sold in the 1990s and the property is now redeveloped for private housing and placed in the buffer zone. Holwood House has been kept within the nominated Property and has been carefully restored and

converted back to residential use. The new buildings are not visible from within the nominated Property.

123. High Elms Golf Course and West Kent Golf Course both have clubhouses and car parks built in the 1970s. The brick buildings are two storeys high and are visible within the golf courses, but they have limited visual impact elsewhere in the nominated Property. Although the golf course can be seen from the nominated Property, they are sympathetically and well managed. The ancient field patterns are preserved in the valley bottoms of the Property and can be seen from footpaths.

124. A number of agricultural buildings have been built within the nominated Property since Darwin's time for management and storage of stock, crops and machinery. They are all functional buildings of their time for farming operations of broadly similar kinds and on a similar scale to those of Darwin's time.

125. Christmas Tree Farm on the outskirts of Downe is a small farm with facilities for children to interact with farm animals. It has wood and brick buildings in keeping with their surroundings and includes landscaped gardens, a small garden centre selling plants and shrubs, a tearoom and a small car park.

126. The only other significant additions to the built fabric of the nominated Property since Darwin's time are the four car parks with up to 30 spaces each that have been created for visitors to High Elms Country Park and Keston Common. They are all visited and screened for minimum adverse effect on the countryside around.

3.d iii Down House and Grounds

Before 1842

127. When Darwin acquired Down House in 1842 it was already a complex structure with fabric of different periods. Building analysis, archaeological investigation, documentary records and cartographic research suggest that the first house was built in the mid-seventeenth century. It appears to have been substantially rebuilt in the 1730s or 40s and much of the fabric of the central main block dates from that period. It was modernised in the late eighteenth century, possibly by a purchaser in 1778, and a new kitchen and service block was built onto the southern end. Further modernisation was carried out in the early 1800s.

1842-1882 - Darwin's Occupancy

128. Shortly after acquiring the property and moving in, Darwin added a three-storey rear bay. He made further minor extensions in later years for his growing family and in 1872 he added a verandah outside the drawing room.

129. There are few records of the garden prior to the Darwin's occupation, but the tithe map of 1840 shows that there was then a pleasure garden to the west of the house planted with laurels, and a kitchen garden beyond, walled on three sides with a hedge for the southern boundary. The drive and turning circle was north of the house and was divided from the road by a wall and a row of large trees. In 1843, the drive was moved from the north of the house to its present location. The road was lowered and the spoil was used to construct a bank to the north of the house and mounds to the west on the lawn. A new orchard was established to the north of the house where the old drive had been. Paths were also improved and new ones made, and the kitchen garden was brought back into full production. In 1846 Darwin leased a strip of land adjoining Great House Meadow from Sir John Lubbock III, laid a path round it and planted it with woodland trees and native flowers. The path became known as the Sand-walk. In 1855-56 Darwin built a greenhouse in the kitchen garden. In 1863 and 1864 he added two heated compartments. In 1872 he purchased the freehold of the Sand-walk plot. In 1881 he built a tennis court and his garden laboratory for plant experiments.

1882-1907 - Mrs Darwin's Widowhood and After

130. Following Darwin's death, his wife Emma used Down House as a summer retreat but lived for the rest of the year in Cambridge with her sons. She maintained the garden and there are no surviving records of any



West Kent Golf Course

alterations. After her death in 1896 Down House remained in the ownership of the family. The greenhouse was renovated during 1898. Furniture was removed in 1899 and from 1900 to 1906 the property was let to a Mr Whitehead.

1907–1927 - Use by Two Schools

131. In 1907 the property was let by the Darwin family to Miss Olive Willis and she established Downe House School on the premises. The lawn to the west of the house was extended; some school buildings were constructed in the orchard, and the addition to the greenhouse was used as a science classroom. From 1922 to 1924 the property was empty and neglected. From 1924 to 1927 it was let by the Darwin family to another school. Nothing is recorded about any alterations to the garden.

1927–1996 - British Association and the Royal College of Surgeons

132. In 1927 Down House was bought by Sir George Buckston Browne, a wealthy surgeon, and presented to the British Association for the Advancement of Science for use as a Darwin museum. The house was repaired; the old study was restored and the Museum was opened in 1929. In 1953 the property was taken over by The Royal College of Surgeons. In 1959 the garden was restored by Lady Nora Barlow and Lady Margaret Keynes, Darwin's granddaughters, according to their memories of visits to the house during their childhood in the 1890s. In the 1960s the roadside wall to the east of the house was set back and lowered in height.

1996–2009 - English Heritage

133. In 1996 English Heritage acquired the freehold of Down House from the Royal College of Surgeons



The George and Dragon Public House today

with assistance from the Heritage Lottery Fund, and took over the running of the property. They carried out documentary, cartographic and pictorial research, archaeological investigations and analysis of the building fabric, historic wallpapers and paint scrapes, and undertook a major restoration of the property including the old study and drawing room. The garden and grounds were restored according to historic photographs, family documents, Darwin's scientific notes and his published writings. The fence between the garden lawn and the meadow was returned to its position in Darwin's time. Some inappropriate plants were replaced by plants known from records to have been grown by the Darwins; the garden paths were repaired and re-laid; the greenhouse was repaired and restocked with plants that Darwin had grown there; the orchard was replanted north of the house, and a number of Darwin's plant experiments were recreated there and in the kitchen garden. Visitor facilities were provided in a new single-storey building next to the old coach house, and a car park was created on a plot of land adjoining Darwin's property on the far side of the orchard.

3.d iv Down House and its Grounds as a Place of Pilgrimage

134. As Darwin's reputation grew around the world from the 1860s, scientists and others from many countries came to visit him, and after his death, Down House became a place of international pilgrimage. Its value for the appreciation and understanding of Darwin's heritage was acknowledged with the creation of the Darwin Museum at the house in 1929. The garden and Sand-walk were also opened to the public and since then, visitors from all regions of the globe have come to see the home of the man whose science they value, to stand in his study and greenhouse, to pace along his Sand-walk and observe the natural life from which he drew his inspiration. A recurring theme in visitors' accounts



Down House when it first opened as a museum in 1929



Down House today

is the 'sense of place', the feeling that the place was important for the science and that because of that close link, a visit can give a very special understanding of the achievement.

To know Charles Darwin, we must first know Downe. Darwin, quite unwittingly, made these few acres of Kent upland an international possession. Down House, then, is a common heritage for truth-seekers of all countries and of all centuries ... a permanent sanctuary for Darwinian pilgrims. In these gardens, orchards, meadows, and walks were slowly hammered, hot from fact, new doctrines which, radiating out from here, penetrated to the ends of the earth, giving humanity a new interpretation of living things and of its relationship to them. Human thought was forcibly and permanently thrust from its old time-honoured ruts. Down House, then, is a common heritage for truth-seekers of all countries and of all centuries.

Sir Arthur Keith speaking at the opening of the Darwin Museum, 1929

3.e Criteria for inscription

135. Darwin's Landscape Laboratory is nominated as a Property under the World Heritage Committee's Criteria (iii) and (vi) (Operational Guidelines (2008) paragraph 77) and as a cultural landscape.

136. Knowledge and its application is fundamental to human progress and the pursuit and application of knowledge underlies all achievements of humanity. Biological sciences underpin modern society and human survival through their role in agriculture, medicine and conservation. The natural sciences as a whole are of central importance to UNESCO because of their bearing on vital areas such as global warming, human health, the relief of poverty, and threats to biodiversity.

137. These achievements, many of which have been recognised on the World Heritage List, are in the fields of technology and agriculture as well in other fields of architecture and religion and are of Outstanding Universal Value to all. The World Heritage Convention recognises that cultural heritage may consist of monuments, groups of buildings and/or Properties which are of '*Outstanding Universal Value from the point of view of history, art or science*'. However, there is a gap in representation on the World Heritage List of Properties demonstrating scientific and technological importance. The natural sciences (physical sciences including astronomy and chemistry, and biological sciences) are particular areas under-represented on the List.

138. The World Heritage Committee has recognised this gap and in 2005 requested, 'the Director of the World Heritage Centre to further explore the thematic initiative "Astronomy and World Heritage" as a means to promote, in particular, nominations which recognize and celebrate achievements in science;' (Decision 29 COM 5B). In 2007, the Committee subsequently considered

the benefits of exploring further the opportunities, issues and additional guidance necessary to achieve its aims in recognising and celebrating achievements of science on the World Heritage List (Decision 31 COM 9). In response to this an Expert Working Group (EWG) met in London in 2008 to: assess and examine the interpretation of scientific heritage in the context of the 1972 WH Convention; identify the opportunities to celebrate landmarks of scientific achievement; develop guiding principles for the nomination and evaluation of such Properties; and recommend a framework for the Advisory Bodies to implement future thematic studies in this area.

139. In 2008 the Committee considered the recommendations of the EWG (WHC-08/32.COM/INF.10) and decided that the findings should be incorporated into the Operational Guidelines for the Implementation of the World Heritage Convention (Decisions 32 COM 10A and 32 COM 13). It is in the context of the World Heritage Committee's acknowledgement of these findings that the criteria for inscription for Darwin's Landscape Laboratory.

140. The key findings of the Expert Working Group (EWG) concerning the physical heritage were:

- There is often a strong link between the tangible and intangible heritage of scientific and/or technological Properties of possible Outstanding Universal Value. This is particularly so with scientific heritage, where the link to the intangible nature of 'great ideas' may be particularly strong.
- Nevertheless, for the World Heritage Convention, the focus should be upon the physical Properties, which are the tangible heritage, where great achievements of universal value were manifested, and to an extent, remain. Tangible evidence needs to survive and this can be in the form of landscape and natural features, buildings and objects.
- The tangible context for the original scientific insight is also important.
- The EWG noted that the World Heritage List is not primarily a means to commemorate famous individuals, and alternative means should be considered for recognition in most cases.
- Although each nomination should be examined on a case-by-case basis, the focus should be upon the place, or a collection of places, where the most important fundamental developments, of universal significance, occurred.

141. The Expert Working Group recognised that the principles of authenticity and integrity are fundamental to the World Heritage Convention. In the case of

scientific and technological heritage, the Expert Working Group suggested that it is possible to have elements of faithful reconstruction on a Property, in exceptional circumstances.

Criterion (iii)

142. Criterion (iii) requires that that the nominated Property should bear a unique or at least exceptional testimony to a cultural tradition or a civilisation which is living or which has disappeared.

143. The living cultural tradition is the modern scientific approach to the understanding of the natural world by observation, hypothesis and experiment, free and wide exchange of information and ideas, theory-building and communication.

144. The Property is a supreme testimony to that tradition showing how Darwin used the compact, varied and farmed landscape around his home together with his own house and grounds as resources for observations and experiments that were landmarks in the history of science. The patterns of life Darwin first observed are still available for us to see, in the valleys, fields, woods, meadows and grounds where Darwin studied them. The ability to repeat Darwin's observations and experiments, both in the nominated Property and also elsewhere around the world are important foundations of the tradition of modern science and is a powerful education tool. His scientific work was then combined with an exhaustive exchange of ideas with fellow scientists throughout the world and culminated in the development and production at Down House, of his world changing theories that are of fundamental importance for modern culture.

Charles Darwin's concept of evolution via natural selection pervades our entire understanding of the biosphere, and of humanity's place in nature. It is one of the greatest scientific ideas of all time. As an iconic figure, Darwin is matched only by Newton and Einstein - indeed, he has perhaps had a more pervasive influence on human culture than any other scientist. He is, more than most great men, associated with a single place where she lived, researched and wrote. Recognising the special status of Downe House and its environs would be a service to future generations who wish to understand his life and his mind.

Lord Rees, Astronomer Royal and President of the Royal Society

After all we have achieved at the Rio and Johannesburg Summits, I particularly welcome the emphasis on Darwin's historic role in explaining the central significance of biodiversity. It is wonderful to hear that the World Heritage Property will include the places where Darwin first studied biodiversity and envisioned the web of relations between all living creatures, and that we can see there today a wealth of flora and fauna close to those which inspired his great insights.

Maurice F Strong, Secretary-General of the Rio Earth Summit, 1992

This unique testimony is tangibly demonstrated in two ways:

145. Firstly the farmed and wooded valley landscape of the nominated Property, that attracted Darwin and led him to work in the locality for the last 40 years of his scientific maturity until the end of his life, leaving it seldom, still contains similar resources to those he documented and, studied. Many of his important observations and experiments on plant and animal life can be repeated today on the descendants of the plants and animals that Darwin observed.

146. Darwin accessed the landscape around his house and grounds via many historic lanes and paths. These enabled him to observe ploughed fields and the growing of crops, pasture for grazing for food and fodder, woodland coppicing and the laying of hedgerows and these can still be observed using the same lanes and paths that Darwin used. The underlying geology and soils, changing over short distances adds even greater variety to this managed landscape. This wealth and diversity of landscapes and habitats meant that Darwin seldom left the nominated Property.

147. Secondly Darwin's home and grounds contain many features which he created and used in his scientific research for *The Origin of Species* and his later work on plant and animal life. The property itself was essential for his achievements as it was his main workplace and open-air laboratory during the seventeen years he worked on the theory of evolution between the first sketch he pencilled in 1842 and the final publication in 1859. Among the bespoke arrangements that he created and used in his scientific work and still extant today are the study; the greenhouse, flower garden, lawn, orchard, sheltering banks and kitchen garden and the sandwalk copse and path which he planted and created. Among the features that were created by him which can be clearly seen today are:

- the study (now furnished with Darwin's own furniture, documents and books) he created documented in a photograph dated in the 1870's where he undertook his observations, documented his research, developed and tested his theories which he communicated to scholars world wide and wrote his books and scientific papers;
- the veranda he added to the house and on which he grew many kinds of creeper for his seminal investigations into climbing plants;
- the flower garden, lawn, orchard, sheltering banks and kitchen garden that he laid out, planted with many different species and varieties and managed for his many other studies of cultivated and wild plants, their insect pollinators and other organisms;
- the wormstone, an installation designed for his long-term scientific investigation of soil;
- the pasture he cultivated as a hay meadow and used for field experiments;
- the greenhouse and garden laboratory he built for cultivation and investigation of plants from other climates and habitats around the globe and for laboratory experiments; and
- the Sand-walk copse which he planted and maintained as an area of sheltered woodland, with the gravel path he laid down around the copse as his 'thinking path' for scientific contemplation.

148. The nominated Property was the setting for research of historic significance in zoology, botany and the study of biodiversity. The work was of fundamental importance for the life sciences as a whole, including core aspects of animal and plant physiology, palaeontology, ecology, anthropology, psychology, ethology, molecular biology, medical sciences and agricultural sciences. The achievement, based as it was on a uniquely effective combination of factual observation, conjecture, experiment, discussion, generalisation and exposition, stands as one of the greatest successes in history for the scientific approach as a whole.

*Charles Darwin is one of the several most important scientists of all time. His *On the Origin of Species* is with certainty the most important book. The incubation of his thought and the field work he conducted there make Downe one of the world's greatest historical sites.*

Professor Edward O Wilson, Harvard University, world authority on biodiversity and author of *The Diversity of Life* (1992)

Criterion (vi)

149. Criterion (vi) requires that the Property should be directly or tangibly associated with events or living traditions, with ideas or with beliefs, with artistic and literary works of outstanding universal significance. (Paragraph 77 (vi)).

As an Ecuadorian I see Darwin first at his point of insight in the Galapagos. Among conservationists with a global view of imperatives for protection of natural ecosystems, I value the fundamental truths about the interdependence of all forms of life which Darwin discovered and explained to us. The works he produced during his years at Downe and his example in field research have been our inspiration. Darwin's heritage at Downe is of outstanding value for the world's present and future understanding of conservation needs.

Sra. Yolanda Kakabadse, Executive President of the Fundacion Futuro Latinoamericano, former Minister for the Environment, Ecuador, and former President of IUCN

150. The ideas of Outstanding Universal Value with which the nominated Property is directly associated are Darwin's theory of evolution by natural selection, his explanation of global biodiversity as a fundamental principle of the natural world, and his demonstration of the ecological interdependence of all life forms. These three fundamental insights are closely intertwined and together provide the central principles for the present scientific understanding of the history of life on earth,

- a. the web of interrelations between organisms in ecosystems of all ranges,
- b. the influence of human pressures on the natural world and
- c. global needs for survival.

The ideas are of such outstanding significance that they have transcended the global scientific community and become a central feature in everyday life and understanding.

151. The Property has unique value for humanity's understanding of those ecological processes and biological diversity because it shows how they were first clearly identified and understood by Darwin. Darwin did this through careful observations in semi-natural habitats close to human settlement; studying how the processes work, globally, in all such habitats and all others; and how they can now be understood by anyone, anywhere who looks at the wildlife around them with the appreciation

Darwin gave us of the interactions between all living organisms and the endless flux they give rise to. Through his studies of the natural life in his neighbourhood at Downe and his comparisons of what he observed there with natural life in other places throughout the world, Darwin developed a truly global explanation of natural processes that is the basis for our present understanding of life on earth. The nominated Property articulates tangibly scientific understanding of the natural world, and the essential link between local views and the global perspective which Darwin developed with supreme effectiveness in his research at Downe and the outstanding series of works he produced there.

152. The ideas born in Darwin's Landscape Laboratory are so strong that people visited the Property as pilgrims even in Darwin's lifetime and have continued ever since. The global correspondence Darwin conducted resulted in his ideas being spread throughout the world. The Property was revered and recognised as it became a museum in 1929 and it has continued ever since to attract visitors from throughout the world. With the dawning of the development of photography Darwin became the first widely recognisable scientist. His image has since been popularly used internationally on banknotes, stamps and in cartoons. Darwin200 is an international programme of events celebrating Charles Darwin's scientific ideas and their impact focused around his two hundredth birthday in 2009.

153. It is one of the most distinctive and valuable features of Darwin's science that he found so many of his most important insights in the forms and life of plants, insects and animals that he observed in his everyday ordinary surroundings at Downe. Visitors to Downe are able to see what he saw and, as they do so, to share directly in his insights. But Darwin also, most importantly, presented his findings in such a way that anyone elsewhere can share his insights in their own surroundings if they learn what to observe and most importantly, how to look. Generations of scientists and naturalists around the world have done so and made Darwin's heritage their treasured possession.

154. The event of Outstanding Universal Value with which the nominated Property is directly linked was Darwin's writing and publication of *The Origin of Species* (1859), one of the most influential books of all time. This transformed scientific and wider public thinking about natural life and humans' place in the natural world. The change in thinking that the book brought about was a historic stage in the development of the modern understanding of life on earth and human nature.

Darwin's explanation of the processes of organic evolution is today the very basis of our understanding of nature and underpins biological research in every part of the world. It is humbling and salutary to realise that although as a young man he spent five years sailing round the world, he gathered and collated the vast majority of his evidence sitting in his study at Down House and observing, with unparalleled acuity, the processes of nature in his own English garden and surroundings. The house, its grounds and the countryside around must surely have a pre-eminent claim to be given World Heritage status.

Sir David Attenborough CH FRS, leading conservationist and presenter of the BBC television series, 'Life on Earth'

There is no law of nature more important than evolution. Darwin's profound insights were to see the unity underlying all living organisms and to understand how variation with natural selection has led to the glorious diversity of life.

James Watson, Nobel Laureate.

The importance of the Galapagos Islands as the living evolutionary laboratory where Darwin found the clue to evolution is abundantly clear. But without his reflections and investigations when he came to Downe, the lessons of the archipelago would not have developed into the theory that revolutionized science worldwide. While the Beagle voyage set the stage, Downe became the theatre where Darwin developed and tested his ideas. Although the habitats were man-managed and distant from the wild areas visited on the Beagle voyage, they displayed similar patterns of life and Darwin's findings there confirmed and added to evidence coming in from the rest of the globe. In this sense, Downe and Galapagos are inseparably linked in the development of the theory that changed the world.

Dr Jim Thorsell, Senior Advisor on World Heritage to IUCN and Board member of the Charles Darwin Foundation for the Galapagos.

Cultural Landscape

155. The countryside around Darwin's property which was so important to him in his scientific work is put forward as a cultural landscape on the basis of the 'powerful cultural associations of the natural element' (Operational Guidelines for the Implementation of the World Heritage Convention, Annex 3 paragraph 10).

The landscape around Downe provides a wonderful visual encapsulation of Darwin's appreciation of the immensity of geological time as he reflected on how the richness of the biological world could only have come about through evolution acting in the context of an ever-changing world. The totality of Darwin's world view can still be appreciated in the patterns of hills and valleys, hedgerows and woods. What a great thing it would be to preserve the outcome of his vision in all its complexity and compass.

Professor Richard Fortey FRS, Department of Palaeontology, Natural History Museum, author of Life, an Unauthorised Biography (1997) and Trilobite (2001).

Recognising this landmark location as a World Heritage Property would continue the legacy of enhancing mankind's education about the scientific underpinnings of Life on Earth.

Angela Cropper, Co-Chair of the UN Millennium Ecosystem Assessment and President of the Cropper Foundation, Trinidad and Tobago.

3.f Proposed Statement of Outstanding Universal Value

Summary

156. Darwin's Landscape Laboratory is the site where the modern scientific study of natural life was pioneered with the development of the theory of evolution by natural selection. It is an intimate farmed valley landscape surrounding Charles Darwin's home at Down House in the Kent North Downs. He walked in the Downe and Cudham valleys every day and studied them intensely for the forty years of his scientific maturity. Many landscape features bear unique witness to the evidence he collected for his world-changing ideas in the natural sciences that were developed at Down House.

157. Darwin's Landscape Laboratory is of fundamental importance to humanity because of his use of the landscape as a resource for science not simply as a commemoration of the man who developed the theory. The ideas developed at this Property have had a profound influence on life sciences, medicine, agriculture, philosophy and religion, as well as on general views of humankind's relation to other living creatures in the natural world and on the sustainability of the planet's resources.

158. Following his inspirational 5-year voyage around the world on HMS Beagle including 5 weeks observing and collecting on the Galapagos Islands in the Pacific, Darwin settled in London and then in 1842, moved 16 miles south to Down House to be able to investigate the natural life around him and to cater for his growing family. The surrounding farmed landscape and its varying geology and soil types also enabled him to access, via numerous footpaths and lanes, a wide variety of plants and wildlife, the raw materials for his research and scientific work. Finding all that he needed for his science he seldom left the locality until his death in 1882. The farmed landscape, together with Down House and its gardens were thus his workplace for his greatest period as a scientist. Easy access to nearby London and to the worldwide postal system, offered Darwin opportunities to test opinion of his developing theories from Downe.

159. The farmland and woodland management of the two small valleys linked by high ground has been sustained since Darwin's time. Thus the tangible context for his original scientific insight is clearly apparent. Darwin's home, gardens and many of habitats and features in the surrounding farmed valleys which he examined and used, survive to reflect his ideas which we are able to study in extensive and comprehensive

collections of Darwin's scientific writings. Due to there being no main roads or railway stations in the area it has escaped much of the 20th century development associated with London's hinterland and the landscape and buildings remain remarkably unchanged since Darwin's death.

Landscape

160. Down House is situated on a plateau, sloping from the south with chalk valleys both sides and an area of high ground to the north-west. A layer of impermeable acidic clay separates the two valleys and the surface water. After exceptionally heavy winter rain runs in small temporary streams known locally as 'bournes' or into man-made ponds. The steep valley sides have permeable chalk close to the surface, which means there are no permanent surface water features on the thin alkaline soil. As the chalk is overlain by sands and pebbles to the north at Keston, water quickly seeps through the thin acidic soil and emerges on the clay that supports the River Ravensbourne and the Keston bog.

161. The soils have been worked by man for woodland, pasture and arable farming for millennia. Very little of the landscape was or is natural in the sense of not being affected by human presence. It has been settled more or less continuously since pre-Roman times. There was a range of fluctuations in land use in Darwin's time. In 1842 it was just down from a maximum of arable following the Napoleonic wars; by the 1880s there was proportionately more pasture and some designed parkland. A mixture of small landholdings and parkland still exists and this allows a similar variety of land uses. The pasture continues to be managed by stock and horse grazing, meadows are cut for hay and these are interspersed by arable fields. The farmland was and remains separated frequently by hedgerows, many still managed by traditional laying and periodic cutting. The woodland persists on otherwise unproductive land and still exhibits management as high forest, coppice with standards or secondary woodland with scrub.

Darwin's use

162. Darwin's Landscape Laboratory is a man-managed cultural landscape in which Darwin observed processes such as clearance, grazing, ploughing and hedge-laying over time and their impact on natural habitats and the way in which the habitats change as a result. This intimate landscape of just 7km² enabled him to conduct in places very close together, a wide variety of activities such as: observation of wildlife; experimentation in natural settings and cultivation; and observation and experimentation in his grounds. He was welcome to

investigate the land owned by his neighbours within a 30 minute walk. An established network of lanes and footpaths, partly for managing the land and partly as access between settlements, was used by Darwin for half day outings from Down House to reach different places for study.

163. Darwin made extensive use of his own flower garden, lawn, orchard, kitchen garden, field, plantation and house for observation and experiment on cultivated and exotic plants, and native plants growing in the countryside around which he wanted to investigate with frequent and close monitoring.

164. The different semi-natural habitats, all in close proximity, supported the species that Darwin studied, including for example, 13 species of native wild orchid that still grow in the locality and which Darwin was able to examine as the basis for his work on the inter-dependence between orchids and their insect pollinators. He also used different slopes and flatlands in the neighbourhood for work his seminal work on the global influence of earthworms' perpetual working of the soil on landscape forms.

165. Time, both human and geological, was very important in Darwin's thinking, particularly for his theory that small changes could have large impact on natural forms and the evolution of species. In addition to geological observations and his observations on earthworm activity, he undertook a series of experiments and surveys, some lasting over 30 years. These include observations to show the:

- rate chalk and stones are subsumed into the soil;
- viability of buried seed over time;
- establishment of plant diversity in Great Pucklands; and
- ecological succession in grassland and hedgerows.

Attributes on which Outstanding Universal Value depends

166. The attributes of the landscape resource on which the Property's Outstanding Universal Value and which can all be seen today are:

- the geomorphology of the area, the compact 7km² valley landscape that Darwin observed and experimented in, with its two steep chalk valleys to the east and west of Down House standing on clay with flints soils between, with a promontory of sands and gravels to the north, which is a basis for the various semi-natural habitats for the range of organisms that Darwin studied;

- the range of semi-natural and managed habitats resulting from the human settlement of the area and its use for agriculture and forestry
- the many historic lanes and paths which enabled Darwin to explore the Property freely, collect and experiment as he wanted;
- the garden, plant houses and grounds at Down House, which Darwin was able to use both when he needed to make close or extended investigations of plants he found elsewhere in the landscape, and when he wanted to study plants from elsewhere in the world and compare them with local and native plants in order to reach conclusions of global value;
- Down House, Darwin's private home, which he was able to use to further his investigations of plants and other organisms in the landscape, and to draw together all his findings and produce the scientific works in which he gave his ideas to the world.
- Downe Village and other buildings within the landscape that reflect the social context for his work and the people in the local community on whose help he depended.

Features known to have been used by Darwin

33. There are many tangible features of the landscape which Darwin documented that he used for his science and these include:

Feature	Habitat/management
Semi-Natural habitats	
Keston Bog	Acid bog
Keston Common	Acid heathland
Cudham School Pond	Clay pond
Ravensbourne	Gravel stream
Hangrove	Ancient woodland
Downe Valley Terrace	Woodbank and chalk grassland
Orchis Bank	Chalk grassland
Holwood Park	Acid grassland
Managed habitats	
Sand-walk hedge	Managed hedge
Sand-walk copse	Plantation
Cudham Valley	Ploughed land
Great Pucklands	Pasture
Green Hill	Footpaths and bridleways
High Elms	Landscaped grounds

Down House grounds

Hay meadow	Hay and pasture
Lawn	Mowing grass like grazing
Kitchen garden	Cultivation and plant experiments
Flower bed	Exotic plants
Orchard	Domestication of fruit
Hothouse	Tropical plants
Greenhouse	Temperate plants

Down House

External walls	Climbing plants
Interior	Dissection, microscopy, observation of plants and animals Rooms for study, writing and talking.

Buildings

Farm buildings	Agriculture
Farmsteads	Agriculture
Gamekeeper's cottage	Management of game
Country mansions	Estate management
Gentry villas	Neighbours' help with horticulture
Villages with artisans' and labourers' cottages.	Crafts and labour
Village churches, schools and inns.	Community and education

3.g Authenticity and Integrity

Authenticity

167. Darwin was meticulous in recording his scientific work, and his observations and experiments at Downe are extensively documented in the many thousands of pages of his scientific papers and other material that survives from his time at Downe. There are also more than a hundred photographs and drawings of Down House, the grounds and Darwin's scientific work during the forty years he spent there. These have all been studied and archived and are available in the Darwin Collection at Down House and the Darwin Archive at Cambridge University Library and will be soon available electronically on the web.

168. Thus the relationship between Darwin and the landscape, and between Darwin and Down House, is based on firm evidence. He describes very clearly the landscape assets that were of value to him and the way he used them. He also describes in detail how he researched the evidence he collected at Down House.

169. There is further evidence for the form and evidence of use of the landscape in Darwin's time in historic mapping by the 1896 UK Ordnance Survey, and the 1840 Tithe Apportionment Survey, which can be used to assess the authenticity of the landscape as it survives.

170. The Nomination dossier shows how the relationship between Darwin and the landscape, what he was able to observe, and the evidence he chose to use, can be appreciated by visitors to the landscape today, as the key landscape characteristics and habitats created by farming and woodland practices still persist.

171. The Outstanding Universal Value of Darwin's Landscape Laboratory is truthfully and credibly expressed through the attributes that carry Outstanding Universal Value. These are:

- **The characteristics of the compact 7km² valley landscape that Darwin witnessed,**

172. The dense and varied landscape patterns, related to farming and woodland uses still persist. There have been few changes in field patterns or paths and tracks; there is still a mix of meadows, pasture, arable and woodland uses, and the habitats that Darwin observed have been maintained. In many cases, the original field boundaries, whether hedgerow, wooded banks, survive. The factual basis is provided in the full records of the uses of the land in 1840, 1869 and 1942 which survive in the 1840 Tithe Reapportionment Survey of the two parishes, the 1869 25 inch Ordnance Survey and Books of Reference, the 1942

National Farm Survey and aerial photographs from the last 60 years.

- **Farming and woodland traditions**

173. Farming is still the dominant land use, although some meadows are now managed by conservation volunteers rather than farmers; the woodlands are now maintained for conservation reasons rather than as productive woodlands but where appropriate following local practices such as coppicing. Overall the distinctive mix of arable, pasture and managed woodland, so important for Darwin's work, is maintained in present times.

- **The many varied habitats that Darwin studied;**

174. The majority of the complete range of habitats that Darwin studied – as a by-product of geology and the farming and woodland systems – still survives to be studied today. The most significant loss, of 80% of the open heathland and bog on Keston Common, is reversible through management of the vegetation on the Common, and action is in hand to restore the former habitats and reintroduce *Drosera rotundifolia*, one of only three individual plant species out of over 50 important for Darwin to have been lost.

- **Lanes and paths which enabled Darwin to explore the Property freely**

175. These are still in place and have public access

- **Down House, and garden**

176. Darwin's house and garden have survived well since Darwin's time despite its twenty year period as a school. The original fabric of the house, garden and estate still survives (in excess of 90%) and is clearly recognisable. English Heritage purchased the property in 1996 from the Royal College of Surgeons who were responsible for display of the museum to the public and undertook a meticulous archaeological, architectural, cartographic, pictorial and documentary survey of the house to inform repair, maintenance and interpretation proposals. Given the wealth of documentary and photographic evidence of the study in 1877 it was decided that the reassemblage of material should be based on that date.

178. It has thus been possible, as has been set out above, to conserve and restore the house using evidence from:

- Darwin's scientific papers
- Physical evidence from the building (e.g. paint, wallpaper, floor coverings etc)

- Correspondence of Darwin's family and accounts of visitors to the House
- Darwin's correspondence
- Archaeology in the garden and building recording
- Botanical analysis

179. This was aided by oral history as many of Darwin's family were involved and have items on long term loan, and photographs taken by Darwin's son Leonard. Original furnishings and furniture have been used wherever available and possible although wallpaper and paint surfaces have been refreshed to enable visitors to see the home and resource where Darwin worked.

180. Some elements of the building's history e.g. some of the buildings connected to its brief use as a school were removed in the early 20th century when the house was converted into a museum by Buxton Brown. Nonetheless, the greater part of the fabric of Down House and its outbuildings survives as they existed in Darwin's time, original and untouched. The only significant losses have been a small section of the greenhouse, the fixtures of the garden laboratory, the well-head, some outbuildings for livestock and the pigeon house which was a wooden structure subject to decay.

181. Some replanting work has taken place in the garden reflecting the fact that annual and perennial plants have a finite life but the basic structure, the hedge plants, many of the trees, greenhouse base (but not the glass) and Sandwalk are original. The garden has been restocked carefully according to available documentary sources and key experiments recreated to aid visitor understanding.

- **Downe and Cudham Villages**

182. These villages were the houses of the farmers, workers and artisan people who worked the land that Darwin used. The villages are now protected as Conservation Areas.

183. The "Downe Village Conservation Area Appraisal and Management Plan 2008" describes the built form of the village as being that of a small rural settlement, clustered closely around a road junction with the 13th Century Church of St Mary the Virgin in its churchyard taking a prominent central position. Comparison with the Ordnance Survey Maps of 1868-78 shows that the strong nuclear form of the village has not changed significantly since that time. There has been very little development taking place in the village since mid-Victorian times. There are 8 statutory listed buildings (including the grade II* listed church) and 15 locally

listed; all buildings are protected by virtue of being in the Conservation Area. Victorian photos show that despite some buildings having been altered and despite the presence of parked cars, the general appearance and form of the village has not changed.

184. The “Cudham Village Conservation Area Appraisal and Management Plan 2008” describes Cudham as a dispersed village strung out along Cudham Lane but with vernacular cottages and farmyard buildings grouped tightly around the 12th century Church of St Peter and St Paul. This group of buildings has not altered significantly since Victorian times, neither has there been any prominent development. The church and nearby Cudham Court are Statutorily Listed and the 4 cottages in the central group are Locally Listed. All buildings in the village are protected by virtue of being in the Conservation Area.

185. Both villages are active places where people today live and work and inevitably, there are some aspects of modern life that affect their appearance. For example, parked cars are present at most times of the day. The villages however retain much of their quiet rural charm and an understanding of village life in the time of Charles Darwin can still be appreciated. The cars and other aspects of modern activity do not detract from the Outstanding Universal Value as represented by the particular features of the landscape as described above.

186. There are other intrusions from the modern world that reflect the property’s location on the edge of London and which impact to a degree on the way the attributes carry Outstanding Universal Value. In particular, there is a line of electricity pylons which cross the northern part of Cudham Valley, and the low noise of aircraft using London Biggin Hill Airport and flying at high altitude to Gatwick and Heathrow. Whilst these factors do have some adverse effect on the appearance and ambience of a small part of the northern part of the nominated Property, they do not detract significantly from the Outstanding Universal Value as represented by the particular features in the landscape as described above.

187. The physical fabric of Down House is in good condition and the effects of deterioration processes on Down House and its gardens are controlled by strict conservation management. Similarly, the other buildings in the two villages and elsewhere in the nominated Property are generally in good condition and protected by statutory controls to prevent their deterioration. Appropriate management is undertaken of the wider landscape in the nominated Property to sustain the

attributes. In conclusion, the attributes identified clearly express truthfully the Outstanding Universal Value of the Property.

Integrity

188. The nominated Property includes all the attributes necessary to express the outstanding universal value of the Property – almost the entire rural landscape around Down House in which Darwin observed and collected plants and insects during his 20 years there and the specific places that were important for his observations and research.

189. The only elements of the landscape that Darwin used on a regular basis and which lie outside the boundary are parts of the Big Woods as these are now separated from the main valleys by a golf course. Sufficient attributes lie within the boundary to encapsulate the Outstanding Universal Value of the Property and thus allow the landscape to be perceived through the eyes of Darwin and show how assets of a fairly commonplace landscape could be used to demonstrate universal scientific theories, which changed perceptions of the way the world evolved.

190. There are few adverse impacts of development and/ or neglect. As noted above, there is some visual intrusion from electricity pylons across the northern part of the Cudham valley. There is also evidence of modern traffic in the form of parked cars and the use by them of the roads within the Property. Nonetheless, the nominated Property maintains a high level of integrity.

