

= Charles Darwin =

Charles Robert Darwin , FRS FRGS FLS FZS ( / ?d??rw?n / ; 12 February 1809 ? 19 April 1882 ) was an English naturalist and geologist , best known for his contributions to the science of evolution . He established that all species of life have descended over time from common ancestors , and in a joint publication with Alfred Russel Wallace introduced his scientific theory that this branching pattern of evolution resulted from a process that he called natural selection , in which the struggle for existence has a similar effect to the artificial selection involved in selective breeding .

Darwin published his theory of evolution with compelling evidence in his 1859 book *On the Origin of Species* , overcoming scientific rejection of earlier concepts of transmutation of species . By the 1870s , the scientific community and much of the general public had accepted evolution as a fact . However , many favoured competing explanations and it was not until the emergence of the modern evolutionary synthesis from the 1930s to the 1950s that a broad consensus developed in which natural selection was the basic mechanism of evolution . In modified form , Darwin 's scientific discovery is the unifying theory of the life sciences , explaining the diversity of life .

Darwin 's early interest in nature led him to neglect his medical education at the University of Edinburgh ; instead , he helped to investigate marine invertebrates . Studies at the University of Cambridge ( Christ 's College ) encouraged his passion for natural science . His five @-@ year voyage on HMS Beagle established him as an eminent geologist whose observations and theories supported Charles Lyell 's uniformitarian ideas , and publication of his journal of the voyage made him famous as a popular author .

Puzzled by the geographical distribution of wildlife and fossils he collected on the voyage , Darwin began detailed investigations and in 1838 conceived his theory of natural selection . Although he discussed his ideas with several naturalists , he needed time for extensive research and his geological work had priority . He was writing up his theory in 1858 when Alfred Russel Wallace sent him an essay that described the same idea , prompting immediate joint publication of both of their theories . Darwin 's work established evolutionary descent with modification as the dominant scientific explanation of diversification in nature . In 1871 he examined human evolution and sexual selection in *The Descent of Man* , and *Selection in Relation to Sex* , followed by *The Expression of the Emotions in Man and Animals* . His research on plants was published in a series of books , and in his final book , *The Formation of Vegetable Mould , through the Actions of Worms* ( published 1881 ) , he examined earthworms and their effect on soil .

Darwin has been described as one of the most influential figures in human history ; and was honoured by burial in Westminster Abbey .

= = Biography = =

= = = Early life and education = = =

Charles Robert Darwin was born in Shrewsbury , Shropshire , England , on 12 February 1809 at his family 's home , The Mount . He was the fifth of six children of wealthy society doctor and financier Robert Darwin , and of Susannah Darwin ( née Wedgwood ) . He was the grandson of two prominent abolitionists : Erasmus Darwin on his father 's side , and Josiah Wedgwood on his mother 's side .

Both families were largely Unitarian , though the Wedgwoods were adopting Anglicanism . Robert Darwin , himself quietly a freethinker , had baby Charles baptised in November 1809 in the Anglican St Chad 's Church , Shrewsbury , but Charles and his siblings attended the Unitarian chapel with their mother . The eight @-@ year @-@ old Charles already had a taste for natural history and collecting when he joined the day school run by its preacher in 1817 . That July , his mother died . From September 1818 , he joined his older brother Erasmus attending the nearby Anglican Shrewsbury School as a boarder .

Darwin spent the summer of 1825 as an apprentice doctor , helping his father treat the poor of

Shropshire , before going to the University of Edinburgh Medical School ( at the time the best medical school in the UK ) with his brother Erasmus in October 1825 . He found lectures dull and surgery distressing , so neglected his studies . He learned taxidermy in around 40 daily hour @-@ long sessions from John Edmonstone , a freed black slave who had accompanied Charles Waterton in the South American rainforest .

In Darwin 's second year at the university he joined the Plinian Society , a student natural @-@ history group featuring lively debates in which radical democratic students with materialistic views challenged orthodox religious concepts of science . He assisted Robert Edmond Grant 's investigations of the anatomy and life cycle of marine invertebrates in the Firth of Forth , and on 27 March 1827 presented at the Plinian his own discovery that black spores found in oyster shells were the eggs of a skate leech . One day , Grant praised Lamarck 's evolutionary ideas . Darwin was astonished by Grant 's audacity , but had recently read similar ideas in his grandfather Erasmus ' journals . Darwin was rather bored by Robert Jameson 's natural @-@ history course , which covered geology - including the debate between Neptunism and Plutonism . He learned the classification of plants , and assisted with work on the collections of the University Museum , one of the largest museums in Europe at the time .

Darwin 's neglect of medical studies annoyed his father , who shrewdly sent him to Christ 's College , Cambridge , to study for a Bachelor of Arts degree as the first step towards becoming an Anglican parson . As Darwin was unqualified for the Tripos , he joined the ordinary degree course in January 1828 . He preferred riding and shooting to studying . His cousin William Darwin Fox introduced him to the popular craze for beetle collecting ; Darwin pursued this zealously , getting some of his finds published in Stevens ' Illustrations of British entomology . He became a close friend and follower of botany professor John Stevens Henslow and met other leading parson @-@ naturalists who saw scientific work as religious natural theology , becoming known to these dons as " the man who walks with Henslow " . When his own exams drew near , Darwin focused on his studies and was delighted by the language and logic of William Paley 's Evidences of Christianity ( 1794 ) . In his final examination in January 1831 Darwin did well , coming tenth out of 178 candidates for the ordinary degree .

Darwin had to stay at Cambridge until June 1831 . He studied Paley 's Natural Theology or Evidences of the Existence and Attributes of the Deity ( first published in 1802 ) , which made an argument for divine design in nature , explaining adaptation as God acting through laws of nature . He read John Herschel 's new book , Preliminary Discourse on the Study of Natural Philosophy ( 1831 ) , which described the highest aim of natural philosophy as understanding such laws through inductive reasoning based on observation , and Alexander von Humboldt 's Personal Narrative of scientific travels in 1799 @-@ 1804 . Inspired with " a burning zeal " to contribute , Darwin planned to visit Tenerife with some classmates after graduation to study natural history in the tropics . In preparation , he joined Adam Sedgwick 's geology course , then travelled with him in the summer for a fortnight , in order to map strata in Wales .

= = = Voyage of the Beagle = = =

After a week with student friends at Barmouth , Darwin returned home on 29 August to find a letter from Henslow proposing him as a suitable ( if unfinished ) gentleman naturalist for a self @-@ funded supernumerary place on HMS Beagle with captain Robert FitzRoy , more as a companion than a mere collector . The ship was to leave in four weeks on an expedition to chart the coastline of South America . Robert Darwin objected to his son 's planned two @-@ year voyage , regarding it as a waste of time , but was persuaded by his brother @-@ in @-@ law , Josiah Wedgwood , to agree to ( and fund ) his son 's participation . Darwin took care to remain in a private capacity to retain control over his collection : the ship 's surgeon Robert McCormick expected to be the official naturalist .

After delays , the voyage began on 27 December 1831 ; it lasted almost five years . As FitzRoy had intended , Darwin spent most of that time on land investigating geology and making natural history collections , while the Beagle surveyed and charted coasts . He kept careful notes of his

observations and theoretical speculations , and at intervals during the voyage his specimens were sent to Cambridge together with letters including a copy of his journal for his family . He had some expertise in geology , beetle collecting and dissecting marine invertebrates , but in all other areas was a novice and ably collected specimens for expert appraisal . Despite suffering badly from seasickness , Darwin wrote copious notes while on board the ship . Most of his zoology notes are about marine invertebrates , starting with plankton collected in a calm spell .

On their first stop ashore at St Jago in Cape Verde , Darwin found that a white band high in the volcanic rock cliffs included seashells . FitzRoy had given him the first volume of Charles Lyell 's Principles of Geology , which set out uniformitarian concepts of land slowly rising or falling over immense periods , and Darwin saw things Lyell 's way , theorising and thinking of writing a book on geology .

When they reached Brazil , Darwin was delighted by the tropical forest , but detested the sight of slavery . McCormick left the ship at this point , feeling that Darwin had supplanted him as naturalist .

The survey continued to the south in Patagonia . They stopped at Bahía Blanca , and in cliffs near Punta Alta Darwin made a major find of fossil bones of huge extinct mammals beside modern seashells , indicating recent extinction with no signs of change in climate or catastrophe . He identified the little @-@ known Megatherium by a tooth and its association with bony armour , which had at first seemed to him to be like a giant version of the armour on local armadillos . The finds brought great interest when they reached England .

On rides with gauchos into the interior to explore geology and collect more fossils , Darwin gained social , political and anthropological insights into both native and colonial people at a time of revolution , and learnt that two types of rhea had separate but overlapping territories . Further south , he saw stepped plains of shingle and seashells as raised beaches showing a series of elevations . He read Lyell 's second volume and accepted its view of " centres of creation " of species , but his discoveries and theorising challenged Lyell 's ideas of smooth continuity and of extinction of species .

Three Fuegians on board had been seized during the first Beagle voyage , then during a year in England were educated as missionaries . Darwin found them friendly and civilised , yet at Tierra del Fuego he met " miserable , degraded savages " , as different as wild from domesticated animals . He remained convinced that , despite this diversity , all humans were interrelated with a shared origin and potential for improvement towards civilisation . Unlike his scientist friends , he now thought there was no unbridgeable gap between humans and animals . A year on , the mission had been abandoned . The Fuegian they had named Jemmy Button lived like the other natives , had a wife , and had no wish to return to England .

Darwin experienced an earthquake in Chile and saw signs that the land had just been raised , including mussel @-@ beds stranded above high tide . High in the Andes he saw seashells , and several fossil trees that had grown on a sand beach . He theorised that as the land rose , oceanic islands sank , and coral reefs round them grew to form atolls .

On the geologically new Galápagos Islands , Darwin looked for evidence attaching wildlife to an older " centre of creation " , and found mockingbirds allied to those in Chile but differing from island to island . He heard that slight variations in the shape of tortoise shells showed which island they came from , but failed to collect them , even after eating tortoises taken on board as food . In Australia , the marsupial rat @-@ kangaroo and the platypus seemed so unusual that Darwin thought it was almost as though two distinct Creators had been at work . He found the Aborigines " good @-@ humoured & pleasant " , and noted their depletion by European settlement .

The Beagle investigated how the atolls of the Cocos ( Keeling ) Islands had formed , and the survey supported Darwin 's theorising . FitzRoy began writing the official Narrative of the Beagle voyages , and after reading Darwin 's diary he proposed incorporating it into the account . Darwin 's Journal was eventually rewritten as a separate third volume , on natural history .

In Cape Town , Darwin and FitzRoy met John Herschel , who had recently written to Lyell praising his uniformitarianism as opening bold speculation on " that mystery of mysteries , the replacement of extinct species by others " as " a natural in contradistinction to a miraculous process " . When organising his notes as the ship sailed home , Darwin wrote that , if his growing suspicions about the

mockingbirds , the tortoises and the Falkland Islands fox were correct , " such facts undermine the stability of Species " , then cautiously added " would " before " undermine " . He later wrote that such facts " seemed to me to throw some light on the origin of species " .

= = = Inception of Darwin 's evolutionary theory = = =

When the Beagle reached Falmouth , Cornwall , on 2 October 1836 , Darwin was already a celebrity in scientific circles as in December 1835 Henslow had fostered his former pupil 's reputation by giving selected naturalists a pamphlet of Darwin 's geological letters . Darwin visited his home in Shrewsbury and saw relatives , then hurried to Cambridge to see Henslow , who advised him on finding naturalists available to catalogue the collections and agreed to take on the botanical specimens . Darwin 's father organised investments , enabling his son to be a self @-@ funded gentleman scientist , and an excited Darwin went round the London institutions being fêted and seeking experts to describe the collections . Zoologists had a huge backlog of work , and there was a danger of specimens just being left in storage .

Charles Lyell eagerly met Darwin for the first time on 29 October and soon introduced him to the up @-@ and @-@ coming anatomist Richard Owen , who had the facilities of the Royal College of Surgeons to work on the fossil bones collected by Darwin . Owen 's surprising results included other gigantic extinct ground sloths as well as the Megatherium , a near complete skeleton of the unknown Scelidotherium and a hippopotamus @-@ sized rodent @-@ like skull named Toxodon resembling a giant capybara . The armour fragments were actually from Glyptodon , a huge armadillo @-@ like creature as Darwin had initially thought . These extinct creatures were related to living species in South America .

In mid @-@ December , Darwin took lodgings in Cambridge to organise work on his collections and rewrite his Journal . He wrote his first paper , showing that the South American landmass was slowly rising , and with Lyell 's enthusiastic backing read it to the Geological Society of London on 4 January 1837 . On the same day , he presented his mammal and bird specimens to the Zoological Society . The ornithologist John Gould soon announced that the Galapagos birds that Darwin had thought a mixture of blackbirds , " gros @-@ beaks " and finches , were , in fact , twelve separate species of finches . On 17 February , Darwin was elected to the Council of the Geological Society , and Lyell 's presidential address presented Owen 's findings on Darwin 's fossils , stressing geographical continuity of species as supporting his uniformitarian ideas .

Early in March , Darwin moved to London to be near this work , joining Lyell 's social circle of scientists and experts such as Charles Babbage , who described God as a programmer of laws . Darwin stayed with his freethinking brother Erasmus , part of this Whig circle and a close friend of the writer Harriet Martineau , who promoted Malthusianism underlying the controversial Whig Poor Law reforms to stop welfare from causing overpopulation and more poverty . As a Unitarian , she welcomed the radical implications of transmutation of species , promoted by Grant and younger surgeons influenced by Geoffroy . Transmutation was anathema to Anglicans defending social order , but reputable scientists openly discussed the subject and there was wide interest in John Herschel 's letter praising Lyell 's approach as a way to find a natural cause of the origin of new species .

Gould met Darwin and told him that the Galápagos mockingbirds from different islands were separate species , not just varieties , and what Darwin had thought was a " wren " was also in the finch group . Darwin had not labelled the finches by island , but from the notes of others on the Beagle , including FitzRoy , he allocated species to islands . The two rheas were also distinct species , and on 14 March Darwin announced how their distribution changed going southwards .

By mid @-@ March , Darwin was speculating in his Red Notebook on the possibility that " one species does change into another " to explain the geographical distribution of living species such as the rheas , and extinct ones such as the strange Macrauchenia , which resembled a giant guanaco . His thoughts on lifespan , asexual reproduction and sexual reproduction developed in his " B " notebook around mid @-@ July on to variation in offspring " to adapt & alter the race to changing world " explaining the Galápagos tortoises , mockingbirds and rheas . He sketched branching descent , then a genealogical branching of a single evolutionary tree , in which " It is absurd to talk

of one animal being higher than another " , discarding Lamarck 's independent lineages progressing to higher forms .

= = = Overwork , illness , and marriage = = =

While developing this intensive study of transmutation , Darwin became mired in more work . Still rewriting his Journal , he took on editing and publishing the expert reports on his collections , and with Henslow 's help obtained a Treasury grant of £ 1 @, @ 000 to sponsor this multi @-@ volume Zoology of the Voyage of H.M.S. Beagle , a sum equivalent to about £ 82 @, @ 000 in 2014 . He stretched the funding to include his planned books on geology , and agreed to unrealistic dates with the publisher . As the Victorian era began , Darwin pressed on with writing his Journal , and in August 1837 began correcting printer 's proofs .

Darwin 's health suffered under the pressure . On 20 September he had " an uncomfortable palpitation of the heart " , so his doctors urged him to " knock off all work " and live in the country for a few weeks . After visiting Shrewsbury he joined his Wedgwood relatives at Maer Hall , Staffordshire , but found them too eager for tales of his travels to give him much rest . His charming , intelligent , and cultured cousin Emma Wedgwood , nine months older than Darwin , was nursing his invalid aunt . His uncle Jos pointed out an area of ground where cinders had disappeared under loam and suggested that this might have been the work of earthworms , inspiring " a new & important theory " on their role in soil formation , which Darwin presented at the Geological Society on 1 November .

William Whewell pushed Darwin to take on the duties of Secretary of the Geological Society . After initially declining the work , he accepted the post in March 1838 . Despite the grind of writing and editing the Beagle reports , Darwin made remarkable progress on transmutation , taking every opportunity to question expert naturalists and , unconventionally , people with practical experience such as farmers and pigeon fanciers . Over time , his research drew on information from his relatives and children , the family butler , neighbours , colonists and former shipmates . He included mankind in his speculations from the outset , and on seeing an orangutan in the zoo on 28 March 1838 noted its childlike behaviour .

The strain took a toll , and by June he was being laid up for days on end with stomach problems , headaches and heart symptoms . For the rest of his life , he was repeatedly incapacitated with episodes of stomach pains , vomiting , severe boils , palpitations , trembling and other symptoms , particularly during times of stress , such as attending meetings or making social visits . The cause of Darwin 's illness remained unknown , and attempts at treatment had little success .

On 23 June , he took a break and went " geologising " in Scotland . He visited Glen Roy in glorious weather to see the parallel " roads " cut into the hillsides at three heights . He later published his view that these were marine raised beaches , but then had to accept that they were shorelines of a proglacial lake .

Fully recuperated , he returned to Shrewsbury in July . Used to jotting down daily notes on animal breeding , he scrawled rambling thoughts about career and prospects on two scraps of paper , one with columns headed " Marry " and " Not Marry " . Advantages included " constant companion and a friend in old age ... better than a dog anyhow " , against points such as " less money for books " and " terrible loss of time . " Having decided in favour , he discussed it with his father , then went to visit Emma on 29 July . He did not get around to proposing , but against his father 's advice he mentioned his ideas on transmutation .

= = = Malthus and natural selection = = =

Continuing his research in London , Darwin 's wide reading now included the sixth edition of Malthus 's An Essay on the Principle of Population , and on 28 September 1838 he noted its assertion that human " population , when unchecked , goes on doubling itself every twenty five years , or increases in a geometrical ratio " , a geometric progression so that population soon exceeds food supply in what is known as a Malthusian catastrophe . Darwin was well prepared to

compare this to de Candolle 's " warring of the species " of plants and the struggle for existence among wildlife , explaining how numbers of a species kept roughly stable . As species always breed beyond available resources , favourable variations would make organisms better at surviving and passing the variations on to their offspring , while unfavourable variations would be lost . He wrote that the " final cause of all this wedging , must be to sort out proper structure , & adapt it to changes " , so that " One may say there is a force like a hundred thousand wedges trying force into every kind of adapted structure into the gaps of in the economy of nature , or rather forming gaps by thrusting out weaker ones . " This would result in the formation of new species . As he later wrote in his Autobiography :

In October 1838 , that is , fifteen months after I had begun my systematic enquiry , I happened to read for amusement Malthus on Population , and being well prepared to appreciate the struggle for existence which everywhere goes on from long @-@ continued observation of the habits of animals and plants , it at once struck me that under these circumstances favourable variations would tend to be preserved , and unfavourable ones to be destroyed . The result of this would be the formation of new species . Here , then , I had at last got a theory by which to work ... "

By mid December , Darwin saw a similarity between farmers picking the best stock in selective breeding , and a Malthusian Nature selecting from chance variants so that " every part of newly acquired structure is fully practical and perfected " , thinking this comparison " a beautiful part of my theory " . He later called his theory natural selection , an analogy with what he termed the artificial selection of selective breeding .

On 11 November , he returned to Maer and proposed to Emma , once more telling her his ideas . She accepted , then in exchanges of loving letters she showed how she valued his openness in sharing their differences , also expressing her strong Unitarian beliefs and concerns that his honest doubts might separate them in the afterlife . While he was house @-@ hunting in London , bouts of illness continued and Emma wrote urging him to get some rest , almost prophetically remarking " So don 't be ill any more my dear Charley till I can be with you to nurse you . " He found what they called " Macaw Cottage " ( because of its gaudy interiors ) in Gower Street , then moved his " museum " in over Christmas . On 24 January 1839 , Darwin was elected a Fellow of the Royal Society ( FRS ) .

On 29 January , Darwin and Emma Wedgwood were married at Maer in an Anglican ceremony arranged to suit the Unitarians , then immediately caught the train to London and their new home .

= = = Geology books , barnacles , evolutionary research = = =

Darwin now had the framework of his theory of natural selection " by which to work " , as his " prime hobby " . His research included extensive experimental selective breeding of plants and animals , finding evidence that species were not fixed and investigating many detailed ideas to refine and substantiate his theory . For fifteen years this work was in the background to his main occupation of writing on geology and publishing expert reports on the Beagle collections .

When FitzRoy 's Narrative was published in May 1839 , Darwin 's Journal and Remarks was such a success as the third volume that later that year it was published on its own . Early in 1842 , Darwin wrote about his ideas to Charles Lyell , who noted that his ally " denies seeing a beginning to each crop of species " .

Darwin 's book The Structure and Distribution of Coral Reefs on his theory of atoll formation was published in May 1842 after more than three years of work , and he then wrote his first " pencil sketch " of his theory of natural selection . To escape the pressures of London , the family moved to rural Down House in September . On 11 January 1844 , Darwin mentioned his theorising to the botanist Joseph Dalton Hooker , writing with melodramatic humour " it is like confessing a murder " . Hooker replied " There may in my opinion have been a series of productions on different spots , & also a gradual change of species . I shall be delighted to hear how you think that this change may have taken place , as no presently conceived opinions satisfy me on the subject . "

By July , Darwin had expanded his " sketch " into a 230 @-@ page " Essay " , to be expanded with his research results if he died prematurely . In November , the anonymously published sensational

best @-@ seller Vestiges of the Natural History of Creation brought wide interest in transmutation . Darwin scorned its amateurish geology and zoology , but carefully reviewed his own arguments . Controversy erupted , and it continued to sell well despite contemptuous dismissal by scientists .

Darwin completed his third geological book in 1846 . He now renewed a fascination and expertise in marine invertebrates , dating back to his student days with Grant , by dissecting and classifying the barnacles he had collected on the voyage , enjoying observing beautiful structures and thinking about comparisons with allied structures . In 1847 , Hooker read the " Essay " and sent notes that provided Darwin with the calm critical feedback that he needed , but would not commit himself and questioned Darwin 's opposition to continuing acts of creation .

In an attempt to improve his chronic ill health , Darwin went in 1849 to Dr. James Gully 's Malvern spa and was surprised to find some benefit from hydrotherapy . Then , in 1851 , his treasured daughter Annie fell ill , reawakening his fears that his illness might be hereditary , and after a long series of crises she died .

In eight years of work on barnacles ( Cirripedia ) , Darwin 's theory helped him to find " homologies " showing that slightly changed body parts served different functions to meet new conditions , and in some genera he found minute males parasitic on hermaphrodites , showing an intermediate stage in evolution of distinct sexes . In 1853 , it earned him the Royal Society 's Royal Medal , and it made his reputation as a biologist . In 1854 he became a Fellow of the Linnean Society of London , gaining postal access to its library . He began a major reassessment of his theory of species , and in November realised that divergence in the character of descendants could be explained by them becoming adapted to " diversified places in the economy of nature " .

= = = Publication of the theory of natural selection = = =

By the start of 1856 , Darwin was investigating whether eggs and seeds could survive travel across seawater to spread species across oceans . Hooker increasingly doubted the traditional view that species were fixed , but their young friend Thomas Henry Huxley was firmly against the transmutation of species . Lyell was intrigued by Darwin 's speculations without realising their extent . When he read a paper by Alfred Russel Wallace , " On the Law which has Regulated the Introduction of New Species " , he saw similarities with Darwin 's thoughts and urged him to publish to establish precedence . Though Darwin saw no threat , on 14 May 1856 he began writing a short paper . Finding answers to difficult questions held him up repeatedly , and he expanded his plans to a " big book on species " titled Natural Selection , which was to include his " note on Man " . He continued his researches , obtaining information and specimens from naturalists worldwide including Wallace who was working in Borneo . In mid @-@ 1857 he added a chapter heading ; " Theory applied to Races of Man " , but then left out this topic . On 5 September 1857 , Darwin sent the American botanist Asa Gray a detailed outline of his ideas , including an abstract of Natural Selection , which omitted human origins and sexual selection . In December , Darwin received a letter from Wallace asking if the book would examine human origins . He responded that he would avoid that subject , " so surrounded with prejudices " , while encouraging Wallace 's theorising and adding that " I go much further than you . "

Darwin 's book was only partly written when , on 18 June 1858 , he received a paper from Wallace describing natural selection . Shocked that he had been " forestalled " , Darwin sent it on that day to Lyell , as requested by Wallace , and although Wallace had not asked for publication , Darwin suggested he would send it to any journal that Wallace chose . His family was in crisis with children in the village dying of scarlet fever , and he put matters in the hands of his friends . After some discussion , Lyell and Hooker decided on a joint presentation at the Linnean Society on 1 July of On the Tendency of Species to form Varieties ; and on the Perpetuation of Varieties and Species by Natural Means of Selection . On the evening of 28 June , Darwin 's baby son died of scarlet fever after almost a week of severe illness , and he was too distraught to attend .

There was little immediate attention to this announcement of the theory ; the president of the Linnean Society remarked in May 1859 that the year had not been marked by any revolutionary discoveries . Only one review rankled enough for Darwin to recall it later ; Professor Samuel

Haughton of Dublin claimed that " all that was new in them was false , and what was true was old " . Darwin struggled for thirteen months to produce an abstract of his " big book " , suffering from ill health but getting constant encouragement from his scientific friends . Lyell arranged to have it published by John Murray .

On the Origin of Species proved unexpectedly popular , with the entire stock of 1 @, @ 250 copies oversubscribed when it went on sale to booksellers on 22 November 1859 . In the book , Darwin set out " one long argument " of detailed observations , inferences and consideration of anticipated objections . In making the case for common descent , he included evidence of homologies between humans and other mammals . Having outlined sexual selection , he hinted that it could explain differences between human races . He avoided explicit discussion of human origins , but implied the significance of his work with the sentence ; " Light will be thrown on the origin of man and his history " . His theory is simply stated in the introduction :

As many more individuals of each species are born than can possibly survive ; and as , consequently , there is a frequently recurring struggle for existence , it follows that any being , if it vary however slightly in any manner profitable to itself , under the complex and sometimes varying conditions of life , will have a better chance of surviving , and thus be naturally selected . From the strong principle of inheritance , any selected variety will tend to propagate its new and modified form .

At the end of the book he concluded that :

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 .

The last word was the only variant of " evolved " in the first five editions of the book . " Evolutionism " at that time was associated with other concepts , most commonly with embryological development , and Darwin first used the word evolution in The Descent of Man in 1871 , before adding it in 1872 to the 6th edition of The Origin of Species .

= = = Responses to publication = = =

The book aroused international interest , with less controversy than had greeted the popular Vestiges of the Natural History of Creation . Though Darwin 's illness kept him away from the public debates , he eagerly scrutinised the scientific response , commenting on press cuttings , reviews , articles , satires and caricatures , and corresponded on it with colleagues worldwide . The book did not explicitly discuss human origins , but included a number of hints about the animal ancestry of humans from which the inference could be made . The first review asked , " If a monkey has become a man ? what may not a man become ? " and said it should be left to theologians as it was too dangerous for ordinary readers . Amongst early favourable responses , Huxley 's reviews swiped at Richard Owen , leader of the scientific establishment Huxley was trying to overthrow . In April , Owen 's review attacked Darwin 's friends and condescendingly dismissed his ideas , angering Darwin , but Owen and others began to promote ideas of supernaturally guided evolution . Patrick Matthew drew attention to his 1831 book which had a brief appendix suggesting a concept of natural selection leading to new species , but he had not developed the idea .

The Church of England 's response was mixed . Darwin 's old Cambridge tutors Sedgwick and Henslow dismissed the ideas , but liberal clergymen interpreted natural selection as an instrument of God 's design , with the cleric Charles Kingsley seeing it as " just as noble a conception of Deity " . In 1860 , the publication of Essays and Reviews by seven liberal Anglican theologians diverted clerical attention from Darwin , with its ideas including higher criticism attacked by church authorities as heresy . In it , Baden Powell argued that miracles broke God 's laws , so belief in them was atheistic , and praised " Mr Darwin 's masterly volume [ supporting ] the grand principle of the self @-@ evolving powers of nature " . Asa Gray discussed teleology with Darwin , who imported and distributed Gray 's pamphlet on theistic evolution , Natural Selection is not inconsistent with natural theology . The most famous confrontation was at the public 1860 Oxford evolution debate during a



meeting of the British Association for the Advancement of Science , where the Bishop of Oxford Samuel Wilberforce , though not opposed to transmutation of species , argued against Darwin 's explanation and human descent from apes . Joseph Hooker argued strongly for Darwin , and Thomas Huxley 's legendary retort , that he would rather be descended from an ape than a man who misused his gifts , came to symbolise a triumph of science over religion .

Even Darwin 's close friends Gray , Hooker , Huxley and Lyell still expressed various reservations but gave strong support , as did many others , particularly younger naturalists . Gray and Lyell sought reconciliation with faith , while Huxley portrayed a polarisation between religion and science . He campaigned pugnaciously against the authority of the clergy in education , aiming to overturn the dominance of clergymen and aristocratic amateurs under Owen in favour of a new generation of professional scientists . Owen 's claim that brain anatomy proved humans to be a separate biological order from apes was shown to be false by Huxley in a long running dispute parodied by Kingsley as the " Great Hippocampus Question " , and discredited Owen .

Darwinism became a movement covering a wide range of evolutionary ideas . In 1863 Lyell 's Geological Evidences of the Antiquity of Man popularised prehistory , though his caution on evolution disappointed Darwin . Weeks later Huxley 's Evidence as to Man 's Place in Nature showed that anatomically , humans are apes , then The Naturalist on the River Amazons by Henry Walter Bates provided empirical evidence of natural selection . Lobbying brought Darwin Britain 's highest scientific honour , the Royal Society 's Copley Medal , awarded on 3 November 1864 . That day , Huxley held the first meeting of what became the influential " X Club " devoted to " science , pure and free , untrammelled by religious dogmas " . By the end of the decade most scientists agreed that evolution occurred , but only a minority supported Darwin 's view that the chief mechanism was natural selection .

The Origin of Species was translated into many languages , becoming a staple scientific text attracting thoughtful attention from all walks of life , including the " working men " who flocked to Huxley 's lectures . Darwin 's theory also resonated with various movements at the time and became a key fixture of popular culture . Cartoonists parodied animal ancestry in an old tradition of showing humans with animal traits , and in Britain these droll images served to popularise Darwin 's theory in an unthreatening way . While ill in 1862 Darwin began growing a beard , and when he reappeared in public in 1866 caricatures of him as an ape helped to identify all forms of evolutionism with Darwinism .

= = = Descent of Man , sexual selection , and botany = = =

Despite repeated bouts of illness during the last twenty @-@ two years of his life , Darwin 's work continued . Having published On the Origin of Species as an abstract of his theory , he pressed on with experiments , research , and writing of his " big book " . He covered human descent from earlier animals including evolution of society and of mental abilities , as well as explaining decorative beauty in wildlife and diversifying into innovative plant studies .

Enquiries about insect pollination led in 1861 to novel studies of wild orchids , showing adaptation of their flowers to attract specific moths to each species and ensure cross fertilisation . In 1862 Fertilisation of Orchids gave his first detailed demonstration of the power of natural selection to explain complex ecological relationships , making testable predictions . As his health declined , he lay on his sickbed in a room filled with inventive experiments to trace the movements of climbing plants . Admiring visitors included Ernst Haeckel , a zealous proponent of Darwinismus incorporating Lamarckism and Goethe 's idealism . Wallace remained supportive , though he increasingly turned to Spiritualism .

The Variation of Animals and Plants under Domestication of 1868 was the first part of Darwin 's planned " big book " , and included his unsuccessful hypothesis of pangenesis attempting to explain heredity . It sold briskly at first , despite its size , and was translated into many languages . He wrote most of a second part , on natural selection , but it remained unpublished in his lifetime .

Lyell had already popularised human prehistory , and Huxley had shown that anatomically humans are apes . With The Descent of Man , and Selection in Relation to Sex published in 1871 , Darwin

set out evidence from numerous sources that humans are animals , showing continuity of physical and mental attributes , and presented sexual selection to explain impractical animal features such as the peacock 's plumage as well as human evolution of culture , differences between sexes , and physical and cultural racial characteristics , while emphasising that humans are all one species . His research using images was expanded in his 1872 book *The Expression of the Emotions in Man and Animals* , one of the first books to feature printed photographs , which discussed the evolution of human psychology and its continuity with the behaviour of animals . Both books proved very popular , and Darwin was impressed by the general assent with which his views had been received , remarking that " everybody is talking about it without being shocked . " His conclusion was " that man with all his noble qualities , with sympathy which feels for the most debased , with benevolence which extends not only to other men but to the humblest living creature , with his god @-@ like intellect which has penetrated into the movements and constitution of the solar system ? with all these exalted powers ? Man still bears in his bodily frame the indelible stamp of his lowly origin . "

His evolution @-@ related experiments and investigations led to books on *Orchids* , *Insectivorous Plants* , *The Effects of Cross and Self Fertilisation in the Vegetable Kingdom* , different forms of flowers on plants of the same species , and *The Power of Movement in Plants* . His botanical work was interpreted and popularised by various writers including Grant Allen and H. G. Wells , and helped transform plant science in the late C19 and early C20 . In his last book he returned to *The Formation of Vegetable Mould through the Action of Worms* .

= = = Death and funeral = = =

In 1882 he was diagnosed with what was called " angina pectoris " which then meant coronary thrombosis and disease of the heart . At the time of his death , the physicians diagnosed " anginal attacks " , and " heart @-@ failure " .

He died at Down House on 19 April 1882 . His last words were to his family , telling Emma " I am not the least afraid of death ? Remember what a good wife you have been to me ? Tell all my children to remember how good they have been to me " , then while she rested , he repeatedly told Henrietta and Francis " It 's almost worth while to be sick to be nursed by you " . He had expected to be buried in St Mary 's churchyard at Downe , but at the request of Darwin 's colleagues , after public and parliamentary petitioning , William Spottiswoode ( President of the Royal Society ) arranged for Darwin to be honoured by burial in Westminster Abbey , close to John Herschel and Isaac Newton . The funeral was held on Wednesday 26 April and was attended by thousands of people , including family , friends , scientists , philosophers and dignitaries .

= = Legacy = =

Darwin had convinced most scientists that evolution as descent with modification was correct , and he was regarded as a great scientist who had revolutionised ideas . Though few agreed with his view that " natural selection has been the main but not the exclusive means of modification " , he was honoured in June 1909 by more than 400 officials and scientists from across the world who met in Cambridge to commemorate his centenary and the fiftieth anniversary of *On the Origin of Species* . During this period , which has been called " the eclipse of Darwinism " , scientists proposed various alternative evolutionary mechanisms which eventually proved untenable . Ronald Fisher , an English statistician finally united Mendelian genetics with natural selection between 1918 and his 1930 book *The Genetical Theory of Natural Selection* , giving the theory a mathematical footing and bringing broad scientific consensus that it was the basic mechanism of evolution , founding the basis for population genetics and the modern evolutionary synthesis , with J.B.S. Haldane and Sewall Wright , which set the frame of reference for modern debates and refinements of the theory .

= = = Commemoration = = =

During Darwin 's lifetime , many geographical features were given his name . An expanse of water

adjoining the Beagle Channel was named Darwin Sound by Robert FitzRoy after Darwin 's prompt action , along with two or three of the men , saved them from being marooned on a nearby shore when a collapsing glacier caused a large wave that would have swept away their boats , and the nearby Mount Darwin in the Andes was named in celebration of Darwin 's 25th birthday . When the Beagle was surveying Australia in 1839 , Darwin 's friend John Lort Stokes sighted a natural harbour which the ship 's captain Wickham named Port Darwin : a nearby settlement was renamed Darwin in 1911 , and it became the capital city of Australia 's Northern Territory .

More than 120 species and nine genera have been named after Darwin . In one example , the group of tanagers related to those Darwin found in the Galápagos Islands became popularly known as " Darwin 's finches " in 1947 , fostering inaccurate legends about their significance to his work .

Darwin 's work has continued to be celebrated by numerous publications and events . The Linnean Society of London has commemorated Darwin 's achievements by the award of the Darwin ? Wallace Medal since 1908 . Darwin Day has become an annual celebration , and in 2009 worldwide events were arranged for the bicentenary of Darwin 's birth and the 150th anniversary of the publication of *On the Origin of Species* .

Darwin has been commemorated in the UK , with his portrait printed on the reverse of £ 10 banknotes printed along with a hummingbird and HMS Beagle , issued by the Bank of England .

A life size seated statue of Darwin can be seen in the main hall of the Natural History Museum in London .

A seated statue of Darwin , unveiled 1897 , stands in front of Shrewsbury Library , the building that used to house Shrewsbury School , which Darwin attended as a boy . Another statue of Darwin as a young man is situated in the grounds of Christ 's College , Cambridge .

Darwin College , a postgraduate college at Cambridge University , is named after the Darwin family .

= = Children = =

The Darwins had ten children : two died in infancy , and Annie 's death at the age of ten had a devastating effect on her parents . Charles was a devoted father and uncommonly attentive to his children . Whenever they fell ill , he feared that they might have inherited weaknesses from inbreeding due to the close family ties he shared with his wife and cousin , Emma Wedgwood . He examined this topic in his writings , contrasting it with the advantages of crossing amongst many organisms . Despite his fears , most of the surviving children and many of their descendants went on to have distinguished careers ( see Darwin @-@ Wedgwood family ) .

Of his surviving children , George , Francis and Horace became Fellows of the Royal Society , distinguished as astronomer , botanist and civil engineer , respectively . All three were knighted . Another son , Leonard , went on to be a soldier , politician , economist , eugenicist and mentor of the statistician and evolutionary biologist Ronald Fisher .

= = Views and opinions = =

= = = Religious views = = =

Darwin 's family tradition was nonconformist Unitarianism , while his father and grandfather were freethinkers , and his baptism and boarding school were Church of England . When going to Cambridge to become an Anglican clergyman , he did not doubt the literal truth of the Bible . He learned John Herschel 's science which , like William Paley 's natural theology , sought explanations in laws of nature rather than miracles and saw adaptation of species as evidence of design . On board the Beagle , Darwin was quite orthodox and would quote the Bible as an authority on morality . He looked for " centres of creation " to explain distribution , and related the antlion found near kangaroos to distinct " periods of Creation " .

By his return , he was critical of the Bible as history , and wondered why all religions should not be

equally valid . In the next few years , while intensively speculating on geology and the transmutation of species , he gave much thought to religion and openly discussed this with his wife Emma , whose beliefs also came from intensive study and questioning . The theodicy of Paley and Thomas Malthus vindicated evils such as starvation as a result of a benevolent creator 's laws , which had an overall good effect . To Darwin , natural selection produced the good of adaptation but removed the need for design , and he could not see the work of an omnipotent deity in all the pain and suffering , such as the ichneumon wasp paralysing caterpillars as live food for its eggs . He still viewed organisms as perfectly adapted , and *On the Origin of Species* reflects theological views . Though he thought of religion as a tribal survival strategy , Darwin was reluctant to give up the idea of God as an ultimate lawgiver . He was increasingly troubled by the problem of evil .

Darwin remained close friends with the vicar of Downe , John Brodie Innes , and continued to play a leading part in the parish work of the church , but from around 1849 would go for a walk on Sundays while his family attended church . He considered it " absurd to doubt that a man might be an ardent theist and an evolutionist " and , though reticent about his religious views , in 1879 he wrote that " I have never been an atheist in the sense of denying the existence of a God . ? I think that generally ... an agnostic would be the most correct description of my state of mind " .

The " Lady Hope Story " , published in 1915 , claimed that Darwin had reverted to Christianity on his sickbed . The claims were repudiated by Darwin 's children and have been dismissed as false by historians .

= = = Human society = = =

Darwin 's views on social and political issues reflected his time and social position . He grew up in a family of Whig reformers who , like his uncle Josiah Wedgwood , supported electoral reform and the emancipation of slaves . Darwin was passionately opposed to slavery , while seeing no problem with the working conditions of English factory workers or servants . His taxidermy lessons in 1826 from the freed slave John Edmonstone , who he long recalled as " a very pleasant and intelligent man " , reinforced his belief that black people shared the same feelings , and could be as intelligent as people of other races . He took the same attitude to native people he met on the *Beagle* voyage . These attitudes were not unusual in Britain in the 1820s , much as it shocked visiting Americans . British society became more racist in mid century , but Darwin remained strongly against slavery , against " ranking the so @-@ called races of man as distinct species " , and against ill @-@ treatment of native people . He valued European civilisation and saw colonisation as spreading its benefits , with the sad but inevitable effect that savage peoples who did not become civilised faced extinction . Darwin 's theories presented this as natural , and were cited to promote policies that went against his humanitarian principles .

He thought men 's eminence over women was the outcome of sexual selection , a view disputed by Antoinette Brown Blackwell in *The Sexes Throughout Nature* .

Darwin was intrigued by his half @-@ cousin Francis Galton 's argument , introduced in 1865 , that statistical analysis of heredity showed that moral and mental human traits could be inherited , and principles of animal breeding could apply to humans . In *The Descent of Man* , Darwin noted that aiding the weak to survive and have families could lose the benefits of natural selection , but cautioned that withholding such aid would endanger the instinct of sympathy , " the noblest part of our nature " , and factors such as education could be more important . When Galton suggested that publishing research could encourage intermarriage within a " caste " of " those who are naturally gifted " , Darwin foresaw practical difficulties , and thought it " the sole feasible , yet I fear utopian , plan of procedure in improving the human race " , preferring to simply publicise the importance of inheritance and leave decisions to individuals . Francis Galton named this field of study " eugenics " in 1883 .

= = Evolutionary social movements = =

Darwin 's fame and popularity led to his name being associated with ideas and movements that , at

times , had only an indirect relation to his writings , and sometimes went directly against his express comments .

Thomas Malthus had argued that population growth beyond resources was ordained by God to get humans to work productively and show restraint in getting families , this was used in the 1830s to justify workhouses and laissez @-@ faire economics . Evolution was by then seen as having social implications , and Herbert Spencer 's 1851 book Social Statics based ideas of human freedom and individual liberties on his Lamarckian evolutionary theory .

Soon after the Origin was published in 1859 , critics derided his description of a struggle for existence as a Malthusian justification for the English industrial capitalism of the time . The term Darwinism was used for the evolutionary ideas of others , including Spencer 's " survival of the fittest " as free @-@ market progress , and Ernst Haeckel 's racist ideas of human development . Writers used natural selection to argue for various , often contradictory , ideologies such as laissez @-@ faire dog @-@ eat dog capitalism , racism , warfare , colonialism and imperialism . However , Darwin 's holistic view of nature included " dependence of one being on another " ; thus pacifists , socialists , liberal social reformers and anarchists such as Peter Kropotkin stressed the value of co @-@ operation over struggle within a species . Darwin himself insisted that social policy should not simply be guided by concepts of struggle and selection in nature .

After the 1880s , a eugenics movement developed on ideas of biological inheritance , and for scientific justification of their ideas appealed to some concepts of Darwinism . In Britain , most shared Darwin 's cautious views on voluntary improvement and sought to encourage those with good traits in " positive eugenics " . During the " Eclipse of Darwinism " , a scientific foundation for eugenics was provided by Mendelian genetics . Negative eugenics to remove the " feeble-minded " were popular in America , Canada and Australia , and eugenics in the United States introduced compulsory sterilization laws , followed by several other countries . Subsequently , Nazi eugenics brought the field into disrepute .

The term " Social Darwinism " was used infrequently from around the 1890s , but became popular as a derogatory term in the 1940s when used by Richard Hofstadter to attack the laissez @-@ faire conservatism of those like William Graham Sumner who opposed reform and socialism . Since then , it has been used as a term of abuse by those opposed to what they think are the moral consequences of evolution .

= = Works = =

Darwin was a prolific writer . Even without publication of his works on evolution , he would have had a considerable reputation as the author of The Voyage of the Beagle , as a geologist who had published extensively on South America and had solved the puzzle of the formation of coral atolls , and as a biologist who had published the definitive work on barnacles . While On the Origin of Species dominates perceptions of his work , The Descent of Man and The Expression of the Emotions in Man and Animals had considerable impact , and his books on plants including The Power of Movement in Plants were innovative studies of great importance , as was his final work on The Formation of Vegetable Mould through the Action of Worms .