



## The Galton–Darwin–Wedgwood Pedigree of H. H. Laughlin

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A pedigree of the Galton–Darwin–Wedgwood families that was exhibited as a poster at the Third International Congress of Eugenics in 1932 at the American Museum of Natural History has been located in the archives of Truman State University in Kirksville, Missouri. This pedigree was prepared by Harry Hamilton Laughlin, Director of the Eugenics Record Office of the Carnegie Institute. The pedigree shows consanguineous marriages within the three families. A special collection of rare Darwin family photographs assembled by Leonard Darwin has also been found in the Truman State University archives. These photographs were exhibited as a poster alongside the pedigree at the 1932 Eugenics Congress. The poster of the Galton–Darwin–Wedgwood pedigree is published here, together with a tabular version providing ready access to the information contained in the pedigree. Also included are the Darwin family photographs and a biographical sketch of Laughlin. © 2010 The Linnean Society of London, *Biological Journal of the Linnean Society*, 2010, **101**, 228–241.

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### INTRODUCTION

The most authoritative and comprehensive pedigree of the Darwin family can be found in Freeman's 1984 facsimile of H. Farnham Burke's 1888 privately published pedigree. However, this work emphasizes only those individuals who were born Darwins. Freeman (1984) rectified this shortcoming by putting the Darwin family in a 400-year context by including pedigrees of the Wedgwoods (Wedgwood & Wedgwood, 1980) and the Galtons (Pearson, 1914, 1924, 1930). When searching for materials to use in a genetic analysis of inbreeding in the Darwin–Wedgwood dynasty (Berra, Alvarez & Ceballos, 2010), a reference to an extensive Galton–Darwin–Wedgwood (GDW) pedigree was located (Laughlin, 1934: plate 7). This pedigree, produced by the Eugenics Record Office under the direction of H. H. Laughlin in the format of a large poster, was exhibited during the Third

International Congress of Eugenics held at the American Museum of Natural History (AMNH) in New York City on 21–23 August 1932. However, the pedigree, as reproduced in plate 7 of Laughlin (1934), was unreadable as a result of its small size relative to the original large poster, which we estimate to be approximately 1.9 × 1.4 m. Many of Laughlin's papers were deposited at Truman State University in Kirksville, Missouri. A description of the archives and a biographical sketch of Laughlin were given by Bird & Allen (1981). Although the original poster could not be located, the Truman State University librarian/archivist was able to supply a digital version of a photograph of the pedigree, which is readable. The purpose of the present paper is to make the GDW (also known as the Laughlin) pedigree and related materials available to Darwin scholars.

### LAUGHLIN'S LIFE

Harry Hamilton Laughlin (1880–1943) (Fig. 1) was born in Oskaloosa, Iowa on 11 March 1880 and grew

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Apopala Sept. 1923.

**Figure 1.** From left to right, Harry H. Laughlin and wife Pansy, Mrs Leonard Darwin, Major Leonard Darwin, and an unidentified woman, possibly Mrs Herman Lundborg. This photograph is labeled Uppsala, September 1923. It was sent to H. H. Laughlin as a postcard by Herman Bernard Lundborg (1863–1943), a physician, eugenicist, and Director of the Institute of Racial Biology at the University of Uppsala, Sweden. Lundborg studied a genetic form of myoclonic epilepsy now known as Unverricht-Lundborg disease. The postcard back reads: ‘Am sending you a little photo from your visit in U – I shall very shortly send you some articles in English, among them our report regarding the question of sterilization. Please give my kind regards to Mrs Laughlin. Yours sincerely, H. Lundborg.’ Photograph courtesy of Harry H. Laughlin Papers, Truman State University.

up in Kirksville, Missouri. He received a bachelor’s degree in 1900 from First District Normal School (now renamed Truman State University). He served as a high school principal, school superintendent, and taught agriculture courses at his *alma mater* (Reilly, 1999). His interest in agricultural breeding experiments with poultry resulted in contact with Charles Benedict Davenport (1866–1944), the director of the Station for Experimental Evolution at Cold Spring Harbor on Long Island, New York. Dr Davenport was a zoologist, geneticist, and eugenicist and one of the first US scientists to utilize Mendelian genetics. As early as 1908, he recognized that most mutations were neutral or deleterious and generally recessive. With a gift from a wealthy benefactor, Mrs E. H. Harriman, Davenport established the Eugenics Record Office (ERO) (of the Department of Genetics of the Carnegie Institute of Washington, DC) located in Cold Spring Harbor and asked Laughlin to be its superintendent (Riddle, 1947). The ERO developed into the foremost centre for eugenics in the USA, and one of its missions was to collect pedigrees of prominent families. Laughlin served as superintendent from 1910 until 1921 and, as assistant director (under the overall directorship of Davenport), from 1921 until 1939 (Bird & Allen, 1981). In 1917, Laughlin received a DSc degree from Princeton University for his thesis involving mitotic stages in dividing onion root-tip cells (Bird & Allen, 1981) (Reilly, 1999, referred to a PhD).

Laughlin served as a eugenics expert for several governmental organizations and influenced compulsory sterilization and restrictive immigration legislation passed by more than 30 US states. He testified before the House Committee on Immigration and Naturalization in 1923 and 1924, which resulted in the passage of the Johnson Act (Immigration Restriction Act) in 1924 (Bird & Allen, 1981). He was an expert witness for the state before the Supreme Court in *Buck vs. Bell*, which upheld the constitutionality of Virginia’s involuntary eugenic sterilization law in 1927 (Reilly, 1999). This decision caused a number of states to enact such laws. His eugenicist career has been reviewed by Haller (1961) and Hasenbalch (1969). By all accounts, he was an extremely hard worker and zealously committed to eugenics.

As a geneticist, he was also interested in such divergent topics as thoroughbred race horses and sex determination in date palms.

Laughlin corresponded with many prominent American eugenics figures, including Alexander Graham Bell and David Starr Jordan (the first president of Stanford University). Henry Fairfield Osborn, director of vertebrate paleontology at the AMNH, was influential in convincing the Third International Congress of Eugenics to meet at the museum in 1932. Letters between Laughlin and Madison Grant (author of *The Passing of the Great Race* 1921, friend of Theodore Roosevelt, and a founder and president of the New York Zoological Society) display ‘the deeply rooted racial and nationalistic prejudice that pervaded American eugenics’ (Bird & Allen, 1981). Many eugenicists of that time decried the imagined contamination of the ‘white race’ with genes of other races and promoted racial segregation and sterilization of the ‘unfit’. This xenophobic and disturbing thinking was a product of its time and sounds archaic today in light of modern genetic understanding (Gould, 1981; Micklos & Carlson, 2000) and the expectations of the human genome project (Lander *et al.*, 2001; Venter *et al.*, 2001). Further historical insights can be found on the web site of the Eugenics Archives at: <http://www.eugenicsarchive.org/eugenics/>.

Laughlin was secretary of the Third International Congress of Eugenics in 1932 when he assembled the GDW pedigree under discussion. The stated purpose of the exhibit at the AMNH ‘is to take stock of man’s present knowledge about the inborn elements in human qualities, physical, mental and spiritual, and about the control of such qualities in family-stocks, in races and in national populations, in their turnover from generation to generation. More briefly this exhibit is about improvement in the breed of man.’ (Laughlin, 1934: plate 2). Resta (1995) opined that there may have been selective omissions in earlier pedigrees of these families, that no women were indicated as brilliant, and that the early pedigree authors were ‘... guilty of looking at the world through biased eugenics glasses.’

The eugenics movement was founded by Sir Francis Galton (1869) (1822–1911), Charles Darwin’s half-first

cousin (Berra *et al.*, 2010). Galton coined the word ‘eugenics’ in 1883. Darwin’s son Leonard (1850–1943) was president of the First International Congress of Eugenics in London in 1912. He was a major in the army’s royal engineers and later became a member of parliament. Figure 1 shows the Laughlins and the Leonard Darwins together in Uppsala, Sweden in 1923. Laughlin published many articles and books on eugenics and is best known for his work on eugenical sterilization (of ‘hereditary defectives’) and immigration restrictions (of ‘worthless’ immigrants) (Laughlin, 1922). Nazi Germany’s 1933 sterilization laws were modelled after Laughlin’s ideas (Reilly, 1999). The University of Heidelberg awarded Laughlin an honorary MD degree in 1936 ‘in recognition of studies made on human heredity and population analysis and control.’ After retirement from the Eugenics Record Office, Laughlin and his wife Pansy returned to Kirksville where he died on 26 January 1943. They had no children (Reilly, 1999). His widow gave his papers to the Pickler Memorial Library of what was then called Northeast Missouri State University (Bird & Allen, 1981), which eventually became Truman State University.

### THE ARCHIVES

Truman State University holds Laughlin’s papers and the American Philosophical Society is the repository for the materials of the Eugenics Record Office. Truman State University has a very comprehensive online finding aid for the Laughlin manuscript collection (<http://library.truman.edu/manuscripts/laughlinindex.asp>). Laughlin Papers Box D-2-1:10 includes a handwritten notepaper listing six resources for the GDW pedigree. They are Moffat (1904), Galton & Schuster (1906), Pearson (1914, 1924, 1930), Downing (1928), Who’s Who (1911), and the Encyclopedia Britannica (presumably either the 11th, 12th or 13th editions). There are photographs of the exhibit hall of the Third International Congress of Eugenics, held at the AMNH (Fig. 2). Of particular interest is the GDW pedigree (Fig. 3). The small paper sign shown to the left of the pedigree in Figure 2B is also partly visible in Figure 3. This demonstrates that the photograph of the GDW pedigree (Fig. 3) was taken when the pedigree was on exhibit at the AMNH in 1932. When enlarged, the words ‘Wedgwood’ and ‘Laughlin’ are readable on the sign.

The GDW pedigree was hung on a wall next to what appears to be the introductory panels (Fig. 2B), including a poster entitled *Special Collection of Rare Darwin Family Pictures . . .* assembled by Major Leonard Darwin (Figs 4, 5). A few of these Darwin family photographs are relatively well known and join other Darwin family photographs published in

various biographies of Darwin, such as Desmond & Moore (1991), Browne (1995, 2002), Keynes (2001), Healey (2001), Berra (2009), Riley (2009), amongst others, but many of them are not well known or readily available.

Laughlin Papers Box C-2-3:5 is entitled Darwin Family Pictures and Correspondence. It includes a variety of photographs (mostly identified) as well as some correspondence. Many of these photographs are included on the pedigree (Fig. 3) or on the Darwin Family Pictures poster (Fig. 5), but some, such as Figure 1, have never been published, as far as we are aware. The correspondence includes letters from Leonard Darwin on sterilization and on his appointment as honorary president of the International Congress. Also included is a memorandum on the GDW pedigree, which has three points: (1) to remind Leonard Darwin of his promise to supply photographs; (2) to secure photos of Darwin’s home; and (3) the mention of two books: Emma Darwin’s *A Century of Family Letters* and the H. Farnham Burke pedigree.

Laughlin Papers Box E-1-2:4 contains a photograph of the GDW family pedigree ‘issued by the Eugenics Education Society’ (Fig. 3). The Eugenics Education Society was founded by Francis Galton in 1907 to advocate positive eugenics (i.e. to encourage the ‘best’ families to have more children). Leonard Darwin promoted Galton’s ideas and became director of what was then called the English Eugenics Society in the 1920s. This group became the Galton Institute in 1989 and persists today to ‘promote the public understanding of human heredity and to facilitate informed debate about the ethical issues raised by advances in reproductive technology’ (<http://www.galtoninstitute.org.uk/>).

The whereabouts of the GDW pedigree poster today is unknown. Bird & Allen (1981: 349) stated, ‘We also found, in a dusty and battered old box, some of Laughlin’s teaching devices: a wall poster (six feet by three) showing the family pedigree of John Burroughs; some oversized pedigree charts showing the supposed inheritance of ‘scholarship,’ ‘pauperism,’ ‘entrepreneurship,’ and intelligence; . . .’, but there is no mention of the GDW pedigree.

### DIGITAL MANIPULATION

For clarity of reproduction, we used the software Adobe Photoshop CS4 (Adobe Systems, Inc.) to digitally enhance the writing on the pedigree (Fig. 3) and the Darwin family photographs (Fig. 5). The original handwritten text was faint and blurry and difficult to read. The software allowed us to detect slight tonal shifts between the pixels within the digital reproductions. We increased the contrast between these pixels and then used a Wacom Intuos Professional Pen



**Figure 2.** (A) Long view of the Third International Congress of Eugenics exhibit at the American Museum of Natural History in 1932 in New York City. Note the bust of Charles Darwin in the centre and the Galton–Darwin–Wedgwood (GDW) (Laughlin) pedigree poster to the right of the Darwin bust. (B) Close up view of the GDW pedigree. Note small white label to left of pedigree (the white label indicating that the pedigree was photographed *in situ* can also be seen in Fig. 3). To the left of the pedigree are photographs of the Darwin family (Figs 4 and 5). Photographs courtesy of Harry H. Laughlin Papers, Truman State University.

Tablet to digitally trace the original handwritten text, making it darker, sharper, and improving its overall readability. We enhanced only what was present and made no interpretations or editorial corrections. Additionally, we selectively increased the contrast within the Darwin family photographs to improve their definition, which had deteriorated through reproduction, and we removed dust spots and scratches.

## DISCUSSION

The Laughlin pedigree (Fig. 3) contains a good deal of genealogical information on the GDW families and reflects a number of consanguineous marriages among all three families. Kuper (2009) chronicled this very common trend, involving approximately 10% of marriages among the upper middle class of Victorian England. Recently, Berra *et al.* (2010) constructed a pedigree of the Darwin–Wedgwood dynasty combining genealogical information obtained from numerous sources to compute inbreeding coefficients for Charles Darwin and his progeny and related families. Given that the Berra *et al.* (2010) pedigree is probably the most complete pedigree of the Darwin–Wedgwood dynasty constructed to date for inbreeding analysis, we use this pedigree as a reference and compare the Laughlin pedigree with it (Table 1).

The Berra *et al.* (2010) pedigree contains more information on the Wedgwood family, and the Laughlin (GDW) pedigree emphasizes the Galton lineage (Table 1). Both pedigrees show the first-cousin marriage between Charles Darwin and Emma Wedgwood and the third-cousin marriage between Josiah Wedgwood I and Sarah Wedgwood, the parents of Charles Darwin's mother, Susannah (Fig. 3). The Laughlin pedigree shows only one consanguineous marriage not included in the Berra *et al.* (2010) pedigree: the parents (generation IV) of Lucy Barclay (1757–1817) (generation V), whom the pedigree identifies as a 'clever and very beautiful woman', were first cousins once removed. This term is applied to the kinship of an individual with the child of his first cousin and refers to a type of consanguineous marriage intermediate between first cousins and second cousins. Lucy's photograph is included on the left side of the pedigree (Fig. 3). She was married to Samuel Galton (1753–1832). The ancestors of Lucy and Samuel were omitted

from the Berra *et al.* (2010) pedigree. However, this genealogical information does not affect Berra *et al.*'s (2010) computations of inbreeding for Charles Darwin and his progeny and the association analysis between mortality and the inbreeding coefficient.

The Berra *et al.* (2010) pedigree showed some consanguineous marriages not included in the Laughlin pedigree: specifically the marriages of Emma's brothers (Josiah III, Henry, and Hensleigh) (Table 1). Regarding Charles Darwin and his progeny, both the Laughlin and Berra *et al.* (2010) pedigrees are complete for only a few generations. The critical point is the Wedgwood family because we do not have genealogical information for several Wedgwood wives (Mary Stringer, Susan Irlam, etc.). With respect to Charles Darwin's progeny, the Laughlin pedigree has no information on the Allen family (Emma's mother was Elizabeth Allen). The Berra *et al.* (2010) pedigree has much more information on the Allen family, although it is still incomplete.

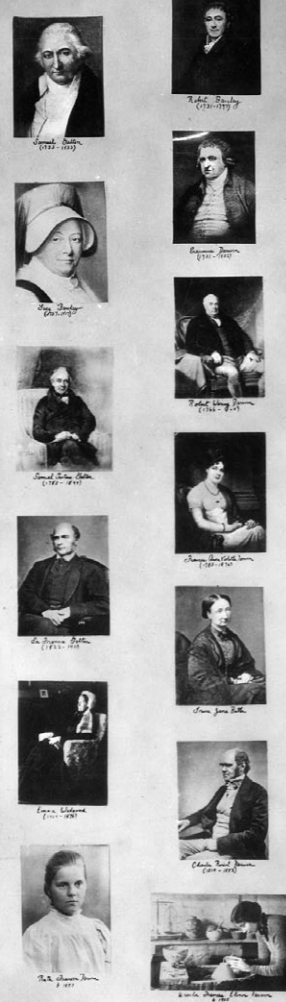
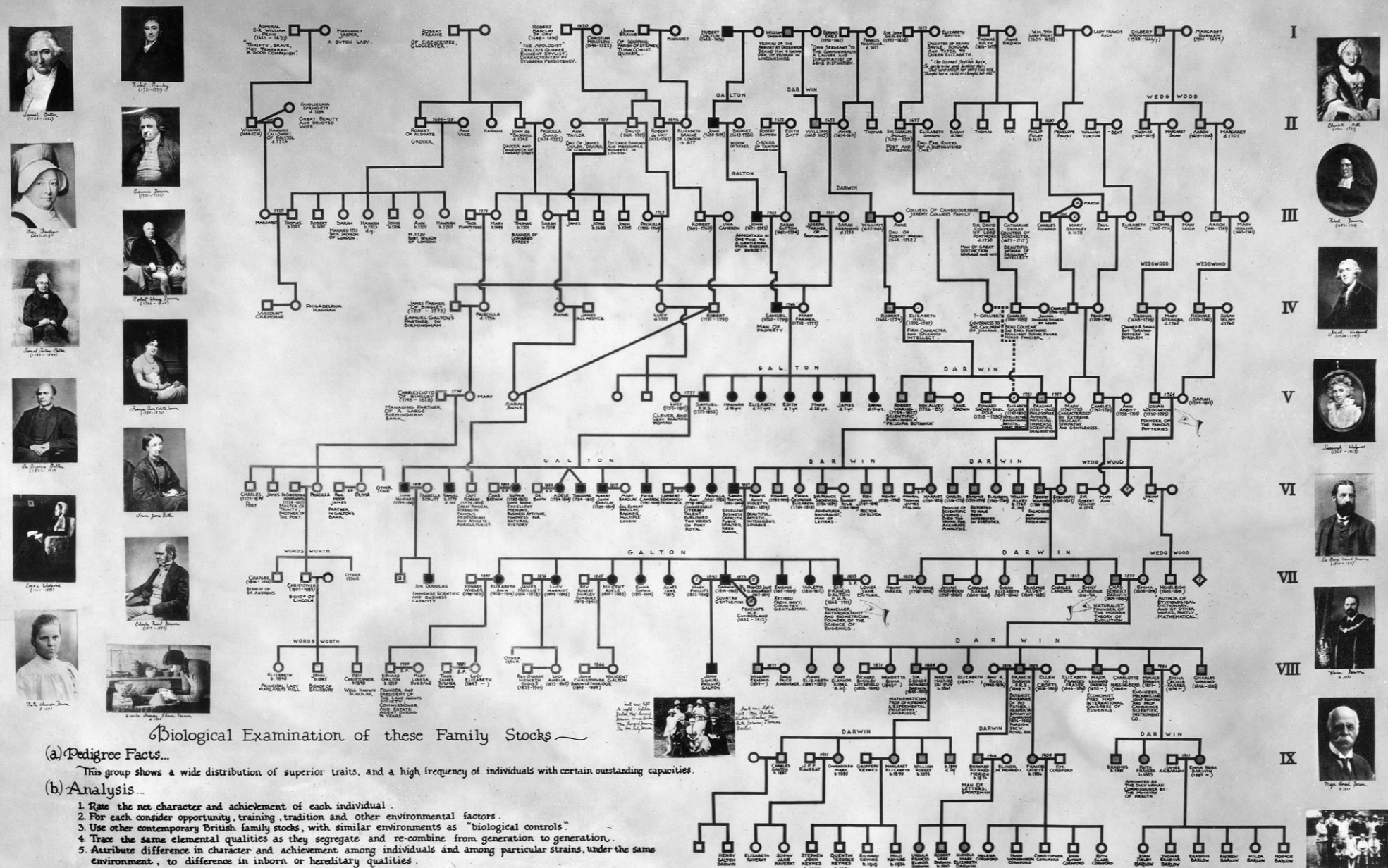
The Laughlin pedigree is incomplete with respect to some Darwin grandchildren. For example, George Darwin's son, William Robert Darwin (1884–1970), was married to Monica Slingsby (Freeman, 1978). They have Darwin descendants that are alive today, although this marriage does not appear in Figure 3.

Charles Darwin was ill for most of his adult life. His illness has been variously attributed to allergies, arsenic poisoning, Crohn's disease, hypochondria, and psychosomatic disorders, to name just a few diagnoses (Colp, 2008). Campbell & Matthews (2005) made a cogent case for systemic lactose intolerance. Chagas disease, a parasitic infection acquired in South America during the voyage of HMS *Beagle* (Colp, 2008) is also a likely possibility. Hayman (2009) most recently speculated that Darwin's symptoms were consistent with cyclic vomiting syndrome, a maternally inherited mitochondrial abnormality.

Golubovsky (2008) concluded that unexplained infertility in both sexes of Darwin's children (William Erasmus, Henrietta and Leonard) was a result of segregation of autosomal recessive meiotic mutations that led to abnormal gametogenesis without negative influence on vitality or longevity. Such 'both sexes' mutations are very rare. Golubovsky (2008) speculated that this mutation could have been inherited by

# PEDIGREE OF THE GALTON-DARWIN-WEDGWOOD FAMILY.

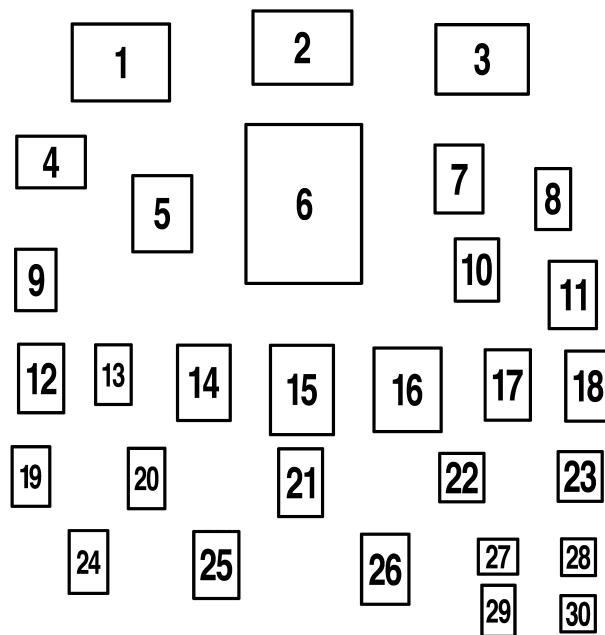
A GROUP OF CLOSELY RELATED FAMILY-STOCKS CHARACTERIZED BY OUTSTANDING CAPACITIES IN PHILOSOPHY, SCIENCE AND ART.



### Biological Examination of these Family Stocks

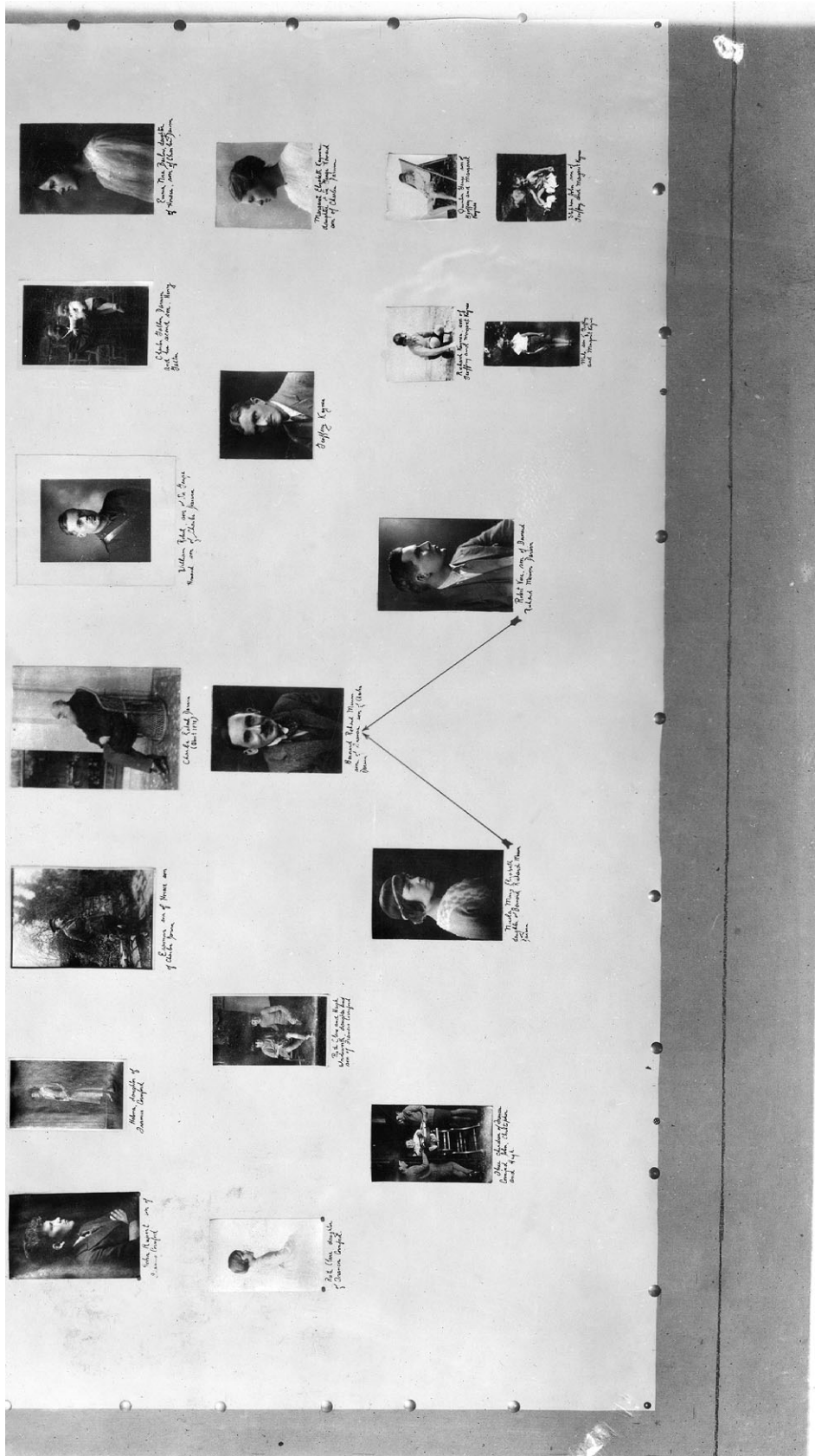
- (a) Pedigree Facts... This group shows a wide distribution of superior traits, and a high frequency of individuals with certain outstanding capacities.
- (b) Analysis...  
 1. Rate the net character and achievement of each individual.  
 2. For each consider opportunity, training, tradition and other environmental factors.  
 3. Use other contemporary British family stocks, with similar environments as "biological controls."  
 4. Trace the same elemental qualities as they segregate and re-combine from generation to generation.  
 5. Attribute difference in character and achievement among individuals and among particular strains, under the same environment, to difference in inborn or hereditary qualities.
- (c) Evaluation... In the final rating, it seems that the outstanding qualities of this family must be credited mainly to the superior hereditary endowments of its "founders, selected parents and mates."

**Figure 3.** The Galton–Darwin–Wedgwood pedigree produced by Harry Hamilton Laughlin of the Eugenics Record Office and displayed in 1932 at the Third International Eugenics Congress at the American Museum of Natural History in New York City. Photograph courtesy of Harry H. Laughlin Papers, Truman State University. ‘A group of closely related family-stocks characterized by outstanding capacities in philosophy, science and art.’ (Laughlin, 1934, plate 7). Left column: Samuel Galton (1753–1832), Lucy Barclay (1757–1817), Samuel Tertius Galton (1783–1844), Sr Francis Galton (1822–1911), Emma Wedgwood (1808–1896), Ruth Frances Darwin (b 1883). Middle column: Robert Barclay (1731–1797) [correct b = 1732], Erasmus Darwin (1731–1802), Robert Waring Darwin (1766–1848), Frances Anne Violetta Darwin (1783–1874), Louisa Jane Butler, Charles Robert Darwin (1809–1882), Ursula Frances Elinor Darwin (b 1908). Middle group photograph of Charles Darwin relatives: front row left to right: Hilda Barlow (great granddaughter), Maj Leonard Darwin (son), Horace Barlow (great grandson), Mrs Leonard Darwin (daughter in law), The Hon. Lady Darwin (daughter in law); back row left to right: Mrs Barlow (granddaughter), Andrew Barlow (great grandson), Miss Ruth Darwin (granddaughter), Thomas Barlow (great grandson). Right column: Elizabeth Hill (1702–1797), Robert Darwin (1682–1754), Josiah Wedgwood (1730–1795), Susannah Wedgwood (1765–1817), Sr George Howard Darwin (1845–1912), Horace Darwin (b 1851), Major Leonard Darwin (b 1850). Group photograph (of Charles Darwin’s great-grandchildren) on the seat from left to right: Richard Keynes, Hilda Barlow, Milo Keynes, Horace Barlow; standing left to right: Christopher Cornford, Thomas Barlow, Robert Vere Darwin, Elizabeth Raverat, Ursula Darwin, John Rupert Cornford, Nichola Darwin, Helena Cornford, Andrew Barlow. [The figures in this paper can viewed and enlarged online in Wiley Online Library: [http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1095-8312](http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1095-8312).]



**Figure 4.** Key to the photographs in Figure 5. 1, path leading to Sandwalk at Down House Showing George Darwin, Charles Darwin’s son; 2, the study at Down House where the *Origin of Species* was written; 3, Down House as it was in the lifetime of Charles Darwin; 4, daughter and son of Charles Darwin, Henrietta Emma Litchfield, Francis Darwin with the latter’s daughter Frances Cornford; 5, Francis, son of Charles Darwin; 6, Charles Darwin, a hitherto unpublished picture taken by Leonard Darwin at his brother’s house in Southampton probably in 1876; 7, Gwendolen Mary Raverat, daughter of Sr George, son of Charles Darwin; 8, Sophy Jane, daughter of Gwendolen Mary Raverat; 9, Frances Cornford, daughter of Francis, son of Charles Darwin; 10, Elizabeth, daughter of Gwendolen Mary Raverat; 11, Charles Galton, son of Sr George Howard, son of Charles Darwin; 12, John Rupert, son of Frances Cornford; 13, Helena, daughter of Frances Cornford; 14, Erasmus, son of Horace, son of Charles Darwin; 15, Charles Robert Darwin (about 1878); 16, William Robert, son of Sr George Howard, son of Charles Darwin; 17, Charles Galton Darwin and his second son Henry Galton; 18, Emma Nora Barlow, daughter of Horace, son of Charles Darwin; 19, Ruth Clare, daughter of Frances Cornford; 20, Ruth Clare and Hugh Wordsworth, daughter and son of Frances Cornford; 21, Bernard Richard Meirion, son of Francis, son of Charles Darwin; 22, Geoffery Keynes; 23, Margaret Elizabeth Keynes, daughter of Sr George Howard, son of Charles Darwin; 24, three children of Frances Cornford, John, Christopher, Hugh; 25, Nichola Mary Elizabeth, daughter of Bernard Richard Meirion Darwin; 26, Robert Vere, son of Bernard Richard Meirion Darwin; 27, Richard Keynes, son of Geoffery and Margaret Keynes; 28, Quentin George, son of Geoffery and Margaret Keynes; 29, Milo, son of Geoffery and Margaret Keynes; 30, Stephen John, son of Geoffery and Margaret Keynes.





**Figure 5.** Special Collection of Rare Darwin family pictures organized by Leonard Darwin. Photograph courtesy of Harry H. Laughlin Papers, Truman State University. For a key to the identification of images, see Fig. 4.

**Table 1.** Genealogical information on Galton–Darwin–Wedgwood families according to the Laughlin pedigree (Figure 3) and Berra *et al.* (2010).

Individual	Father	Mother	Berra <i>et al.</i> (2010)	Laughlin (1932)
John Galton (1650–1695)	Hubert Galton			X
Elizabeth Braine	John Braine	Margaret		X
John de Bushhill	Robert Freame			X
William Darwin (1620–1675)	William Darwin (1573–1644)	Mary Healey	X	X
Thomas Wedgwood (1618–1679)	Gilbert Wedgwood	Margaret Burslem	X	X
Aaron Wedgwood (1627–1701)	Gilbert Wedgwood	Margaret Burslem	X	X
John Galton (1671–1743)	John Galton (1650–1695)	Bridget		X
Sarah Button	Robert Button	Edith Batt		X
Robert Barclay (1699–1760)	Robert de Ury (1672–1747)	Elizabeth Braine		X
David Barclay	Robert Barclay de Ury (1648–1698)	Christian Mollison		X
Robert de Ury (1672–1747)	Robert Barclay de Ury (1648–1698)	Christian Mollison		X
Priscilla	John de Bushhill	Priscilla Gould		X
William Darwin (1655–1682)	William Darwin (1620–1675)	Anne Earle	X	X
Anne Waring	Robert Waring	Anne Pate	X	
Thomas Wedgwood (1660–1716)	Thomas Wedgwood (1618–1679)	Margaret Saw	X	X
Aaron Wedgwood (1666–1743)	Aaron Wedgwood (1627–1701)	Margaret	X	X
Samuel Galton (1720–1793)	John Galton (1671–1743)	Sarah Button		X
Mary Farmer	Joseph Farmer	Sarah Abrahams		X
Robert Barclay (1731–1797)	Robert Barclay (1699–1760)	Una Cameron		X
Lucy Barclay	David Barclay	Priscilla		X
Elizabeth Hill	John Hill	Elizabeth Alvey	X	
Robert Darwin (1682–1754)	William Darwin (1655–1682)	Anne Waring	X	X
Thomas Wedgwood (1685–1739)	Thomas Wedgwood (1660–1716)	Mary Leigh	X	X
Richard Wedgwood (1701–1780)	Aaron Wedgwood (1666–1743)	Mary Hollins	X	X
Samuel Galton (1753–1832)	Samuel Galton (1720–1793)	Mary Farmer		X
Lucy Barclay (1757–1817)	Robert Barclay (1731–1797)	Lucy Barclay		X
Elizabeth Collier	Charles Colyear		X	X
Erasmus Darwin (1731–1802)	Robert Darwin (1682–1754)	Elizabeth Hill	X	X
Mary Howard	Charles Howard	Penelope Foley	X	X
Josiah Wedgwood I	Thomas Wedgwood (1685–1739)	Mary Stringer	X	X

Table 1. *Continued*

Individual	Father	Mother	Berra <i>et al.</i> (2010)	Laughlin (1932)
Sarah Wedgwood	Richard Wedgwood	Susan Irlam	X	X
John B. Allen	John Allen	Johana Bartlett	X	
Samuel Galton (1783–1844)	Samuel Galton (1753–1832)	Lucy Barclay 1757–1817	X	X
Violetta Darwin	Erasmus Darwin (1731–1802)	Elizabeth Collier	X	X
Robert Waring Darwin (1766–1848)	Erasmus Darwin (1731–1802)	Mary Howard	X	X
Susannah Wedgwood	Josiah Wedgwood I	Sarah Wedgwood	X	X
Josiah Wedgwood II	Josiah Wedgwood I	Sarah Wedgwood	X	X
John Wedgwood	Josiah Wedgwood I	Sarah Wedgwood	X	
Louisa Allen	John B. Allen	Elizabeth Hensleigh	X	
Elizabeth Allen	John B. Allen	Elizabeth Hensleigh	X	
Catherine Allen	John B. Allen	Elizabeth Hensleigh	X	
Francis Galton	Samuel Galton (1783–1844)	Violetta Darwin	X	X
CHARLES ROBERT DARWIN (1809–1882)	Robert Waring Darwin (1766–1848)	Susannah Wedgwood	X	X
Caroline Darwin (1800–1888)	Robert Waring Darwin (1766–1848)	Susannah Wedgwood	X	X
Emma Wedgwood	Josiah Wedgwood II	Elizabeth Allen	X	X
Josiah Wedgwood III	Josiah Wedgwood II	Elizabeth Allen	X	
Henry Wedgwood	Josiah Wedgwood II	Elizabeth Allen	X	
Hensleigh Wedgwood	Josiah Wedgwood II	Elizabeth Allen	X	
Jessie Wedgwood	John Wedgwood	Louisa Allen	X	
Frances MacKintosh	James MacKintosh	Catherine Allen	X	
William Erasmus Darwin (1839–1914)	Charles Robert Darwin	Emma Wedgwood	X	X
Catherine E. Wedgwood	Josiah Wedgwood III	Caroline Darwin	X	
Louisa F. Wedgwood	Henry Wedgwood	Jessie Wedgwood	X	
Frances J. Wedgwood	Hensleigh Wedgwood	Frances MacKintosh	X	

Charles and Emma from their maternal grandparents Josiah Wedgwood I and Sarah Wedgwood (Fig. 3). Paige (2010) discussed the molecular basis of inbreeding depression and the relative roles of overdominance (heterozygote superiority) and partial dominance (partially recessive deleterious alleles). The latter hypothesis appears to be favoured and was advocated by Davenport (1908).

Darwin was worried about the ill effects that his consanguineous marriage to his first-cousin Emma Wedgwood (Fig. 3) might have on their children (Berra *et al.*, 2010). Charles's son George (1845–1912) became an expert on the family history and hired an American genealogist living in London, Colonel Joseph Lemuel Chester (1821–1882), to produce a pedigree that traced the Darwins back 200 years (Browne, 2002: 471; Kuper, 2009: 86). This pedigree was never printed, although some of Chester's notes

are in the Francis Galton archive in the Library of University College London (Freeman, 1984). George also expressed the opinion that cousin marriages should be restricted (G. Darwin, 1873).

Francis Galton, who shared a grandfather (Erasmus Darwin 1731–1802) with Charles Darwin (Fig. 3), authored a book (Galton, 1869) that purported to show the inheritance of genius abilities. George Darwin, a mathematician, influenced by his cousin Francis Galton (strictly speaking Francis and George were half first cousins once removed) and his father's fears, conducted a statistical study of cousin marriages via questionnaires to investigate whether such unions were harmful. This was one of the first data-based sociological studies (Kuper, 2009). George concluded '... that the percentage of offspring of first-cousin marriages [in mental asylums] is so nearly that of such marriages in the general population, that

one can only draw the negative conclusion that, as far as insanity and idiocy go, no evil has been shown to accrue from consanguineous marriages.' (G. Darwin, 1875; Kuper, 2009: 98).

Karl Pearson, Galton's biographer and protégé, surveyed readers of the *British Medical Journal* and concluded that 'the diseases of children are not largely due to any consanguinity between their parents.' (Pearson, 1908; Kuper, 2009: 101). Bittles (2009) stated that 'Given our present knowledge of genetics, and with the invaluable gift of hindsight, Charles Darwin's concerns on the harmful effects of first-cousin marriage were excessive . . .' Berra *et al.* (2010) presented data to the contrary.

Perhaps the best authority on the effect of inbreeding in humans is the formal set of recommendations (based on an extensive review of available data from the National Society of Genetic Counselors), published by Bennett *et al.* (2002), who reported the increased risks incurred by the offspring of first cousin marriages to be 4.4% for pre-reproductive mortality, 1.7–2.8% for congenital defects, and 7–31% for an adverse medical outcome. Berra *et al.* (2010) calculated that Darwin's children had an inbreeding coefficient of  $F = 0.0630$ , which, for all practical purposes, is the same as the value of  $F = 0.0625$  for the offspring of first cousins (the difference being the result of additional distant lines of common descent). The coefficient of inbreeding ( $F$ ) is 'a measure of the proportion of loci at which the offspring of a consanguineous union would be expected to inherit identical gene copies from both parents' (Bittles, 2009). From a practical point of view, therefore, Darwin's children had the same increased risk as those quoted above. Because unexplained infertility and increased susceptibility to bacterial infection are risk factors of consanguineous marriage, Berra *et al.* (2010) suggested that this might explain the lack of fertility in three Darwin children with long-term marriages (William Erasmus, Henrietta, and Leonard) and the high child mortality of Darwin's progeny because three of Darwin's ten children (Anne Elizabeth, Mary Eleanor, and Charles Waring) died by the age of 10 years (Fig. 3). Daughter Elizabeth, 'Bessy' (1847–1928), was always considered a bit unusual. She never married and led an independent life after Emma died (Healey, 2001).

It is no coincidence that Leonard Darwin assembled a collage of family photographs. The Wedgwoods and the Darwins were pioneers in the development and dissemination of photography. For example, Charles Darwin's uncle, Thomas Wedgwood (1771–1805), in partnership with chemist Humphry Davy, published a paper in 1802 that explained how to produce fleeting images on paper and leather using silver nitrate and light exposure. However, they lacked a method to fix the images, and their discovery was not immediately

appreciated (Prodger, 2009). William, George and Leonard Darwin were keen photographers and probably influenced their father (Browne, 2002). Horace Darwin (1851–1928), as founder of the Cambridge Instrument Company, likely had an interest in photography. Charles Darwin (1872) was the first scientist to use photographs to illustrate a book. In *Expression of Emotions in Man and Animals*, Darwin depicted laughter, crying, anger, etc., in expressive heliotypes made by the peculiar and talented art photographer, Oscar Rejlander. Many of these images are reproduced by Prodger (2009).

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