Commentary: The background and outcomes of the first-cousin marriage controversy in Great Britain

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Introduction
During the early years of Christianity there were major social and legal differences in attitude towards consanguineous marriage in the Eastern and Western Roman empires, reflecting pre-existing divisions between the Classical Greek and Roman worlds. In Athens and Sparta first-cousin, uncle–niece and half-sib marriages were permissible,1–3 with half-sib marriage, and even full-sib marriage continuing within the ruling Ptolemaic dynasty and the settler population of Lower Egypt between the first and the third centuries AD.4 By comparison, in Rome there was strong disapproval of first-cousin marriage,3 and the marriage between the Emperor Claudius (41–54 AD) and his niece Agrippina was regarded as especially scandalous. The genetic relationships involved in these consanguineous unions are summarized in Table 1, accompanied by the equivalent coefficients of relationship (r) indicating the proportion of genes shared by each parent, and coefficients of inbreeding (F), 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.

Not surprisingly, given the period in human history, none of the early judgements on the degrees of permitted and prohibited marriages between biological relatives appears to have had an especially rational scientific basis. However, by the middle of the fifth century the Church had adopted the Roman doctrine on consanguineous marriage, with the initial impact in England recounted by the Venerable Bede writing in the early eighth century.5 According to Bede, on his installation as the first Archbishop of Canterbury, Primate Augustine had requested advice from Pope Gregory I on Church regulations with respect to first-cousin marriages. The reply from the Pope in 591, citing Leviticus 18:6, was that ‘Sacred law forbade a man to uncover the nakedness of his near kin’. Furthermore, depending on the translation consulted, the Pope advised either that ‘unions between consanguineous spouses do not result in children’5 or ‘the offspring of such marriages cannot thrive’.6 The Papal decision to cite the rather vague but apparently all-embracing ban on consanguineous unions in Leviticus 18:6 is noteworthy, since in Leviticus 18:7–18 quite explicit guidelines are provided on the partners a man may or may not take as a wife, with first-cousin unions, and indeed uncle–niece relationships, acceptable.

Church permission to marry a biological relative could be sought and granted on payment of a dispensation fee with two different systems used to calculate degrees of consanguinity: the Roman system counted the distance between relatives by summing the number of links from each related individual to a common ancestor, whereas the Germanic system counted the number of links between one partner in the relationship and their common ancestor.1,6,7 Under a canon issued by Pope Alexander II in 1076, the Germanic system was selected as the formal method of consanguinity classification by the Church. This created considerable initial confusion since, for example, a first-cousin relationship (F = 0.0625) is classified as the fourth degree of consanguinity under the Roman system but the second degree according to the Germanic method.1 Some semblance of order was restored by Pope Innocent III at the IV Lateran Council in 1215 with the decision that the restrictions on consanguineous marriage applied to third-cousin relationships or closer (F ≥ 0.0039).7 This level of regulation was confirmed by the post-Reformation Council of Trent (1545–63) and remained in force until 1917 when the requirement for consanguinity dispensation was reduced to couples related as second cousins or closer (F ≥ 0.0156) and in 1983 to first cousins or closer. Somewhat surprisingly, multiple pathways of consanguinity, which often occur in small endogamous communities, were ignored in the latter revision.7

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Table 1 Human genetic relationships

<table>
<thead>
<tr>
<th>Biological relationship</th>
<th>Coefficient of relatedness ((r))</th>
<th>Coefficient of inbreeding ((F))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incest*</td>
<td>0.5</td>
<td>0.25</td>
</tr>
<tr>
<td>Half-sib</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncle–niece</td>
<td>0.25</td>
<td>0.125</td>
</tr>
<tr>
<td>Double first cousin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First cousin</td>
<td>0.125</td>
<td>0.0625</td>
</tr>
<tr>
<td>First cousin once removed</td>
<td>0.0625</td>
<td>0.0313</td>
</tr>
<tr>
<td>Double second cousin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second cousin</td>
<td>0.0313</td>
<td>0.0156</td>
</tr>
<tr>
<td>Second cousin once removed</td>
<td>0.0156</td>
<td>0.0078</td>
</tr>
<tr>
<td>Double third cousin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third cousin</td>
<td>0.0078</td>
<td>0.0039</td>
</tr>
</tbody>
</table>

*Defined as a father–daughter, mother–son or brother–sister relationship.

As part of his criticism on the practices of the Roman Catholic Church, Martin Luther had condemned the requirement for consanguinity dispensation payments, since according to Divine Rule as revealed in Leviticus 18:7–18, there should be no impediment to marriage between first cousins. Accordingly, first-cousin marriages were accepted by the various Protestant denominations founded in much of northern Europe. Although, ironically, a ban on first-cousin marriage was maintained by the state Lutheran Church in Sweden until 1680, and royal dispensation to marry a first cousin was required until 1844. 8

The situation in England was somewhat different, although it also centred on the permissible relationships between spouses, but with Leviticus 18:7–18 once again cited. On the death of his elder brother Arthur in 1491, Henry VIII had obtained Papal dispensation to marry his brother’s widow Catherine of Aragon. 6 As the marriage failed to produce a male heir, Henry petitioned the Pope for a divorce on the grounds that his marriage to Catherine, his sister-in-law, was invalid under the Levitical statutes. Despite support from English and Continental legal experts his petition was rejected, so in 1533 Henry established the Church of England with himself, as monarch of England, the head of the Church. 6 Having embarked on this major religious realignment, and wishing to marry Catherine Howard, a cousin of his executed second wife Anne Boleyn, in 1540 Henry issued a statute that legalized marriage between all first cousins, consanguineous and affinal. In 1560, during the reign of the Protestant Elizabeth I, the consanguinity and affinity regulations were formally codified by Archbishop Parker as The Tables of Kindred and Affinity of the Church of England, with subsequent revisions in 1563 and 1940. 6

The 19th century controversies on affinal and consanguineous marriage

A late 19th century compilation of books and papers on cousin marriage published in Europe from the 16th to the start of the 19th century suggests limited interest in consanguinity, 9 and during the early 1800s attention in England was concentrated on affinal rather than consanguineous marriage, i.e. unions between individuals related through marriage rather than genetic relationships. Lord Chancellor Lyndhurst had introduced a bill into the House of Lords to place a restriction on the time period during which marriages within the prohibited degrees of affinity could be annulled, and a revised form of the Lyndhurst Bill passed by Parliament declared valid all such marriages contracted before 31 August 1835. 10 A clause was, however, added that made affinal marriages solemnized after that date void. Opposition to the impact of this clause on widowers who wished to marry their deceased wife’s sister resulted in the introduction of the Wife’s Sister Bill to Parliament in 1842, but formal approval of this seemingly innocuous piece of legislation was not obtained until 1907, with the Bill unsuccessfully brought before Parliament on numerous occasions during the intervening years. 10

In the interim, despite the widespread acceptance of first-cousin unions in England, as evidenced in the popular literature of the first half of the 19th century, 11 increased concerns were being expressed on the adverse health effects of first-cousin marriage. The initial reports from France on an increased prevalence of deaf–mutism among the progeny of first cousins 12 were investigated by Sir William Wilde, who, as Assistant Census Commissioner, included a question on consanguineous marriage and deaf–mutism in the Post-Famine 1851 Census of Ireland. According to the Irish Censal data, 4747 individuals with deaf–mutism were enumerated, a prevalence of 1/1380, and in 3.6% of cases the parents were related as first, second or third cousins. 13

The controversy surrounding first-cousin marriage rapidly escalated, especially in the USA after an article delivered in 1855 to the Ninth Meeting of the American Association for the Advancement of Science by the Rev. Charles Brooks, an Episcopal clergyman who in a diatribe against first-cousin marriage declared that ‘The improvement of society and prosperity of thousands of families depend on its solution; and, in a degree, the safety and elevation of society’. 14 This claim appeared to be justified by an extensive study into the outcomes of consanguineous unions by Dr Samuel Bemiss of Louisville, Kentucky, based on information provided by medical colleagues into the mean number of offspring and the rates of early deaths that resulted from consanguineous unions ranging from incest \((F=0.25)\) to third
cousins \(F = 0.0039\) versus deaths among non-consanguineous progeny.\(^{15}\) The data showed a significant positive relationship between early deaths and the degree of consanguinity. But they also indicated that although tuberculosis had been diagnosed as the cause of death in 8.7% of non-consanguineous progeny, it was responsible for 22.7% of deaths among consanguineous offspring, a finding strongly suggestive of a significant difference in the living conditions of the two groups.

**Charles Darwin and the first-cousin marriage controversy in England**

In 1839, the then 30-year-old Charles Darwin married his first cousin Emma Wedgwood aged 32 years, following the marriage of Charles' elder sister Caroline to Emma's brother Josiah Wedgwood III in 1837. Ten children were born during the course of the next 17 years and by all accounts the marriage was happy, with Charles and Emma sharing a close companionship. However, in his letters to friends, Darwin expressed a concern that the periodic bouts of debilitating ill-health from which he suffered might be transmitted to their children.\(^ {16}\) In fact, 3 of their 10 children died in childhood. Their third-born girl Mary of unknown cause within weeks of her birth in 1842, his favourite daughter Annie at 10 years of age in 1851, probably of tuberculosis, and in 1858 their last-born child Charles Waring, born when Emma was 48 years of age and whose death at 18 months is assumed associated with Down syndrome comorbidities.\(^ {16}\) The remaining seven offspring appear to have enjoyed good health, with a mean age at death of 77 years, and three of the sons, George, Francis and Horace, were elected Fellows of the Royal Society of London for their scientific work, and Leonard was a Member of Parliament from 1892 to 1895 and President of the Geographical Society from 1908 to 1911.

Darwin would have been aware of the heated discourse in England and elsewhere on the advisability of marriage between first cousins; for example, the letters in the columns of the *British Medical Journal*,\(^ {17,18}\) and in France 25 papers on different aspects of consanguinity were published in 1862 alone.\(^ {9}\) Especially after the death of his daughter Annie, Darwin appears to have become convinced that marriage to his first cousin may have been a mistake from a biological perspective. His concerns were first publicly expressed in the improbable context of the avoidance of self-fertilization in orchids.\(^ {19}\)

On the basis of this observation, Darwin postulated the existence of a universal mechanism to reduce the harmful effects of close inbreeding, concluding in the final sentence of his book ‘For may we not infer as probable … that marriage between near relations is likewise in some way injurious, - that some unknown great good is derived from the union of individuals which have been kept distinct for many generations?’ Coming from such a distinguished scientist, married to a first cousin and connected by birth and marriage to the Wedgwood industrial dynasty, Darwin's views were rapidly disseminated and vigorously debated by members of the medical and legal professions.\(^ {3,20,21}\)

To produce credible evidence on the topic of consanguinity, Darwin persuaded his friend and neighbour Sir John Lubbock, MP, to petition Parliament for the inclusion of a question on the prevalence of first-cousin marriage in the 1871 Census of Great Britain and Ireland. The proposal was voted down by the Parliamentary Committee vetting the content of the 1871 Census Bill,\(^ {22}\) evoking from Darwin the response ‘When the principles of breeding and of inheritance are better understood, we shall not hear ignorant members of our legislature rejecting with scorn a plan for ascertaining by an easy method whether or not consanguineous marriages are injurious to health’.\(^ {23}\)

**George Darwin and the prevalence and outcomes of first-cousin marriage in England**

Charles and Emma Darwin's second son George had an obvious personal interest in his father's views on first-cousin marriage, and he also had been annoyed at the rejection of Lubbock's proposal to Parliament ‘… amidst the scornful laughter of the House …’\(^ {24,25}\) As indicated in the reprinted *Fortnightly Review* article by George Darwin,\(^ {24}\) which closely matches a paper concurrently published in the *Journal of the Statistical Society*,\(^ {25}\) to circumvent the Parliamentary veto, Darwin devised a mathematical method of estimating the prevalence of first-cousin marriage based on the proportion of marriages between persons with the same surname. Using as his initial data source *The Registrar-General's Annual Report for 1853*, with an estimated 32 818 different surnames recorded for the 275 405 persons listed, Darwin observed that ‘... about one marriage in a thousand takes place in which the parties are of the same surname, and have been uninfluenced by any relationship between them ...’ But rather than the expected 0.1% of same-surname (isonymous) marriages that might have been predicted on this random basis, when Darwin and a research assistant checked the marriage announcements printed in *The Pall Mall Gazette* for the years 1859–63 they found that 1.25% of the 18 528 marriages listed were between persons with the same surname. The questions that then arose were: (i) what proportion of the 1.25% of same-surname marriages were between first cousins?; and (ii) what proportion of first-cousin marriages were between couples who shared the same surname?\(^ {24,25}\)
To answer the first question for first-cousin marriage among ‘the upper classes’, Darwin sought guidance from two socially impeccable sources, Burkes Landed Gentry and the English and Irish Peerage, from which he calculated that 0.78% of same-surname marriages were between first cousins, and to solve the second question he distributed approximately 800 pre-stamped circulars to members of the ‘upper middle and upper classes’, with the request that they provide the names of any family members who had married their first cousins, and also those who had married someone with the same surname but who was not their first cousin.

Darwin acknowledged that the information provided may have been incomplete: ‘I have been most surprised to find how very little people know of the marriages of their relations’. He also realized that there would be probable positive bias, since respondents may have been more likely to recall a first-cousin union but fail to respond if they had no same-surname or first-cousin marriages to report. Despite these problems, Darwin was able to calculate that same-surname first-cousin unions accounted for 57% of all same-surname marriages, whereas the ratio of same-surname first-cousin marriages to different-surname first-cousin marriages was 1:4. To translate these figures into city, urban and rural categories Darwin consulted the General Registry of Marriages for 1872 and calculated that the highest percentage of first-cousin unions occurred in rural districts (2.25%), and the lowest in metropolitan London (1.5%). However, these levels of consanguinity fell far short of the first-cousin marriage rates he had calculated for the landed gentry (3.5%) and members of the aristocracy (4.5%).

The second part of Darwin’s enquiry was to examine the possible adverse health consequences of first-cousin marriage, which he initially assessed by determining the comparative prevalence of first-cousin offspring among the inmates of 19 lunatic asylums in England, Scotland, Wales and Ireland. Once again, quite serious problems were noted in the collection of reliable and unbiased data. Some regional variation also was indicated, with the 5.25% first-cousin parentage among inmates in Scottish institutions explained in terms of the often mountainous nature of the Caledonian terrain, which may have led to a higher proportion of consanguineous unions in geographically isolated communities. However, the overall prevalence of 3.9% first-cousin parentage among the asylum inmates for whom relevant information was available versus the 3.4% first-cousin unions in the general population suggested that the adverse effects of consanguinity on mental health had previously been over stated.

Commenting on the paper after its presentation to the Statistical Society, Francis Galton, a half-cousin of Charles Darwin, summarized the findings as having ‘…undoubtedly swept away, to some extent, an exaggerated opinion which was current as to the evil resulting from first-cousin marriages’. In a subsequent private letter to Darwin dated 10 November 1875 Galton further stated that ‘You have exploded most effectively a popular scare’, and in jocular vein suggested that George Darwin could very profitably write a pamphlet on the theme ‘WORDS of scientific COMFORT and ENCOURAGEMENT To COUSINS who are LOVERS’, which given the probable numbers of actual and potential first-cousin couples in England at the time could attract annual sales of some 8000 copies.

By that stage George Darwin had extended his studies to focus on more general health effects of first-cousin marriage by determining the prevalence of first-cousin parentage among the rowing eights of the Colleges of Oxford and Cambridge Universities, whom he described as ‘… a picked body of athletic men …’, but with coxes excluded. Since 2.4–2.8% of these picked athletes were the offspring of first-cousins by comparison with the 3.0–3.5% first-cousin parentage of their social peers as calculated in Darwin’s earlier studies, he concluded that ‘… these numbers appear, to some extent, to justify the belief that offspring of first cousins are deficient physically …’. Although this interpretation is dependent on acceptance of the superior physical status accorded by Darwin to Oxford and Cambridge boating men.

The aftermath

Given the findings of his son’s studies, and perhaps influenced by their enthusiastic welcome by Francis Galton, Charles Darwin revised his previously negative opinion on the health outcomes of first-cousin marriage on the grounds that ‘… the widely different habits of life of men and women in civilised nations, especially amongst the upper classes, would tend to counter-balance any evil from marriages between healthy and somewhat closely related persons’. This apparent triumph of nurture over nature, at least among the socio-economically advantaged, was further reflected in the omission of any reference to the inadvisability of marriage between close relatives in the second edition of his book on self-fertilization in orchids, and with the phrase ‘And on the Good Effects on Intercrossing’ removed from the book’s title. 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, and his extrapolation from the ill-effects of self-fertilization in plants where the progeny would predictably be homozygous at 100% of gene loci ($F=1$) to the outcomes of first-cousin marriage in humans ($F=0.0625$) is difficult to justify.

Despite the results of George Darwin’s studies and his father’s recantation, first-cousin marriage rapidly
declined in prevalence in Great Britain from the levels calculated by George Darwin and supported by a survey of medical practitioners conducted by Karl Pearson covering the mid- to late 19th century.\textsuperscript{30} By the beginning of the 20th century, just 0.9% of children in Great Ormonde Street Hospital, London, had first-cousin parents,\textsuperscript{30} a survey of genealogists’ families in the 1920s indicated 0.3% first-cousin marriage\textsuperscript{31} and the most recent hospital-based data suggest 0.2% first-cousin unions among autochthonous UK residents in the English Midlands.\textsuperscript{32} The change has been much more extreme in the USA, where by the end of the 19th century 13 states had already introduced legislation to control or ban first-cousin marriage.\textsuperscript{1} Currently, first-cousin marriage is illegal or a criminal offence in 31 of the 50 states,\textsuperscript{33} and despite a unanimous legal recommendation in 1970 that all state laws prohibiting first-cousin marriage should be rescinded because of a lack of evidence of significant ill-effects,\textsuperscript{34} legislation banning first-cousin marriages in Texas was passed in 2005.

Consanguineous marriage in the 21st century

George Darwin’s influence on studies into the distribution and prevalence of cousin marriage continues, with the isonymic (same-surname) method he devised used to estimate random and non-random inbreeding in historical communities and in present-day populations where pedigree or genomic information is unavailable. As detailed on the Global Consanguinity website http://www.consang.net, consanguineous marriage remains popular in many parts of Asia and Africa and it has been estimated that currently >10% of the global population are either married to a partner related as second cousin or closer ($F \geq 0.0156$) or are the progeny of such a union.\textsuperscript{35}

Over the course of the last 50 years there has been large-scale migration from these regions to many Western countries. In the UK and several other European countries concern has been expressed on the adverse health effects of consanguineous marriage, driven in the UK by inflammatory claims from some Members of Parliament whose constituencies include sizeable communities of South Asian migrants, with calls for a ban on first-cousin marriage.\textsuperscript{35} However well intentioned, in their tone and willingness to cite vague health ‘statistics’, the proponents of the move to prohibit first-cousin marriage curiously echo their counterparts of the 19th century. There is no doubt that in some families first-cousin marriage can facilitate the expression of rare recessive disease genes carried by both parents, causing major childhood illness.\textsuperscript{36} However, a recent meta-analysis of 69 studies from 15 countries has indicated a mean 3.5% increase in prereproductive mortality at first-cousin level, which is lower than earlier estimates and indicates that a large majority of first-cousin progeny are no more likely to be seriously disadvantaged in health terms than the offspring of unrelated parents.\textsuperscript{35}

As cogently warned in the 19th century by Dr Arthur Mitchell, Deputy Commissioner in Lunacy for Scotland and a contemporary of Charles and George Darwin, ‘Startling illustrations of calamitous sequences to cousin-marriages have been detailed, and pointed at with a finger of warning, the relation of cause and effect being assumed (author’s italics)’.\textsuperscript{37} This unfortunate tendency continues, with a readiness to blame any and all types of adverse pregnancy, birth and childhood health outcomes on consanguinity, despite the lack of any obvious let alone proven causal relationship, adequate control for sociodemographic variables, or allowance for the influence of other important population genetic factors, in particular clan, tribe and biraderi endogamy according to the population studied.\textsuperscript{33,38,39}

Thus in the UK Bangladeshi community, which has a rate of sensorineural childhood deafness of 3.86/1000 versus 1.65/1000 in the general UK population, consanguineous marriage has been widely and uncritically assumed to be the causative factor. A study of Bangladeshi patients confirmed both a high prevalence of first-cousin (24.8%) and other forms of consanguineous marriage (8.6%) among the parents of affected persons, and in 60% of cases the deafness was genetic in origin with a recessive mutation in the $GJB2$ (Connexin 26) gene identified in 17% of patients.\textsuperscript{40} However, the rate of deafness was 2.73/1000 in children born to the two-thirds of Bangladeshi families who had not contracted a cousin marriage, suggesting that mutant genes causing the disorder are common in the Bangladeshi gene pool, and indicating other major non-genetic causes including congenital cytomegalovirus infection.\textsuperscript{40}

Conclusion

The study by George Darwin provided valuable evidence that fears regarding the ill-effects of first-cousin marriage were exaggerated. Especially in high-income countries there is the capacity to provide health education at individual, family and community levels, with genetic counselling, premarital diagnosis and prenatal diagnosis for genetic disorders widely available where requested. Rather than seeking to ban a form of marriage that has been legal in England for >450 years, i.e. some 15–20 generations, ensuring access to these viable and non-discriminatory options is the logical way to proceed and more likely both to receive community acceptance and be successful in maintaining and improving health.
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