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HOW CELTIC ARE THE CORNISH?: A STUDY OF BIOLOGICAL AFFINITIES

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The purpose of this article is to see, by comparative analysis, whether the rich and multifarious Celtic heritage of Cornwall extends to the biological realm. The sample comprised 254 volunteers who were born in Cornwall, 82 per cent. of whom had four, and the remainder three, Cornish-born grandparents. Anthropometric, dermatoglyphic and pigmentary traits are the multifactorial characters studied. Red-green colour vision deficiency and alleles of five blood group systems comprise the genetically determined characteristics. Among the multifactorial traits, such characteristics as head size, hair and eye colour point to greater affinities with the Celtic language-speaking peoples of Wales, Ireland and Scotland, than with the neighbours of the Cornish to the east. On the other hand, the blood group evidence shows that the sample occupies a somewhat intermediate position between Celtic and Anglo-Saxon populations, but with a definite tendency to be aligned with the latter. A third category of observations points to some distinctive features, notably in the Duffy and Kell blood group systems and in the epidermal ridge configurations on the palms. A surprising result is that the Cornish and Breton Bigouden peoples, according to the evidence of recent sampling, are remarkably distant in their multivariate blood group relationships.

This article describes a wide range of physical characteristics among a sample of native-born Cornish people, whose biological affinities are sought by analysis of comparative material from Britain and Europe. This study was prompted by the remarkable dearth of systematic biological population studies of the British Isles, in spite of stimulus given by Roberts and Sunderland's *Genetic variation in Britain* (1973), and more than a quarter of a century after Mourant, Morgan Watkin and Fraser Roberts pioneered the study of regional blood group distributions—tributary streams, these, which culminated in Kopeč's grand inundation of 1970. It remains a fact that, with few exceptions, our knowledge of what the people of Britain look like on a regional basis, how big they are, and how the frequencies of their genetic markers are distributed is very incomplete. The second motive is the particular regard in which Cornwall is held, both in the eyes of the Cornish and of those looking towards the south-west peninsular

from England 'up-country' or across the Severn. For more than a thousand years Cornwall has been a focus of interest in Celtic reality and romance.

Our purpose, therefore, in describing the physical anthropology of our chosen sample, is to see by comparative analysis whether the rich and multifarious Celtic heritage of Cornwall extends to the biological realm. What are the grounds for this hypothesis? First, is it likely that the Cornish population had an appreciable Celtic ancestral component linking it by descent with the Welsh and Irish and second, if such were the case, will these Celtic genes be detectable in the modern population? Finally, to what extent do the people of Brittany, now residing in those areas of Armorica that once provided refuge for the Brythonic language-speakers of Cornwall, still retain a biological affinity with their neighbours across the Channel?

Irish immigration to Cornwall, directly and via south Wales, during the fifth and sixth centuries A.D. is central to the matter. At first sight the case for a substantial Irish settlement seems overwhelming. Between the departure of the Romans, by whom it was little affected, and the final capitulation of Dumnonia to the Anglo-Saxons, Cornwall came to possess artefacts and monuments of Irish provenance and a large number of churches dedicated to the band of saints peculiar to Celtic Christianity whose cults also occur widely in Ireland, Wales and Brittany. A richly Celtic written history and hagiography, a Brythonic language widely spoken until Tudor times and persisting in the south-west until the eighteenth century, and a large number of place-names and surnames of Celtic origin complete the list of material to be considered. This backcloth to our present investigation must briefly be examined for weaker strands and, as will be seen, for later darns and embroideries.

Thomas (1972), who has reviewed the evidence for Irish colonisation of post-Roman Britain's western seaboard, and who does not doubt the reality of Irish settlement in Cornwall, concedes that the sixth-century grass-marked pottery found in Penwith without local Romano-British precedent, but related to the Souterrain ware of Ulster, can provide evidence of only small-scale settlement. The evidence for earlier, fifth-century colonisation is largely epigraphical and consists mainly of the ogam-inscribed stones and those commemorating men with Irish names by British funeral formulae written in Latin. These stones occur infrequently in Cornwall and widely in Ireland, the Isle of Man and Wales (Bowen 1977: 47).

Whilst the Cornish language certainly implies a Celtic population, the persistence of Brythonic Celtic in Wales and Cornwall rather than Goidelic as in Irish, Manx and Scottish Gaelic indicates to Thomas (1972) some less commanding position either numerically, economically or socially for Irish settlers in Wales and Cornwall. Manifestly, the persistence of language is of complex determination, and cannot be used reliably to quantify settlement.

The 'Lives of the Saints', the hagiographies embodying the tradition that Celtic Christianity moved from Ireland and Wales into Cornwall after the Roman withdrawal, are discounted by Thomas (1972) as being informative of individuals rather than populations, and as in any case unreliable. Pearce (1978) discusses the problems in interpreting this material as history. She shows that many of the Cornish saints had no connexion with Ireland before the stories

were recast by southern Welsh writers in the twelfth century; furthermore it was not uncommon for the churches celebrating the Celtic saints to have been re-dedicated to them in later centuries. In a like manner the Arthurian legends and the story of Tristan and Isolt were re-located in the south-west peninsula by Welsh writers in order to assert Celtic tradition in the face of Norman conquest and to fill the British political vacuum in Cornwall left by the fall of Dunmonia in A.D. 926 (Pearce 1978: 155). Whilst the hagiographies are not without some factual basis she concludes that 'The saints' lives, together with genealogical and other narrative tracts produced between the sixth and the twelfth centuries, form an interlocking corpus of material which both sheds light on the history of the earlier centuries, and, of equal importance, illuminates the successive phases of the sense of the past' (Pearce 1978: 131).

Our inference from consideration of these lines of evidence is that there was only a limited amount of Irish settlement in Cornwall—though the claim is certainly far better supported than that of Norse settlement, for example (Wakelin 1976: 7)—with a cultural importance which far exceeds the demographic, owing in some part to the Celtic revivals in subsequent centuries. The significance of this conclusion lies in its genetic implications. The disparate tribal subdivision of Celtic mainland Britain at the coming of the Romans gives less encouragement to an expectation of genetic homogeneity among areas of persistent Celtic culture than if each had received a considerable amount of Irish settlement. As for the Bretons, it may well have been a response to the pressure of Irish immigration, real or anticipated, on the west coast of Cornwall, as well as to Saxon invasion in the east, that precipitated the emigration of Brythonic Celts from Cornwall, perhaps under Welsh leadership, to Armorica in the fifth and sixth centuries (Chadwick 1963: 50). The degree of persistence of Celtic traits, physical and genetic, among the present peoples of Brittany is therefore of particular interest in this study.

We turn now to the question of whether a predominantly Celtic population in Cornwall at the Norman Conquest will exhibit genetic evidence of its provenance in the late twentieth century.

The micro-evolutionary processes which could prevent this are genetic drift, natural selection and migration. If we dismiss genetic drift as being unlikely to have an effect on the whole population of Cornwall, and natural selection as being frankly too difficult to detect with our present resources, we are left with migration as the most probable and tractable cause of gene frequency change. From the pattern of English demographic history it is rather more likely that widespread migration occurred in the recent rather than the remote past so we shall confine our assessment of possibilities to the nineteenth century. Notwithstanding the fact that the Cornish themselves have emigrated to a wide range of destinations at the collapse of the mining industry (Halliday 1975) a weight of historical as well as modern tradition suggests that Cornwall has always resisted infiltration from England 'up country' even at the time when its industries were booming. Certainly, at the 1851 Census Cornwall was the most isolated of English counties, with over 90 per cent. of the inhabitants born there. A more detailed survey of 953 married couples, randomly selected from the 1851 Census enumerators' books of the parishes between Truro and St Austell, shows

forty-one immigrant men and thirty-four women (including fifteen couples where both were born outside Cornwall). Of these seventy-five people, a third had been born in the adjacent county, Devon.

In terms of occupation, by far the greatest number of incomers were coastguards, with fourteen of the seventeen being immigrant, as were seven of their wives. The remainder of the incomers tended to be professionals and tradesmen, though there were a few agricultural labourers in this category. Including wives, there was among the fisher families one immigrant (from Devon) out of 180; of agricultural labourers ten (including seven from Devon) out of 506; and of farmers four out of 284. The next hundred years, however, saw a gradual decline in Cornwall's proportion of native-born inhabitants—by 1951 it had fallen just below 70 per cent. for the first time.

Our sample for biological analysis comprised 254 volunteers who were born in Cornwall, with both parents and at least three, and preferably four, grandparents born there too. This sampling strategy is designed to obviate the effects of recent immigration in order to search for Celtic genes; it is not intended to represent the present-day population of Cornwall, which includes twentieth-century immigrants and their descendants. As far as this cursory analysis goes, we can say that among our sample a notional ancestral gene pool will be less likely to have been diluted by immigrant genes than would one similarly drawn from any other county. We cannot ignore, however, that migration and intermarriage are characteristic of the historical process in England; consequently an unmixed gene pool in a population as large as Cornwall's is necessarily an unrealistic abstraction and cannot actually be attained even by our sampling strategy.

Materials and methods

Our sample of 254 Cornish men and women was examined at eleven different localities in Cornwall during April and May 1984. Over 90 per cent. of them volunteered for the anthropological study in response to appeals in the media. The remaining 9 per cent. of the sample were students and teachers of the Cornwall College for Further and Higher Education. From the 346 people who applied for, and returned, family information questionnaires to the Institute of Cornish Studies and the British Museum (Natural History) during March 1984, 108 men and 146 women were selected. Eighty-two per cent. of them had all four grandparents born in Cornwall. The distribution of their parents' and grandparents' birthplaces in the present-day administrative districts of Cornwall (fig. 1) is given in table 1. Over half their grandparents were born in the western districts of Kerrier and Penwith, compared with 16 per cent. in the northern and eastern regions of Cornwall (N. Cornwall and Caradon Districts). The central districts of Carrick and Restormel account for the remaining 32 per cent. of grandparents' birthplaces.

Through the generosity of Professor F. S. Hulse we have obtained data for an additional sample of Cornish people for comparison with those of the present study. These concern 143 Cornish adult males aged between eighteen and seventy-two years examined in the Autumn of 1952 (Hulse, unpublished

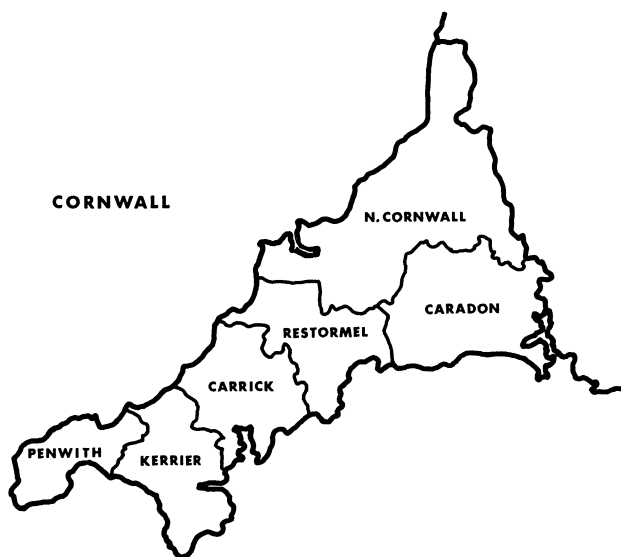


FIGURE 1. Census districts of Cornwall.

TABLE I. Distribution of parents' and grandparents' birthplaces of Cornish men and women included in the anthropological studies of 1984 and 1952.

| District or Region | <i>Present study (1984)</i> | | | | <i>Hulse sample (1952)</i> | |
|-----------------------|---------------------------------|-------|--------------------------------------|-------|---------------------------------|-------|
| | <i>Parents' birthplaces</i> | | <i>Grandparents' birthplaces</i> | | <i>Parents' birthplaces</i> | |
| | No. | % | No. | % | No. | % |
| PENWITH | 95 | 19.4 | 195 | 21.3 | 45 | 16.1 |
| KERRIER | 155 | 31.6 | 282 | 30.8 | 119 | 42.7 |
| CARRICK | 102 | 20.8 | 182 | 19.9 | 85 | 30.5 |
| RESTORMEL | 65 | 13.3 | 111 | 12.1 | 16 | 5.7 |
| N. CORNWALL | 48 | 9.8 | 94 | 10.3 | 10 | 3.6 |
| CARADON | 25 | 5.1 | 51 | 5.6 | 4 | 1.4 |
| Sub Total | 490 | 100.0 | 915 | 100.0 | 279 | 100.0 |
| Cornwall | 1 | | 48 | | 3 | |
| 'Cornish' | — | | 5 | | 4 | |
| England* | 6 | | 23 | | — | |
| Wales | 1 | | 1 | | — | |
| Scotland | — | | 2 | | — | |
| N. Ireland + Eire | 1 | | 4 | | — | |
| Abroad | 9 | | 8 | | — | |
| Unknown | — | | 10 | | — | |
| TOTAL | 508 | | 1016 | | 286 | |

* Excluding Cornwall

observations). Their grandparents' birthplaces were not recorded routinely. For the purposes of the present study, therefore, the sample was selected on the basis of two Cornish-born parents for each subject. There were, in addition, four cases where one of the parents had been born abroad; however, as the grand-

parents on the appropriate sides of the families in question were recorded as Cornish-born they were not excluded. The distribution of parental birthplaces is shown for comparison with the 1984 sample in table 1 and reveals some noteworthy, and statistically significant, differences. Forty-three per cent. of the Hulse subjects' parents were born in the present district of Kerrier, compared with 32 per cent. of the 1984 sample. Only 5 per cent. of the former had parents born in the northern and eastern parts of the county, whereas 15 per cent. of the 1984 parents' birthplaces are located in the Districts of Caradon and North Cornwall combined. Fewer of the 1952 sample parents came from the far west of Cornwall and there were fewer from the Restormel District. These differences in regional distribution are significant at $p < 0.0001$ (χ^2 5DF = 38.99) and we shall consider them during the later discussion of the results.

Anthropometric measurements. Procedures originally developed for the International Biological Programme Human Adaptability Project (IBP/HA) were used during the 1984 fieldwork (Weiner & Lourie 1981). Stature was measured to the nearest millimetre with a Harpenden portable stadiometer, and the seven craniofacial dimensions were measured using IBP/HA recommended instruments and techniques. In the 1952 fieldwork directed by Professor Hulse not all the subjects had their stature measured without shoes. A correction for heel thickness was recorded, where appropriate, at the time of the survey and has been used to correct individual stature measurements prior to statistical analysis. The 1952 craniofacial measurements were all taken by standard anthropometric techniques and appear to be compatible with the 1984 series.

Dermatoglyphics. Fingerprints were taken, rolled, using Ozalid 'Durester Printake' material. Patterns were classified as in Harvey & Suter (1983*a*; 1983*b*) into eleven categories, following the methods originally introduced by Henry (1905) and Cummins & Midlo (1943). Ridge counting, which included radial and ulnar counts of patterns with more than one triradius, was performed by the methods of Cummins and Midlo (1943: 74) and Holt (1968: 40).

Palm prints were made on plain paper over a 5 cm diameter roller, using Durester Printake material. Patterns in the five configurational areas of the palm were recorded using the topological system of Penrose & Loesch (1970), recently reviewed by Loesch (1983: 44). Mainline Index (Cummins & Midlo 1943: 114) and a-b ridge count (Holt 1968: 88) were also recorded.

Hair colour. The Fischer-Saller *Haarfarbentafel* was used in both 1984 and 1952 field studies. During the 1984 fieldwork grey-haired subjects were asked to select a switch of hair from the colour standard which they considered to be closest to their natural shade when they were in their twenties. The same procedure was adopted for the small number of cases of artificially-coloured hair. In the 1952 series grey-haired individuals were excluded from the analysis unless it was evident from their field-notes that sufficient non-grey hair was present for a colour match to have been made. The thirty shades of hair colour in the Fischer-Saller scale were amalgamated, as follows, into four major

categories: Blonde (A – L + N), Brown (M, O, P–T), Brown–Black (U–Y) and Red (I–VI). A higher degree of precision was not considered justifiable in view of the broad age range of the people sampled and the fact that some of the observations were based on recalled colour.

Eye colour. The American AO system of eye colour standards (Siber, Hegner & Co. Inc.), consisting of four sets of twelve iris colours, Brown (3021), Green (3022), Blue (3023) and Grey (3024) were used in the 1984 series. The 1952 Hulse study was based on the R. Martin *Augenfarbentafel* of sixteen iris shades. For the purposes of comparison the iris colours in the two different international standards were amalgamated into five major categories: Blue, Grey, Mixed, Green and Brown. The equivalence between the two standards was assessed by an observer with normal colour vision and hue discrimination, determined by the Ishihara and Pickford-Nicolson Anomaloscope colour vision tests (see below). To avoid any confusion about the methodology used, the equivalence of the standards as assessed for the present study is given in full in table 2.

TABLE 2. Major eye colour categories and American (AO) series and R. Martin equivalent colour shades used in this study.

| Category | Test | Shade number |
|----------|-----------|---|
| BLUE | AO | N62, N73, T12, T13, T16, T25, T34 |
| | R. Martin | 14, 15, 16 |
| GREY | AO | T11, T20, T24, T27, T29, T33, T40 |
| | R. Martin | 10, 12 |
| MIXED | AO | N29, N35, N45, N65, N75, N91, T14, T17, T26, T28 |
| | R. Martin | 11, 13 |
| GREEN | AO | T10, T15, T30, T31, T32, T35, T39 |
| | R. Martin | 7, 8, 9 |
| BROWN | AO | 1A, 1B, 3J, N7, N10, N16, N17, N30, T8, T9, T21, T22, T23 |
| | R. Martin | 1, 2, 3, 4, 5, 6 |

Colour vision. Tests for red–green colour vision deficiency were performed with Ishihara plates 2–25 in the 1976, 38–plate edition. Subjects whose colour vision was diagnosed as defective were further tested with a Pickford-Nicolson Anomaloscope to confirm and quantify their deficiency. One male subject who claimed to be ‘colour-blind’ but who had normal red–green colour vision was given the Yellow–Blue test with the anomaloscope and was found to be mildly tritanomalous.

Blood sampling. Blood samples were collected by venepuncture into 10 ml Sarstedt Monovette tubes containing KEDTA. They were sent by rail in refrigerated containers to the serological and biochemical laboratory of the Department of Anthropology, University of Durham, where they were tested for the following blood group antigens: A, A₁, B; M, N, S, s; D, C, E, c, e; Lu^a, Lu^b; K, k; Fy^a, Fy^b; Jk^a, Jk^b, of the ABO, MNS, Rhesus, Lutheran, Kell Duffy and Kidd blood groups.

Results

Anthropometry. Means and standard deviations of eight anthropometric measurements and three indices are given in table 3 for the 1984 and 1952 samples. The age distributions for the men and women of the 1984 sample are not significantly different, whereas the 1952 sample of males has a higher proportion of middle-aged individuals and a lower proportion of older subjects than the recent male sample (χ^2 4DF = 12.46, $p < .05$).

TABLE 3. Anthropometric measurements of the Cornish.

| Variable | Present study (1984) | | | | | | Hulse study (1952) | | |
|--------------------|----------------------|-------|------|---------|-------|------|--------------------|-------|------|
| | Males | | | Females | | | Males | | |
| | N. | Mean | S.D. | N. | Mean | S.D. | N. | Mean | S.D. |
| Stature | 108 | 175.2 | 7.2 | 146 | 161.6 | 5.5 | 143 | 171.3 | 7.5 |
| Head length | 108 | 196.6 | 6.8 | 146 | 186.1 | 5.5 | 143 | 193.7 | 7.2 |
| Head breadth | 108 | 155.6 | 5.8 | 146 | 147.3 | 5.2 | 143 | 154.2 | 5.8 |
| Bizygomatic diam. | 108 | 141.1 | 5.3 | 145 | 131.4 | 5.1 | 143 | 139.5 | 6.1 |
| Bigonial diam. | 108 | 108.2 | 7.1 | 146 | 101.0 | 5.6 | 143 | 107.8 | 5.9 |
| Morph. Face height | 108 | 124.1 | 7.4 | 146 | 113.3 | 6.1 | 143 | 125.9 | 5.9 |
| Nose height | 108 | 56.4 | 4.0 | 146 | 51.1 | 3.6 | 143 | 57.7 | 3.6 |
| Nose breadth | 108 | 35.9 | 2.9 | 146 | 32.4 | 2.6 | 143 | 34.2 | 2.8 |
| Cephalic Index | 108 | 79.2 | 3.4 | 146 | 79.2 | 3.4 | 143 | 79.7 | 3.5 |
| Morph. Face Index | 108 | 88.1 | 5.8 | 145 | 86.3 | 6.0 | 143 | 90.4 | 5.8 |
| Nasal Index | 108 | 63.9 | 6.3 | 146 | 63.6 | 6.1 | 143 | 59.5 | 5.7 |
| Age | 108 | 47.2 | 14.5 | 146 | 44.8 | 14.7 | 140 | 42.3 | 12.8 |
| Stature 17-20 yrs. | 6 | 180.6 | 1.9 | 21 | 162.5 | 4.6 | — | — | — |
| Stature 21-30 yrs. | 8 | 180.9 | 3.1 | 16 | 161.9 | 5.6 | 30 | 174.9 | 6.1 |
| Stature 31-40 yrs. | 24 | 177.2 | 5.2 | 22 | 164.7 | 4.3 | 32 | 171.7 | 6.2 |
| Stature 41-50 yrs. | 21 | 176.6 | 7.8 | 21 | 161.3 | 5.3 | 41 | 171.7 | 7.4 |
| Stature 51-60 yrs. | 23 | 173.6 | 7.0 | 31 | 161.9 | 5.5 | 22 | 168.7 | 8.0 |
| Stature > 61 yrs. | 26 | 170.3 | 7.0 | 35 | 159.0 | 5.7 | 15 | 164.1 | 7.7 |

The only measurement strongly associated with age is stature, and this has a negative correlation which is greater in the males than in the females. There is a remarkable conformity in the cross-sectional age trends for stature in the two male samples, the average stature of the over-sixties being about eleven centimetres less than the 21-30 age-group. A difference of about five to six centimetres between the 1984 and 1952 samples is maintained across all age groups, providing strong evidence of a secular trend towards greater stature in the more recently measured sample. The age trend in stature of the females is less regular than in the males and the difference between youngest and oldest age groups is considerably less marked. A comparison of the 1984 and 1952 results yields an estimate of secular increase in stature of about 1.8 cm per decade.

Morphological face height and nose height are the only measurements in the 1952 sample with higher mean values than the 1984 series of males. There are three other significant differences in craniofacial dimensions between the two series, head length, bizygomatic diameter and nose breadth.

TABLE 4. Frequencies (in percent.) of finger ridge patterns of the Cornish.

| Pattern type | Left hand | | | | | Right hand | | | | | All fingers | |
|-------------------|-----------|------|------|------|------|------------|------|------|------|------|-------------|--|
| | I | II | III | IV | V | I | II | III | IV | V | | |
| Males (N = 108) | | | | | | | | | | | | |
| Plain arch | 3.7 | 8.3 | 10.2 | 1.9 | 0.9 | 1.9 | 13.0 | 7.4 | 1.9 | 0.9 | 5.0 | |
| Tented arch | 0.0 | 1.9 | 1.9 | 0.0 | 0.9 | 0.0 | 0.9 | 0.9 | 0.0 | 0.0 | 0.6 | |
| Ulnar loop | 66.7 | 38.9 | 70.4 | 59.3 | 87.0 | 58.3 | 36.1 | 73.1 | 44.4 | 75.9 | 61.0 | |
| Radial loop | 0.9 | 20.4 | 0.9 | 0.0 | 0.0 | 0.0 | 23.1 | 0.0 | 0.0 | 0.0 | 4.5 | |
| Ulnar c. pocket | 0.0 | 3.7 | 2.8 | 17.6 | 4.6 | 2.8 | 0.0 | 4.6 | 15.7 | 15.7 | 6.8 | |
| Radial c. pocket | 0.0 | 3.7 | 0.0 | 0.0 | 0.0 | 0.0 | 7.4 | 0.9 | 0.0 | 0.0 | 1.2 | |
| Ulnar l. pocket | 0.9 | 0.9 | 0.9 | 1.9 | 2.8 | 12.0 | 1.9 | 0.0 | 0.0 | 1.9 | 2.3 | |
| Radial l. pocket | 2.8 | 4.6 | 0.9 | 0.0 | 0.0 | 2.8 | 3.7 | 0.0 | 0.0 | 0.0 | 1.5 | |
| Twin loop | 14.8 | 5.6 | 0.9 | 0.9 | 0.0 | 1.9 | 0.0 | 1.9 | 0.0 | 0.0 | 2.6 | |
| True whorl | 10.2 | 12.0 | 11.1 | 18.5 | 3.7 | 20.4 | 13.9 | 11.1 | 38.0 | 5.6 | 14.4 | |
| TOTAL 'WHORLS' | 28.7 | 30.5 | 16.6 | 38.9 | 11.1 | 39.9 | 26.9 | 18.5 | 53.7 | 23.2 | 25.2 | |
| Females (N = 139) | | | | | | | | | | | | |
| Plain arch | 7.2 | 10.8 | 11.5 | 5.8 | 1.4 | 2.9 | 10.8 | 7.9 | 2.9 | 2.2 | 6.3 | |
| Tented arch | 0.0 | 0.7 | 1.4 | 0.0 | 0.0 | 0.0 | 2.2 | 0.0 | 0.0 | 0.7 | 0.5 | |
| Ulnar loop | 68.3 | 43.9 | 65.5 | 58.3 | 86.4 | 69.8 | 41.7 | 74.8 | 59.7 | 87.1 | 65.5 | |
| Radial loop | 0.0 | 20.9 | 3.6 | 0.0 | 0.0 | 0.0 | 12.2 | 1.4 | 0.7 | 0.0 | 3.9 | |
| Ulnar c. pocket | 0.7 | 0.0 | 0.0 | 7.9 | 1.4 | 0.7 | 0.0 | 1.4 | 9.4 | 3.6 | 2.5 | |
| Radial c. pocket | 0.0 | 3.6 | 1.4 | 1.4 | 0.7 | 0.0 | 3.6 | 1.4 | 1.4 | 0.0 | 1.4 | |
| Ulnar l. pocket | 1.4 | 0.7 | 0.0 | 2.2 | 1.4 | 5.8 | 0.0 | 1.4 | 1.4 | 0.0 | 1.4 | |
| Radial l. pocket | 0.7 | 1.4 | 0.7 | 0.0 | 0.0 | 0.0 | 1.4 | 1.4 | 0.0 | 0.0 | 0.6 | |
| Twin loop | 6.5 | 4.3 | 4.3 | 0.0 | 0.0 | 3.6 | 4.3 | 0.0 | 0.0 | 0.7 | 2.4 | |
| True whorl | 15.1 | 13.7 | 11.5 | 24.5 | 8.6 | 17.3 | 23.7 | 10.2 | 24.5 | 5.8 | 15.5 | |
| TOTAL 'WHORLS' | 24.4 | 23.7 | 17.9 | 36.0 | 12.1 | 27.4 | 33.0 | 15.7 | 36.7 | 10.1 | 23.7 | |

TABLE 5. Means and standard deviations of finger ridge counts and total ridge count in the Cornish.

| | Left hand | | | | | Right hand | | | | | TRC | |
|-------------------|-----------|------|------|------|------|------------|------|------|------|------|-------|--|
| | I | II | III | IV | V | I | II | III | IV | V | | |
| Males (n = 105) | | | | | | | | | | | | |
| Mean | 15.7 | 10.7 | 11.6 | 14.9 | 12.8 | 18.5 | 11.2 | 11.6 | 15.5 | 13.1 | 135.6 | |
| S.D. | 5.9 | 6.5 | 6.5 | 6.1 | 5.6 | 5.9 | 7.0 | 6.2 | 6.1 | 5.5 | 48.2 | |
| Females (n = 131) | | | | | | | | | | | | |
| Mean | 14.6 | 10.7 | 11.0 | 14.0 | 12.7 | 17.5 | 10.4 | 11.4 | 15.6 | 12.3 | 130.1 | |
| S.D. | 6.9 | 7.1 | 7.0 | 7.2 | 5.3 | 5.6 | 7.3 | 5.9 | 7.0 | 5.7 | 50.8 | |

Dermatoglyphics. The frequency of finger ridge patterns is given by sex, finger, and for all fingers combined in table 4. The combined values for the four main pattern types show the high frequency of ulnar loops (about 63 per cent.) and the relatively low frequency of whorls (about 24 per cent.) that is characteristic of north-west European populations. The universally-observed sex differences, in which males have more whorls, more radial loops and fewer arches than females, are well-illustrated by the Cornish samples. As expected, whorls are more frequent on right hands than on left, there are fewer arch patterns on right hands, and bicentric whorls occur in a predictably consistent order of magnitude $I \gg II > III > IV > V$ in both sexes and, with one exception, on both hands.

The greatest bimanual differences in pattern frequencies are found in ulnar loops and true whorls. The largest differences in pattern frequency occur on fingers IV, V and I in males whereas in females the greatest differences are found on the second and third fingers. Arch patterns are associated most strongly with fingers II and III, ulnar loops with I and III, radial loops with II and monocentric whorls with IV.

Means and standard deviations of maximum unilateral ridge counts and Total Ridge Count (TRC) are given in table 5. As in the majority of European populations the order of magnitude of ridge count means across the fingers is $I > IV > V > III > II$ (Harvey & Suter 1983*a*). With one exception the mean ridge counts are higher on right-hand fingers than on left and their relative variability, expressed in terms of the coefficient of variation, is greatest on fingers II & III and least on I & V. Variation is greater in the females than in the males.

As might be expected from the predominance of ulnar loops in the sample, the mean radial ridge counts (table 6) follow the same trend as the maximum unilateral counts. In contrast, the ulnar ridge counts are higher on the fingers that bear, respectively, the greatest number of radial loops (II) and whorls (IV). The relative variability of radial counts is far greater than the ulnar, and a large number of zero values in the radial counts reflects the predominantly ulnar orientation of the patterns.

TABLE 6. Means and standard deviations of radial (r) and ulnar (u) finger ridge counts in the Cornish.

| | | I | | II | | III | | IV | | V | |
|----------|-------|------|-----|-----|-----|------|-----|------|-----|------|-----|
| | | r | u | r | u | r | u | r | u | r | u |
| Males: | Left | | | | | | | | | | |
| | Mean | 15.3 | 4.3 | 7.9 | 6.2 | 11.4 | 2.5 | 14.8 | 4.9 | 12.8 | 1.0 |
| | S.D. | 6.0 | 7.2 | 6.4 | 7.7 | 6.3 | 6.0 | 6.1 | 7.1 | 5.6 | 3.1 |
| Males: | Right | | | | | | | | | | |
| | Mean | 18.3 | 5.8 | 7.4 | 7.1 | 11.2 | 2.8 | 15.4 | 6.7 | 13.1 | 2.1 |
| | S.D. | 6.0 | 7.7 | 6.9 | 8.2 | 5.9 | 6.3 | 6.1 | 7.3 | 5.6 | 4.2 |
| Females: | Left | | | | | | | | | | |
| | Mean | 14.1 | 3.5 | 7.8 | 5.6 | 10.4 | 2.9 | 13.7 | 4.5 | 12.7 | 0.9 |
| | S.D. | 6.7 | 7.2 | 6.9 | 8.1 | 6.7 | 6.7 | 7.3 | 7.0 | 5.3 | 3.2 |
| Females: | Right | | | | | | | | | | |
| | Mean | 17.4 | 3.9 | 8.5 | 5.4 | 11.1 | 2.3 | 15.5 | 4.3 | 12.3 | 0.9 |
| | S.D. | 5.5 | 7.0 | 6.9 | 7.7 | 5.8 | 5.7 | 7.1 | 6.9 | 5.7 | 2.8 |

The frequency of individually-specified palmar patterns, occurring singly and in various combinations is given in table 7. The most highly patterned of the five palmar areas are III and IV on right hands, IV and III on left. It is in these areas that the largest bimanual differences in pattern frequency occur, especially in the single peripheral loops *III* and *IV*, and the double loops *IV*, *IV*. Tented loops in the third interdigital space, *III^T*, also show large bimanual differences. These variations between hands are very striking and show close resemblance to the pattern of variation observed in other European samples recorded with the topological system (Loesch 1983: 84). Among the Cornish the bimanual differences are most strongly expressed in the males, among whom they are statistically significant.

TABLE 7. Frequency (in percent) of palm patterns and triradii classified by the topological method in five configurational areas for 106 men and 140 women of Cornish ancestry.

| Palmar Area | Pattern type | Males | | | Females | | |
|-------------|--------------------|-------|-------|----------|---------|-------|----------|
| | | Left | Right | Bimanual | Left | Right | Bimanual |
| Area I | No pattern | 90.6 | 92.5 | 87.7 | 93.6 | 95.7 | 92.1 |
| | I | 2.8 | 0.9 | 0.0 | 1.4 | 1.4 | 0.7 |
| | I ^r | 3.8 | 5.7 | 2.8 | 2.1 | 1.4 | 0.0 |
| | II ^r | 1.9 | 0.9 | 0.0 | 2.9 | 0.7 | 0.7 |
| | III ^r | 0.9 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 |
| Area II | No pattern | 95.3 | 89.6 | 87.7 | 96.4 | 94.3 | 93.6 |
| | II | 4.7 | 10.4 | 2.8 | 3.6 | 5.7 | 2.9 |
| Area III | No pattern | 51.9 | 31.1 | 24.5 | 56.4 | 37.1 | 32.1 |
| | III | 30.2 | 55.7 | 26.4 | 30.0 | 57.1 | 27.1 |
| | III ^T | 17.9 | 13.2 | 3.8 | 13.6 | 5.7 | 1.4 |
| Area IV | No pattern | 49.1 | 67.0 | 40.6 | 42.9 | 55.7 | 33.6 |
| | IV | 44.3 | 32.1 | 17.9 | 52.9 | 44.3 | 32.1 |
| | IV IV | 6.6 | 0.9 | 0.0 | 2.9 | 0.0 | 0.0 |
| | IV IV ^r | 0.0 | 0.0 | 0.0 | 1.4 | 0.0 | 0.0 |
| Area V | No pattern | 71.7 | 67.0 | 60.4 | 66.4 | 62.9 | 51.4 |
| | H | 5.7 | 10.4 | 3.8 | 4.3 | 6.4 | 0.7 |
| | Ĥ | 16.0 | 10.4 | 6.6 | 22.1 | 22.9 | 11.4 |
| | H ^r | 0.9 | 0.0 | 0.0 | 0.0 | 2.9 | 0.0 |
| | H Ĥ | 0.0 | 4.7 | 0.0 | 1.4 | 0.0 | 0.0 |
| | Ĥ Ĥ | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Ĥ H ^r | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 |
| | H H ^r | 0.9 | 2.8 | 0.0 | 4.3 | 2.9 | 2.9 |
| | Radial Arch | 3.8 | 4.7 | 3.8 | 0.0 | 2.1 | 0.0 |
| | T ^u | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 |
| Triradii | t | 69.8 | 61.3 | 57.5 | 73.6 | 74.3 | 64.3 |
| | t' | 16.0 | 13.2 | 9.4 | 14.3 | 13.6 | 7.1 |
| | t'' | 2.8 | 2.8 | 1.9 | 1.4 | 1.4 | 0.0 |
| | tt | 0.0 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| | tt' | 4.7 | 11.3 | 3.8 | 5.0 | 4.3 | 1.4 |
| | tt'' | 2.8 | 4.7 | 0.0 | 5.0 | 4.3 | 2.1 |
| | t't' | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 |
| | t ^b | 22.6 | 22.6 | 15.0 | 28.6 | 30.7 | 18.6 |
| | t ^u | 0.0 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| | aa' | 4.7 | 10.4 | 2.8 | 3.6 | 5.7 | 2.9 |
| | bb' | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 |
| | cc' | 0.0 | 0.9 | 0.0 | 0.7 | 2.9 | 0.0 |
| | dd' | 17.0 | 10.4 | 4.7 | 15.0 | 8.6 | 4.3 |

Sex differences in pattern frequency are expressed predominantly on right hands, again most notably in the third and fourth interdigital areas, however there are some other noteworthy examples of sexual dimorphism particularly in the frequencies of *I*^r, *II* and *H* patterns and the border triradius *t*^b. One remarkable feature of the palm patterns is the unusually high frequency of bimanual hypothenar radial arches in the males.

The Main Line Index (table 8) demonstrates the usual contrast between right and left hands in the transversality of A and D lines (Cummins & Midlo 1943: 115), the differences being significant in both sexes. There are also significant bimanual differences in the distribution of C-line terminations. There are, however, no significant differences between the sexes. The frequency of missing C triradius on left hands is surprisingly high.

Pigmentation. All three samples are characterised by a low frequency of red hair (table 9). Among the other shades Brown-Black hair predominates and is more frequent among the males. The differences in frequency of non-red categories among the three samples are not statistically significant.

Green is the most frequently occurring eye colour category and the Cornish men and women examined during the recent field-study had similar frequencies of this shade. Fewer men than women had brown eyes and more had blue, than

TABLE 8. Mainline Index and C-Line terminations on the palms of Cornish men and women.

| | | Mainline Index | | Ulnar | C-line terminations | | |
|----------------------|-------|----------------|------|-------|---------------------|----------|----------|
| | | Mean | S.D. | % | Radial | Proximal | Absent C |
| | | | | | % | % | % |
| Males (N = 106) | Left | 7.8 | 2.3 | 40.6 | 31.1 | 17.9 | 10.4 |
| | Right | 9.0 | 2.0 | 22.6 | 54.7 | 13.2 | 9.4 |
| Females (N = 140) | Left | 7.5 | 2.1 | 46.4 | 30.0 | 14.3 | 9.3 |
| | Right | 8.9 | 1.9 | 33.6 | 54.3 | 6.4 | 5.7 |

TABLE 9. Hair and eye colour of the Cornish.

| Observation | Category | Present study (1984) | | | | Hulse study (1952) | |
|-------------|-------------|----------------------|-------|---------|-------|--------------------|-------|
| | | Males | | Females | | Males | |
| | | N. | % | N. | % | N. | % |
| Hair colour | Blonde | 7 | 6.5 | 21 | 14.4 | 15 | 12.9 |
| | Brown | 31 | 29.0 | 40 | 27.4 | 23 | 19.8 |
| | Brown-Black | 68 | 63.6 | 82 | 56.2 | 75 | 64.7 |
| | Red | 1 | 0.9 | 3 | 2.0 | 3 | 2.6 |
| | TOTAL | 107 | 100.0 | 146 | 100.0 | 116 | 100.0 |
| Eye colour | Blue | 18 | 16.7 | 16 | 11.0 | 30 | 21.6 |
| | Grey | 5 | 4.6 | 12 | 8.2 | 28 | 20.1 |
| | Mixed | 26 | 24.1 | 29 | 19.9 | 23 | 16.5 |
| | Green | 39 | 36.1 | 52 | 35.6 | 29 | 20.9 |
| | Brown | 20 | 18.5 | 37 | 25.3 | 29 | 20.9 |
| | TOTAL | 108 | 100.0 | 146 | 100.0 | 139 | 100.0 |

the women although both sexes had about 20 per cent. of the 'light' eye colours, blue and grey. Mixed shades, combining central iris zones of brown with outer zones of blue or grey, occurred more frequently among the males of the 1984 sample than among the females, however none of the differences is statistically significant. In contrast, there are some marked and significant differences between the 1984 and 1952 samples of males. In the Hulse study blue and grey eyes were encountered far more frequently than in the 1984 fieldwork. Table 9 shows the contrast between the two series and provides evidence of a much higher frequency of green and mixed shades in the more recently obtained sample. The overall differences in distribution of eye colour in the two male series are highly significant ($p < .001$).

Hair and eye colour associations were investigated in the 1984 samples and revealed that 24 per cent. of the men and 18.5 per cent. of the women examined had a combination of Brown-Black hair and 'light' eyes, compared with 14 per cent. of men and 15 per cent. of women with the Brown-Black hair/Brown eye combination.

Colour vision. Seven per cent. of the 115 men tested had some form of red-green colour vision deficiency (table 10). The anomaloscope tests confirmed that deuteranomaly was the most commonly occurring type and that the ratio of Deuteran to Protan deficiencies was approximately 1.7:1. None of the 145 women tested had any red-green colour vision defect.

TABLE 10. Red-green colour vision deficiency in the Cornish.

| <i>Red-green colour vision</i> | <i>Males</i> | | <i>Females</i> | |
|--------------------------------|--------------|----------|----------------|----------|
| | <i>N.</i> | <i>%</i> | <i>N.</i> | <i>%</i> |
| Normal | 99 | 92.5 | 145 | 100.0 |
| Deuteranomalous | 5 | 4.7 | 0 | — |
| Deuteranopic | 0 | — | 0 | — |
| Protanomalous | 1 | 0.9 | 0 | — |
| Protanopic | 2 | 1.9 | 0 | — |
| TOTAL RED-GREEN CVD | 8 | 7.5 | 0 | — |

Blood groups. The phenotype, allele and haplotype frequencies for seven blood group systems are shown in table 11. In none of the systems is there a significant departure from Hardy-Weinberg equilibrium. Forty-seven per cent. of the Cornish sampled were blood group O, 43 per cent. were A, 7 per cent. were B and 4 per cent. were AB. Seventy-seven per cent. were phenotype M and 20 per cent. were Rhesus (D) negative. The outstandingly high frequency of the Fy^a (0.47) and the low frequency of the K allele (0.28) will be discussed later, in comparison with data for other European populations.

Discussion

Anthropometry. 'Cornwall nourishes a stalwart race, superior to the Devonians in stature and length of limb' (Beddoe 1885). Although there are no recent data

TABLE II. Blood groups of the Cornish.

| System | Phenotypes | Observed numbers | Alleles | Allele frequencies | System | Phenotypes | Observed numbers | Alleles | Allele frequencies | |
|--------|------------------|------------------|----------------|--------------------|--------|-----------------|------------------|-----------------|--------------------|--|
| ABO | A ₁ | 80 | | | Duffy | Fy(a+b-) | 51 | Fy ^a | 47.28 | |
| | A ₂ | 21 | P ₁ | 20.05 | | Fy(a+b+) | 119 | Fy ^b | 52.41 | |
| | B | 17 | P ₂ | 6.16 | | Fy(a-b+) | 63 | Fy | 0.31 | |
| | A ₁ B | 4 | q | 4.84 | | TOTAL | 233 | | | |
| | A ₂ B | 1 | r | 68.95 | | | | | | |
| | O | 110 | | | | | | | | |
| TOTAL | | 233 | | | | | | | | |
| MNSs | MMSS | 11 | | | Kell | KK | 0 | | | |
| | MMSs | 39 | | | | Kk | 13 | K | 2.79 | |
| | MMss | 21 | | | | kk | 220 | k | 97.21 | |
| | MNSS | 11 | MS | 25.29 | | TOTAL | 233 | | | |
| | MNSs | 54 | Ms | 28.57 | | | | | | |
| | MNss | 44 | NS | 6.25 | | Kp(a+b-) | 0 | | | |
| | NNSS | 1 | Ns | 39.89 | | Kp(a+b+) | 6 | Kp ^a | 1.29 | |
| | NNSs | 8 | | | | Kp(a-b+) | 227 | Kp ^b | 98.71 | |
| | NNss | 44 | | | | TOTAL | 233 | | | |
| | TOTAL | | 233 | | | | | | | |
| Rhesus | CCDee | 42 | | | Kidd | Jk(a+b-) | 77 | | | |
| | CCddee | 0 | | | | Jk(a+b+) | 104 | Jk ^a | 53.57 | |
| | CcDEe | 25 | | | | Jk(a-b+) | 52 | Jk ^b | 43.17 | |
| | CcDee | 77 | CDe | 39.62 | | Jk(a-b-) | 0 | Jk | 3.25 | |
| | CcddEe | 0 | Cde | 0.51 | | TOTAL | 233 | | | |
| | Ccddee | 1 | cDE | 14.75 | | | | | | |
| | ccDEE | 7 | cDe | 1.43 | | | | | | |
| | ccDEe | 32 | cdE | 0.92 | | | | | | |
| | ccDee | 3 | cde | 42.77 | | Lutheran | Lu(a+b-) | 0 | | |
| | ccddEE | 0 | | | | Lu(a+b+) | 13 | Lu ^a | 2.79 | |
| ccddEe | 2 | | | Lu(a-b+) | 220 | Lu ^b | 96.45 | | | |
| ccddeE | 44 | | | Lu(a-b-) | 0 | | | | | |
| TOTAL | | 233 | | TOTAL | 233 | | | | | |

from Devon with which to compare the present anthropometric results it is clear that in comparison with the national average for Great Britain (OPCS Monitor SS 81/1, 1981) the Cornish are tall. The mean stature of the men sampled in 1984 is about 1.5 cm above the 1980 average for Great Britain, and that of the women exceeds the national average by about 0.75 cm.

During the first three decades of this century anthropologists had few inhibitions about preparing distribution maps. Their aim was to give a comprehensive overview of anthropometric variation across extensive geographical areas. The map for stature of Europeans published by Coon (1939: 252) is an example of the bold, expansive approach. Within the British Isles Coon shows an area of large body height in Cornwall and comparable, though more extensive areas of tall stature in Ireland, especially in the south-west. There are also patches in central and south-western Scotland, in Cumbria, north-eastern England and down the eastern coast of Britain. The dearth of information on regional variation in stature among contemporary British populations makes it impossible to deduce whether the pattern of variation illustrated by Coon still persists. One of the few recent studies with which the Cornish results can be compared is that of Sunderland *et al.* (1981), who obtained samples of Welsh men and women during the National Eisteddfod at Wrexham in 1977. Taking the results for subjects with Welsh-born parents and combining the data for six regions of Wales it is apparent that the 1984 Cornish men and women are taller, in the males slightly larger in head length and breadth and in both sexes significantly larger in bizygomatic and bigonial diameters than the Welsh.

After allowance has been made for the probable influence of the secular trend towards larger body size in younger generations, there remain in the comparison of the 1984 and 1952 Cornish samples two significant differences in mean craniofacial dimensions to be accounted for. These are nose height and face height. Methodological differences in measurement technique are probably not responsible, as the same methods of *nasion* location were used in both studies (Hulse, personal communication). Bearing in mind the significant differences in the distribution of parents' birthplaces shown in table 1 it seems plausible to suggest that regional variation in facial characteristics within the County of Cornwall may account for the differences observed.

Pigmentation. Again, it is to the earlier anthropological literature that we must turn for an overview of pigmentary variation in Europe. As Smith (1983) makes clear in her extensive review of variation in hair, eye and skin colour in the British Isles, the number of studies that have used reasonably objective criteria, such as standard hair colour sets, ceramic or plastic eyes with an appropriate range of iris colours, or spectrophotometric methods of colour measurement, is very small. Skin colour has received more attention than either hair or eye colour in recent years. The problem of making comparisons between population samples is further compounded by the well-established trend towards darkening of the hair colour with age (Post & Little 1983) and the smaller, though not insignificant variation of eye colour between different age groups of the same population (Hulse 1983; Bean 1935).

By far the most extensive observations of hair and eye colour variation in

Britain are those of Beddoe (1885), who used personal observations and data from military schedules to compile tables and distribution maps. The latter show prominent regions of 'Nigrescence' in hair colour, calculated as an Index (Dark plus 2 × Black minus Red minus Fair) in Cornwall, Wales and western Ireland (Smith 1983). Beddoe noted the hair and eye colour of 2,717 Cornish men and women in six different localities across the county. By re-tabulating his results and applying statistical tests on contingency tables it has been possible to deduce that there is evidence of regional heterogeneity for both these characteristics in Cornwall but only in hair colour does it approach statistical significance (χ^2 18DF = 26.6). Unfortunately Beddoe's subjective assessments of hair and eye colour cannot be used for direct comparison with the data from the present studies as the colour categories are not equivalent. Nevertheless the evidence of regional variation is strong enough to suggest that the differences in pigmentation between the 1984 and 1952 samples shown in table 9 may be due to differences in the regional ancestry of the people studied.

In a distribution map for Europe Coon (1939: 270) shows prominent regions of dark hair and dark eyes in Cornwall, Wales, the Welsh borders and in south-west Ireland. He notes that in a study of 10,000 Irish men dark brown hair occurred more frequently in the south-western counties than in the rest of the country. Red hair had an overall frequency of 8 per cent. and was most common in Ulster, rarest in Wexford and Waterford. Neither of the two recent field studies in Cornwall yields a frequency of red hair comparable to that of Ireland, nor do they confirm the relatively high frequency of 5.13 per cent. reported by Sunderland (1956) for the counties of Cornwall, Devon, Somerset and Dorset combined, although the latter study was based on only thirty-nine individuals. Red hair among contemporary Cornish people seems to be less common than among Welsh samples obtained by Fleure over a forty-year period, which gave frequencies between 3.2 and 14.5 per cent. in eleven regions of the country (Fleure & Davies 1958). On all the evidence available at present, however, the closest similarities to the Cornish for both hair and eye colour are to be found in Wales (especially in mid-Wales) and in southern and western Ireland.

Dermatoglyphics. One of the purposes of documenting the dermatoglyphic characteristics of the Cornish in detail is to make available the frequencies of finger ridge counts and pattern types on fingers and palms for future studies employing multivariate techniques. Dennis *et al.* (1982) have illustrated very effectively the discriminating power of various combinations of dermatoglyphic characters in British population studies. Their successful application of multivariate statistics was made possible by the uniformity of methods used for scoring, recording and analysing dermatoglyphic traits that has become a feature of the 'Durham School'. The absence of a rigorously standardised methodology in other British population studies has the effect of reducing to a rather superficial level the comparisons that are possible between one regional population sample and another. One universally acceptable starting point is to examine the geographical distribution of mean total ridge count (TRC), a characteristic with high but variable heritability (Holt 1968: 63; Froelich 1976: 278). In figure 2 the variation in mean TRC, compiled from various sources, is

shown for Great Britain. The pattern of variation is similar, though not identical, in males and females and is characterised by a very low mean TRC in the far north. The number of populations sampled on a strict, regional-assignment basis is small; there is, however, some evidence of the occurrence of higher mean values in the northern part of England (Pennine dales) and the Welsh borders (Powys and Salop) than in the south Midlands and the south-west (Cornwall).

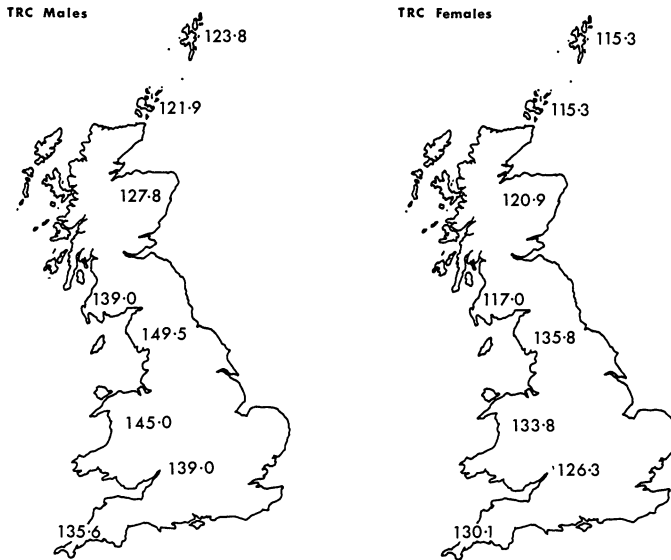


FIGURE 2. Variation in mean total ridge count (TRC) in regional samples of Great Britain. Data from Dennis & Sunderland (1979), Muir (1977), Roberts & Muir (pers. comm.), Roberts & Coope (1972), Suter (pers. comm.), Williams (1978) and the present study.

Many of the observations on sex and laterality differences presented in the results section are commensurate with those that are increasingly regarded as 'universals', in the sense that they have been found to occur in the majority of European or European-derived populations (Cummins & Midlo 1943; Plato *et al.* 1975; Roche *et al.* 1979; Dennis & Sunderland 1979; Harvey & Suter 1983a; Loesch 1983: 84). There are, however, several noteworthy features which may ultimately prove to distinguish the Cornish from other populations in the British Isles. Among these are the high frequency of bimanual hypothenar radial arches in the males and the high frequency in both sexes of missing *C* triradius. There is some evidence that these two characteristics are associated (Harvey 1982) but it remains to be seen how effectively they may be used as 'dermatoglyphic markers' in population studies. Dennis *et al.* (1978) tabulated the frequencies of hypothenar radial arches for various parts of the British Isles and reported high frequencies in a sample from Carnew, Rossmore and Roscommon counties of Ireland. The highest single-handed occurrence was in right hands of females from the north Pennine dales (2.79 per cent.), a frequency

which is exceeded by the admittedly much smaller sample of Cornish males (4.7 per cent.).

Colour vision deficiency. The frequency of red-green colour vision deficiency in the sample of Cornish males (7.5 per cent.) is within the range quoted by Kalmus (1965: 86) for England. Under conditions of Hardy-Weinberg equilibrium the expected frequency among Cornish females would be 1.56 per cent., so that the absence of colour-blind women in this random sample is within the bounds of chance. The ratio of deuteran to protan types of deficiency in the males (1.67:1) is lower than the frequently quoted ratio of 3:1 given by Wright (1953).

The Cornish sample is relatively small; the observed result is best seen, however, in the context of regional variation in frequency for males in Great Britain (fig. 3). As in the case of mean total ridge count (fig. 2) the most striking general feature is the contrast between north and south, with low frequencies in Scotland and the Northern Isles. The high frequency of 9.5 per cent. in south-western England is based on a regional sample of over 6,000 Royal Navy recruits studied by Vernon & Straker (1943). The frequency in the Cornish does not conform to a trend towards high frequencies in the south and south-west, but the reservations about sample size remain.

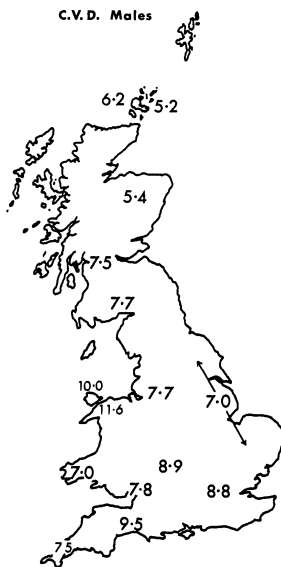


FIGURE 3. Variation in the frequency of red-green colour vision deficiency among males of Great Britain. Data from Boyce *et al.* in Roberts & Sunderland (1973), Muir (1977), Pullin & Sunderland (1963), Fraser Roberts & Sunderland (unpubl. obs.), Vernon & Straker (1943).

Blood groups. Kopeć (1970) identified three regions in the West Country, which included the whole of Cornwall and most of Devon, that were heterogeneous with regard to O and A phenotypes. The regions were homogeneous with respect to phenotypes B and AB. The results for two of Kopeć's regions are of

interest for comparison with the present results as they include blood donors residing in postal districts of western Cornwall (Region 37) and eastern Cornwall plus a small part of south-west Devon (Region 36). The results of her analysis give the following allele frequencies for the two regions: 25.7 per cent. *p*, 6.3 per cent. *q* and 68.0 per cent. *r*, for the *A*, *B* and *O* alleles in region 36 and 28.4 per cent. *p*, 5.7 per cent. *q* and 65.9 per cent. *r* for region 37. The results of the present study differ in two notable respects: the frequency of the *B* allele is lower and the *O* allele higher than in either of the two Kopeč regions.

An explanation for the difference may be in the regional variation within Cornwall that is evident in Kopeč's tables for the sixteen postal districts of the county (one of which, Launceston, includes a small area of west Devon). All the samples contained over 100 individuals and the ABO allele frequencies range widely. Allele *p* varies from 21.2 to 34.0 per cent., *q* 3.1 to 7.9 per cent. and *r* from 62.1 to 73.0 per cent. The St Austell district, with a sample of 295, happens to be remarkably close in allele frequencies to the Cornish sample of the present study.

Before discussing a multivariate approach to the analysis of the Cornish blood groups there are several features of the individual allele frequencies that are worth noting in the context of relationships with neighbouring peoples across the English and Bristol Channels, the Irish Sea, and within Great Britain. Some of the features of the ABO system in the west of England and western France have been reviewed by Mourant *et al.* (1976: 66) and attention has been drawn to the departures from the average northern French allele frequencies shown by the populations of Normandy and Brittany. Similarities have also been noted between the latter and the greater part of Wales.

The most recent blood group survey to have been published for Brittany concerns the Bigouden who live in the extreme south-west of Finistère (Youinou *et al.* 1983). According to Cornou and Giot (1973) the Pays Bigouden is the most characteristic Breton district, for the region was settled almost exclusively from Brythonic and Goidelic language-speaking areas of the British Isles, including Cornwall, Wales and Ireland, in the sixth century. The inhabitants do, however, exhibit certain curious pathological features, for example a high incidence of congenital dislocation of the hip and a substantial occurrence of a monoclonal gammopathy. Thus there is a suggestion that cultural isolation and inbreeding may have influenced the genetic structure of this population.

In the present Cornish sample the frequency of the *O* allele is high, as in Wales and the greater part of Brittany, but not as high as in Ireland, particularly the western half, and Scotland, especially in the north-west, where frequencies of over 70 per cent. are common. The Bigouden also have a high frequency of *O* (74 per cent.). Unlike the Welsh the *B* frequency of the Cornish sample is low (<5 per cent.), but is similar to the Bigouden (5.1 per cent.).

The frequency of the *M* allele is higher in Scotland and Ireland than in England and Wales. The Cornish frequency of 54 per cent. *M* is similar to central and southern England and is not as high as in northern France and northern Spain. The *S* allele appears to have moderately high frequencies in Wales (>35 per cent.), contrasting with the Cornish frequency of 31.6 per cent.

Twenty per cent. of the Cornish people sampled were Rhesus negative, a high

frequency which is similar to Ireland, Cumbria and south-west Scotland. The *CDe* haplotype frequency in the Cornish (39.6 per cent.) contrasts with the Welsh and the Bigouden who have high frequencies (>43 per cent.). In general the Rh haplotype frequencies of the Bigouden are markedly different from the Cornish, especially in their high *CDe*, very low *cDE* and low *cde*.

The Cornish have an outstandingly high frequency of the Fy^a allele (47.3 per cent.). Comparable values occur mainly in central and eastern Europe, but a high value (45.2 per cent.) has also been found in south Wales (Drummond 1969). The Cornish sample contrasts sharply with the Bigouden in the Duffy system as the latter have a remarkably low frequency of the Fy^a allele (35.2 per cent.).

The Cornish frequency of the *K* allele is very low in comparison with other north-west European populations and differs markedly from frequencies reported for other western sea-routes regions of the British Isles such as Ireland, the Isle of Man, Cumbria and Scotland. The Bigouden have an extremely high *K* frequency (6.4 per cent.). There are fewer comparative data available for the *Kp* alleles of the Kell system and for the Kidd system but it is worth noting that the frequency of *Kp* (*a+*) in the Cornish sample is similar to that reported for an English sample of over 1,000 obtained in London by Cleghorn (1961). The Cornish Jk^a frequency of 53.6 per cent. is close to the middle of the range found in north-western Europe.

Genetic distance analysis. In order to elucidate the serological genetic relationships between the Cornish and neighbouring populations we have compiled from the extensive resources of Mourant *et al.* (1976) and Tills *et al.* (1983) a data set for the populations of eighteen regions of Europe, for whom results for ABO, Rhesus, MNSs, Duffy and Kell blood groups have been obtained. They include several large-sample surveys from European countries bordering the southern and eastern seaboard of the British Isles and several smaller-scale studies of regional populations in Britain, including one from Powys, at the eastern Welsh border (Fullerlove, personal communication). The genetic distance of Rogers (1972) was calculated using the BIOSYS-1 program of Swofford & Selander (1981). The matrix of genetic distances was subsequently used in a cluster analysis, again via BIOSYS-1, employing the unweighted pair-group method using arithmetic averages (UPGMA) of Sneath & Sokal (1973).

Genetic distances from the Cornish, based on the frequencies of nineteen alleles in the five blood groups systems are given in table 12. In terms of genetic distance the Cornish are not especially close to the other samples; the sample from south-eastern England is the nearest, followed by the Netherlands, Western Germany and Denmark. Remarkably, the Breton Bigouden sample is the second most remote, its genetic distance from Cornwall being exceeded only by Iceland.

The cluster analysis (fig. 4) provides a further insight into the results. The tightest cluster is formed by a predominantly Anglo-Saxon group of populations comprising Western Germany, the Netherlands, south-eastern England and Denmark. To this group Norway and Sweden, joined at a lower level, are added. Then the sample from south-central France is linked on, followed by

TABLE 12. Rogers' Genetic Distances from Cornwall, based on 19 alleles in the ABO, MNSs, Rh, Duffy and Kell systems.

| Population | Distance | Population | Distance | Population | Distance |
|--------------|----------|---------------|----------|------------|----------|
| S.E. England | .022 | Eire | .035 | N. Ireland | .039 |
| Netherlands | .026 | Orkney | .035 | Norway | .041 |
| W. Germany | .028 | Cumbria | .036 | E. Wales | .044 |
| Denmark | .030 | France (S.C.) | .036 | Brittany | .054 |
| Isle of Man | .031 | Sweden | .036 | Iceland | .063 |
| South Wales | .034 | S.W. Scotland | .038 | | |

Cornwall, south Wales and east Wales. This large and to some extent, heterogeneous cluster is separated from a second main cluster which is composed of two sub-groups. The first contains the two Irish samples, joined at a lower level by the Isle of Man. The second links Cumbria and south-west Scotland, and to these populations the Breton Bigouden are added, though at a low level. Finally a third sub-division includes Iceland and Orkney, whose populations are united in the analysis simply because they have a less remote relationship with each other than with any of the other populations.

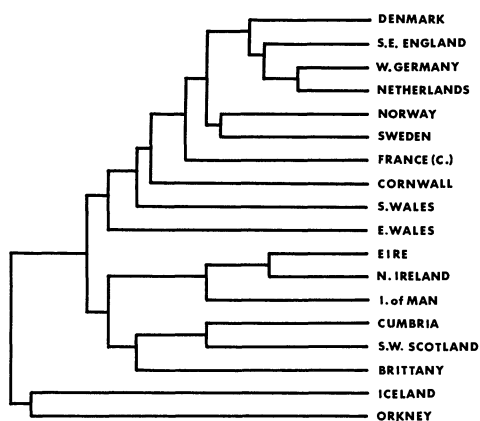


FIGURE 4. Cluster analysis by UPGMA (Sneath & Sokal 1973) of Rogers's (1972) genetic distance, calculated from the frequencies of alleles in the ABO, Rh, MNSs, Duffy and Kell systems. Comparative data were compiled from the tables of Mourant *et al.* 1976, Tills *et al.* 1983, Fullerlove (pers. comm.) and Youinou *et al.* 1983.

The results of the multivariate analysis reveal a pattern of relationships between populations of the British Isles and Europe which, in general, are those expected from the known history of settlement and migration. The large-sample populations in the 'Anglo-Saxon' group are, predictably, clustered more closely than the smaller-sample populations of Wales and Cornwall, where sampling error may lead to more extreme values of allele frequencies. The main interest is that even though the Cornish sample is small it is unequivocally aligned more closely with the 'Anglo-Saxon' populations to the east of Cornwall than with the Celtic peoples in the western parts of the British Isles. In this respect the clustering relationship of the Breton Bigouden is of particular interest, being closest in distance to Cumbria ($D = 0.031$) and south-western

Scotland ($D = 0.035$) but lying no closer to these populations than for example the Cornish do to the populations of Denmark and West Germany.

Conclusions

One purpose of this survey has been to describe in detail the physical and genetic traits of a sample of Cornish people studied for the first time by standardised methods. The sample is small and we have endeavoured to interpret the results in an appropriately cautious manner. We have already alluded to the fact that the Cornish men and women, upon whom the results are based, have a strong claim to Cornish ancestry. Eighty-two per cent. of their grandparents were Cornish born, and at that time between 80–90 per cent. of the Cornish population was born in Cornwall (Decennial Census for the years 1861 and 1911). Thus there is a good likelihood that the majority of the subjects in the 1984 fieldwork had deep Cornish roots.

The measurement of biological relationship between the Cornish and their neighbours has been of particular interest. We have based our assessment of this relationship either on multifactorial characteristics with a high hereditary component in their variation, such as stature, epidermal ridge counts and pigmentation, or on traits exclusively determined by heredity such as blood groups and red-green colour vision deficiency. As we have seen, the biological evidence is not easy to interpret. On the one hand, such characteristics as general body size, head size, hair and eye colour point to greater affinities with the Celtic language-speaking peoples of Wales, Ireland and Scotland than with the neighbours of the Cornish to the east. On the other hand, the blood group evidence shows that the Cornish sample occupies a somewhat intermediate position between 'Celtic' and 'Anglo-Saxon' populations, but with a definite tendency to be aligned with the latter. A third category of observations points to some distinctive features, such as the outstandingly high frequency of the Fy^a allele and low frequency of the K allele, also the high frequency of hypothenar radial arches and absence of the c triradius on the palms.

A most surprising result is that the Cornish and Breton Bigouden samples are so distant in their overall blood group relationships. Their strong linguistic and cultural associations, and the settlement history of the Breton region of South Finistère, would lead us to expect a much closer genetic similarity. However, the Bigouden people have had sufficient time (perhaps 40–45 generations) in separate development from the Brythonic language speakers of Cornwall for them to acquire distinctive genetic characteristics; a tendency that may have been enhanced by cultural isolation from other populations in north-western France. The loose but significant alignment of the Breton Bigouden with peoples of the western sea-routes regions of the British Isles, shown by the cluster analysis, is particularly interesting and deserves further attention in future studies. Indeed, we hope that this relatively small-scale study of the Cornish will provide a stimulus for more extensive regional studies in the south-west of Great Britain and across the English Channel.

How Celtic are the Cornish? Our title is provocative: we would not presume to measure on the yardstick of heredity that which might more satisfactorily be

assessed through genealogy, geography, dialect and culture. Yet to approach the question from another side is no less than fair—the Cornish are Celtic; they might therefore be expected to share the genetic characteristics of other Celtic populations of western Europe. That they do so to so slight an extent is testimony to the power of successive Celtic revivals, including the present Cornish language revival, and to the selective retention of cultural traits and manipulation of kinship links in promoting the Celtic identity of a population whose interest in and validation of its roots tends, not unnaturally, to be genealogical rather than genetic.

NOTES

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