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DERMATOGLYPHICS IN THE SOUTH WALES COALFIELD: AN ANALYSIS OF GENETIC VARIATION

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One whorl, poor; two whorls, rich;
Three whorls, four whorls, open a pawnshop;
Five whorls, be a go-between;
Six whorls, be a thief;
Seven whorls, meet calamities;
Eight whorls, eat chaff;
Nine whorls and one loop, no work to do -
eat till you are old.

A. H. Smith: Proverbs and Common Sayings of
the Chinese (1902)

ABSTRACT

In Chapter I, the subject of dermatoglyphics was introduced, and the aims of the present study outlined: to establish the range of local variation of various dermatoglyphic traits in the South Wales Coalfield and surrounding areas. Chapter II described the area studied in more detail, paying attention to its physical geography and historical demography. In Chapter III, the sample itself was introduced, problems and methods of sampling touched upon and procedures for the analysis and interpretation of dermatoglyphic prints presented, mentioning problems of classification and the current ideas on the mode of inheritance of the various traits.

Chapter IV dealt with the analysis of the data collected. The distribution of the data sets was first described using univariate procedures, and then the inter-relationships between the sub-populations created investigated, using multivariate procedures, in particular the Generalised Distance Statistic of Mahalanobis (D^2).

The findings of the statistical analysis were discussed in Chapter V, and placed in the context of other investigations of dermatoglyphic variation and previous studies of genetic variation in Wales. An attempt was made to account for the pattern of local heterogeneity disclosed by the study and the degree of care which should be exercised in the delineation of local populations in any study of genetic relationships also emphasised.

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Perhaps of paramount importance has been the assistance and co-operation of those participating in this study. It would not have been possible without the consent of the Directors of Education (named in the Text), headteachers, parents and pupils resident in the sample area and approached for inclusion in the survey. Their interest and involvement made field trips a pleasure rather than a necessary chore. At this point, too, I should like to thank Mr. Michael Carr who accompanied me on many of the school visits.

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Joan Smith.

CHAPTER I

INTRODUCTION

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1. RIDGED SKIN

Ridged skin occurs on the palms and soles of all primates, including man, and is apparently associated with the prehensile use of hands, feet and tail - i.e. to prevent slipping in grasping and in locomotion. In man the surface of the entire palmar surface of the hands and fingers and of the plantar surface of the feet and toes is ridged. The ridging continues along the margins of palms, soles, fingers and toes, as well as over the tips of the digits. There are no hairs or sebaceous (oil) glands in these areas. There are, however, abundant sweat glands, the pores of which are situated along the crests of the ridges. Nerve endings are also plentiful in the skin of these regions.

Ridge configurations are determined partly by heredity and partly by environmental influences occurring in the womb during foetal development. Configurations occur on the sites of the volar pads, which are areas of differential growth in the foetus. These pads begin to subside early in the fourth month of foetal development (see Table I). If subsidence is incomplete before ridge formation begins, a pattern results. Patterns, therefore, occur in certain definite areas of the palm and sole. Present knowledge of the inheritance of dermal ridges seems to indicate that configurations on fingers are affected to a lesser extent by environmental factors than those on palms. This may be due to the precosity of ridge formation on fingers as compared with palms.

The mechanism which determines the actual patterning of the ridges is at present still obscure, though various theories have been offered. The earliest, by Bonnevie (1924) is that the patterns on the finger tips depend on the underlying arrangements of peripheral nerves. A nerve developed on the ulnar side would produce an ulnar triradius and a radial loop; correspondingly, a radially placed nerve would lead to an ulnar

TABLE I

Development of Dermal Ridges in the Foetus

(after Mulvihill and Smith. J. Pediat. 1969)

Weeks	STAGE Crown-Rump Length m.m.		EVENT
4-6	4-13	Early limb development:	Arm bud appears, the hand plate develops, digits separate as web recedes.
$6\frac{1}{2}$-8	17-30	Pad appearance:	Foetal pads appear in this order: II, III, IV interdigital, central palmar, digital thenar and hypothenar, paired proximal phalangeal.
10-12	40-55	Beginning of pad regression:	The central palmar pad recedes rapidly and completely; thenar and hypothenar pads regress at variable rate; interdigital and apical pads persist longer - even into post natal life.
13	70		
		Ridge formation:	Primary deep dermal ridges appear;
15	90		Primary ridges multiply.
16	100		Sweat anlage and stratum corneum appear.
19	140		Secondary deep ridges develop.
21	160	Definite pattern is complete by this time:	Keratinized epidermal surface becomes ridged over the primary deep dermal ridges.

loop; and two equally powerful nerves to a whorl.

Harold Cummins (1926) believed that configurations could not be considered as independent self-differentiating existences, but that they owed their character wholly to growth phenomena correlated with the form of the foetal parts in which they lay. Thus, it is suggested that apical pads of the following types are each associated with a given configuration. An apical pad generally rounded throughout, merging peripherally into the general contours of the distal phalanx is associated with a simple arch. Slight unevenness of contour and asymmetrical bulging of the prominence may account for individual variations. Secondly, the pad may be formed as in the first case but gently impressed proximally, resulting in a tented arch. Thirdly, the pad may have a circumscribed corona, which may or may not be symmetrical with reference to the digital axis. This type is associated with a true whorl, the size of the corona having a direct relationship to the size of the whorl. Fourthly, the pad may have a coroniform elevation of marked radial or ulnar asymmetry, the slope on one side being less abrupt than on the other. When the abrupt descent is on the radial side, an ulnar loop is formed; when on the ulnar side, a radial loop is formed. A pad may also have more than one apical elevation, or perhaps a marked depression in relation to an elevation. When this occurs a lateral pocket loop, a twin loop or even a triple loop is formed. Lastly, there are pads which represent combinations or intermediates of the various possibilities and these produce the corresponding complex or intermediate patterns.

Penrose (1973) put forward the suggestion that the cells in the lower part of the epidermis are, at a very early period, sensitive to curvature and that pressure produced by the concavity in the primitive basal layers induces cells to multiply and form folds, with rows of papillae, along the lines of pressure rather than in other directions.

This would mean that, from the external point of view, the parallel lines would follow the greatest convexity (or at least concavity) of the external surface. In favour of such a view is the observation that, in the absence of a pattern, ridges tend to run around the limb or digit at right angles to the long axis and in the direction of greatest curvature.

Dermal ridges have various characteristics which make them important, not only for personal identification, but also in human biology. Firstly, they are not affected developmentally by age; secondly, environmental influences on their configuration only occur in the womb and are therefore minimal; thirdly, the detailed structure of individual ridges is extremely variable, with no two hands or feet ever being exactly the same, but the patterns they form can be readily classified into several main types; and lastly, though the actual mechanism of inheritance is not fully understood, it is well established that dermal ridges are inherited.

2. AIMS OF PRESENT STUDY

Francis Galton (1892) first suggested that "local (dermatoglyphic) peculiarities exist in England, the children in schools of some localities seeming to be statistically more alike in their patterns than English children generally."

Regional variation in the features of palm and fingerprints was demonstrated by Abel (1935) and Poll (1937) among samples living in various parts of Germany, and Coope (1966, unpublished) in Warwickshire and Oxford. They have also been more recently studied by R.L.H. Dennis (Ph.D. Thesis 1977, unpublished) in the North Yorkshire Dales, and by W.R. Williams (Ph.D. Thesis, 1978, unpublished) in the Marcher Counties of Powys and Shropshire. By and large, however, dermal traits have been little used in investigations into local population differences, in spite of the fact that the heritability of total finger ridge count is one of the highest yet established in man. Most previous studies of dermatoglyphic variation have been at 'national' level, where a sample is collected randomly (usually from the environs of the capital city) and then said to be representative of the national population.

Thus, the study of dermatoglyphic variation, firstly to see if it does exist and secondly to what extent ignoring it obscures local differences, is of importance in establishing the range of human heterogeneity. It is also important in the growing study of the association of dermal patterns and various diseases and inherited abnormalities (See Appendix 4). This is because it is only possible to study abnormal variation if one is already aware of normal variation in a given geographical area.

Therefore, the aim of this study is to increase the amount of information on the subject of the normal variation of dermatoglyphic traits and to attempt to correlate present day population variation with the intricacies of historial demography in the area studied.

The area chosen for the study consisted of the old county of Glamorganshire in South Wales, with adjoining areas of Breconshire and the town of Llanelli in Carmarthenshire. This area was chosen for several reasons. Firstly, it is an area of comparatively high population density and thus allows for greater ease in collecting data. Secondly, it was well known to the author since she is a native of the area. Thirdly, and most importantly, even though there was great population movement into the area in the nineteenth and early twentieth centuries, the vast majority of immigrants came from neighbouring Welsh, or English marcher counties (Thomas, 1930; Watkin, 1965). Since the beginning of the twentieth century, there has been a steady, though not uninterrupted, industrial decline in much of the area with the result that the main movements of population have been out of the area. The exceptions have been the port towns of Cardiff and Swansea, the town of Port Talbot which is centered on the Margam Abbey Steel works, and the Vale of Glamorgan towns of Cowbridge and Bridgend which have seen recent residential growth mainly as commuter towns for Cardiff and Port Talbot. Thus, the towns on the coalfield show a predominantly Welsh born population and those on the coastal belt show a much greater percentage of English born inhabitants.

CHAPTER II

THE AREA

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1. GEOGRAPHICAL OUTLINE

The South Wales Coalfield underlies an oval-shaped plateau area mainly in the old county of Glamorgan, but shared also by the neighbouring counties of Carmarthen, Brecon and Monmouth. This plateau is defined by bounding escarpments of the Carboniferous System and earlier strata, but its margin is broken in the southwest by the breaching of both Swansea Bay and Carmarthen Bay. Within the limits of the plateau, rivers have sculpted valleys and these, in turn, have been further modified by the gouging and depositional activities of ice. Oscillations of the level of the sea and the effects of the weather have added further changes, as, indeed, has man himself.

The Vale of Glamorgan is, in common with the Gower Peninsula, a coastal platform. This is a peneplane of marine erosion which has been uplifted forming a plateau of between 200 and 600 feet, with entrenched river valleys. Also part of the area are two coastal flat regions, one at Kenfig Burrows near Port Talbot and the other in the Cardiff region. These are below 50 feet and were formed as a result of marine and stream deposition in Quaternary times (see Figure 1.).

2. HISTORICAL PERSPECTIVE

This physical environment imposed limitations on the pattern of settlement in the area, because of its very nature. The coastal areas were, before the Industrial Revolution, much the more thickly populated due to their accessibility and to the richness of the agricultural land. Thus, it is important when considering the present-day structure of population in the area to remember what elements went into its composition

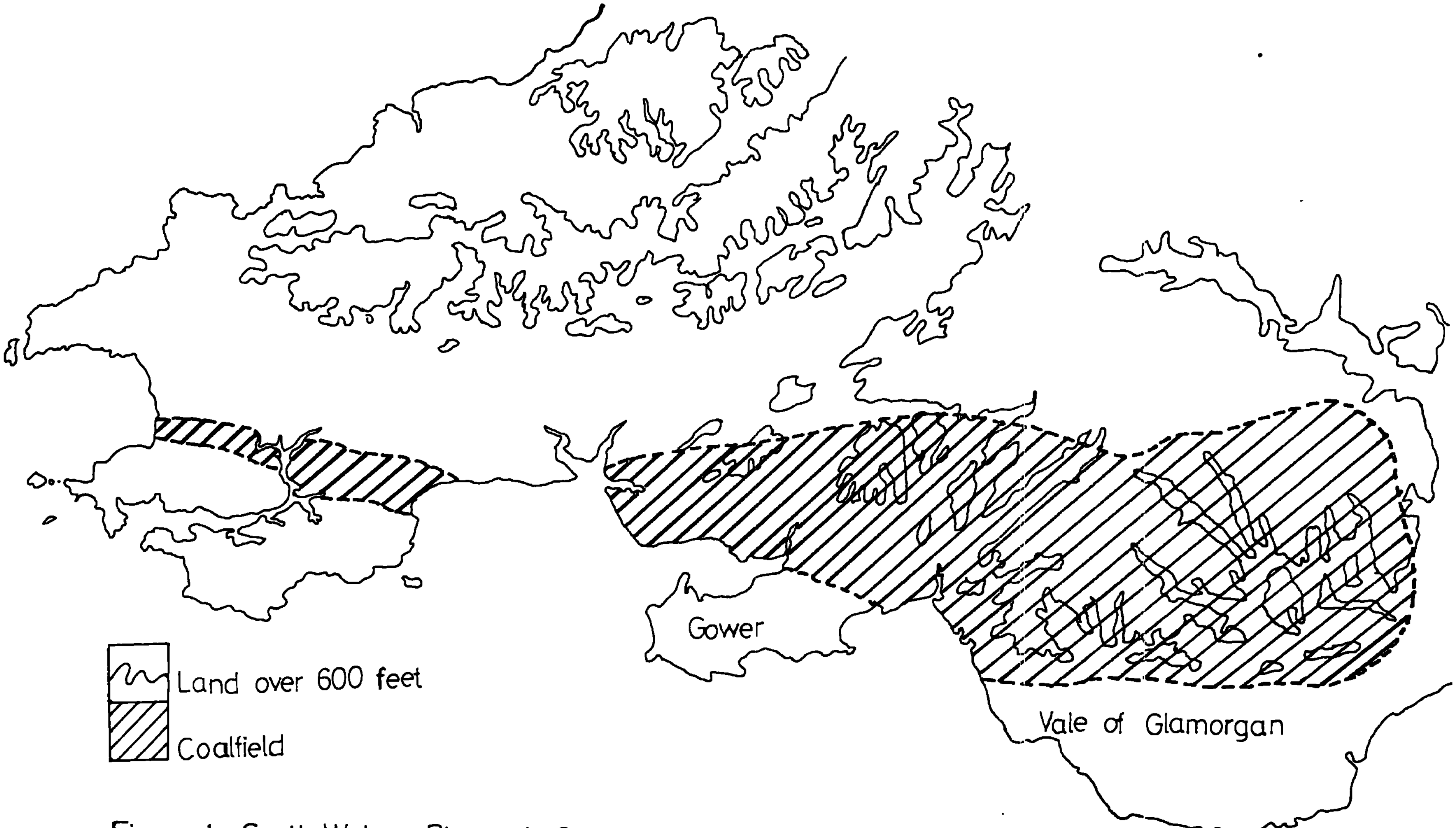


Figure 1: South Wales - Physical Geography

and how a study of them will increase our understanding of local differences.

Throughout prehistoric times Wales was a thinly populated area, with the earliest certain evidence of the presence of man being in paleolithic cave dwellings in the carboniferous limestone. A famous example is Paviland Cave in Gower. At the end of the ice age and the onset of forested conditions, the valleys became thickly forested with much swamp on the valley floors. In sheltered areas the tree limit is thought to have extended up to 1500' and thus only the higher mountain plateaux and exposed coastal areas remained free of forest. For this reason, and also because the beaches were the only source of flint, the coastal areas were most usually chosen for habitation.

Some physical anthropologists (Fleure and James, 1916) have claimed that some of the most inaccessible areas of Wales like the Plynlimon moorland or the Black Mountain country of Carmarthenshire contains many individuals who are thought to resemble in their physical appearance the people who lived in Upper Paleolithic times. These people have dark hair and eyes and often swarthy skins. Their large heads are very long, narrow and high, their brow ridges often stand out strongly, while their cheek bones and noses are broad and mouths usually prominent. More recent work on blood group frequencies in these areas tend to support the view that these people represent the survival of very early human stocks. The geographical distribution of blood group frequencies shows that most of the West European peoples belong to groups A or O, with a marked dominance of group B in central and eastern Europe. However, in the Plynlimon moorlands, B frequencies exceeding 10% are common and in the Black Mountain country of Carmarthen 16% frequencies are found. However, it should be emphasised that both these areas are sparsely populated, isolated, and often the people are inter-related. These factors might well have caused 'distortion' of the figures and given rise to a false impression about the two areas.

During the later part of the Neolithic Age there were several waves of immigrants into Wales, mainly of Megalithic peoples, from the sea. It is during this period that the physical anthropologist looks for the introduction of some of the basic elements in the Welsh population-

(1) the short, dark, Atlanto-Mediterranean type, moderately long-headed, smooth featured and of slender build.

(2) broad-headed, dark people of tall stature who are characteristic of a number of coastal patches in Wales, including South Glamorgan.

(3) tall, broad-headed people with strong eyebrow ridges, well-arched skulls and rather light colouring - archaeology associates this type with the Beaker peoples and they are found in the valleys of the upper Dee, middle Wye and Usk, the Towy, and sporadically along the Vale of Glamorgan.

In the Bronze Age, Wales received many elements of Irish culture by way of the western sea routes and cultural influences from Lowland Britain also affected Wales on its eastern margins, South Wales being affected by the Wessex Kingdom.

The next important formative period in the history of Wales occurred in the pre-Roman Iron Age. Celtic peoples began to spread into Lowland Britain shortly after 500 B.C. and from about 250 B.C. there is considerable evidence of similar movements into the British area along the western sea routes from Britanny and Western Gaul. It was this western Iron Age culture, known as Iron Age B, that primarily affected Wales, and whose abundant presence is illustrated by the large numbers of hill forts found in Wales. It was also these invaders who introduced a Celtic language of the Brythonic Group which was ancestral to the modern Welsh language.

The Roman occupation seems to have had little effect on the Iron Age culture of Wales, and there was not much racial admixture. However, some must have occurred in the 'border' areas, controlled from the encampments of Caerleon and Caerwent near modern Newport in the south, and also Chester in the north. There is also evidence of domestic Roman settlement in Wales, for example the villa discovered at Mumbles near Swansea, which implies a province relatively well subdued and integrated into the Roman Empire. Indeed, the departure of the Romans in A.D. 383 allowed greater movements of peoples using the western sea routes and there were strong infusions of Irish settlers who introduced the Goidelic form of Celtic. Around 400 A.D. it is thought that considerable numbers of Brythonic-speaking Celts moved or were moved from what is now Southern Scotland and Northeast England into North-west Wales in order to drive out these Irish settlers. These people were known as the Sons of Cunedda and their conquests by the eighth century A. D. covered most of North, West and Southwest Wales. Recent work has shown them to be racially akin to the Iron Age B hillfort dwellers and to speak a Brythonic dialect of Celtic. They also developed a largely pastoral and tribal-based economy, where cultivation of the land was a lesser occupation carried out by serfs.

On the eastern borders of Wales and especially in the Severn and Wye valleys, strongly built fair types, both Alpine and Nordic in character, are particularly noticable. These probably derive from Scandinavian, Anglo-Saxon or Anglo-Norman immigrants, or possibly from the earlier Iron Age B invaders.

After the Norman invasions the population of Wales remained fairly stable racially. It is with the development of the Industrial Revolution in the late eighteenth century that new upheavals took place. The influx from outside Wales was counterbalanced by an internal migration from the non-industrial areas and it can be said that apart from increasing still further the short, dark, long-headed stock in the Principality, the great movements of people in recent times have added little new to the racial composition of the population.

There were various clearly defined phases in the industrial development of South Wales which obviously affected population structure since population movements at this time were usually economically motivated. Before 1750, industrial activity was essentially desultory in character and scattered in location, though there was an important concentration of ore smelting in the Swansea and Neath valleys. Between 1750 and 1850 the iron ore industry, based on coke and initially located on the north-east rim of the coalfield around Merthyr Tydfil, developed. From 1850 until the outbreak of the First World War various inventions - the Bessemer 'converter' (1856) which enabled steel to be produced cheaply; and the Siemen's open hearth process (1861) - were patented. These advances, coupled with the exhaustion of easily accessible local supplies of iron ore, undermined the iron industry of the northern part of the coalfield and resulted in a coastal migration. At the same time the export market for coal expanded rapidly. The inter-war years were marked by industrial decline and a slump in both heavy industry and coal mining which resulted in widespread unemployment and social disruption. This slump was a symptom of worldwide economic depression but can also be related to the effects of the First World War blockades of coal export; and the importing countries subsequent need either to look elsewhere for their supplies or to develop their own resources. It should also be remembered that South Wales coal is notoriously difficult and expensive to mine, and that by 1918, 150 years of concentrated mining had exhausted most of the more accessible seams, particularly in the Eastern part of the coalfield.

Since World War Two long term planning and 'rationalisation' has resulted in a revival of heavy industry, and, to a lesser extent, coalmining, accompanied by the establishment of industrial estates and also of large plants e.g. that of the British Steel Corporation and B.P. Chemicals at Margam.

3. THE STRUCTURE AND ORIGINS OF THE POPULATION OF SOUTH WALES

It is well known that the population of South Wales underwent drastic changes as a result of the Industrial Revolution. It is useful for the purposes of the present study to investigate these changes in some detail.

Until the beginning of the nineteenth century, the population of Wales generally remained relatively stable, with a gradual overall increase (see Table 2). In Glamorgan, in 1800, the population was fairly evenly distributed over the whole county. The lowland regions of the Vale of Glamorgan and the Gower Peninsula (average density of 50-100 persons/square mile) were in fact more populous than the hill districts of the coalfield where there were still extensive areas with a density of only 20-30 per square mile. Carmarthen was probably the largest town in the region, with a population of 4-5,000. It and Brecon formed the two provincial capitals in which several of the smaller country gentlemen had their town houses. Of the towns which later were to be flourishing industrial centres, Swansea was by far the most important. With a population of about 3,000, Swansea was the busiest harbour in South Wales, although it was reported at the middle of the century that grass grew in its main streets. Cardiff was little bigger than Haverfordwest and its trade was sufficiently small to allow the collector of customs to combine his duties with the trade

TABLE II

The Population of Wales (1536-1841)

(compiled from various sources)

Year	Estimates	Year	Census
1536	278,000	1801	587,245
1570	325,000	1811	673,340
1600	379,000	1821	794,154
1630	405,000	1831	894,400
1670	408,000	1841	1,046,073
1700	412,000		
1750	482,000		

of glazier.

Although it is true to say that in 1800 the majority of the people of Glamorgan still earned their living from the land, it was, nevertheless, becoming increasingly evident that alternative forms of employment were already attracting workers away from rural life. If, in the traditional 'push-pull' of migration, the 'push' was from uplands overpopulated in relation to resources developed, then the 'pull' consisted of the opportunities available in England and overseas and above all the attraction of the coalfield. Early industry had been concentrated in the Neath and Swansea area and along the northern and eastern rim of the coalfield east of the Vale of Neath. Within these areas the metallurgical industries, above all the iron industry, were dominant. This resulted in the growth of a series of settlements extending from Aberdare to Pontypool along the coalfield rim. To a large extent the labour force being here built up was derived from local sources. Unskilled labour was easily recruited - skilled was more of a problem. However, the characteristic movement of skilled labour was a short distance movement. The concentration of the greater part of the copper smelting and tinplate industries on this coalfield, the relatively small numbers they employed, and their gradual development, made this short-distance movement almost inevitable. In 1717 the Forrest Copper Works, Swansea, obtained most of its chief men from Sir Humphrey Mackworth's Melin-y-Gryddan Works at Neath, and almost a century later the new concerns at Llanelli procured their skilled men from works at Swansea and Penclawdd. In both the iron and coal industries a similar short distance movement was common. Ironworkers and colliers moved from one valley to the next as works were established and as individual concerns expanded or contracted. Thus, in the 1840's Monmouthshire colliers moved steadily westwards as the rapid development of the steam coals in Merthyr and later in the Aberdare and lower Rhondda valleys took place.

The bulk of the long distance migration of skilled men was probably the result of some special need, rather than of a general lack of skilled labour. Such a need would arise, for example, when the technical knowledge of local workmen proved inadequate to solve a particular problem. e.g. Ignorance of the use of gunpowder amongst Welsh colliers meant that in 1738 Robert Morris brought two men from Cornwall. Again, in 1750 Sir Humphrey Mackworth established a colony of Staffordshire miners at Neath to drain his mines. The replacing of disaffected workmen and the breaking of strikes by imported skilled workmen from England (e.g. in 1816 at the Cyfarthfa Works in Merthyr Tydfil) is another example of these special movements.

As on other coalfields, the unskilled labour which formed the greater part of this new industrial labour force, was drawn from the surrounding agricultural counties, usually attracted by high wages. There was also an element of seasonal migration of labour. The tradition of a Welsh migration to harvest the crops of the Midland counties was often replaced or added to, by a winter migration to the ironworks. In 1849, for example, Merthyr Tydfil had a 'floating population' of between 10 and 11,000, mainly comprised of young unmarried men.

Despite the freedom of movement and the complicating of the drift into industrial areas by currents of long-distance migration, labour does not appear to have been sufficiently mobile to meet the demands of the convulsive growth of the iron industry. At the peak of the railway boom in 1845, when the depression in agriculture and the high wages in the iron industry had increased the number of people moving from the western counties into Glamorgan, the shortage of labour was such that at least one ironmaster "sent a man into Pembrokeshire to hire workmen, paying him £5 for every 50 he secured."

The growth of the Irish element in the coalfield commenced in the 1820's, but was not considerable until the famines of the 1840's, when large numbers did arrive. Most of them moved into the industrial towns, but many found employment in the farms along the coast where, working for half the wages of the natives, they partially relieved the burden on the impoverished farmers. They usually performed the most menial tasks and were disliked because they were associated with squalor - they were blamed for the cholera epidemic of 1849, for example.

However, it was after 1850 that the more spectacular movement began with the gradual rise to dominance of coal mining as against the iron industry, and also with the development of the Rhondda Valleys. The period 1850-70 also saw a very rapid expansion of the rail network, allowing migration from a much wider area than previously.

The pace at which the population of Glamorgan grew during this second phase of industrial development is illustrated in the table which follows.

Year	1851	1901	1911
Population	231,849	859,931	1,120,910

It should be noted that the population of the whole of Wales in 1911 was only 2,240,921 persons. The change of emphasis from iron to coal production is also reflected in the population figures for Cardiff in this period when compared to those for Merthyr and Swansea:

	1801	1841	1861	1901
Cardiff	1,870	10,077	32,954	164,333
Swansea	6,821	19,115	33,972	94,537
Merthyr	7,700	34,977	49,794	69,228

The volume of immigration between 1861 and 1911 also assumed striking proportions:

	1861	1871	1881	1891	1901	1911
Total popn. Glamorgan	317,752	397,859	511,433	687,218	859,931	1,120,910
Number born Elsewhere	116,812	117,904	180,794	260,684	297,833	390,941

But whilst the movement of workers into Glamorgan from other counties continued, there was at the same time some degree of redistribution of population taking place locally. Early in the 1860's workers from the iron works at Merthyr were already moving in small but significant numbers to the coal pits of the Rhondda. At the same time, the movement of agricultural workers away from the land continued, and these movements seem to have assumed a fairly clear pattern.

Despite the upward trend in agricultural wages and other incentives which were offered in an attempt to keep men on the land, the indigenous labourers still moved toward the relatively higher wages obtainable in the non-agricultural occupations. The consequent local labour shortages were made good by immigrant labourers from elsehwere who were themselves attracted, initially by the relatively high agricultural wages in the Vale of Glamorgan.

The last decade of the century witnessed an intensification of work in the coalfield and this resulted in a further movement of indigenous workers away from the Vales. Meanwhile the relatively high rates of agricultural wages had attracted so many farm workers from the neighbouring counties of Enlgand that by 1893 it was officially stated that: "labourers from Wiltshire, Somerset and Devon, from Hereford and the Cirencester district of Gloucestershire have almost everywhere superseded the indigenous Welsh labourer in the Vale of Glamorgan, excepting along the seaboard in parts that are remotest from railway communication." But even the newcomers did not remain very long on the farms, "for higher wages and shorter hours almost invariably succeeded in attracting them to the mineral districts, so that other labourers have to be continually drafted from the same English counties to replace them."

It would be wrong, however, to conclude that there was a continuous efflux of persons from all parishes of the Vale to the industrial areas of the Uplands. It would be more correct to argue that towards the end of the century there was a general movement of workers away from agricultural occupations within the Vale rather than from the respective parishes of the Vale itself (aided by improvements in communication, particularly the building of railways e.g. Vale of Glamorgan Railway - Bridgend to Barry (1888); Llantrisant to Cowbridge (1865)).

It is also of interest to examine the source of external migration into Glamorgan and the coalfield generally. It would appear that the absolute contribution of the border counties remained more or less stable from 1871 to 1911, but the stream from more distant counties fluctuated directly with the bouyancy of the coal trade (see Table III below). Three considerable waves of migration are clearly discernable

TABLE III

Number of Migrants from Border and Non-Border Counties

	Border	%	Non-Border	%	Total
1871-81	37,200	50	37,500	50	74,700
1881-91	39,900	37	68,600	63	108,500
1891-1901	42,000	44	52,400	56	94,400
1901-11	34,400	27	94,100	73	128,500

and they synchronised with the periodic cycles of prosperity in the mining industry (see Table IV). Migrations out of the area were also affected by these same cyclical variations in prosperity. Thus in a period of expansion the wages were comparatively higher than in other industries and emigration was low. One interesting point is that, in years of stress, the movement out of the area was composed of a large proportion of females, suggesting that low wages and unemployment tended to force the miner to lighten his family budget as a temporary expedient rather than to leave the area altogether (see Table V).

The industrial depression that characterised the period after the First World War initiated new trends. Minor slumps were clearly marked in the nineteenth century population trends, indicating the close link between the prosperity of coal mining and population movement. In the late 1920's and early 1930's complete collapse of the coal trade together with a general slump in other heavy industry led to mass unemployment. This in turn added to rural depopulation the severe erosion of population away from the centres where generally it had been collecting for the past one hundred years. Between 1921 and 1931 the counties of Glamorgan, Monmouth and Brecon lost 241,000 people. There were very few opportunities of work elsewhere in Wales, so this movement was essentially one out of Wales and mainly into the

TABLE IV

Estimated Number of Migrants Entering Glamorgan

(after Thomas)

Counties of Birth	1861-71	1871-81	1881-91	1891-01	1901-11	1911 Census
Other Welsh counties:						
Monmouth	2,300	10,000	10,500	13,500	11,600	48,000
Carms.	5,700	4,900	9,300	11,000	6,800	38,000
Pembs.	3,700	5,800	5,500	7,100	5,500	28,000
Cards.	1,500	4,100	7,600	3,800	2,900	20,000
Brecs. & Radnor	2,500	4,300	5,700	4,900	5,100	18,000
Montgomery	400	1,400	4,100	1,400	2,200	10,000
North Wales	100	600	3,600	2,000	6,300	7,000
Merioneth	100	200	1,600	1,100	2,500	6,000
English counties:						
Gloucester	-	6,400	9,400	6,000	19,300	41,000
Somerset	-	9,900	11,900	8,700	6,000	37,000
Devon	400	8,700	3,900	4,600	6,200	23,000
London	200	1,900	3,200	2,800	8,000	16,000
S. E. Counties	200	1,700	2,700	1,900	4,400	22,000
Wiltshire	300	1,700	2,900	1,800	3,400	10,000
Cornwall	1,700	2,500	1,500	1,900	2,000	10,000
N. E. Counties	-	1,900	3,400	2,500	4,600	12,000
N. W. Counties	200	1,300	2,700	2,600	4,500	9,000
Dorset	-	1,200	1,500	600	2,600	6,000
Staffordshire	300	600	1,600	1,100	2,700	5,000
Other Midland Counties	100	1,300	2,700	2,000	5,000	7,000
Ireland	-	-	3,000	6,600	3,800	14,000
Scotland	300	1,000	1,600	1,200	1,800	6,000

centres of light industry in the so-called axial belt stretching from London north and west to Liverpool and Manchester.

By 1931 the lowest ebb in the demographic history of Wales had been reinforced by industrial decay and in the Census of 1931, Wales showed a decrease in total population for the first time since the Census began.

TABLE V

Natives of Glamorgan found in London and other English Industrial Areas

(after Thomas)

	Males	Females	Total
1871	4,931	5,951	10,882
1881	7,550	9,452	17,002
1891	9,645	11,887	21,532
1901	14,556	16,794	31,350

Present day population distributions still show that South Wales is characterised by a declining population. The key to the distribution of population in the area is the association of finger-like extensions along the valleys uniting along the coastal fringe at focal points. These lines of dense population give way sharply and aburptly to moorland areas of very sparse population density: there is no rural transition. The focal points in this scheme are Newport (for the Monmouthshire valleys), Cardiff (for the East Glamorganshire valleys), and Swansea (for the West Glamorganshire and East Carmarthenshire areas). Attention must be directed to the clear way in which two belts of population, one along the northern outcrop and one along the southern, stand out. The northern extends from Blaenavon in the East, South-West to Aberdare and thence North-West to Ammanford. This represents especially in the eastern part the earliest phase of development of the coalfield. The southern belt extends from Caerleon South-West to include the northernmost extension of Cardiff, thence through Pontyclun and Llanharan to Aberkenfig merging with the rapidly developing area between Pyle, Bridgend and Porthcawl. This is a heterogeneous zone, modern in its development, including not only the areas of more recent large scale mining along the Southern outcrop of the coalfield but also a large proportion of suburban development.

Apart from the industrial areas of the coalfield, the coastal and border belt of fertile agricultural land, comprising the Vales of Gwent and Glamorgan and Gower, remain relatively stable in population size and composition. However, there are occasional artificial centres of population such as the military camp at St. Athan and the growing development of rural 'dormitory' villages for the commuting middle classes of the large industrial centres.

From this outline of the historical demography of South Wales several points make themselves abundantly clear. Firstly, that from the middle of the eighteenth until the beginning of the twentieth century, there was a steady influx of population into what had previously been a predominantly rural area. This migration involved large numbers of individuals, from all over Britain, but the largest part of the movement came from the bordering counties of Wales and England, from what were, historically at least, relatively similar racial groups.

Secondly, the migrations were often of family or local groups which stayed together, forming the basis of new genetic populations. This trait is amply illustrated in the popular accounts of life during this period, and indeed recalled by the older element of the population. Thirdly, the population of the area since the early twentieth century has fallen into two distinct halves. There is that half which lives and works on the coalfield which is stable and where the most significant influence on gene pools has been loss of information due to emigrations; and there is that part of the population associated with the coastal belt of large towns and smaller satellite towns which has much less of a 'local' element in its composition and where population appears to be increasing.

CHAPTER III

THE SAMPLE

CHAPTER III THE SAMPLE

1. PROBLEMS AND METHODS OF SAMPLING

The attempt to describe the genetic structure of a population, or, in this case, dermatoglyphic variation within a population, is a task fraught with difficulties and uncertainties. Perhaps the biggest difficulty, and one which is often overlooked, is the virtual impossibility of defining any population, of exactly placing its external boundaries, be they physical or social. For, except perhaps in the case of island populations, no human population exists in isolation: there is a continual exchange of genetic information with other populations, especially with neighbours. Thus, it can be convincingly argued that the division of human beings into populations, especially on the local level, is a statistical artefact, created for the amusement of population geneticists.

However, if we wish to understand more about human beings, especially how and why they vary in respect to genetic constitution, we have to make use of these artefacts in order to be able to examine groups of something approaching manageable size. We also have to ignore another basic problem. This problem is that populations have an existence in time as well as in space. We can usually only describe a particular population at a particular point in time, though we can of course describe and compare the same population at two or more different points in time, just as we can compare two different spatial populations at the same point in time. It is not beyond the bounds of imagination to visualise a situation in which a given population varies in its genetic constitution from generation to generation about a 'mean' genetic constitution for that population; in much the same way as we describe a trait as having a mean frequency with a calculable amount of variation within a given population. In this way we cannot guarantee that our time-slice of the population in question is in any way representative of the genetic constitution of that population through time.

It is also this problem of time which makes the study of ancestral populations, or 'indigenous' elements in a given local population so difficult. Population theory tells us that the Mendelian population does not exist in a Hardy-Weinberg equilibrium, however useful mathematically it is to assume that it does, but that it is continually changing, evolving. Theoretically we can assume that there are four forces of evolution acting on the gene pool of a given population: mutation and gene flow, both of which can introduce new genetic material into the population, and natural selection and genetic drift, which determine what happens to that material once it has been introduced. The changes which these forces bring about are, to say the least, difficult to isolate and assess, and, indeed, this has been but rarely attempted on 'real' populations. Thus, we cannot assume that, in seeking an 'indigenous' or 'ancestral' population by examining remnants of it in the present population, we are making correct extrapolations about its genetic constitution by using that present population as a guideline.

Indeed, it is arguable that to extract portions of a gene pool for examination makes nonsense of the concept of a gene pool. Perhaps, therefore, in attempting to describe the dermatoglyphic variation of the Welsh section of a gene pool as against the non-Welsh section of that same gene pool, both sections somewhat arbitarily selected and apportioned, we are conducting a meaningless statistical exercise.

However, in spite of these reservations, this study will attempt to assess dermatoglyphic variation between the Welsh, non-Welsh and half-Welsh sections of the Glamorganshire population's gene pool. It is possible to justify this, even given the above remarks, because of the nature of the population to be studied. As described in Chapter II, the area of the South Wales coalfield has had a varied demographic history with much population movement and subsequent 'reorganisation' of gene pools. However, the population has been relatively stable since the early part of the twentieth century, the time when most of the grandparents involved in this study were born. Apart from certain well-defined areas, particularly in the Vale of Glamorgan, there has been relatively little influx into the area, the main population movements being away from centres of high unemployment in the traditional mining and heavy industry sections. This has obviously had its own effect on the constitution of the gene pool, but at least what has been left behind can be clearly recognised as a predominantly 'Welsh' population. It is the belief of the author that this sort of study could not and should not be attempted in a more heterogeneous area - i.e. probably a more prosperous industrial area.

Having decided on the limits and probable composition of the population to be studied, the researcher is faced with a further series of problems. Firstly, unless it is very small, or that unlimited time and finance is available, there is no way in which the whole population can be examined. Therefore, a sample of that population has to be selected. Again, the researcher has to decide if he requires a random sample of that population and also what he means by a random sample. A true random sample would probably involve a percentage of the total population, including proportions of the social classes, levels of intelligence, so-called abnormal individuals, criminals, each sex, age groups,........ad infinitum. Most researchers do not attempt what can only be described as an impossible task and settle instead for a random sample of the normal population, usually defining 'normal' fairly loosely as those people in 'general circulation' who are willing and able to participate in the study.

2. COLLECTION OF DATA FOR THE PRESENT STUDY

In order to collect as random a sample as possible, and since dermal patterns do not vary, except in size, with age, it was decided to take the sample from secondary schoolchildren living in the area. To this end, the Directors of Education for the County Boroughs of Merthyr Tydfil (then Mr. John Beale); Swansea (then Mr. L. J. Drew); the city of Cardiff (then Mr. G. J. Mackay) and the counties of Breconshire (then Mr. Deiniol Williams); Carmarthenshire (then Mr. Iorwerth Howells) and Glamorganshire (then Mr. Brynmor Jones), were applied to for permission to approach various headteachers in the areas under their jurisdiction. These all very kindly gave their permission.

The next step was to select the schools to be included in the study and write to the relevant headteachers for permission to approach the parents of pupils who were in one academic year in each school. It was decided to sample only one academic year from each school because otherwise the numbers involved would have been too large, and, secondly, to maintain the random nature of the sample. In all, 31 secondary schools were visited in the period from September 1971 to September 1973 (see Appendix 2 for a list of schools), and 2,569 sets of palm prints obtained. All the children were between the ages of 11 and 16 when the palm prints were taken, the majority being in the age range 11-13 as the schools found the first and second years more conveniently released for sampling.

Before a child was included in the sample, he/she was given a form to take home to his/her parents. This gave an outline of what was involved and requested certain information. If a child did not return the form (i.e. parental permission was refused) he/she was not included in the sample. Each person's sex, age when printed, place of birth, place of birth of both parents and both sets of grandparents, and mother's maiden name were recorded. Each person was also given a reference number: a letter(s) indicating where the prints were taken and a number indicating their place in that series e.g. prints taken in Llanelli schools were numbered L1 to L239.

The prints themselves were obtained using the Reed International inkless method. The hand is first wiped clean of any excess moisture or dirt, then 'inked' with the special fluid and pressed down on the specially treated paper. This sheet of paper was placed on a piece of foam to allow the central hollow of the hand to be printed. Each print was immediately checked to see if the relevant information had been obtained and if not, repeat prints were taken until a satisfactory reproduction of the hand was obtained. Fingerprints were not taken separately as it was not intended to record finger ridge counts, but each finger was examined 'in situ' and the pattern type recorded in the appropriate place on the print of the hand.

When the palm prints had been collected they were analysed. On each hand, the finger patterns were recorded using E. R. Henry's book 'The Classification and Uses of Fingerprints' (1901) as a guideline. The digital triradii on the palm were located and the number of ridges crossing or touching a straight line joining the a and b, b and c and c and d triradii respectively, were counted. The axial triradius 't' was located and the 'atd' angle measured, when more than one axial triradius was present, the most proximal one was taken to be 't', since more distal axial triradii are normally involved in pattern configurations.

The five pattern areas on the hand were located and the details of configurations in these areas noted. The first two hundred sets of prints collected were analysed for palmar pattern types according to the classification methods of both Cummins and Midlo (1943) and Penrose and Loesch (1970). However, for reasons mentioned below, it was decided that the method of classification advocated by Penrose and Loesch gave a better description of the ridge configurations and could be more readily used in comparative studies, so it was decided to analyse the patterning of the rest of the prints collected using this classification.

3. THE ANALYSIS OF DERMATOGLYPHIC PRINTS

(i) Classifications

A classification in dermatoglyphics is a means of recording the features in the topology of the palmar or plantar areas which consistently vary in such a way as to increase understanding of those features and to standardise comparisons. For the purposes of this study all remarks concerning classifications will refer to the palmar and digital areas, though the same principles apply to the study of plantar dermatoglyphics.

(a) Fingers

The fact that recognizable and classifiable patterns occur on human (and other primate) fingers has long been recognized, as is evidenced by the carvings on a burial passage on L'Isle de Gavr'inis off the coast of Brittany which were made in Neolithic times. Thumb prints have also been used as a mark of identity by potters on their work, or on documents. One of the most well-known of these appreciations of the uniqueness of finger prints is the personal mark of Thomas Bewick (1753 - 1829), an English engraver, author and naturalist. Bewick made wood engravings of his fingerprints and printed them as vignettes or colophons in his books.

The works of Nathaniel Grew (1684), Bidloo (1685) and Malpighi (1686) are among the earliest scientific descriptions of dermatoglyphics. Grew presented before the Royal Society in London a report of his observations on patternings of the fingers and palm. He describes the sweat pores, the epidermal ridges and their arrangements and presents a drawing of the configurations of a hand.

However, finger patterns were first systematically classified by Francis Galton in 1892. He divided the patterns into three main types, arches, loops and whorls, according to the number of triradii present. (A triradius being defined as the junction of three regions each containing systems of ridges which are approximately parallel in small fields of these regions (Penrose 1964)). Galton's classification was modified slightly by E. R. Henry in "The Classification and Uses of Fingerprints" (1901) for many years the police manual on the subject, to include another category, the subdivision of loops into ulnar and radial loops depending on the direction of their open end. Thus, a simple arch is defined as having no triradius, but is merely a succession of gently curving ridges. A loop has one triradius; if it opens towards the ulnar margin of the hand and has the triradius on the radial side it is an ulnar loop; if it opens towards the radial margin and has an ulnar triradius it is a radial loop. Whorls, which have two triradii, are of three main types: symmetrical whorls composed of concentric ridges around a single centre; spiral whorls, turning either clockwise or anticlockwise; and double loop whorls which have two cores. Henry's work is particularly useful in that each variation of fingerprint pattern he discovered has been illustrated and placed in a sequence of pattern types to give immediate classification.

Though much research has been conducted on the subject of fingerprints, the classification has not altered substantially since Henry's day. One example of a minor attempt to clarify the classification of whorls is that proposed by Bhanu in 1975. He identifies, names and describes nine different types based on the direction of the course of the ridges inside the pattern area of true whorls. These types he calls 'clockwise', 'counter-clockwise', and 'concentric', the other six types being combinations of these three. Using this classification he studied data from the Ezhava caste in Kerala, India, and found what he describes as significant bilateral differences for the 'clockwise' and 'counter-clockwise' types.

(b) Palms

Palmar (and plantar) dermatoglyphics were first scientifically studied by Harris Hawthorne Wilder and his wife Inez Whipple Wilder at the end of the last and early part of this century. Harold Cummins and Charles Midlo expanded and elucidated Wilder's work in the 1920's and 1930's and it was they who coined the work "dermatoglyphics" in 1926 (literally derma: skin + glyphè: carve) as a "term embracing the skin patternings of fingers, toes, palms and soles . . . . and it applies also to the division of anatomy which embraces their study. The word is literally descriptive of the delicately sculptured skin surface, inclusive of single ridges and their configurational arrangements." (Cummins and Midlo: "Fingerprints, Palms and Soles, an Introduction to Dermatoglyphics" p. 22.)

Their classification, described below, still remains in general usage today, but is slowly being superceded by that proposed by L. S. Penrose and Danuta Loesch in 1970 - the first serious challenger to Cummins and Midlo's classification since it was formulated.

(1) Cummins and Midlo's Method of Classification

The palmar area is divided into six dermatoglyphic areas or configurational fields in the descriptive formulation proposed by Cummins and Midlo: hypothenar, thenar, and four interdigitals (see Figure 2). Each of the areas is a topographical unit, its individuality being expressed both by the existence on some palms of a discrete pattern and by the characteristic presence of partial boundaries formed by triradii and their radiants.

On most hands there are four digital triradii located at the bases of digits II, III, IV and V (see again Figure 2), and named, in radio-ulnar sequence, a b c d, though it is possible for any one of these to be absent and also for there to be accessory digital triradii. Axial triradii (t) are usually located at, or very near, the proximal border of the palm, in the space between the thenar and hypothenar eminences. However, they may occur as far distally as the centre of the palm. Again, accessory axial triradii, usually associated with patterning in the thenar and/or hypothenar areas are often present.

Formulation records the number and levels of axial triradii. In the palmar formula, the symbol(s) for axial triradii follow the main-line formula, separated from it and the succeeding pattern formula by dashes. Lacking precise means of definition, this formulation was recognised by Cummins and Midlo as being the least satisfactory of all elements of their palmar formula. However, it is generally accepted that an axial triradius at or very near the proximal margin is called t, one very near the centre of the palm, t'', and one at an intermediate level, t'. When more than one axial triradius is present

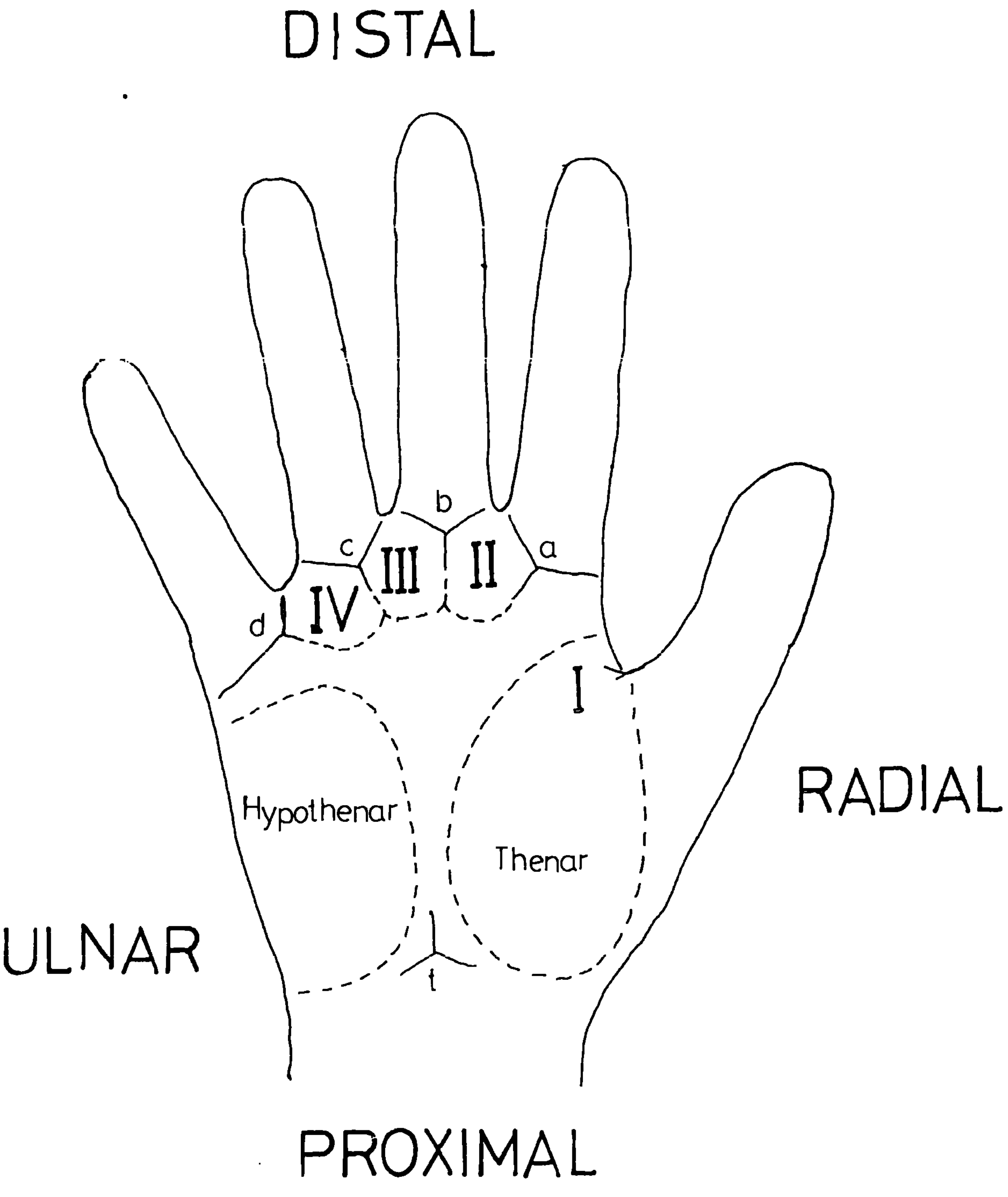


Figure 2: Configurational Areas of the Palm

(usually associated with patterning), they are formulated in proximo-distal order (e.g. t t' t'').

Cummins and Midlo also advocated the tracing and formulation of the palmar main lines. Lines A, B, C and D originate from the respective digital triradii as their proximal radiants, and line T is the distal radiant of the axial triradius (T is traced from the most proximal axial triradius when more than one is present.). They believed that, completely traced, the main lines of a palm constituted a skeleton of the palmar configuration (see Figure 3). The formulation (classification) of main lines was based on a numbered sequence of positions around the periphery of the palm, each traced line being described according to its place of termination (see Figure 3). Having traced the four main lines, the symbols for their terminations were represented as a main-line formula in one order D, C, B, A with full stops separating the symbols e.g. the formulation of figure 3 would be: 11.7.7.4.

The next step in the analysis of palmar configurations is the analysis of the configurational areas. These are formulated individually, by a descriptive symbol, and included in the palmar formula in the order: hypothenar; thenar/interdigital I; interdigital II; interdigital III; and interdigital IV.

Cummins and Midlo distinguished three primary types of configurations in the hypothenar area: whorls, loops and tented arches. They also noted as primary configurational types but not true patterns, plain arches, open fields, multiplications and vestiges. True whorls are distinguished by concentric ridges, typically having three triradii, though the one occurring on the ulnar margin may be extralimital. A concentric whorl is formulated W; one with a spiral or double-loop centre, W^s. Loops may open in any one of three directions: the radial

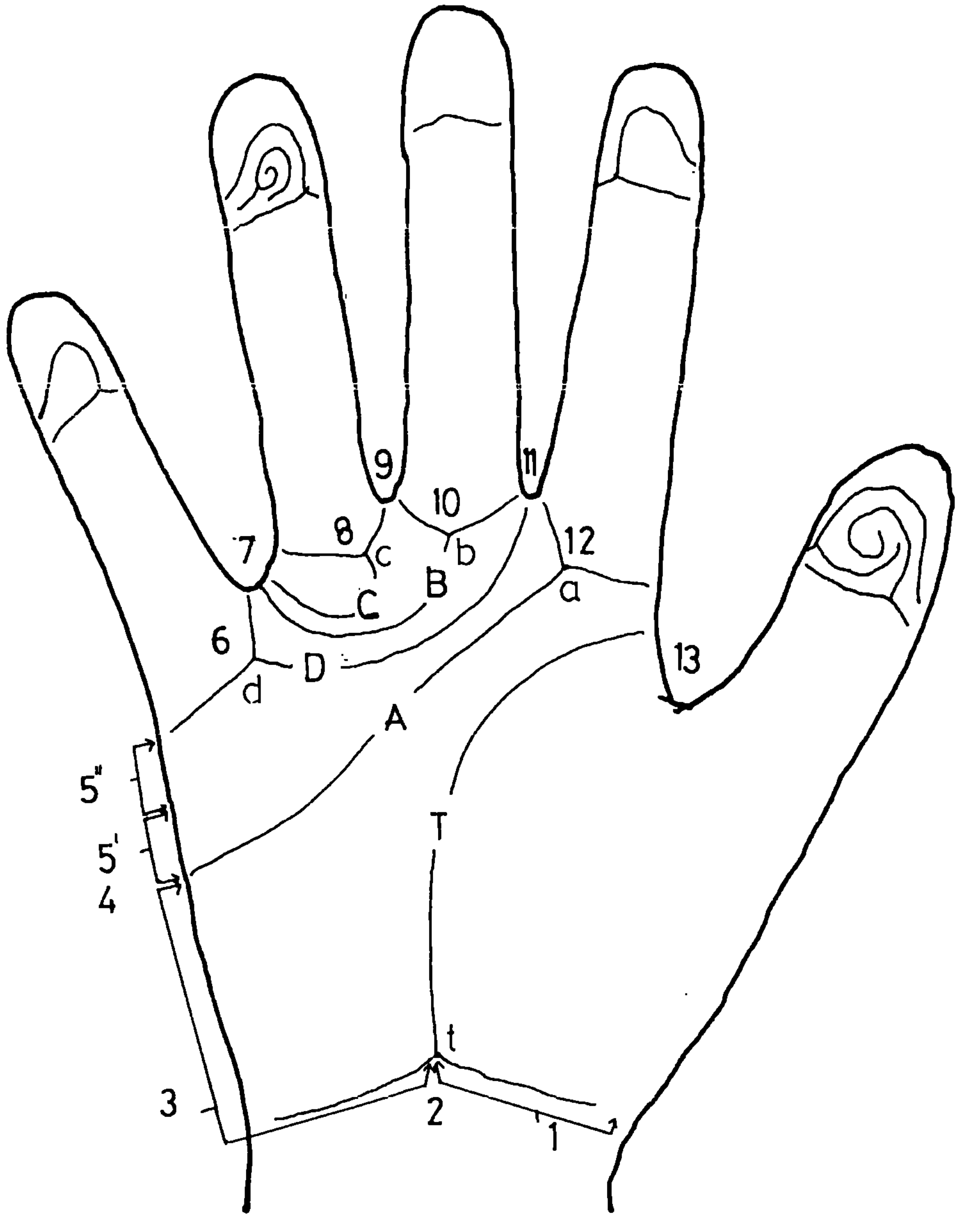
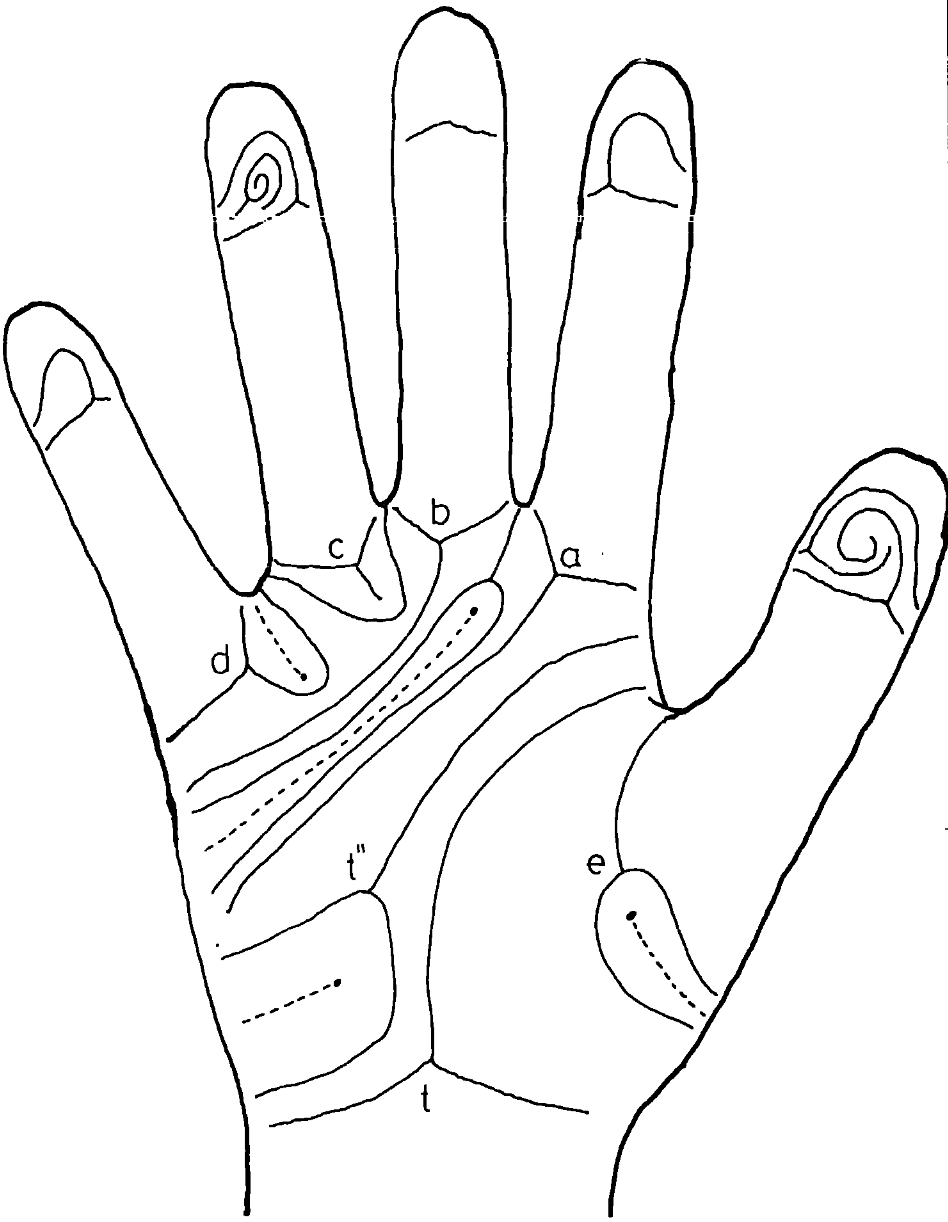


Figure 3: Palmar Main Lines

margin, the ulnar margin or the proximal (carpal) margin. The symbol for all loops is L, and the superscripts L^R, L^U and L^C indicating the direction of the open end. *Tented arches* can also be orientated in three different directions, the symbol T being superscripted T^U, T^R or T^C according to the direction of the base. A *Plain arch*, a special form of open field, has an arched form and the symbol A, the superscripts A^U, A^R and A^C indicating the direction of their concavity. They differ from *open fields* (symbol O) in that, in the latter, the ridges are essentially straight instead of arched. *Vestiges* are local disturbances of ridges which lack the sharp recurvatures of ridges which distinguish true patterns. The hypothenar area may also contain more than one primary pattern i.e. a 'duplex configuration' and a dual formulation is applied to show the presence of two primary types.

The configurations of the thenar and first interdigital area are closely related anatomically, and, in patterning, are often virtually indistinguishable. Cummins and Midlo make the distinction between firstly both areas being a continuous open field; secondly a single pattern or vestige occurring in an intermediate position between the thenar and interdigital I areas; thirdly a pattern or vestige in interdigital I with the thenar area an open field; fourthly a pattern or vestige in the thenar area with interdigital I an open field; and lastly, a pattern or vestige in both areas. When patterns occur they can be whorls or loops, the symbols being the same as for those occurring in the hypothenar area i.e. W (whorl), L (loop), V (vestige) and O (open field).

In Cummins and Midlo's classification, the configuration of an interdigital area may be a true pattern (whorl or loop) a vestige or an open field. There may also be more than one pattern in any interdigital area. Whorls are always, and loops sometimes, associated



Palmar formula: tt''A^{u}.L.L.O.L

Figure 4 : Example of palmar formula (Cummins and Midlo)

with accessory triradii.

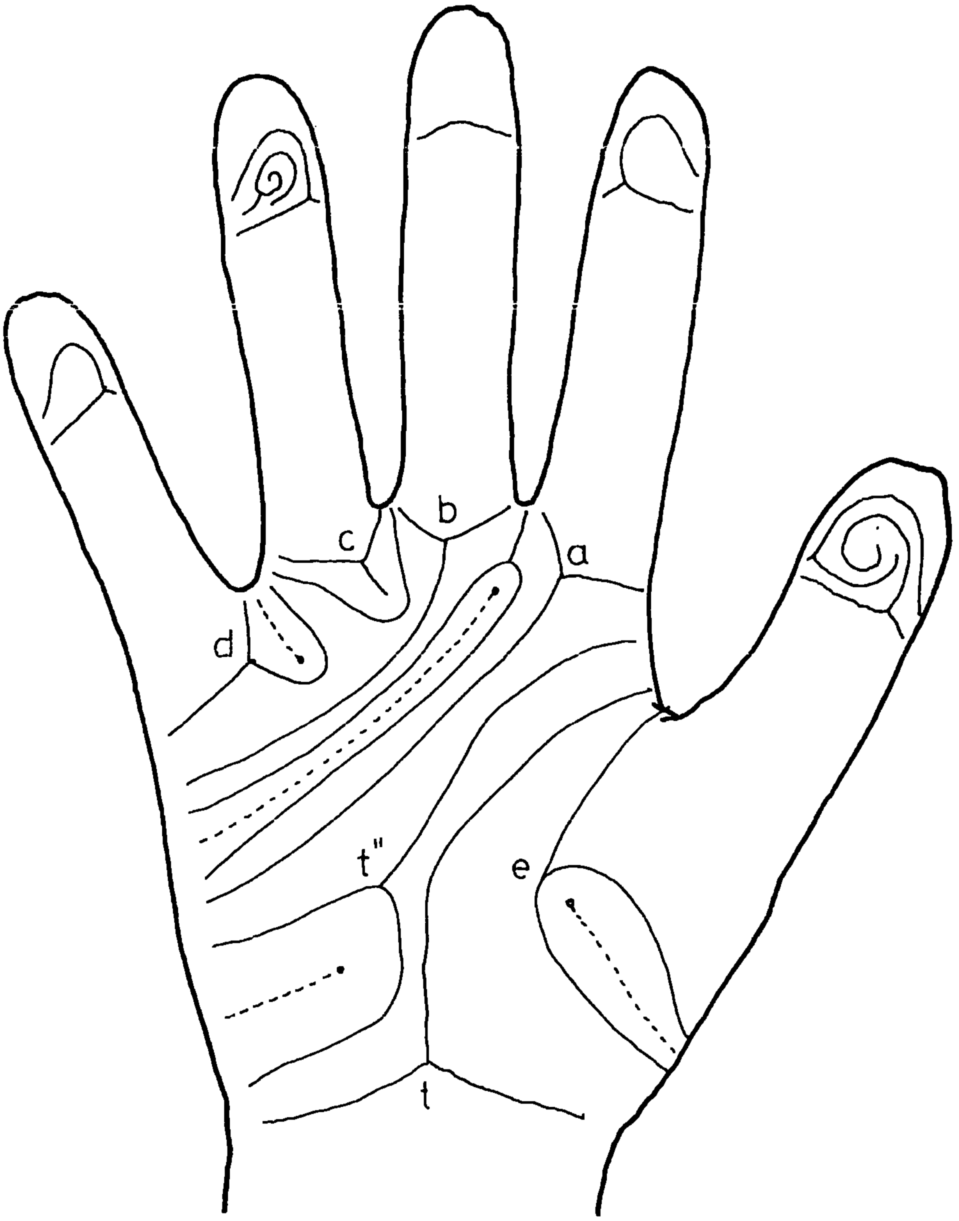
Once all the pattern areas and main line terminations have been defined, they are expressed in the 'palmar formula' which gives an indication of the topology of the hand (example Figure 4).

(2) Penrose and Loesch's Method of Classification

L. S. Penrose and Danuta Loesch, however, felt that the traditional classification of Cummins and Midlo had not always proved convenient in clinical and genetical studies and they set out in an article in the "Journal of Mental Deficiency Research" in 1970, a topological classification which they hoped would fulfil this need.

In this classification, the first step is to describe all the loops occurring on the hand, noting that a whorl always consists of two loops and secondly to enumerate all the triradii, remembering that the number of triradii on a normal hand including those which are extralimital, always exceeds the number of loops by four (Penrose 1965). Arch formations, cusps, multiplications, fans and vestiges are excluded because they are not true patterns and thus not topographically significant. Thus, main line terminations are also ignored in the classification, though such information, formulated according to the method described above, can be added if thought necessary, at the end of the palmar formula.

Each loop is specified according to the configurational area in which it occurs and the direction of its core (see Figure 5). Loops are classified as peripheral (I, II, III, IV and H) when their cores point away from the centre of the palm and central ($\hat{\text{I}}$, $\hat{\text{II}}$, $\widehat{\text{III}}$, $\hat{\text{IV}}$ and $\hat{\text{H}}$) when they point towards it. This method of classification is derived from imaginary lines which are drawn at right angles to the ridges. Three particular loops are individually specified. The



Palmar formula: $\mathrm{I}^{r}\,\widehat{\mathrm{II}}\,\mathrm{III}^{t}\,\mathrm{IV}\,\mathrm{H}\,e\,t\,t''\,4$

Figure 5: Example of palmar formula (Penrose and Loesch)

first is IV^U, a peripheral loop in the fourth interdigital area whose core points towards the ulnar border of the palm; second is H^R, equivalent to Cummins and Midlo's carpal loop, which is a hypothenar loop with its direction and exit towards the radial side of the wrist; thirdly is I^R, a peripheral loop in area one with its exit on the radial thenar border. Tented loops are also distinguished, in areas II, III, IV by the superscript T e.g. most commonly III^T, and in the hypothenar area, according to Cummins and Midlo's nomenclature, T^C, T^R and T^U, according to the direction of their open ends.

Every triradius is located and named. In area I, a triradius is called 'e' when it lies in the distal half of the area; otherwise 'f'. Axial triradii, as before, are called t, t', t'' and t'''. A border, or extralimital, triradius is called t^b and one situated near the centre of the hypothenar area t^u. When a triradius deviates to the radial side of the palm, a rare occurrence, it is called t^r.

Special formulation is also given on those occasions when two interdigital triradii (a, b, c or d) fuse. When a and b are fused, the new triradius is called Z. Fused bc produce Z' and cd, Z'' to indicate zygodactylous tendencies.

(3) Comparison of the Two Methods of Classification

The first two hundred sets of palm prints collected in the present sample were analysed according to both the methods of classification described above. During the course of this analysis several points became obvious. Firstly, that the classification advocated by Penrose and Loesch allowed much less room for 'individual' interpretation of pattern types. and thus variations in analysis, because its nomenclature seemed to be reduced to the basics of patterning more than that advocated by Cummins and Midlo. Also for this reason, it proved much easier to classify atypical patterns using Penrose and Loesch's classification - without resorting to the complicated descriptions which Cummins and Midlo found necessary. Penrose and Loesch's methods also facilitated comparisons between and among data. In the newer classification no item was left unrecorded, often the case with Cummins and Midlo. This especially applied to the case of accessory triradii in the palmar areas and to the pattern described as III^T (i.e. a tented loop around digital triradius 'c') which occurred frequently among the palms studied and could not be classified under Cummins and Midlo's scheme.

The only drawback in Penrose and Loesch's method was felt to be that whorls were not individually classified but treated as double loops. This leads to the same description being applied to two (or more) different patternings, in particular the case of the occurrence in one hand of a simple whorl in the hypothenar area, and in another of two separate loops, one directed away from and one towards the centre of the palm. These would receive the same description $H\overset{\frown}{H}$ under Penrose and Loesch, but would be called W and L^R L^U respectively by Cummins and Midlo. However, this seems a minor drawback, since both types of patterning are comparatively rare and obviously do have basic similarities.

It was thus concluded that the method of classification advocated by Penrose and Loesch gave a better and more accurate description of the ridge alignments on the hand. Further, it facilitated comparative and genetic studies because it did not merely describe the pattern as it was, but attempted to describe its structure, and, in doing so, disregarded no feature of the patterning such as accessory triradii.

(c) Minor Classifications

Apart from the overall classifications of Cummins and Midlo and Penrose and Loesch, various attempts have been made to reclassify various areas of the palmar surface. Because they sometimes present rather unusual configurations, much attention has been focused on the interdigital areas.

The most comprehensive study of the interdigital areas was made by Inez Whipple Wilder in an article published in the 'Journal of Morphology' in 1930, in which she described the interdigital patterns of two hundred randomly selected individuals and created a nomenclature, based on that of Cummins and Midlo. A true whorl was represented by the letter 'W' and a spiral whorl by W^{SL}; a loop by the letter 'L' and a vestige by 'V'. Then, small letters were placed after the pattern type to indicate the respective triradii involved in the pattern (r: radial; u: ulnar; p: proximal and d: distal), their order indicating their location with relation to the core or axis of the pattern, starting with the triradius furthest from the centre and working inwards. The final letter, therefore, stands for the triradius which, if the method of modification indicated by the form of the pattern were continued, would be the next triradius to disappear. When two or more triradial centres are connected by their radiants and are therefore practically, if not exactly, equidistant from the pattern core or axis, the fact is indicated by a hyphen placed between the symbols. When symbols are so hyphenated, they are recorded in a clockwise direction. When there is no pattern (i.e. an open field) no initial letter is used, but the identity of the remaining triradius is indicated.

I. W. Wilder also formulated an 'evolutionary tree' of all the patterns she observed, showing how each type fits into a developmental progression.

A more recent publication by Plato and Wertelecki (1972) attempted a new classification of interdigital patterns based on the direction of main line terminations, as well as the presence of accessory triradii. They found eight possible pattern types under this classification.

Attempts have also been made to standardize the notations for main line terminations and for the position of the axial triradius 't'; without altering the mode of classification with regard to the axial triradius 't' in particular, many ingenious methods of standardising the naming of its location have been devised, in particular, the transparent plastic instruments invented by Sharma (1963a, 1963b, 1966). Others have attempted to standardise 't' by using the value of the 'atd' angle (Mavalwala 1963), or by constructing a formula intended to obtain a 'corrected atd' (David 1971).

Plato (1970) reclassified the terminations of the palmar main line C into four modal types according to the direction of its path i.e. ulnar, radial, proximal and absence (associated with the absence of the digital triradius 'c'). Indeed, there has been much discussion about the positions of the various terminations of the palmar main lines and how these should be recorded.

Interest has also been shown in the patterns on the middle and basal phalanges of the finger (Basu 1973) and in the metacarpophalangeal creases (Okajima, 1966). However, palm prints must be obtained using the 'rolled' method in order to obtain adequate records of the ridge configurations in these areas and this has precluded widespread investigation.

However, these minor classifications, while elucidating one particular feature of the palmar area, do not attempt to see the problem as a whole. It would seem that in such a highly correlated area as the palm that one area or aspect cannot be profitably studied without reference to the wider situation.

(ii) Inheritance of Dermal Ridges

It has been previously stated in this thesis that dermal ridge configurations are inherited and that they can be usefully used as a tool in population differentiation. It is thus considered necessary to examine the evidence for this assertion, and to attempt to elucidate the means of inheritance.

The information gained so far on the inheritance of the configurations of dermal ridges is far from being definitive for two main reasons. Firstly the phenotypes considered are invariably those set up for identification purposes, though the new classification of Penrose and Loesch (1970) has eased the problem here; and secondly, most studies have concerned themselves with one aspect of dermal ridge configurations and ignored correlations with other aspects and areas.

One interesting theory of correlation is that described by Mavalwala (1966) who argues that if a vertical axis is drawn on the palm, running between the third and fourth digits, and on between the thenar and hypothenar areas, the two ulnar digits and the hypothenar area will be positively correlated, as will the three radial digits and the thenar area. He believes that it would be more feasible to investigate inheritance mechanisms if the palm is divided in this way, and not merely individual configurational areas or features compared.

Another theory of correlation is that put forward by Thompson and Bandler (1973) who suggest that all ten digits should be considered as a unit when studying variation. They base this on their findings on 592 and 125 Down's Syndrome subjects where the number of persons with few or many patterns of the same type exceeds binomial expectation and the number in between is below expectation, demonstrating that finger print patterns are not independently determined. In contrast, Jantz (1975) argues that the level of inter-finger diversity in an individual results from interaction between two groups of digits: digits II and III acting as one unit and digits I, IV and V as the other. While Reed et al. (1975) argue that the thumb exists as a separate unit to the rest of the digits and might be more closely related to big toe patterning.

Inheritance studies have been carried out on all aspects of dermatoglyphics, but we shall concern ourselves here only with those referring to the palmar and digital surfaces. The most detailed studies have been done using the information gained from fingerprints - for obvious reasons when one considers the complexity of palmar patterning. When studying the genetics of dermal ridges, there can be two separate approaches: a study of the actual patterns or configurations (qualitative); or of the distance between various key points, usually measured by counting the number of dermal ridges crossing a line joining these points, or by measuring the angle subtended by them (quantitative).

The earlier students of dermatoglyphics had first to establish the fact of inheritance, leaving for later investigation the mode of transmission. Francis Galton (1892) undertook a preliminary examination of the inheritance of pattern type in the second digit of the right hand of 105 paired siblings. Noting the pattern types occurring in each couplet, he counted the instances in which each of the nine possible combinations of patterns occurs. Comparisons were made against a control series of unrelated persons, the second digit on their right hands being randomly paired into couplets. In this control series the observed frequency of each of the nine possible combinations of pattern types agrees closely with the calculated chance of such combinations in random selection (expected frequency), while the number of agreements of pattern types in the paired siblings is greater than would be expected on the basis of chance. The increased concordance, argued Galton, was due to the inheritance of pattern type. He also performed similar experiments using the fingerprints of twins and reached the same conclusions.

H. H. Wilder's early studies on twins extended the evidence of inheritance, and he also published two family trees which demonstrated the transmission of patterns as being dominant to open fields in some configurational areas.

However, it remained for Kristine Bonnevie to create a more fruitful approach. Her first observations were confined to fingerprints in family material amounting to about two hundred individuals and a small series of twins. She concluded that in the phenotypic expression of patterns at least three different characters are transmitted independently of each other i.e. the quantitative value of the pattern (ridge-count); the breadth/height proportion, the variants composing three general classes of pattern form (circular, intermediate and elliptical); and lastly, the tendency to 'twisting' (indicated by lateral pockets and twin loops as well as whorls with interlocked double cores). She also showed that some minor characteristics of pattern construction and direction (e.g. radial loops) are possibly inherited.

In subsequent studies, based on a hundred families with 321 children, she extended and modified these conclusions, mainly due to observations of pattern formation in the foetus. She showed that affinities among traditional patterns form a 'continuum' of pattern types and that each digit represents one part of a common genetic complex and its pattern is not independently determined. She proved that variations in pattern form (breadth/height proportion) are hereditary and suggested that elliptical and circular patterns represent a pair of alleles of which the elliptical allele is dominant. She did not find extensive evidence for the heredity of the direction of finger patterns (radial or ulnar).

Elderton (1920) confined his attention to patterns on the index fingers and considered right and left hands separately. He observed that, in family material comprising about 650 children neither Arch x Arch nor Arch x composite resulted in a whorl, neither Whorl x Whorl nor Whorl x composite resulted in an Arch. Arch x loop; Arch x Whorl; Composite x Loop; Loop x Loop, produced all types, possibly Composite x Composite produced no Arches. He also produced a continuum of pattern types, divided into classes for expediency.

Several authors have studied the occurrence of a particular pattern and speculated on its mode of inheritance. Selka (1962) believes that radial loop and arch patterns on fingers are dominantly inherited, and Walker (1941) believes that a radial loop occurring on the second digit of a right hand is a sex-linked recessive character. Fang (1950) demonstrated that a pattern occurring in the third interdigital area on the palm was inherited but said that the variation of the character could not be explained by any simple genetic hypothesis. Rife and Bansal (1962) showed that a single dominant gene with about 86% penetrance was responsible for the presence of accessory triradii and vestiges in interdigital areas II and III. Holt (1975) presents evidence from two families which indicates that the rare hypothenar radial arch might be recessively inherited. However, her evidence is scanty to say the least.

Ridge counts, because of their quantitative nature, have attracted a great deal of attention. Fang (1950, 1951 and 1952) has studied the a-b ridge count on the palm (i.e. the number of epidermal ridges crossing or touching a straight line drawn between the digital triradii 'a' and 'b', the triradial point not being included in the count). He considered that the genetic factors determining variation in the a-b count consist of a main gene whose expression is affected by multiple modifying factors. The allele determining a high count (over 79 ridges) is dominant over that determining a low count. (N.B. the count from both hands is added.) Modifying factors affect the place in the high or low category which the individual occupies. More recently, Pateira (1974) studied the mechanism of inheritance of the ridge count of the palmar interdigital areas among the Brahmans of Sagar in Central India. He found that the correlation coefficients between ridge counts (right and left hands added together) in various family relationships lent support to the concept of an additive genetic model, especially for the b-c count, but his findings were not conclusive. However, support for this hypothesis is also found in Pons' (1964) study of Spanish a-b counts; and Sciulli and Rao's (1973) path analysis, using Pateira's data, also found significant heritability estimates for each of the three counts, though with the b-c count again having significantly the highest heritability.

Singh (1971) studied the correlation of the a-b count amongst 996 Australians of European descent. He found a-b ridge counts to be positively correlated with the atd angle and negatively correlated with the mainline index; the latter finding confirmed by Floris (1975) in a study of 809 Sardinian individuals.

Shiono et al. (1975) studied a-b ridge counts on the palms of 480 normal Japanese (351 males and 129 females), plus samples of twenty-five Japanese with Klinefelter's Syndrome and five with Turner's Syndrome. He found that increased numbers of sex chromosomes were associated with the reduced mean sum of the a-b ridge count (see Figure 6). He also found the Japanese population to have significantly lower mean sum a-b counts (74.05) than the British population studied by Fang (1951) (83.03), or the Spanish population studied by Pons (1964) (83.31). However, the low numbers of individuals with abnormal sex chromosome complement in this study must be borne in mind when considering the importance of these results.

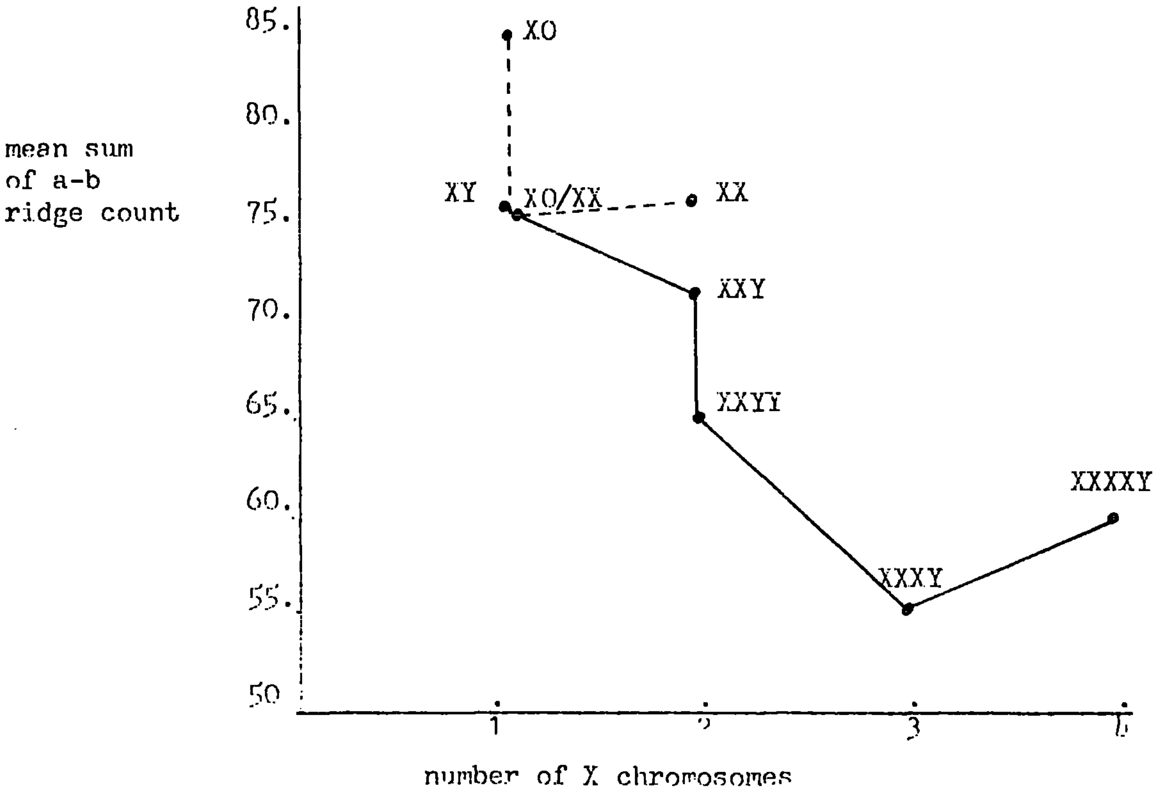


Figure 6: Mean sum of a-b ridge count related to number of X and Y chromosomes. (after Shiono et al., 1975)

Parsons (1964) studied fingerprint pattern variability in a sample of Australians of British origin. He found, in agreement with other authors, that various measures of variability of ridge counts and triradius number showed females to be usually more variable than males. He suggested that this might follow from the variable inactivation of one X chromosome during development as postulated by Lyon (1962). This idea was developed by Penrose (1967) who associated the presence of an extra X chromosome with increased fluid in the womb during foetal development. This would cause foetal oedema, increasing the surface area to be covered by ridges and thus giving higher ridge counts and often, more complex patterning. Conversely an absent X chromosome makes the cells slightly smaller than usual because fluid collects between them and the reverse process occurs, the ridges having less area to cover and the patterning being less complex. This is most clearly illustrated in cases of abnormality of the number of sex chromosomes (see Figure 7). Thus, Penrose suggests that the distortions of dermatglyphic patterns which are associated with chromosomal aberrations may have a mechanical origin, rather than being direct results of gene chemistry.

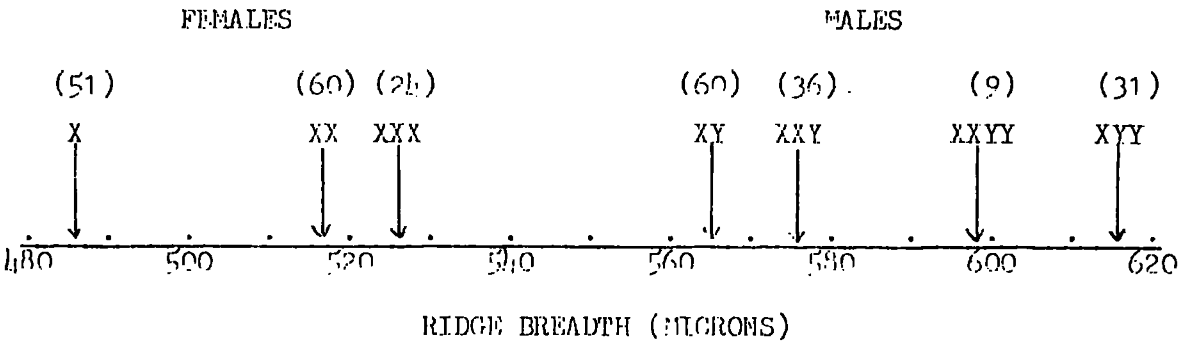


Figure 7: Mean ridge breadth (measured between triradii 'a' and 'b' on the palm). (after Penrose, 1967)

Barlow (1973) has another explanation. He produces evidence that heterochromatic X and Y chromosomes can slow down the mitotic cycle of cells, at least in culture. Applied to the problem of total finger ridge count, a regression analysis shows that one unit of heterochromatin (or one X chromosome) causes the ridge count total to fall by twenty-nine ridges. He explains this phenomenon by referring to the retarding effect of extra heterochromatic X and Y chromosomes on cell division in the developing fingertip. The finger ridges rise above a paired row of dermal papillae whose cells proliferate into the epidermis (Bonnevie, 1927) . Differences in the rate of proliferation of cells that give rise to the dermal papillae within the limited area of the dermal meristem could lead to differences in the number of papillae rows and thus the number of epidermal ridges.

Changes in ridge counts are also associated with changes of ridge topology. As the ridge count falls, with the increase of sex chromosomes, so the ratio of arches to loops and whorls increases. In 45 X and 46 XY individuals, arches account for only about 4% of the finger patterns, while in one 49 penta X individual all fingers had arches. Penrose (1969) states that one explanation for the topology of ridges is that they follow lines of curvature of the embryonic epidermis and so are, in effect, indicators of the contours of the raised hump of the embryonic finger tip. A higher hump, brought about by more cell divisions, will therefore have a greater number of ridges than a lower hump. In females who are mosaics of 45 X and 46 XX cells Polani and Polani (1969) found that there was a greater asymmetry of total ridge counts between hands than there was in non-mosaic controls. This can be explained, says Barlow, by differences in the rates of division of the two cell types in the mosaic embryonic finger tip.

Jantz (1977) has applied Barlow's hypothesis to various racial groups, and produced some rather confusing results. Since Barlow showed, in an English sample, that the total ridge count is reduced by twenty-nine ridges for each extra X and by ten ridges for each Y chromosome, this would lead to an expected sex difference of nineteen ridges between normal males and females. Samples of European and West Asian extraction showed an average sex difference of 16.8 ridges. However, a study of twenty-one samples of African extraction showed an average sex difference of only 8.6 ridges. Thus, in order to support the original hypothesis, Jantz would have us believe that the Y chromosome varies racially in its effect on ridge count, since racial variation in total ridge count is supposedly largely limited to males.

Probably the most important work to date on the quantitative aspect of dermatoglyphics has been done by S. B. Holt in a series of articles from 1949 to 1960, summarized in her book, 'The Genetics of Dermal Ridges' (1968). She concentrated on the total finger ridge count, maintaining that it was the best example of agreement in man between observed and theoretical correlations for a metrical character. The total finger ridge count is composed of the separate ridge counts from all ten digits, each count being the number of ridges which cross or touch a straight line drawn from the triradius to the core of the pattern, not counting the triradius or the ridge which forms the core of a pattern. Thus, an arch will have no ridge count as it has no triradius, a loop one and a whorl two. In the case of whorls, only the larger ridge count is commonly used, though Bonnevie made use of both counts in some of her work. Holt obtained various correlation coefficients using finger ridge counts (see Table VI).

These figures show remarkable agreement with the theoretical values for perfectly additive genes. Thus, it may be concluded that

TABLE VI

Correlation Coefficients for Total Finger Ridge Count

Degree of relationship	No. of pairs used	Observed Correlation Coeff.	Theoretical Correlation when genes additive
Parent -child	810	0.40	0.5
Mother - child	405	0.48 ± 0.04	0.5
Father - child	405	0.49 ± 0.04	0.5
Midparent - child	405	0.66 ± 0.03	0.71
Sib - Sib	642	0.50 ± 0.04	0.5
Twin - Twin (monozygotic)	80	0.95 ± 0.01	1.0
Twin - Twin (dizygotic)	92	0.49 ± 0.08	0.5
Parent - Parent	200	0.05 ± 0.07	0.0 (when mating random)

total finger ridge count is an inherited metrical character, that a number of perfectly additive genes are involved and that environment plays a comparatively small part.

Spence et al. (1973) examined a set of data containing samples from both Caucasian and Japanese populations. They analysed them by fitting a mixture of normal distributions, utilising maximum likelihood estimation. The results were homologous over all subsets of the data and suggest that a single major autosomal locus with two additive alleles may account for over half the variation of the quantitative phenotype absolute finger ridge count. Later, in 1977, Spence, Westlake and Lange, described a method of estimating variance components from pedigree data. They report that a significant contribution to the total ridge count variance could be attributed to the effects of dominance, a finding reported elsewhere neither before nor since.

However, Weninger, Aue-Hauser and Scheiber (1976) are sceptical of this generally accepted hypothesis of an additive polygenic control of total finger ridge count. They maintain that, although the correlation coefficients between various groups of relatives are not significantly different from the theoretical values calculated on the assumption of additive polygenes of independent effect, without dominance or environmental influence, there are various points which shed doubt on the validity of this hypothesis.

Firstly, they point out that methods of ridge counting do not provide a correct and faultless estimation of pattern and foetal pad size. Next, that the distribution curve of total finger ridge count is, in all of the data they have examined, negatively skewed and flattened. They say that this is due to the fact that, total finger ridge count is, in spite of its continuous variation, the sum of a heterogeneous combination of values with complex inter-relationships (i.e. fingers with different means, standard deviations and frequency distributions.). Thus, argue the authors, how can such a heterogeneous term pass for a homogeneous biologically meaningful character?

In spite of their criticisms, however, Weninger et al. have not been able to develop an alternative hypothesis for the inheritance of total finger ridge count, and, whilst recognising the validity of their points, it would seem unnecessary, at the present time at least, to disregard the popular hypothesis of additive polygenic control.

However, two individuals with the same total ridge count can have quite different counts and patterns on individual fingers and the total finger ridge count used on its own sometimes obscures diversity. Poll (1938) showed, with the pair group rule, a near correspondance in pattern frequencies of digits I and IV of the same hand and paired digits II, III and IV of both hands. It has also been shown that adjacent digits are more alike in pattern type than those further apart.

Slatis et al. (1976) analysed ten fingerprints of 571 members of the Habbanite isolate in Israel and suggested a number of inherited patterns and pattern sequences. They postulate a genetic theory which assumes that the basic fingerprint pattern sequence is all ulnar loops and that a variety of genes exist which can cause deviations from this pattern sequence. The genes that have been proposed include:

(1) a semi-dominant gene for whorls on the thumbs (where one homozygote has whorls on both thumbs, the other has ulnar loops on both thumbs and the heterozygote has either two ulnar loops, or one ulnar loop and one whorl.).

(2) a semi-dominant gene for whorls on digit II which acts like the gene for whorls on thumbs.

(3) a dominant gene for arches on the thumbs and often on other fingers.

(4) one or more dominant genes for arches on the fingers.

(5) a dominant gene for whorls on all fingers except an ulnar loop on digit III.

(6) a dominant gene for radial loops on digit II, frequently associated with an arch on digit III.

(7) a recessive gene for radial loops on digits IV and V.

These genes, say Slatis et al., may act independently or may show epistatis. However, it does seem a rather large assumption to assume a basic fingerprint sequence of all ulnar loops and this study needs much more supportative evidence. Mi and Rashad (1975) in a study of 711 families representing six racial groups in Hawaii, did find a possible involvement of dominance and/or common environmental influences, though inconsistent results did not allow any firm conclusions to be made.

Roberts and Coope (1975) have approached the problem using sophisticated statistical techniques. They reiterate the point that total finger ridge count obscures pattern and inter-finger variability though they admit that treating each separate digit as an individual unit does not solve the problem either because that approach ignores the well-proven correlations between homologous and adjacent fingers. Thus, they recommend the use of a statistical technique suited to the analysis of multiple related measurements and decide upon the adoption of principal components analysis.

Using data from Penrose's work on dermatoglyphics involved in disturbances of limb development (1963 and 1965), and from the principal axes of growth in foetal limb formation, they postulate that four growth factors influence the appearance of dermal patterns on the fingers:

(1) a general size factor.

(2) a factor differentiating radial and ulnar sides of the fingers and hand.

(3) parallel to the main axes of development, a factor influencing the counts on the medial digits.

(4) a factor influencing the counts on the lateral digits.

Roberts and Coope believe that the components they have extracted using principal components analysis bear a general resemblance to this scheme, in that the first component can be equated with the general size factor; the second with the differentiation of radial and ulnar counts on the fingers; the third with the contrast between the sides of the hand; and components four and five with effects on the lateral and medial digits. They thus appear to have found a general association between the components extracted governing digital ridge count, and factors affecting the general development of the distal end of the limb. It is also interesting that the principal components analysis yielded no indication of handedness, a point not necessarily in its favour.

Roberts and Coope and Jantz and Owsley (1977) feel that these results are still compatible with the polygenic approach to dermatoglyphic studies, but that perhaps they could be best explained by the application of 'field theory'. This is an approach involving several overlapping spheres of influence, the 'spheres' possibly related to genes, which has found popularity in the study of dental genetics in particular. However, much more work is needed in this area, particularly using family and pedigree data to elucidate the nature of the possible 'fields' involved and also to examine possible differences between components in different populations.

Loesch (1971 and 1974) found that dermatoglyphic characters on palms vary considerably with respect to the proportions of genetical and environmental components: some of them (e.g. hypothenar loop $\hat{H}$, interdigital loop II, triradius 't' and pattern intensity index) have high hereditability indices, while others (e.g. hypothenar distal loop H, radial loop H^R or 'Z' digital triradius) are almost entirely determined by environmental influences. The proportion of genetical component was also found to be related to the area where a given loop was found on the palm or sole; generally the heritability of the finger characters was highest and that of sole characters lowest. She further hypothesizes that some dermatoglyphic characters (e.g. loops $\hat{H}$ and II and triradius 't') may be determined mainly by single genes, those for loops being homozygous recessive. However, she does admit (1974) to great difficulties in interpreting the results of genetical analysis and no conclusive findings have yet come to light.

Pons (1959) analysed the transverseness of the palmar main lines (expressed by the sum of the Cummins main line index for each palm) as a quantitative trait, whose frequency distributions showed a small negative, though not significant, skewness and a significant platykurtosis in the series from Northern Spain which he studied. The intraclass correlation between sibs, and also that between parent and child was here 0.50 and no assortative mating was present, so Pons concluded that the condition was a polymerie with genes of additive effect. The same conclusion was reached by Glanville (1965) when studying the inheritance of palmar main line A.

Studies have also been made of the more minor variables of dermatoglyphics. Differences in the breadth of epidermal ridges were studied by Cummins, Waites and McWitty (1941) who found that it varies directly, though in a loose correlation, with body weight, stature, hand length, hand breadth and digital length. They found that the ridges on the fingers were less coarse than those on the palm with the order of coarseness (i.e. most coarse to least coarse) on the fingers being digits I→II→III→V→IV and on the palm: thenar→hypothenar→interdigital II→interdigital IV→interdigital III. There was no significant bimanual variation but they did find a tendency for ridges on right hands to be coarser than those on left hands. Ohler and Cummins (1942) echoed these findings but also found that females generally had finer ridges than males.

Penrose and Loesch (1967) investigated ridge breadth in the interval between triradii 'a' and 'b' on the palm. The estimate of ridge breadth, measured in μ, was determined by the formula:

$$\mu = \frac{(D_L + D_R)}{(C_L + C_R + 2)}$$

where D_L = distance between a and b (in m.m.) on the left hand

D_R = corresponding measurement on the right hand

C_L = a to b ridge count on the left hand

C_R = a to b count on the right hand

Two ridges have been added to the count to allow for the omission of the triradii. Thus, Penrose and Loesch obtained a mean ridge width in 60 normal adult males of 565 µ and in 60 normal adult females of 514 µ.

Okajima (1967 and 1970) has studied minutiae in the digital and palmar areas, paying special attention to the presence of 'forks'. He found no significant bilateral variation but males had a consistently higher fork index (percentage of forks in total minutiae) than females on both the fingers and the palm. The frequency of occurrence was also found to vary with each digit, the presence of forks being low on digit I, intermediate on II and high on digits III, IV and V; and appearing more frequently in loop patterns than in whorl patterns. He concluded that the frequency of forks was determined in some way by heredity but did not attempt to explain how.

Thus it can be seen that, while geneticists agree that dermatoglyphics are inherited, there is argument and uncertainty about just how they are inherited. It would appear though, that a better understanding of the situation will arise from studying the palm and digits as a whole unit, noting correlations within that unit and making comparisons at this level, rather than with the frequencies of individual pattern types in a given configurational area.

CHAPTER IV

ANALYSIS

CHAPTER IV ANALYSIS

1. DIVISIONS OF THE SAMPLE

The main object of the study was to look for local variation in dermal configurations, but to do this one first had to establish 'local' divisions of the area. It was finally decided to divide the area into postal districts and use these as the local units. This choice was made for several reasons; firstly to aid comparative studies with blood group frequencies since these studies use postal districts as their basic unit. Secondly, because in the area studied, the postal districts do, on the whole, conform to geographical and social boundaries. There are, of course, exceptions to this and Swansea postal district, incorporating the whole of Gower, and of the Swansea valley as well as Swansea itself, proved too large and heterogeneous a unit to be of practical use. Thus, in the survey it is divided into three sections, Swansea urban, Swansea rural south (Gower) and Swansea rural north (Swansea valley). The division of the sample into postal districts was made using 'Postal Addresses: November 1969' issued by the Post Office (see Figure 8).

At the first stage of analysis individuals were then assigned to various categories according to two different sets of criteria: firstly by the place of birth of their grandparents, and secondly by the number of the subjects' Welsh surnames. The place of birth of grandparents was used to divide the sample into three groups each containing both males and females: those having three or more grandparents born within the area of the study were classed as Welsh; those having two grandparents born within the area and two elsewhere as half-Welsh; and those with three or more grandparents born outside the area as non-Welsh.

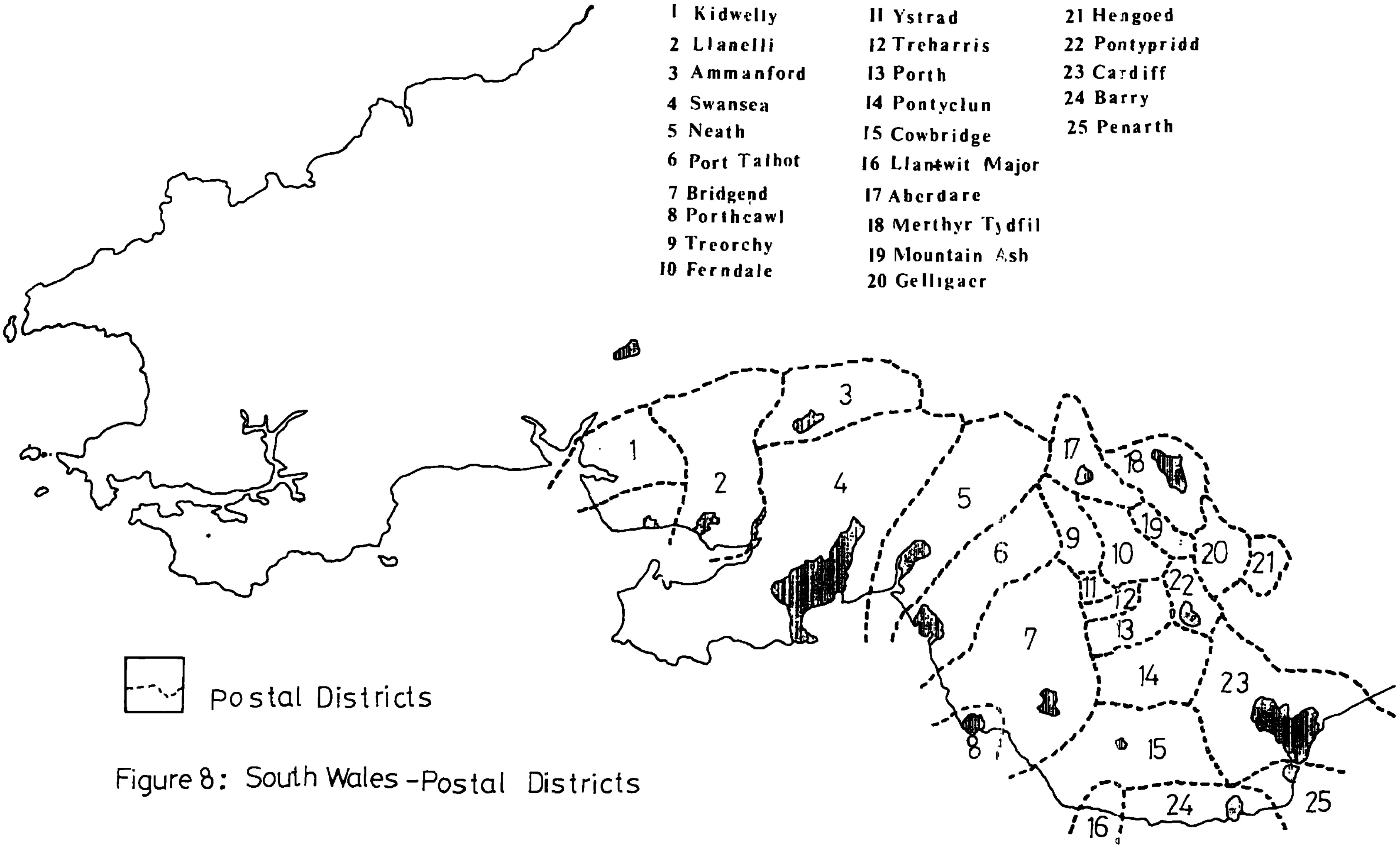


Figure 8: South Wales - Postal Districts

It was found that if the sample was divided on the basis of the place of birth of the individual's grandparents, much of the recent influx of genetic material could be discarded and a picture of actual Welsh variation approximated. However, the same end result could also be achieved by using surnames as the racial marker instead of place of birth. Welsh surnames are clearly defined and easily recognisable and have been used in racial comparisons by both Morgan Watkin (1956) and Ashley (1966). An individual can be reckoned as having two surnames, that of his father's family and that of his mother's family (i.e. his mother's maiden name). When both these surnames are classified as Welsh the individual can be regarded as Welsh, when only one surname is Welsh, as half-Welsh, and when no surname is of Welsh origin, as non-Welsh. Ashley's list of Welsh surnames (1966) was used in these divisions (see Appendix 1).

Therefore, it was decided to divide the sample into Welsh, half-Welsh and non-Welsh at the first stage of analysis in two ways using firstly the places of birth of grandparents and secondly the number of Welsh surnames. This was done in order to see if the criteria one uses for dividing samples materially affects the results on achieves, and also to ascertain if one method gave better discrimination between the three sets of data than the other.

At the second stage of analysis, place of birth of grandparents was used to divide the 'Welsh' population into localities (i.e. postal districts). In this case, surname analysis had to be discarded as it cannot be used to discriminate at local level. It also meant a reduction in the effective sample size since all half-Welsh and non-Welsh individuals, and those of Welsh origin who could not be assigned to any one postal district, had to be ignored. As at the first stage of analysis, three grandparents had to have been born in a given locality (i.e. postal district) before an individual was assigned to it.

At the third stage of analysis, individuals were assigned to localities based on their present place of residence. That is, they were assumed to be representative of the gene pool existing at the given moment in time in the area in which they lived and from which they had been randomly sampled. This meant that the whole sample could once more be utilised. This exercise was intended to investigate the present pattern of variation in the area and to compare it with the pattern extracted, arguably artificially, by removing recent immigrants. It was also thought that the genetic relationships uncovered in this way might shed light on changing patterns of association between different parts of the region studied, probably as a direct result of alterations in the pattern of economic and industrial exploitation of the area.

2. STATISTICAL ANALYSIS: THE CHOICE OF PROCEDURES

Before any form of statistical analysis was attempted, the data were transfered to computer files. A large part of the subsequent statistical interpretation of the data and the conclusions drawn from them was than made, utilising the Statistical Package for the Social Sciences (S.P.S.S.) (2nd edition, 1975, ed. Nie et al.).

Statistical packages, like S.P.S.S., can be important tools in the research process because they provide simple and rapid access to the researcher's data and make available a wide variety of statistical techniques. However, precisely because of their power, they may be easily abused; firstly, ease of access often means over-access; and secondly, through uninformed use of the available statistical procedures. Thus great care must be exercised in the choice and utilisation of procedures.

The first task of data analysis is to determine the basic distributional characteristics of each of the variables to be used in the subsequent statistical analysis. Information on the distribution, variability and central tendencies of the variables provides the researcher with necessary information required for the selection of subsequent statistical techniques.

After examining the distribution of each of the variables, the researcher begins to investigate sets of relationships among the variables. The type of analysis chosen will depend on the characteristics of the variables, whether they are discrete or continuous, as well as upon the general research design.

A measure of association indicates how strongly two variables are related to each other. However, it only tells us how strongly the two variables are related in the cases that have been studied. Researchers, naturally, usually only study a sample of the universe of all possible cases. The researcher is not interested in the sampled cases per se, but hopes to infer that a relationship found in the sample actually exists in the universe that the sample represents.

A test of statistical significance tells the researcher the probability that the observed relationship could have occurred by chance or that, in the universe of all possible cases, that the variables would exhibit a relationship as strong as the observed relationship. A test of statistical significance is thus itself based on the results of a hypothetical experiment. It is assumed that the two variables are totally unrelated to each other in the universe but are each distributed exactly as they are in the observed sample. It is then supposed that an infinite number of samples of the same size are drawn from the universe of cases. The probability of the observed relationship occurring by chance is equal to the proportion of samples in which the relationship between the two variables is as strong or stronger than in the observed sample. However, three points should here be borne in mind. Firstly statistical significance depends not only on the strength of the observed relationship but also on the size of the sample. Secondly, that tests of statistical significance only indicate the likelihood that an observed relationship actually exists in the universe, they do not indicate how strong the relationship is. Finally, that a relationship may be statistically significant without being substantively important.

Chi-square is such a test of statistical significance. It helps to determine whether a systematic relationship exists between two variables. This is done by computing the cell frequencies which would be expected if no relationship is present and comparing them with the actual values found in the table according to a formula. Thus, the greater the discrepancies between the expected and actual frequencies, the larger chi-square becomes. If no relationship exists between two variables in the sample under study, then any deviations from the expected values which occur in a table based on randomly selected sample data are due to chance. Thus, small values of chi-square are interpreted to indicate the absence of a relationship and a large chi-square implies that a systematic relationship of some sort exists between the variables.

In order to determine whether a systematic relationship does exist, it is necessary to ascertain the probability of obtaining a value of chi-square as large or larger than the one calculated from the sample, when in fact the variables are actually independent. This depends, in part, on the degrees of freedom. These vary with the number of rows and columns in the table, and they are important because the probability of obtaining a specific chi-square depends on the number of cells in the table.

By itself, chi-square only helps to decide whether the variables are independent or related. It does not indicate how strongly they are related. Part of the reason is that the sample size and table size have such an influence on chi-square. Several statistics which adjust for these factors are available (e.g. Lambda, Cramer's V). When chi-square is thus adjusted it becomes the basis for assessing strength of relationship.

When the object is to discover and evaluate differences between effects rather than the effects themselves, for example to compare two groups of subjects, another type of statistic, known as Student's 't' may be applied. Student's 't' is a statistic generally applicable to a normally distributed random variable where the mean is known and the population variance is estimated from a sample.

The basic problem with this statistic is determining whether or not a difference between two samples implies a true difference in the parent populations. Since it is highly probable that two samples from the same population would be different due to the natural variability in the population, it is clear that a difference in sample means does not necessarily imply that the populations from which they were drawn actually differ for the characteristic being studied. The aim of the statistical analysis is to establish whether or not a difference between two samples is significant i.e. that a true difference exists between the two populations.

Therefore, at the univariate level, the data collected in this study were divided into sub-populations using the various parameters outlined above and examined, variable by variable. Differences between sub-populations were examined using Student's 't' statistic when the data were parametric (i.e. at least approximated to a normal distribution) and by the chi-square test for significance when the data was non-parametric (i.e. discrete and usually qualitative in nature). Correlation and regression coefficients were not applied to the data because it was intended to extend the statistical analysis of the sub-populations further by use of discriminant analysis and distance statistics, and the former statistical procedures were felt in this situation to be superfluous. Also, the prime intention of the present study was not to elucidate the genetic relationships of the variables themselves, but rather the genetic relationships of the sub-populations existing in the sample area. The results of the univariate analysis appear in the next section.

Geneticists and physical anthropologists have been interested for some time in comparing the magnitude of 'difference' between two or more populations, as evaluated by one or more sets of biological characteristics. In accordance with the magnitude of their interest is the large amount of literature and variety of statistical techniques available for the measurement of 'distance' between populations. Many of these statistical procedures and the mathematical rationale behind them are admirably summarized by Constandse-Westermann (1972) and will not be examined in detail here. The choice of distance statistic is a difficult problem. Essentially, the choice depends on the type of variable or variables being used to differentiated between the chosen populations. If the variable is quantitative, having a normal, continuous variation, one set of distance statistic is appropriate. If, however, the variable is qualitative, having a polymodal, discrete distribution, another set of distance statistics is appropriate. Lastly, there are a small number of distance statistics, notably Hiernaux's Δg and Olivier's $\chi^2 g$, which attempt, albeit rather simplistically, to combine both quantitative and qualitative traits in the calculation of distance between populations.

Many different forms of distance statistic have been applied to various populations with varying amounts of success (see Crawford and Workman, 1973). Particularly relevant to this study, however, has been the analysis of the structure of the society of the Yanomama Indians of South America, carried out by a number of researchers over a period of years. In this study a wide range of phenotypic and genotypic traits was studied, and a number of different distance statistics used to differentiate between subdivisions of the Yanomama tribe. Spielman and Smouse (1976) found that anthropometric traits generally differentiated better between villages than did genetic traits, a finding borne out in Wales by Sunderland (personal communication). Rothhammer, Chakraborty and Llop (1976) used dermatoglyphic traits to describe inter-populational diversity at various levels of differentiation and compared the results with those obtained from similar analysis using gene frequency data. They used Nei's non-parametric distance matrices and dendrograms, partitioning total variability into its between and within population components. They found that the agreement between dermatoglyphic and gene marker measures of distance appears to vary with the level of population differentiation, and speculated that polygenic characters evolve at a slower rate than monogenic characters, thus lessening the effects of random genetic drift and maintaining population differences, or, of course, similarities, longer. Certainly, it does appear, from these two studies, that polygenic characters such as dermatoglyphics, if more difficult to employ in distance analysis because of their statistical nature, do give "better" distinctions between populations.

Neel, Rothhammer and Lingoes (1974) examined the agreement between representations of village distances among the Yanomama Indians based on different sets of characteristics. These characteristics were nine dermatoglyphic traits, twelve anthropometric measurements and gene frequencies at nine separate loci. Various dermatoglyphic traits are known to be positively correlated (Loesch, 1974; Holt, 1968). In order to take this into account, the authors advocate the use of Mahalanobis' D^2 statistic. They say, however, ". . we have applied this function to the dermatoglyphic data, recognising . . . that the dermatoglyphic characteristics in question are, for the most part, discontinuous and/or qualitative and, in some instances, not normally distributed. It is realised that . . . (this use) . . . of D^2 involves assumptions which may not be met by the data; the sensitivity of the statistic to these particular violations of the assumptions on which it is based is unknown." However, they proceed to demonstrate good correlations between distances arrived at by this unorthodox use of Mahalanobis' D^2 and other matrices arrived at more conventionally. Indeed, other authors, including Harpending (1974) and Jantz (1974) maintain that most distance statistics, especially that of Mahalanobis, are robust enough to be able to withstand at least some violation of their basic assumptions.

Thus, although a number of different types of distance statistic exist and have been successfully applied to inter- and intra-population differences (e.g. Murillo et al., 1976; Workman et al., 1975; Rudan, 1976; Nei, 1972, 1973; Marquer and Jakobi, 1976) the differences between the results obtained using these various statistics, when compared within one population (e.g. the Yanomama Indians), are not statistically significant. Thus, while it is not advocated that all basic assumptions should be violated, it is probably true that Mahalanobis' D^2 provides as accurate a measure of distance between populations as any other distance statistic and that it can be applied to dermatoglyphic data (as in the study of the Yanomama Indians) with confidence, in spite of the fact that some dermatoglyphic traits, being qualitative rather than quantitative in nature, do not fulfil its basic conditions.

The distance analysis involved in the present study was undertaken using the discriminant analysis programmes of S.P.S.S. The mathematical objective of discriminant analysis is to weight and linearly combine the discriminating variables (in this case dermatoglyphic traits) in such a fashion that the 'groups' or 'populations' are forced to be as statistically distinct as possible. The statistical theory of discriminant analysis assumes that the discriminating variables have a multivariate normal distribution and that they have equal variance-covariance matrices within each group. However, as mentioned above, and admitted by the authors of the S.P.S.S. package, the technique is, in practice, very robust and the basic assumptions need not be adhered to strongly.

The analysis attempts to discriminate by forming one or more linear combinations of the discriminating variables. The maximum number of functions which can be derived is either one less than the number of groups or equal to the number of discriminating variables, if there are more groups than variables. Ideally, the discriminant scores (D's) for the cases within a particular goup will be fairly similar. At any rate, the functions are formed in such a way as to maximise the separation of groups. In the package there are also statistical tests for measuring the success with which the discriminating variables actually discriminate when combined into the discriminant functions. It is also possible to identify the variables which contribute most to differentiation along the respective dimension.

More important to the present study is the fact that, once a set of variables is found which provides satisfactory discrimination for cases with known group membership, a set of classification functions can be derived which will permit the classification of new cases with unknown memberships. As a check on the adequacy of the discriminant functions, the original set of cases can be classified in this way to see how many are correctly classified by the variables being used. The procedure for classification involves the use of a separate linear combination of the discriminating variables for each group. They produce a probability of membership in the respective group, and the case is assigned to the group with the highest probability.

Rightmire (1976), Dennis (1977b) and Williams (1978) advocate that, after producing a matrix of distances between populations, the intergroup relationships need to be worked out. They point out that discriminant analysis plots the controids of each group in a reduced space for the first two discriminating functions only. This works perfectly adquately when these two functions are the only ones which contain significant amounts of information, but the procedure becomes increasingly less relaible when more than two functions are involved. In this case they propose the use of the technique of non-metric multidimensional scaling, which permits scaling in up to ten dimensions. The procedure is an iterative one, and within a space of specified dimensionality the groups are moved about to obtain a monotone relationship between the original proximity measures and the distances in the configuration. The extent of success in this endeavour is expressed as a measure of 'stress' (after Kruskal, 1964). Stress is thus high when the fit of the new distances to the original rank order is poor and becomes lower as this fit improves, until theoretically the value reaches zero, or a perfect fit. There is, however, limited evidence in the literature of the application of this technique to the results of discriminant analysis and some argument among statisticians relating to the sort of results it achieves. Thus, in the present study, no attempt was made to transform the representation of group distances achieved by the methods of discriminant analysis, though the author accepts that there is possibly a case for doing so.

3. RESULTS

(i) Univariate Procedures

The results of the univariate statistical analysis will be examined in terms of the various dividing parameters. For the basic information regarding the distributional characteristics of each of the variables, the reader is referred to Appendix 3. Discussion in this section will be limited to differences in the distribution of variables between sub-populations, however those sub-populations may be recruited.

(a) Sample divided by surname analysis

Surname analysis (see above and Appendix 2) was used as a dividing parameter to separate the total sample into three sub-populations i.e. Welsh (presence of two 'Welsh' surnames); half-Welsh (presence of one 'Welsh' surname); and non-Welsh (no 'Welsh' surname). The three sub-populations thus produced were then examined for differences in the frequency of dermatoglyphic traits, using Student's 't' test on quantitative data and chi-square and Cramer's V on qualitative data.

(1) Total Palmar Ridge Count

The total palmar ridge count was taken as the number of ridges crossing or touching a line drawn from the digital triradius 'a' to 'b' to 'c' to 'd'. Where digital triradius 'c' was absent, a line was drawn connecting triradii 'b' and 'd'. The 'abcd' count was summed for each hand, in the same way as total finger ridge count is summed, though there is evidence (see above) of a differing genetic component in each of the individual counts. The results of Student's 't' test for significance (see Table VII) do not show any consistent pattern. Neither the Welsh nor the non-Welsh populations show significant bilateral differences, but the half-Welsh do so at the 1% level.

TABLE VII

Sample Divided by Surname: Total Palmar Ridge Count: Student's 't' Test

		Non-Welsh		Half-Welsh		Welsh	
		L	R	L	R	L	R
Non-Welsh	L		-1.4719	1.5604	-0.3299	1.9761*	0.5243
	R			3.1778***	1.3104	3.3366***	1.8933*
Half-Welsh	L				-2.1132*	0.9593	-0.8395
	R					2.4775**	0.8766
Welsh	L						-1.3856
	R						

Level of significance: * 0.025
** 0.01
*** 0.005

Most significant differences do appear, however, to be related to the left hand, the left hands of the Welsh group being consistantly significantly different from the other groups, and being most different from the non-Welsh group.

(2) atd Angle

The atd angle was taken to be the maximal angle subtended by the most proximal axial triradius 't' and the digital triradii 'a' and 'd'. None of the results obtained from Student's 't' test (see Table VIII) showed any significance at any level. This differed quite dramatically from the findings of other investigators (Dennis, 1977b).

TABLE VIII

Sample Divided by Surname: Maximal atd Angle:

Student's 't' Test

		Non-Welsh		Half-Welsh		Welsh	
		L	R	L	R	L	R
Non-Welsh	L		1.1573	0.4208	0.2271	-0.3394	0.4733
	R			-0.8199	-1.0046	-1.3646	-0.4864
Half-Welsh	L				-0.2067	-0.7236	0.1581
	R					-0.5526	0.3126
Welsh	L						0.7082
	R						

All results are non-significant

(3) Finger Pattern Types

Differences between males and females for these variables were tested in the total sample using the chi-square test. The results obtained were rather inconclusive, in that chi-square values showed significant association at the 5% level on most of the digits (except digits 4 and 5 on the left hand), reaching its highest levels of significance on digits 1, 2 and 3 of the right hand. Cramer's V, however, a test of significance of association for attribute data, had uniformly very low results, only reaching 10% on digits 1, 2 and 3 of the right hand. These results obviously raised problems with regard to whether or not the sexes should be treated separately in all succeeding statistical analysis. However, it was finally decided that the levels of significance found in the chi-square statistic, not being mirrored in Cramer's V, must have a limited amount of credibility, and must probably be due, in fact, more to sampling errors and problems of classification and assignment to cells than to any proven underlying differences.

For the distribution and frequency of finger pattern types, the reader is referred to the relevant tables in Appendix 3. There were no significant differences in frequency or distribution of digital pattern types between the three sub-populations of Welsh, half-Welsh and non-Welsh created by surname analysis. For actual chi-square values, see Table IX below.

TABLE IX

Sample Divided by Surname: Finger Pattern Types:

Chi-Square Results

Digit	Left Hand	Right Hand	
1	7.8600	11.8830	
2	12.9503	12.9711	14 degrees of freedom
3	20.7138	15.3771	
4	14.5933	12.4412	
5	8.8249	16.4970	

(4) Palmar Pattern Areas

As for digital pattern types, the frequencies of various patterns in the five pattern areas were tested for significance using the chi-square statistic between males and females in the total sample. On the left hand, differences between males and females were significant at the 5% level in interdigital area III and in the hypothenar area; on the right hand areas II, III and IV were significant and areas I and V (hypothenar) were not. Only in the hypothenar area of the left hand did these differences reach a value of 10% on Cramer's V statistic. Thus, as for digital pattern types, the recorded sex differences had to be attributed to a shortcoming in the chi-square statistical procedure rather than indicating any real differences.

For a breakdown of distribution and frequency of the various possible pattern types in the five palmar pattern areas, the reader is referred to the relevant tables in Appendix 3. Chi-square, performed on the three sub-populations gave largely insignificant results. The exceptions were area V on the right hand where the differences were significant at the 7% level; area IV on the left hand, significant at the 8% level and lastly area III on the left hand which was significant at the 0.3% level - the only difference of any statistical note (see Table X). It seems likely that this difference is due to a decrease in frequency of loops in the third interdigital area and a corresponding increase in frequency of III^T patterns amongst the non-Welsh group as compared with the half-Welsh and Welsh groups. Cramer's V test, however, does not substantiate the claimed significant difference.

TABLE X

Sample Divided by Surname: Palmar Pattern Areas:

Chi-Square Results

Palmar Area	Left Hand	df	Right Hand	df
I	10.0620	8	4.7635	6
II	2.3642	2	3.5843	4
III	19.9577***	6	11.3220	8
IV	19.2830*	12	10.0295	8
V	15.1367	16	24.9300**	16

Level of significance: * 0.08
** 0.07
*** 0.003

(5) Palmar Triradii

Initially, the frequencies of the different forms of palmar triradii were tested for significant differences between males and females in the total sample. Using chi-square, differences significant at the 5% level were found on the left hand in axial triradii 't' and 't''; 't^{b}' and the number and type of 'missing' digital triradii. On the right hand, differences significant at the 5% level were found in triradius 't^{b}' and again in the number and type of 'missing' digital triradii. All other values were insignificant. However, once again no Cramer's V value reached 10%.

Chi-square tests for significance were then performed on the three sub-populations for each of the triradii (see Table XI). As can be seen from the table, statistically significant levels of difference were only reached in four variables, two of which, 't' and 't'' on the right being intimately related, as an imbalance in one is automatically

TABLE XI

Sample Divided by Surname: Palmar Triradii: Chi-Square Values

Triradius	Left Hand	Right Hand	df
e	7.2167	5.7406	6
f	3.9620	2.7443	2
t	2.6957	14.8846**	2
t'	3.4081	13.9215**	4
t''	4.3434	0.9024	2
t'''	2.5896	2.6181	2
t^b	1.2978	5.6745	2
z	3.6410	10.6080*	4
No. of digital triradii	21.6770*	14.7482	12

Levels of significance: * 0.05
** 0.01

reflected in the other. In this case the imbalance seems to have been created by an increased number of axial triradius 't' and a corresponding decrease in distal displacement of 't' to 't'' (i.e. a lower frequency of the latter) in the Welsh population. The other significant differences were due to an increased absence of digital triradius 'c' in the right hands of the Welsh group as compared with the other two; and on the left hand a tendency among both the Welsh and non-Welsh groups to have extra digital triradii as compared with the half-Welsh group. None of the significant chi-square values was accompanied by a significant Cramer's V value.

(b) Sample divided by place of birth

The second major dividing parameter used in this study was the place of birth of the grandparents of the subjects (see above). This was used initially to divide the sample into three groups i.e. Welsh (at least three grandparents born in the sample area); half-Welsh (two grandparents born in the area); and non-Welsh (at least three grandparents born outside the sample area). At a later stage, place of birth of grandparents was used to divide the 'Welsh" sample into localities within the sample area using postal districts as the boundaries of each local area. Here, three grandparents of a subject had to be born in a particular postal district before that individual was assigned to it. The sub-populations thus produced were then examined for differences in the frequency of dermatoglyphic traits using Student's 't' test for quantitative data and chi-square and Cramer's V for qualitative data.

(1) Total Palmar Ridge Count

Total palmar ridge count was first tested for significance between the three major divisions of the sample using the parameter of birthplace (see Table XII). Only two significant values of 't' were found: the hands of the Welsh group were found to exhibit highly significant bilateral asymmetry, and the left hands of the same Welsh group were found to differ significantly from the right hands of the half-Welsh group. This series of results can only be explained by postulating that the left hands of the Welsh group are markedly different from the other hands used in the sample, with the right hands of the Welsh group being the most different from them.

Differences in total palmar ridge count were then examined amongst the Welsh population divided into postal districts. The samples were first tested for bilateral differences, so that figures could be combined where possible. No postal district showed any significant

TABLE XII

Sample Divided by Birthplace: Total Palmar Ridge Count:

Student's 't' Test

		Non-Welsh	Half-Welsh		Welsh	
		R	L	R	L	R
Non-Welsh	L	-0.6853	-0.6249	-1.5566	0.2396	-1.1024
	R		0.0785	-0.8609	1.0799	-0.2197
Half-Welsh	L			-1.0108	1.1763	-0.3756
	R				2.4572*	0.9880
Welsh	L					-2.6546**

Levels of significance: * 0.05
** 0.01

bilateral differences and the left and right hands were correspondingly combined in the local analysis. The Student's 't' test values are given in Table XIII. Partly because of the number of samples involved, these differences are difficult to interpret. Certainly there seems to be a great deal of intra-population variability with regard to total palmar ridge count. The question remains as to how much the variability in this trait is reflected in the other dermatoglyphic traits studied; and also how much of it is an artefact of sampling error - both with regard to the randomness and size of the samples collected.

(2) atd Angle

As can be seen from Table XIV, the values for maximal atd angle did not differ significantly between any of the three major groups of the sample divided by birthplace. The values for the maximal atd angle were then examined amongst the Welsh population divided into postal districts. The samples were first tested for bilateral

TABLE XIII

Sample Divided by Birthplace (Postal Districts): Total Palmar Ridge Count: Student's 't' Test

Area	B	M	L	C	N	A	SU	R	SV	G	T	P	T	C
PortTalbot	-2.19*		-2.67**		-.92		-3.96**		-1.46		-0.30		-0.96	
		-4.51**		-3.43**		-3.31**		-0.32		-2.77**		-0.75		-1.60
Bridgend		-2.83**		-1.52		-1.89		1.94		-1.47		0.28		-0.90
			-0.70		0.97		-1.93		0.30		1.21		2.32*	
Merthyr Tydfil			1.97*		3.18**		1.18		2.44*		2.84**		3.48**	
				1.30		0.38		4.38**		0.51		1.49		0.20
Llanelli				-0.74		-1.25		2.48		-0.96		0.63		-0.62
					1.48		-1.02		0.87		1.64		2.76**	
Cardiff					2.16*		-0.27		1.44		2.06*		2.89**	
						-0.65		3.21**		-0.38		0.91		-0.29
Neath						-2.26*		0.67		-1.85		-0.21		-1.08
							-2.56*		-0.53		0.37		1.40	
Aberdare							0.49		1.82		2.20*		2.89**	
								3.25**		0.17		1.19		0.02
Swansea Urban								3.70**		-0.22		0.99		-0.20
									1.65		2.27*		3.02**	
Rhondda									-1.29		-0.09		1.24	
										-2.78**		-0.65		-1.61
Swansea Valley										-1.70		0.12		-1.04
											0.88		2.05*	

TABLE XIII (Cont.)

Area	B	M	L	C	N	A	SU	R	SV	G	T	P	T	C
Gower											2.06^{*}		2.99^{**}	
												1.37		-0.09
Treorchy												-0.48		-1.21
													0.98	
Porth													1.35	
														-0.87
Tonypandy														-1.72

Level of significance: * 0.05
** 0.01

TABLE XIV

Sample Divided by Birthplace: Maximal atd Angle:

Student's 't' Test

		Non-Welsh	Half-Welsh		Welsh	
		R	L	R	L	R
Non-Welsh	L	0.2253	-1.0359	-0.5546	-0.9303	-0.6403
	R		-1.2518	-0.7819	-1.2433	-0.9070
Half-Welsh	L			0.5355	0.2782	0.6756
	R				-0.4027	0.0000
Welsh	L					0.6697

None of these values is statistically significant.

TABLE XV

Sample Divided by Birthplace (Postal Districts): Maximal atd Angle:

Student's 't' Test: Selected Results

Area	Bridgend	Merthyr Tydfil
Llanelli	2.1447	2.0860
Aberdare	-2.2805	-2.2579
Swansea Valley	-2.0180	-1.9964

All results are significant at the 5% level.

differences, and none being found to be statistically significant, left and right hand values were combined in the intra-regional analysis. Very few statistically significant 't' values were discovered for this variable and to conserve space only those results which were significant will be given (see Table XV). Values for maximal atd angle are obviously relatively homogeneous in this sample.

(3) Finger Pattern Types

For the distribution and frequency of finger pattern types, the reader is referred to the relevant tables in Appendix 3. First, differences between the three major divisions of the sample were examined using chi-square (see Table XVI). No acceptable significant differences were discovered between the three sub-populations, though there was a value significant at the 10% level on digit 5 of the left hand. This is probably due to a decrease in the Half-Welsh group of digital arch patterns, with a corresponding increase in ulnar loop patterns.

TABLE XVI

Sample Divided by Birthplace: Digital Pattern Types:

Chi-square Results

Digit	Left Hand	Right Hand	
1	6.8422	14.4203	
2	10.4121	15.0652	
3	19.1709	12.8264	14 degrees of freedom
4	8.6316	10.1540	
5	21.9003*	8.7150	

Level of significance: * 0.10

Finger pattern types were then examined amongst the Welsh population divided into postal districts (see Table XVII). Only one significant result was found, on digit II of the left hand. Examination of the distribution of pattern types among the sub-populations showed no consistent pattern but a great deal of heterogeneity in relative proportions of the individual pattern types in each area.

TABLE XVII

Sample Divided by Birthplace (Postal Districts): Digital Pattern Types:

Chi-square Values

Digit	Left Hand	df	Right Hand	df
1	92.2310	98	79.5329	84
2	142.0710*	98	90.3943	98
3	97.6698	98	94.1398	98
4	107.0566	98	78.7916	84
5	67.2436	70	78.8843	84

Level of significance: * 0.002

(4) Palmar Pattern Areas

For a breakdown of distribution and frequency of the various possible pattern types in the five palmar pattern areas, the reader is referred to the relevant tables in Appendix 3. Differences between the three major sub-populations in the sample were examined first, using chi-square (see Table XVIII). Only one significant difference was found, a value of chi-square significant at the 5% level occurring in palmar area III of the left hand. Examination of the distribution of pattern types between the sub-populations in this area indicates that this value is probably due to an increase in the relative frequency of loops with a corresponding decrease in the frequency of III^T patterns among the Welsh sub-population.

Palmar pattern types were then examined in the Welsh population

TABLE XVIII

Sample Divided by Birthplace: Palmar Pattern Areas: Chi-square Values

Area	Left Hand	df	Right Hand	df
I	6.6717	8	4.5480	6
II	0.8816	2	1.6804	4
III	13.7420*	6	1.4308	8
IV	15.3441	12	4.2285	8
V	15.7250	16	20.4172	16

Level of significance: * 0.05

divided into postal districts (see Table XIX). Significant differences were discovered in three palmar pattern areas. Area I on the right hand of subjects gave a chi-square value significant at the 5% level, probably the result of variable presence of thenar patterns throughout

TABLE XIX

Sample Divided by Birthplace (Postal Districts): Palmar Pattern Areas Chi-square Values

Area	Left Hand	df	Right Hand	df
I	47.3821	42	62.5084*	42
II	13.5195	14	45.8622*	28
III	86.0577**	42	79.7194*	56
IV	73.9565	70	68.8280	56
V	87.4785	98	109.7014	98

Level of significance: * 0.05
** 0.01

the local areas. Area II, also on the right hand, produced a value significant at the 5% level, probably also due to variable expression of patterns, in this case the presence of loops in interdigital area II. Area III gave bilateral significant results, at the 5% level on the right hand and at the 1% level on the left hand. These values are more difficult to interpret but probably indicate large local heterogeneity in the expression of patterns in area III at all, and also in the type of pattern present i.e. whether it is a loop or a III^{T} pattern.

(5) Palmar Triradii

Chi-square tests for significance were first performed on the three major sub-divisions of the sample (see Table XX). Significant

TABLE XX

Sample Divided by Birthplace: Palmar Triradii:

Chi-square Values

Triradius	Left Hand	df	Right Hand	df
e	1.8441	6	4.2513	6
f	8.6206*	2	3.5640	2
t	2.0570	2	4.4760	2
t'	4.4243	4	4.2025	4
t''	1.7084	2	0.4581	2
t'''	0.3258	2	2.2070	2
t^{b}	3.1422	2	0.6414	2
Z	27.3685**	4	19.9421**	4
No. of digital triradii	12.6954	12	20.2843	14

Level of significance: * 0.05
** 0.01

differences between the three areas were only found in two of the variables: in triradius 'f' on the left hands of subjects, probably due to an increase in thenar patterning generally amongst the Welsh sub-population; and in the frequency of zygodactylous digital triradii. In the latter case there appeared to be a bilateral tendency amongst the Welsh population to have an increased frequency of absence of digital triradius 'b' as opposed to absence of digital triradius 'c' - more common in the other two groups. It should be noted that zygodactylous triradii are notoriously difficult to diagnose accurately and that the possibility should not be discounted that these differences are in fact due to observor error in classification. However, if the chi-square results do indicate a real difference in frequency of occurrence of these two conditions, it is a finding of great interest.

TABLE XXI

Sample Divided by Birthplace (Postal Districts): Palmar Triradii: Chi-square Values

Triradius	Left Hand	df	Right Hand	df
e	46.6980	42	26.5828	28
f	18.2522	14	11.1436	14
t	28.2327*	14	39.6473**	14
t'	25.5994*	14	45.2962	14
t''	20.1189	14	14.3416	14
t'''	9.1299	14	11.0350	14
t^b	15.6880	14	12.2059	14
z	12.6245	28	17.3311	28
No. of digital triradii	73.2415	70	71.4914	70

Level of significance: * 0.05
** 0.01

The Welsh sub-population was then divided into postal districts and the frequencies of the various triradii examined for local differences using the chi-square test (see Table XXI). Once again only two variables, themselves inter-related, showed any statistically significant differences. These were the axial triradii 't' and't'', which showed bilateral differences, reaching the 1% level of significance on the right hand of subjects. These results showed little consistent pattern among the local areas, once again indicating quite considerable local heterogeneity of this variable.

(c) General Conclusions of Univariate Analysis

Preliminary remarks only will be made at this point, as the analysis of intra-population variation as indicated by dermatoglyphic variables will be mainly undertaken using multivariate statistical procedures. What is interesting to note here, however, is the effect the dividing parameters have exercised on the results obtained. An alteration of the dividing parameter used created, in fact, quite substantial reallocation of subjects (for actual numbers involved see Appendix 3). It would be expected that this alteration in relative sample size would produce differences in the statistical results obtained. However, this was generally not found to be so and the exercise in fact probably emphasised those variables which distinguish best between the three major sub-populations.

Both dividing parameters, surnames and birthplace of grandparents, agree that the maximal atd angle and digital pattern types give poor discrimination between sub-groups. They also both agree that, with regard to palmar pattern areas, there appears to be a relative increase in the frequency of loops in the third interdigital area and a corresponding decrease in III^T patterns in a continuum through the three sub-populations, from the Welsh at one extreme to the non-Welsh showing opposite tendencies. Birthplace analysis also indicates quite considerable heterogeneity in the local areas on palmar patterning in areas I, II and III of the right hand, a finding not echoed in the major groupings.

Palmar triradii frequencies are more difficult to compare and interpret, though once again trends seem to be held in common. These trends appear to be concerned with the relative frequencies of the axial triradii 't' and 't'' and also to zygodactylous tendencies exhibited by the digital triradii. The Welsh population generally appears to have less distal displacement of the axial triradii (i.e. a relatively lower frequency of 't'' than the other two groups), however the group is defined. However, the digital triradii present a more difficult problem of interpretation. In the sample divided by surnames, the Welsh group shows an increase over the half-Welsh and Non-Welsh groups in the relative absence of digital triradius 'c'. In the sample divided by birthplace, the reverse trend is indicated, the Welsh group showing a relative increase in frequency of absent 'b' and decrease in frequency of absent 'c'. As previously mentioned, the results obtained for this variable are open to doubt in any case because of the real difficulties involved in correct and consistent classification.

However, for both sets of dividing parameters, the best discriminating variable appears to be that of total palmar ridge count. Of course, there are considerable fluctuations in actual ridge count between individuals in a population and thus correspondingly often large standard deviations associated with the mean values obtained and used for inter-population comparisons. It is thus a possibility which cannot be ignored that the results obtained here, especially those between the postal districts, are as much an artefact of sample size as indicating any real underlying differences. Thus, the possible use of total palmar ridge count as an important discriminating variable on its own is treated with some scepticism.

(ii) Multivariate Analysis

Once again, the results of the multivariate statistical analysis will be examined in terms of the various dividing parameters. The analysis of intra-population differences will take place on two levels. At the first level, the sample will be divided into three sub-populations: Welsh, Half-Welsh and non-Welsh; according to the two different dividing parameters, surnames and birthplace of grand-parents. The results using these two methods of dividing the sample will then be compared.

At the second level of analysis, local variation will be investigated. This will also be done in two ways: firstly by allocating subjects to postal districts using grandparents' birthplace; and secondly by allocating the subjects to the areas (postal districts) in which they were sampled and are presently resident. These two pictures, one of indigenous Welsh variation and one of present population variation will then be compared and an attempt made to account for any differences which might occur.

(a) Differences between the major divisions of the sample

(1) Sample Divided by Surname

Discriminant analysis (subprogram MAHAL) was performed on the sample using the S.P.S.S. package. The analysis was performed twice, the first time employing the option 'PRIORS FOR SIZE' to correct for differences in sub-population size; and the second time without it.

Having obtained a group centroid for each sub-population, the programme then plots these centroids in two-dimensional space, utilising the first two discriminant scores as its axes. There was no appreciable difference in the positioning of the group centroids of the sub-populations when using the option 'PRIORS FOR SIZE' or not, thus only one representation of the plot is given here (see Figure 9). It is interesting to note that the half-Welsh group lies approximately half-way and equidistant from the Welsh and non-Welsh groups - an ideal result!

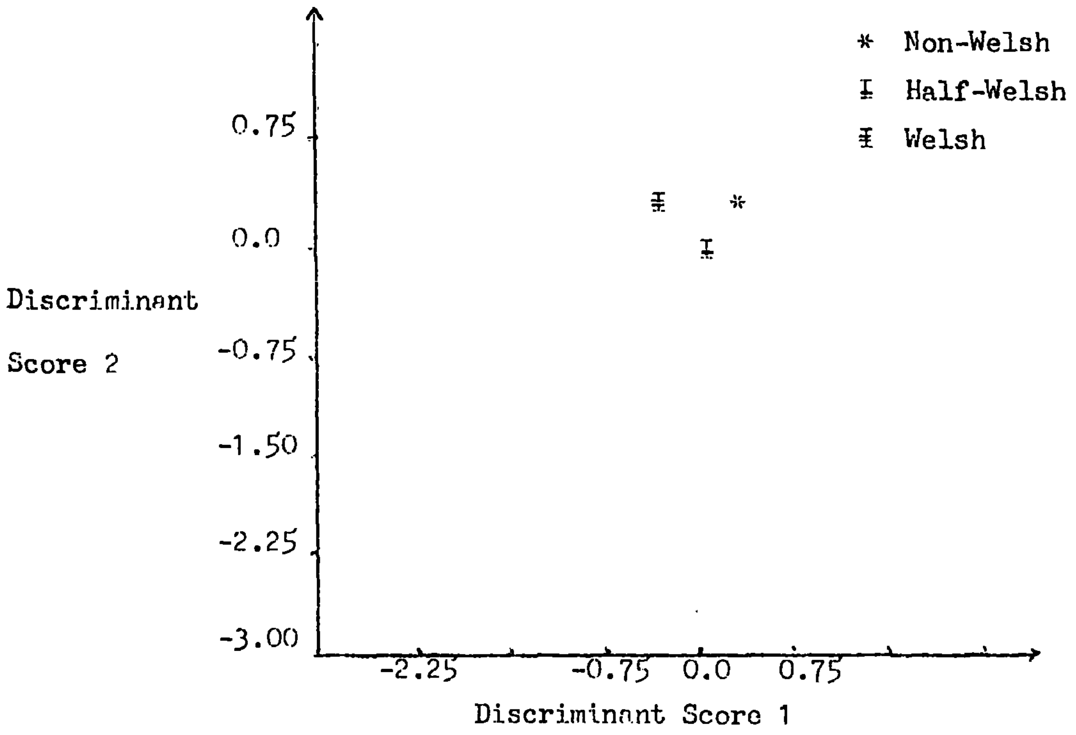


Figure 9: Sample divided by surname: group centroids.

The option 'PRIORS FOR SIZE' does, however, create some differences relating to the number of cases correctly classified, and to the distribution of correctly predicted classifications (see Table XXII). Here it can be seen that when the option is used, a higher number (46.7%)

of cases is correctly classified as compared with when it is not (40.7%). However, there appears to be a better distribution of cases correctly classified when it is not used.

TABLE XXII

Sample divided by surname: number of cases correctly classified

	PRIORS FOR SIZE			PRIORS EQUAL			
Group	Pred. 1	Pred. 2	Pred. 3	Pred. 1	Pred. 2	Pred. 3	N.
1. Non-Welsh	21.4	76.4	2.2	40.0	26.1	33.9	846
2. Half-Welsh	12.2	86.3	1.5	29.5	34.9	35.7	1113
3. Welsh	13.5	80.9	5.6	22.2	24.2	53.6	846

No. of cases correctly classified: 46.7% 40.7%

(2) Sample Divided by Birthplace

As was the case when the other dividing parameter, surnames, was used, the discriminant analysis was performed twice, the first time employing the option 'PRIORS FOR SIZE' to correct for differences in sub-population size, and the second time without it. As previously, there was no appreciable difference in the positioning of the goup centroids of the sub-populations when using the option 'PRIORS FOR SIZE' or not, thus only one representation of the plot is given here (see Figure 10).

In this case the option 'PRIORS FOR SIZE' creates substantial differences relating to the number of cases correctly classified and to the distribution of correctly predicted classifications (see Table XXIII). Here, when the option is used, a much larger proportion of cases is correctly classified (72.6% compared with 36.7%) than

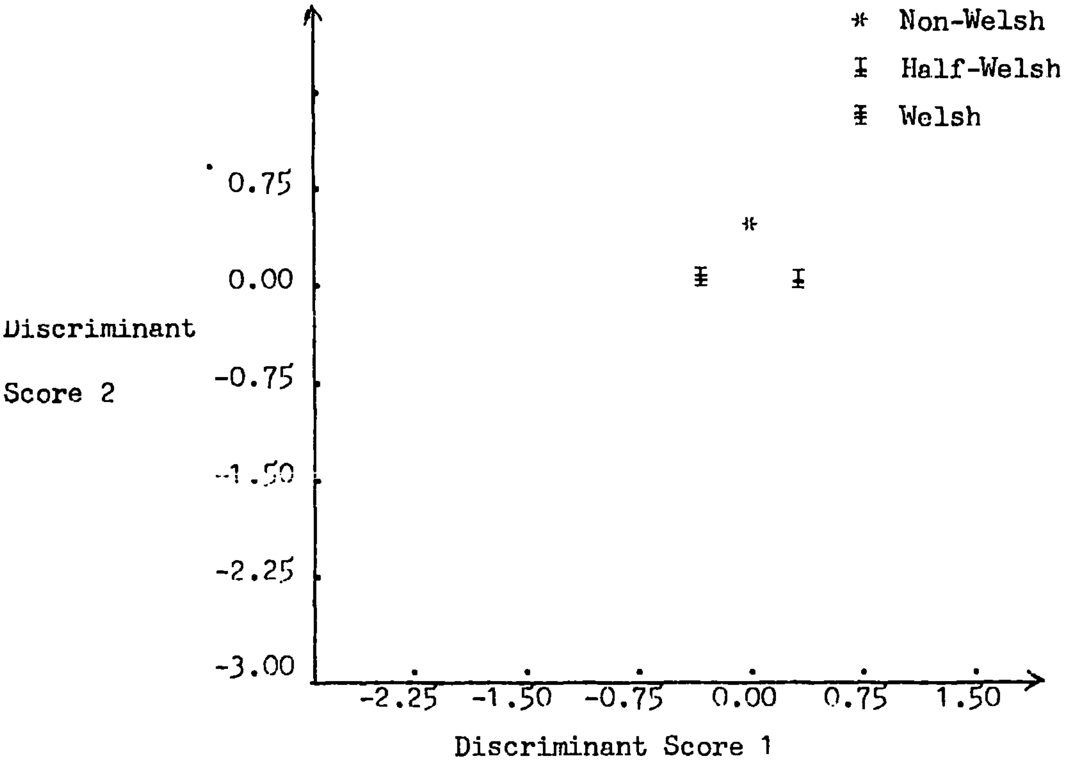


Figure 10: Sample divided by birthplace: group centroids.

TABLE XXIII

Sample divided by birthplace: number of cases correctly classified

	PRIORS FOR SIZE			PRIORS EQUAL			
Group	Pred. 1	Pred. 2	Pred. 3	Pred. 1	Pred. 2	Pred. 3	N.
1. Non-Welsh	$\boxed{0.8}$	0.4	98.9	$\boxed{46.6}$	27.8	25.6	266
2. Half-Welsh	0.5	$\boxed{1.0}$	98.6	31.1	$\boxed{44.0}$	24.9	418
3. Welsh	0.1	0.4	$\boxed{99.5}$	34.0	32.5	$\boxed{33.5}$	1825
No. of cases correctly classified: 72.6%						36.7%	2509

when it is not, but also that, as in the previous analysis, there is a better distribution of cases correctly classified when it is not used. Obviously, the uneven sample size places a large strain on the robustness of the statistic, and it is reassuring that, at least, the group centroid plots and thus, hopefully, the population discrimination, does not appear to be affected.

(3) Differences Created by Choice of Dividing Parameter

The use of multivariate discriminant analysis has brought to light differences in results obtained from the same sample using different dividing parameters which were not apparent in the univariate statistical analysis. When the sample was divided by surname, the half-Welsh group was found to lie halfway and equidistant between the Welsh and the non-Welsh groups. However, this picture was not echoed in the centroid plot obtained when the sample was divided by birthplace. In this case the plot resembled much more an equidistant triangle, with the Welsh group being fractionally nearer the non-Welsh group than the half-Welsh group. However, this last analysis did appear (using PRIORS FOR SIZE) to give a more correct classification of cases i.e. to provide better discrimination between the sub-populations. This latter point could perhaps influence us towards suggesting that the results obtained from the birthplace analysis are more 'correct' than those obtained using surnames. However, the fact remains that, using discriminant analysis on the same data but dividing the sample into sub-populations using different, though equally scientifically approved, parameter, produces different results. This finding is clearly one which requires further investigation as it would appear to have important implications for future research into the genetics of populations.

(b) Local Variation in South Wales

(1) Sample Divided by Birthplace

In order to investigate local differences in the sample area, the total number of subjects was reduced by excluding all the non-Welsh and half-Welsh and also those individuals who did not have at least three grandparents born within the same postal district. This left a sample of 993 individuals, assigned to eleven different postal districts within the sample area. No area sample had a total of less than thirty individuals, and the area totals varied from 224 representing Swansea Urban postal district to 33 representing Gower. It is recognised that the small size of some of the samples would possibly impair the functioning of the discriminant analysis, but it was decided to include as many sub-populations as possible. Those original postal districts with totals of under thirty (Treorchy, Porth, Tonypandy and Carmarthen) were assigned to adjoining postal districts i.e. Treorchy, Porth and Tonypandy were combined with the Rhondda postal district, and Carmarthen was added to Llanelli. One unfortunate aspect of the multivariate analysis is that not all the postal districts (i.e. local populations) in the sample area were represented, or that what representation there was, was not proportional to the size of the population involved. It should be noted, though, that some areas, in particular Cowbridge and Porthcawl, were sampled, but produced no individual with three grandparents born within the postal district. The only other excuse which can be offered for gaps in the sample is one of time.

Having produced the sample and created the eleven sub-populations, the data were analysed on the S.P.S.S. package, subprogram MAHAL, first using the option 'PRIORS FOR SIZE' and then without it. As with the previous analyses, the use of this option made no difference to the plot of the group centroids, but did produce a difference in the percentages of cases correctly classified and also in the distribution of correctly classified cases (see Tables XXIV and XXV). Using 'PRIORS FOR SIZE', 28.1% of cases were correctly classified, whereas

TABLE XXIV

Local Populations (Postal Districts): Number of Cases Correctly Classified (PRIORS FOR SIZE)

	Group	1	2	3	4	5	6	7	8	9	10	11	N
1.	Port Talbot	16.4	9.8	6.6	3.3	6.6	8.2	0.0	37.7	9.8	0.0	1.6	61
2.	Bridgend	2.8	18.7	8.4	2.8	9.3	0.0	0.0	52.3	1.9	2.8	0.9	107
3.	Merthyr Tydfil	4.1	2.5	30.3	6.6	7.4	0.8	0.8	43.4	1.6	0.8	1.6	122
4.	Llanelli	2.2	10.0	13.3	14.4	5.6	3.3	0.0	50.0	0.0	0.0	1.1	90
5.	Cardiff	3.3	7.3	6.5	3.3	22.0	2.4	3.3	48.0	2.4	1.6	0.0	123
6.	Neath	4.8	8.1	4.8	9.7	9.7	12.9	0.0	43.5	4.8	0.0	1.6	62
7.	Aberdare	3.3	3.3	6.7	10.0	18.3	1.7	6.7	45.0	5.0	0.0	0.0	60
8.	Swansea Urban	3.6	5.8	10.7	4.0	7.6	1.8	0.9	62.5	1.3	0.0	1.8	224
9.	Rhondda	5.8	11.6	2.9	8.7	7.2	2.9	0.0	40.6	20.3	0.0	0.0	69
10.	Swansea Valley	4.8	9.5	11.9	7.1	9.5	2.4	0.0	42.9	7.1	4.8	0.0	42
11.	Gower	0.0	3.0	15.2	3.0	6.1	0.0	0.0	57.6	3.0	0.0	12.1	33

28.1% of known cases correctly classified

TABLE XXV

Local Populations (Postal Districts): Number of Cases Correctly Classified (PRIORS EQUAL)

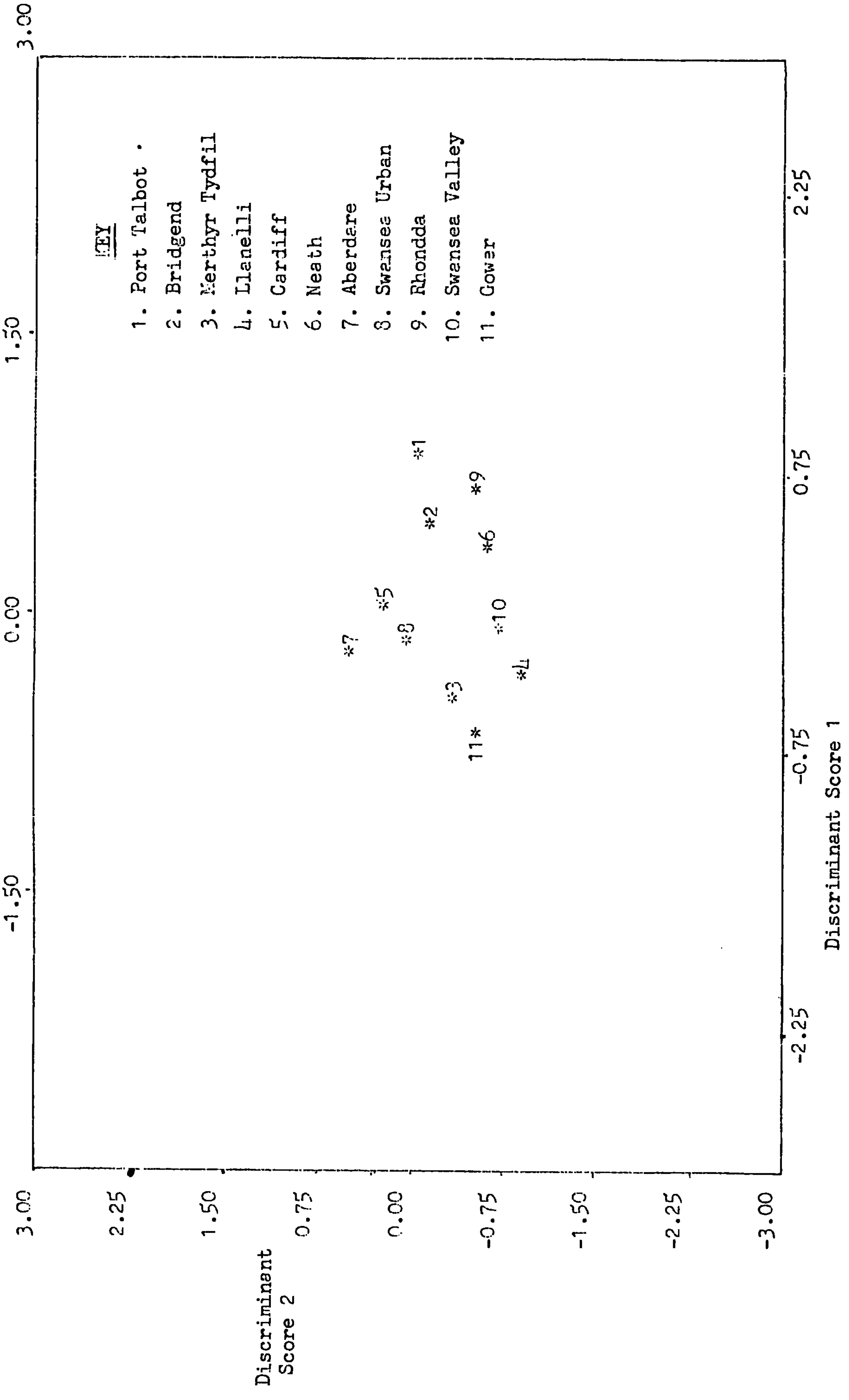
	Group	1	2	3	4	5	6	7	8	9	10	11	N
1.	PortTalbot	41.0	8.2	8.2	0.0	4.9	3.2	4.9	6.6	14.8	0.0	3.3	61
2.	Bridgend	14.0	18.7	6.5	9.3	2.8	0.9	5.6	7.5	11.2	16.8	6.5	107
3.	Merthyr Tydfil	5.7	5.7	27.9	8.2	8.2	3.3	7.4	4.9	5.7	11.5	11.5	122
4.	Llanelli	5.6	7.8	12.2	30.0	5.6	4.4	4.4	6.7	7.8	8.9	6.7	90
5.	Cardiff	7.3	6.5	6.5	4.1	21.1	4.9	14.6	7.3	8.9	11.4	7.3	123
6.	Neath	9.7	12.9	4.8	8.1	1.6	21.0	3.2	6.5	12.9	12.9	6.5	62
7.	Aberdare	6.7	5.0	5.0	6.7	18.3	3.3	26.7	5.0	8.3	8.3	6.7	60
8.	Swansea Urban	8.5	7.1	8.5	12.5	5.8	4.5	9.4	16.5	8.5	8.0	10.7	224
9.	Rhondda	10.1	11.6	1.4	7.2	7.2	5.8	2.9	5.8	27.5	11.6	8.7	69
10.	Swansea Valley	7.1	2.4	14.3	7.1	0.0	7.1	4.8	4.8	9.5	33.3	9.5	42
11.	Gower	3.0	0.0	15.2	6.1	9.1	6.1	3.0	9.1	6.1	6.1	36.4	33

24.5% of known cases correctly classified without the option, 24.5% of cases were correctly classified, though for each group the largest percentage of cases allocated were correctly classified. The distribution of group centroids is shown in Figure 11.

The comparison of Tables XXIV and XXV indicates how strong an influence adjusting for population size has on the distribution of known cases correctly classified. In Table XXIV the larger percentage of known cases correctly classified is largely an artefact of the high number (62.5%) correctly allocated to the most numerous sub-population, Swansea Urban. This high percentage is not echoed when the option is not used. In fact when PRIORS = EQUAL, Swansea Urban has the smallest percentage (16.5%) of correctly classified cases. It would be expected that this sort of discrepancy would affect the plotting of the group centroids, but it actually does not produce any discernible differences.

Examination of the plot of group centroids shows a scatter of sub-populations but no one population which is markedly different from any other. The eye of faith can discern four groupings within the scatter. Merthyr Tydfil and Gower seem to be closely related - which, owing to their respective geographical locations (see Figure 8), is a result which has to be attributed to chance. Similarly, there appears to be a close relationship between Llanelli and Swansea Valley, an association much more credible since they are adjoining areas and there is supportive historical evidence for the link. The third possible group comprises Cardiff, Aberdare and Swansea Urban, again a surprising relationship in view of their respective geographical locations and volume of intervening populations. The last group consists of Port Talbot, Neath, Rhondda and Bridgend. This possible relationship has much more feasibility than the last one, these areas all being adjoining and comprising much of the populations of the centre of the sample area.

Figure 11: Local populations (postal districts): group centroids



Apart from two of the four groupings, then, the distribution and location of the centroid plots bears little relationship to the actual geographical locations. However, it can be argued that if two of the groupings have to be dismissed on practical grounds, how much weight can be placed on the other two groupings? One is in danger of selecting those results which fit into preconceived ideas of the situation and rejecting those which do not, for no better reason than prejudice.

(2) Sample Divided by Place of Residence

Since most similar studies of intra-population variation are conducted using subject's place of residence or even place of collection of data as a means of allocating them to a sub-population, it was decided to investigate the pattern of actual variation within the whole sample collected instead of attempting to describe variation within the indigenous 'Welsh' population. To this end, the subjects were allocated to subpopulations depending on where they were resident (and attending school) at the time of the collection of the data. This created fifteen sub-populations which were only approximately equivalent to the eleven postal districts. This approximation was the result of two main factors. Firstly, two populations, Porthcawl and Cowbridge, were created which had not been present in the first analysis. This was due to the fact that, although quite large samples (74 and 58 individuals respectively) were taken from these two areas, no one individual was found to have three grandparents born in either postal district. They are both towns of very recent growth and influx of population. Secondly, some separate sub-populations were included when previously they would have been combined into the same postal district. These were Penclawdd and Gowerton, which were previously both classified under Gower; and Cymmer Afan and Port Talbot which both belonged to the Port Talbot postal district. These populations were included separately because historically and geographically they form separate units, even though postal district divisions combine them, and there were large enough samples from each (i.e. at least 35 individuals) to merit separate categories.

However, in spite of an overall increase in sample size (2507 individuals), there still remained vast discrepancies in relative sample size, ranging from the largest sample, 366 individuals from Bridgend, to the smallest, 36 individuals from Penclawdd. Relative sample size, as mentioned before, is an important problem in any form of statistical analysis, let alone a multivariate technique. However, it should be remembered that real populations are not themselves equivalent in sample size, and generally, the relative size of the samples involved goes at least part of the way towards reflecting relative size in the real situation. Bearing in mind the greater success of the options 'PRIORS FOR SIZE' in correctly classifying known cases in all previous analyses, this option only was employed for this analysis.

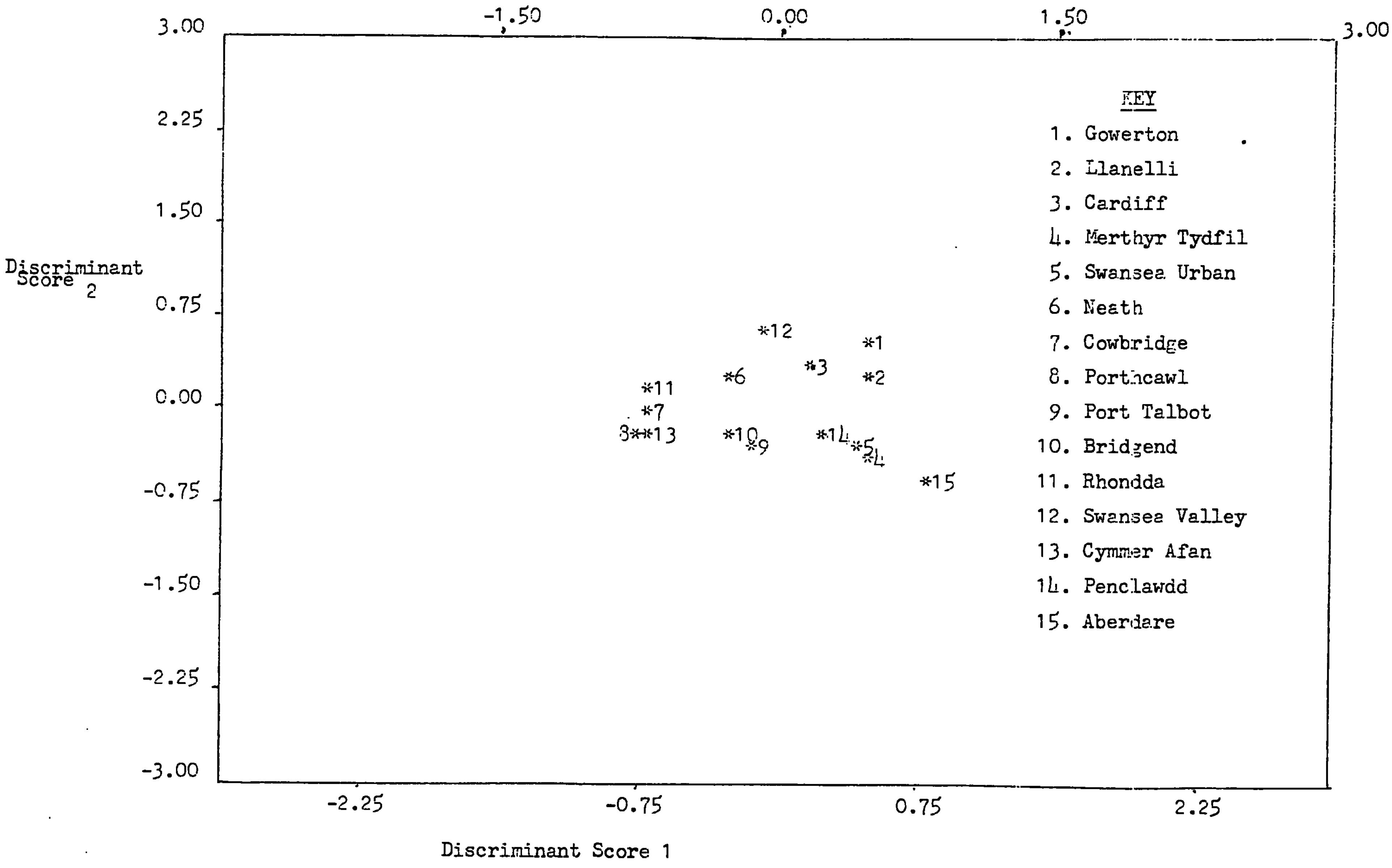
The results show that 22.4% of known cases were correctly classified, the highest numbers for each sub-population being closely related to the size of that sub-population (see Table XXVI). The plot of the group centroids (see Figure 12) showed some interesting features. Firstly was the relative positioning of those populations here examined separately, but previously included in the same postal district i.e. Penclawdd and Gowerton and Cymmer Afan and Port Talbot. Both pairings showed some genetic distance from each other, both with intervening locations of centroid plots from other populations. The 'pairs' also appeared to belong to different groupings of the centroid plots.

TABLE XXVI

Local Populations (Place of Residence): Number of Cases Correctly Classified (PRIORS FOR SIZE)

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	N
1. Gowerton	11.9	14.9	14.2	6.7	20.9	2.2	0.7	0.0	1.5	21.6	1.5	0.7	2.2	0.7	0.0	134
2. Llanelli	3.4	15.0	14.5	8.5	18.4	4.3	0.9	0.0	2.1	28.2	3.8	0.0	0.9	0.0	0.0	234
3. Cardiff	3.4	8.1	22.9	10.2	22.5	1.7	0.0	0.4	0.8	24.2	2.1	0.0	2.1	0.0	1.7	236
4. Merthyr Tydfil	1.4	5.8	9.1	22.8	22.8	1.4	0.4	1.1	3.3	27.9	2.2	0.0	1.1	0.0	0.7	276
5. Swansea Urban	2.8	6.8	9.9	10.8	38.4	2.3	0.3	0.3	1.7	22.2	2.0	0.6	0.6	0.6	0.9	352
6. Neath	1.2	8.1	6.9	6.4	11.0	13.9	1.7	1.2	2.9	37.0	6.9	0.0	1.7	0.0	1.2	173
7. Cowbridge	0.0	3.4	8.6	3.4	12.1	5.2	1.7	1.7	0.0	55.2	3.4	0.0	5.2	0.0	0.0	58
8. Porthcawl	1.4	6.8	5.4	2.7	18.9	2.7	1.4	4.1	4.1	43.2	6.8	0.0	2.7	0.0	0.0	74
9. Port Talbot	1.0	4.4	7.8	6.9	22.5	4.4	0.5	1.5	7.8	35.3	5.4	1.5	1.0	0.0	0.0	204
10. Bridgend	1.4	6.6	5.2	7.4	16.4	3.0	0.5	0.8	3.3	46.4	5.5	0.3	1.9	0.5	0.8	366
11. Rhondda	0.6	6.9	6.9	3.8	8.1	3.1	0.6	1.9	4.4	43.1	17.5	0.0	2.5	0.0	0.6	160
12. Swansea Valley	0.0	12.7	11.1	7.9	6.3	1.6	1.6	1.6	0.0	44.4	7.9	3.2	1.6	0.0	0.0	63
13. Cymmer Afan	1.3	3.9	6.5	5.2	6.5	2.6	0.0	1.3	5.2	44.2	11.7	1.3	10.4	0.0	0.0	77
14. Penclawdd	2.8	11.1	5.6	11.1	30.6	5.6	0.0	0.0	2.8	25.0	2.8	0.0	0.0	2.8	0.0	36
15. Aberdare	3.1	10.9	7.8	23.4	20.3	0.0	0.0	0.0	1.6	18.8	3.1	0.0	3.1	0.0	7.8	64

Figure 12: Local populations (place of residence): group centroids



As with the previous analysis, there appear to be a series of rather spurious relationships. These include the apparent close relationship of Rhondda, Cymmer Afan, Cowbridge and Porthcawl. The association of Rhondda and Cymmer Afan seems geographically likely, but both Cowbridge and Porthcawl have intervening population areas and seem extremely unlikely to be related to each other, let alone to Rhondda and Cymmer Afan. Most of the other relationships are reasonable in geographic terms. Bridgend and Port Talbot are close together; as are Penclawdd, Swansea Urban, Merthyr Tydfil and Aberdare - the latter relationship following the rim of the coalfield. However, one would have expected Swansea Valley to figure in this relationship; instead it is positioned on the opposite side of the cluster of plots. Also closely related are Gowerton and Llanelli, though the position of Cardiff half-way between them and Neath is rather puzzling. Indeed, the general postion of Cardiff in the plot is difficult to explain, its nearest neighbours being Neath, Swansea Valley, Llanelli and Penclawdd, none of which have any real geographical relationship with Cardiff.

(3) Differences Created by Choice of Dividing Parameter

It is evident that the means creating local populations can dramatically affect the kind of results one obtains. The plot of group centroids obtained, using birthplace of grandparents as the recruiting parameter for the local populations, showed a much more evenly spaced dispersal of points than did the plot of sub-populations recruited by place of residence. In the latter situation, groupings of sub-populations were much more obvious. There were also differences in the relative positions of several of the sub-populations. For example, in the birthplace analysis plot, Aberdare and Port Talbot appeared to be relatively extreme sub-populations; in the place of residence analysis plot, however, though Aberdare remained on the edge of plots, Port Talbot assumed a more central position, moving much closer to its geographic neighbour, Bridgend. Further discussion and analysis of the relative location of the sub-populations will be confined to Chapter V.

(c) General Conclusions of Multivariate Analysis

As was observed with univariate analysis, the choice of dividing or recruiting parameter exercises often quite considerable influence on the type of results obtained. At the major divisions of the sample level, alteration in the definition of what constituted a 'Welsh' (and therefore 'half-Welsh' and 'non-Welsh') individual gave a different picture in the plotting of group centroids. When 'Welsh' was taken to mean an individual having two Welsh surnames, the half-Welsh population was seen, very conveniently, to fall half-way between the Welsh and non-Welsh populations. However, when 'Welsh' was decided by the place of birth of grandparents, this picture was not maintained, the half-Welsh population becoming more distinct from the other two populations, and the Welsh group moving correspondingly closer to the non-Welsh group. As discussed earlier, the influence of uneven population size on these results cannot be ruled out.

When local variation was investigated, the same trends were also apparent: alteration in the recruitment of the local populations resulted in changes in the distribution and location of the group centroids. Relationships which were not apparent in one analysis became strong in the other - for example, Merthyr Tydfil and Gower appear closely related in the birthplace analysis, but are unrelated when the local groups are based on residence.

In the light of these findings, therefore, it is important to emphasize that great care must be exercised when choosing samples to illustrate or investigate intra- or inter- population variation. If such different pictures of variation can be obtained on the same sample using different parameters, then exact comparability must be reached before one can compare the results of one population with another.

CHAPTER V

DISCUSSION

CHAPTER V DISCUSSION

1. OTHER INVESTIGATIONS OF DERMATOGLYPHIC VARIATION

Various authors have attempted to use dermatoglyphic variables to differentiate between racial groups in much the same way as single gene traits (e.g. blood groups) have been used. Since Wilder's early work in 1904 there have been a number of descriptive studies (see Table XXVII for a summary of pattern frequencies and Table XXVIII for some quantitative data) but little attempt to collect random samples or, even in some cases, normal individuals. Because of the uncertainty surrounding the nature of the samples collected and the fact that the sizes of the samples are often ridiculously small, some of the findings are merely reported here and no attempt is made to compare the findings with those of the present study.

Apart from the studies mentioned above, there have also been a number of studies of intra-populational dermatoglyphic variation. Probably the earliest of this type of study was that performed by Newman on the Highland and Lowland Maya Indians (1960). His statistical analysis was rather simplistic, but his findings and conclusions paved the way for further research and stimulated interest in the concept of using dermatoglyphics as an indicator of population differences.

"The clarity of pattern of biological distances between the community and regional samples amply demonstrates the relevance of established dermatoglyphic methods to the study of actual populational units . . . . . Since dermatoglyphic traits are polygenically controlled, putatively non-adaptive, and undergo no post-natal modifications, they have distinct methodological advantages over either anthropometry or serology in clarifying the older and more basic relationships between human populations." Newman (1960).

TABLE XXVII

Racial Variation in the Frequency of Dermatoglyphic Patterns

(after Plato et al. 1975)

		Australasians		Orientals		Amerindians	
		Range	Mean	Range	Mean	Range	Mean
Finger Prints	W	33-78	52.7%	36-56	46.7%	32-58	42.6%
	L	22-66	46.0%	42-61	51.2%	39-63	52.4%
	L^u	22-64	44.9%	39-57	48.1%	37-58	49.4%
	L^r	0-3	1.1%	0.5-4.3	3.0%	1.2-4.7	3.1%
	A	0-3.7	1.4%	0.6-4.8	1.8%	1.0-9.0	5.0%
N (populations)		= 60		N = 55		N = 76	
Palmar Patterns	H	10-47	23.4%	9-30	20.1%	5-28	13.8%
	I	10-48	22.6%	5-12	9.9%	11-55	33.2%
	II	0-15	5.3%	1-5	2.5%	0-5	1.4%
	III	8-45	25.8%	7-24	16.3%	8-56	25.2%
	IV	55-89	71.2%	55-84	69.5%	43-80	66.8%
N (populations)		= 44		N = 17		N = 46	

		Caucasians		Negroes		Asian Indians	
		Range	Mean	Range	Mean	Range	Mean
Finger Prints	W	26-49	35.4%	15-42	27.4%	33-56	42.6%
	L	55-71	59.8%	50-71	64.1%	31-57	54.0%
	L^u	50-66	55.6%	53-74	61.4%	33-59	51.8%
	L^r	3.5-7.0	4.3%	1-4	2.6%	1-4	2.2%
	A	2.4-8.5	4.3%	2-18	8.8%	1.1-7.4	3.4%
N (populations)		= 112		N = 88		N = 7	
Palmar Patterns	H	21-52	34.5%	15-32	24.9%	15-35	26.6%
	I	6-20	10.1%	9-42	19.3%	3-21	11.6%
	II	0-11	47%	4-29	13.8%	2-6	4.0%
	III	25-58	43.3%	25-58	39-0%	51-53	52.4%
	IV	37-68	54.4%	68-91	81.4%	49-61	55.2%
N (populations)		= 43		N = 32		N = 7	

TABLE XXVIII

Racial Variation in Mean Maximal atd Angles

Population	Source		L	SD	R	SD	N
American Caucasians	Plato et al. (1975)	Male	43.2	-	41.8	-	360
		Female	42.6	-	41.8	-	360
Spanish Basques	Roberts et al. (1976)	Male	45.1	9.0	45.8	9.37	182
		Female	44.8	8.02	45.0	8.30	140
Apache Indians	Flickinger & Yarbrough (1976)	Male	42.94	4.85	42.83	5.91	94
		Female	45.58	7.60	44.15	6.63	
Navajo Indians	(as above)	Male	40.85	4.63	41.27	5.81	102
		Female	41.17	4.73	41.48	4.76	

Of great importance in the study of population differentiation and genetic distance between sub-units has been the study of the Yanomama Indians. In this case, a South American Indian tribe was extensively investigated by a team of population geneticists and anthropologists for various attributes, including dermatoglyphics. The study had several theoretical objectives. Firstly, the researchers wished to determine how well the magnitude of village differences with respect to one group of characteristics corresponded with those manifest when another group of characteristics was taken as a reference point. Then, they were interested in investigating whether the differences between human populations were biologically meaningful, or whether they were unimportant compared to variation within a single population. They point out that it has been claimed that the variation within each human population is so great that population distributions are more notable for their overlap than for their distinctiveness. If this is so, how reliably may an individual be placed in the correct population if one makes full use of all the information available?

The genetic, anthropometric and dermatoglyphic traits were investigated separately initially, and then agreement between the representations of village distances based on different sets of characteristics examined. The dermatoglyphic analysis utilised nine characteristics: total finger ridge count; a-b count; atd angle; main line index; number of digital whorls per person; number of digital ulnar loops per person; number of $\hat{H}$ palmar loops per person; number of absent/abortive C main lines per person; and number of a grouping of palmar loops (i.e. I, I^R, H, III) per person.

These traits are known in some cases to be positively correlated. Mahalanobis' distance function (D^2) for continuously and normally distributed traits was applied to the dermatoglyphic data, recognising, however, that the characteristics in question are for the most part discontinuous and/or qualitative and, in some instances, not normally distributed. Thus, in this treatment, the findings for the two hands were summed and the result treated as a discrete variable. Sex differences were removed by linear regression. Mahalanobis' generalised distances were then computed using the pooled within-village covariance matrix.

The similarity between the three matrices obtained from the genetic, antrhopometric and dermatoglyphic traits were then examined in four different ways (see Neel et al., 1974). The agreement between the gene frequency and the anthropometric distances was found to be significant at at least the 5% level in all approaches; the agreement with the dermatoglyphic distances was often less significant. The twelve anthropometric measures and six genetic traits, available for 520

Yanomama Indians from 19 villages in nine clusters, were then used to allocate individuals to villages. On the basis of anthropometry alone, 36% of the individuals were allocated to the right village and 60% to the right cluster. On the basis of genetic traits alone, 16% were allocated to the right village and 26% to the right cluster. A combination of all eighteen characters yielded 41% allocation to the right village and 63% to the right cluster. The authors explained this discrepancy by noting that anthropometric traits are not totally heritable and that genetic traits are not continuously distributed. They then infer that the village phenotype distributions overlap only partially and that they represent real and substantial population differentiation. No such comparisons were made using the dermatoglyphic traits.

However, the reaearchers do admit to certain shortcomings in their work. Their overall sample size (520 individuals) is small and the numbers of observations per Yanomama village tended also, therefore, to be small, with the data sets only partially overlapping. Also, the villages studied were not uniformly dispersed throughout the tribal distribution. They also suggest that the historical tendency of Yanomama villages to progressive fissionings and the recent centrifugal expansion of the tribe might have had an important influence on the relatively large and unstructured village distances. Thus, important though this study is in the advance of methodology and statistical techniques for dealing with intra-population variation, its findings are not conclusive and should be treated with some caution.

Recently, there have been several studies of European populations similar to that undertaken on the Yanomama Indians. These include a study by Workman et al. (1975) on genetic differentiation among Sardinian villages. Here, the authors investigated genetic heterogeneity by chi-square tests and F and R statistics and discovered an essentially random pattern of differentiation for all alleles. They then used the kinship assays of Morton and Malécot and compared the results with the picture of geographical location of the villages. Rotating a two-dimensional reduction of the kinship matrix to maximum congruence with the geographical distances indicated that about 25% of the genetic distances could be accounted for by the geographic location of the villages. Thus, the authors conclude that isolation due to cultural factors, genetic drift, and special local or regional patterns of historical association between villages, are all involved and should be considered in the pattern of genetic variation.

Rudan's study of six populations on the Yugoslavian island of Hvar (1976) using Penrose's C_H^2 statistic on dermatoglyphic variables, also indicates the effect of social organisation on genetic differentiation. So does the study by Marquer and Jakobi (1976) in Béarn in France. In this study the patterns of dermatoglyphic variation are related to the marriage patterns and in particular the degree of endogamy. However, the relatively small numbers (455 males and 252 females distributed among five areas) must shed some doubt on the validity of the statistical results obtained from the Béarnais study, even though the methodology developed is extremely interesting.

There have been various studies of dermatoglyphic variation in British populations. Muir (1976) for example, included the study of finger prints in her study of Orkney schoolchildren, but Elizabeth Coope's 1966 BSc. thesis was the first attempt to analyse local population variation in Britain using dermatoglyphics. This analysis was later extended and the main findings summarised by Roberts and Coope in 1972. This study demonstrated the existence of heterogeneity in the South Midlands area in digital total ridge count and pattern type frequency.

It would appear that this variation is clinal, those areas of most aberrant ridge count and pattern type frequency coinciding with areas known historically to be most isolated. Thus, it was once more demonstrated that population structure and social organisation, as demonstrated among the Yanomama of South America and the Béarnais of France, also play an important part in local differentiation in Britain. It would appear that differences continue to exist between local gene pools, possibly in the case of the South Midlands area of Oxfordshire and Berkshire, stemming originally from the settlement pattern itself.

Two more recent studies of dermatoglyphic variation in Britain also need to be mentioned. The first is Dennis' study of dermatoglyphic variation in the human populations of the North Pennine Dales (Ph.D. thesis 1977). This is a highly detailed treatment of the subject, examining methodology very closely with particular regard to methods and problems of sampling, analysing dermatoglyphic prints as objectively as possible, and the statistical treatment of the data obtained. However, in spite of what one might have expected in the essentially non-industrial area of the North Pennine Dales, Dennis is forced to conclude that:

"In no subset, not males or females, urban or rural, is there the expected ordering of points. Moreover any close relationship between rural and urban counterparts is absent." (Dennis, 1977)

Williams' study of dermatoglyphic variability in the populations of Central Wales and Shropshire (Ph.D. thesis 1978) encounters similar problems. Here, at least, however, Williams is able to show some pattern of local heterogeneity. This is greatest using the birth location as the dividing parameter amongst females. Males exhibit a less clear picture but, once again, birth location as the dividing parameter does appear to give a consistent pattern of differentiation.

Neither study was able to employ the rule of place of birth of grandparents as a dividing parameter as doing so reduced their samples to ridiculously low values. It would thus appear that, in spite of one's preconceived ideas about which area would be the most heterogeneous, in fact, the South Wales Coalfield area has, generally, seen less movement into it over the last one hundred years, than either the North Pennine Dales or the mid-Wales borderland area of Powys and Shropshire. Considering that the former area is heavily populated, largely urban and intensively industrialised and that the latter two areas are predominantly rural with market towns as the principle urban centres, this is a remarkable finding. It will be discussed more fully later in this chapter.

2. GENETIC STUDIES IN WALES

Generally speaking, Wales, and in particular the South Wales Coalfield area of the present study, has been poorly investigated in terms of genetic variation. The first attempt to describe the Welsh people in scientific terms was made by John Beddoe in his book "The Races of Britain" published in 1885. He concluded, after examining pigmentation and simple anthropometry, that the Welsh were not homogeneous. Beddoe believed there to be at least two races present in South Wales, which were (then) not yet 'thoroughly amalgamated'. His description of local variation in appearance among the Welsh is of interest to the present study:

"In the warm low lands of Monmouthshire and Glamorgan, the ancient seats of Saxon, Norman and Flemish colonisation, I find the index of hair-colour as low as 33.5, and the proportion of dark eyes to light, 63; while in the cold, rainy and mountainous interior, if we exclude the children of English and Irish immigrants, the figures rise to 57.3 and 109.5, the last ratio indicating a prevalence of dark eyes beyond what I have met with in any other part of Britain.

The statistics for Wales give several very distinct indications; they represent the Welsh as generally dark-haired and often dark-eyed people, among whom the Gaelic combination is common; but the opposite one, of dark eyes with chestnut or lightish hair, is by no means rare. It is generally accompanied by broad cheekbones and a short compact build, and by the dark complexion prevalent among the Welsh.

The inferences that can be drawn from my head measurements respecting the Welsh are but scanty. From the larger series, of 66, almost all South Welshmen, we may with some confidence put the index of breadth at about 78, somewhat greater than that of the Irish or of the Wiltshire or West Somerset men, but below that of the Eastern Englishman. From the smaller series, of 16, which is included in the greater one, we may infer with less certainty a broad forehead, a small glabella, a somewhat low head, a somewhat short face, and a considerable lateral development of the zygoma. Dark complexions, square foreheads, and sinuous noses prevail; noses more or less aquiline are more common than the concave."

John Beddoe (1885)

Fleure and James (1916) extended this analysis to give a summary of the types and distributions of Welsh physical variations. They distinguished a fundamental type with five subtypes which they regarded as being representatives of a Mediterranean race dating back to early Neolithic times. This was the longheaded brunet of the moorlands and their inland valleys, found most typically amongst the valleys of the Glamorgan and Monmouth hill country but also on the higher ground of

South Cardiganshire, North Pembrokeshire and North Carmarthenshire. Their second main type they referred to as Nordic or Nordic/Alpine. These individuals had light brown or fair hair and were tall. They were very common in South and Southwest Pembrokeshire but also occurred along the Welsh border country near Powys and the Bala cleft. The third group consisted of powerfully built, often intensely dark, broad-headed and faced, strong and square jawed men characteristic of the Ardudwy coast, the South Glamorgan coast and parts of North Pembrokeshire and Cardiganshire. Fleure and James also distinguished two 'uncommon' types: an Alpine type found in the valleys of North Montgomeryshire; and a 'red' type, probably related to the Nordics, but also possibly the result of crossing.

Since 1916, few studies have examined the physical characteristics of Welshmen in any detail. There are, however, two notable exceptions to this statement. These take the form of M.A.Theses from the University College of Wales at Aberystwyth undertaken by Bowen (1926) who concentrated on Pembrokeshire and Carmarthenshire; and Sunderland (1952) who examined the people of the Ammanford region of Carmarthenshire. Sunderland later summarised his M.A. Thesis findings in an article (1961) indicating that the physical type of the natives of the Ammanford area was not significantly different from other groups in Wales. Since both studies are primarily outside the geographic area of this thesis, they have not been considered in detail.

Detailed studies appertaining more to the region studied in this thesis have been undertaken on the A B O blood group frequencies and variations. Most of this has been carried out by Watkin (1956 and 1965), using Blood Transfusion Unit data (see Table XXIX). Watkin's main study (1956) was based on the A B O blood group results of 16,760 donors, bearing Welsh surnames, drawn from all parts of Wales except

TABLE XXIX

The A B O Blood Group Frequencies in South Wales

(after Watkin 1965)

Area	Total	Group Frequencies				Expected AB per cent	X^2 for Homogeneity	Gene Frequencies		
		O	A	B	AB			O	A	B
West Monmouthshire	964	46.1	41.8	9.3	2.8	3.4	0.69	67.7	25.8	6.5
East Glamorgan	1,106	45.0	40.9	10.4	3.7	3.8	0.01	67.1	25.6	7.3
Mid Glamorgan	958	49.7	36.7	10.2	3.3	3.1	0.12	70.6	22.5	6.9
West Glamorgan	1,080	47.0	38.0	11.0	4.0	3.6	0.32	68.7	23.7	7.6
East Carmarthenshire	1,249	48.8	37.1	11.1	3.0	3.4	0.60	69.7	22.7	7.5
Merthyr Tydfil	435	48.5	37.9	9.7	3.9	3.1	0.68	69.9	23.4	6.6
Aberdare	372	39.8	43.5	12.6	4.0	5.3	0.70	62.7	28.0	9.3
Cardiff	1,287	48.0	41.7	7.8	2.5	2.7	0.22	69.2	25.4	5.4
Upper Swansea Valley	258	50.4	32.9	12.8	3.9	3.5	0.98	71.1	20.3	8.5
Lower Swansea Valley	345	42.6	45.2	8.7	3.5	3.6	0.01	65.2	28.4	6.3
Grand Total	8,054									

the South Wales Coalfield area. This group showed wide fluctuations in the frequencies of O, A and B genes. Generally, the I^O frequency rises as one proceeds northwards, as in the rest of Britain, though there are higher frequencies in Wales than in areas of equivalent latitude in England. There are marked differences between North and South Wales, with frequencies of I^O of 59% in South Pembrokeshire and the Black Mountain of Carmarthenshire, and of frequencies of up to 75% in parts of North Wales (e.g. Flint, parts of Denbigh and the Merioneth coast near Harlech). The frequencies of I^A in rural South, Southwest and much of Mid-Wales ranges from 23 to 27%. However, in the high I^O areas of the North, it falls to under 20%. An extreme I^A frequency of 34% is found in South Pembrokeshire which is possibly the result of Viking or Flemish settlement. The frequency of I^{A2} is unusually prevalent in Mid-Wales.

The frequencies of I^B are significantly higher in West than in East Wales, reaching their peak of over 10% in the Black Mountain of Carmarthenshire (13.82% according to Garlick and Pantin, 1957), a figure often much alluded to in the literature. However, this relatively high frequency is probably as much a result of inbreeding and genetic drift or even of sampling error as an indication of survival of an early human stock.

Within this broad picture of A B O blood group variation in Wales, can be seen the picture of local heterogeneity in the area of the present study. The frequency of I^O (see Table XXIX) in the coalfield area averages at 68.19%, the lowest frequency (62.7%) being recorded at Aberdare, and the highest (71.1%) in the Upper Swansea Valley. Gower, the Vale of Glamorgan and all the country surrounding the coalfield fit in well with this pattern, having frequencies of between 65 and 69%.

The frequency of I^A in the coalfield area averages at 24.58%, showing greater heterogeneity than the I^O frequencies, ranging from the lowest frequency of 20.3% in the Upper Swansea Valley to the highest frequency of 28.4% in the lower Swansea Valley. In the surrounding areas, the I^A frequencies are between 25 and 30%, with the exception of Carmarthenshire, and here there seems to be a clinal effect with frequencies of circa 20% in the Upper Swansea Valley at Ystradgynlais gradually increasing westwards, through Burry Port (22%) and Llanelli (24%) to the Towy Valley.

The frequency of I^B in the coalfield area is even more heterogeneous, varying from 5.4% in Cardiff to 9.3% in Aberdare, with a mean value of 7.19%. The surrounding areas echo this heterogeneity. Gower, the Vale of Glamorgan, Brecon and Monmouthshire have frequencies between 5 and 7.4%, while the Black Mountain area of Carmarthenshire has a frequency of circa 10%. The rest of Carmarthenshire, including Llanelli and Burry Port also, however, exhibit relatively high frequencies, ranging from 7.5 to 10%. Indeed, Garlick and Pantin (1957) quote frequencies of 11.07% for West Wales.

The frequencies of the ability to taste the substance phenylthiourea (P.T.C.) have also been examined in the South Wales area. Beach (1953) compared a sample of 49 from the Plynlimon moorland with a sample of 151, from the general Welsh population. He found a higher frequency of the 't' gene for non-tasters in the Plynlimon population (0.5533 compared with 0.4152 in the general Welsh population) which he attributed to some form of natural selection acting on this particular population, though, once more, inbreeding and genetic drift seem more likely reasons. Other studies in Wales (e.g. Partridge et al., 1962) show frequencies of 43.3% of non-tasters in the Black Mountain in a sample of 60; and 35.1% non-tasters in Carmarthenshire. Unpublished data from North Wales (Frazer-Smith and Sunderland) give a frequency of non-tasters at 20.5% and data from Northern Ireland at 14%. No data are available for Mid-Wales. This sort of local heterogeneity in Wales fits in well with the picture for sampled populations in the rest of Britain. Sunderland and Cartwright (1967) demonstrated considerable regional variation, the highest frequencies of non-tasters reaching 40.3%. The conclusions to be drawn from the information are tentative, but seem to indicate that this dominant gene varies quite considerably between local populations, at least in Britain, probably more as a result of inbreeding and genetic drift rather than because of any major selective advantage, though some authors have certainly attributed high frequencies in certain areas to some form of natural selection.

Ashley and Davies (1966) and Ashley (1968) investigated the use of the surname as a genetic marker in Wales. They found that those individuals with Welsh surnames differed from those without Welsh surnames in that the former had a higher frequency of I^B in the A B O blood group system and a lower frequency of Rhesus negative. Also, a smaller proportion of the Welsh surname group had light-coloured hair. However, no differences were found with respect to height, weight, secretor status, ability to taste P.T.C. or eye colour. The two groups did, however, exhibit differential susceptibility to disease which could not be attributed to environmental, social class or economic reasons. These diseases included an enhanced susceptibility to gastric cancer, prostatic hyperplasia, coronary thrombosis, diabetes and cardiovascular disease. No differences were indicated in the relative frequencies of lung cancer and bronchitis and the higher frequencies of these diseases in Wales are attributed to environmental causes, in particular the hazards associated with coal-mining.

Therefore, although genetic studies on the Welsh have not been extensive, the results obtained do indicate firstly differences from non-Welsh populations, and secondly, at least a degree of local heterogeneity. As has been shown in Chapter IV, these trends are also exhibited by the dermatoglyphic analysis. It remains to be seen how closely the dermatoglyphic findings echo those findings described above.

3. INTERPRETATION OF RESULTS AND CONCLUSIONS

The actual interpretation of results should be approached with great caution. Several problems, some of which have already been touched on earlier in this thesis, immediately spring to mind.

The first, most obvious, problem is whether one has collected a random sample of the population to be studied, so that realistic extrapolations can be made to that whole population. The problems of sampling are vast and, given limited time, virtually insurmountable. Even the simple constraint of 'willingness to participate' must exercise an influence on the accumulation of cases, let alone any methodological shortcomings involved in whom one asks to participate. As Dennis (1977b) so admirably demonstrates, schoolchildren are, in fact, an acceptable approach to obtaining a random, representative sample of an area, always supposing, of course, that one is interested in collecting a normal population. Also involved in the collection of data is the decision about overall and relative size of the final sample. Should one, for example, attempt a proportional representation of the various sub-populations involved in any geographic region, always assuming of course that one could easily identify these sub-populations.

Having collected one's sample, the next problem encountered is methodological. In this case, the standardisation, both personally and with other researchers, in the recognition and interpretation of dermatoglyphic traits. Again, Dennis' (1977a) efforts have proved exhaustive. At least, one can usually be sure that, by analysing all the prints oneself, one has at least reduced the error factor to that of a relatively consistent personal nature.

Next comes the statistical analysis of the raw data. Once again, the possible pitfalls are daunting. Statistical procedures, it should always be remembered, are merely tools for the ordering, assessing and interpretation of data. Like any other tools they are only as good as the workman who uses them. Thus, the choice of statistical procedures is an extremely sensitive area, requiring careful understanding both of the properties of the data involved and of the end results one hopes to achieve. Here, a whole new series of problems are encountered. Obviously, particularly in the comparison of sub-populations within a larger area, the major problem involves the delineation of those sub-populations. In the present thesis this particular problem has been met at more than one stage of the analysis. It was first encountered when deciding on how to allocate individual subjects to one of the three categories of 'Welsh','Half-Welsh' and 'non-Welsh'. The analysis was performed using each of two methodologically accepted parameters, namely birthplace of grandparents and surname analysis (the latter particularly appropriate in Wales). As the results of these two analyses of the same data group indicate, the choice of dividing parameter is of vital importance since, at the multivariate level of analysis, quite different pictures of the genetic relationships between these three groups was indicated.

This problem of group delineation was again encountered at the local population level. It was decided to use postal districts as the boundaries for the local areas, largely because these areas had already been used in the analysis of A B O blood group variation in the area, but also partly because, on the coalfield, the postal districts do, generally, approximate to geographic regions. Having decided on the boundaries of these local areas, it then had to be decided how to recruit the representatives for these areas. The first of the two ways in which this was done was by place of residence at the time of collection of the data. This produced, using D^2, 22.4% of known cases correctly classified. This is a disappointingly low figure until one compares Dennis' (1977b) results for the North Pennine Dales where his best analysis could only give 16.34% of known cases correctly classified. However, a much better discrimination between the local areas in South Wales was obtained when recruiting for birthplace of grandparents; in this analysis 28.1% of known cases were correctly classified. This corresponds to Williams' findings in the Welsh marcher country where birthplace also gave the best discrimination between local populations.

Therefore, once again choice of parameter influences the amount of local heterogeneity indicated and also, more importantly, the picture of the pattern of variation. Granted, the two sets of analysis mentioned above involve different overall numbers and different distributions of individuals into the local areas, but the two end results are very disparate indeed (see above, Chapter IV). Considering that both methods have been, and still are, being used to describe intrapopulation variability, perhaps more care should be exercised in comparability of studies before one extrapolates findings or results in common.

Perhaps also deserving of comment at this stage is the actual choice of statistical procedures made for the interpretation of dermatoglyphic data. As previously mentioned, dermatoglyphic data, containing quantitative and qualitative aspects, and with many variables being inter-correlated, does not easily lend itself to a reliable statistical interpretation. A series of studies employing different sorts of distance statistic have already been discussed and it has been indicated that, in fact, they are relatively robust procedures, especially the Generalised Distance Statistic (D^2) developed mainly by Mahalanobis. The use of D^2 in this thesis is justified in the light of much professional agreement with this last statement, including the S.P.S.S. manual itself.

However, the fact remains that, theoretically speaking, D^2 should not be used to estimate the genetic distance of local populations when qualitative dermatoglyphic traits are employed as well as quantitative ones. Indeed, it has also been questioned whether even some of the quantitative dermatoglyphic traits completely fulfil all D^2's conditions, since it now seems likely that, for example, total finger ridge count does not have the accepted normal distribution, but is, in fact, negatively skewed and flattened. There is also the question of Rao's paradox, described by Kowalski in 1972. He maintains that inclusion of 'noise' variables i.e. those variables which individually do not give good discrimination between local populations, but which are homogeneously distributed throughout the whole population, decreases the discriminating ability of D^2. This problem is of particular relevance to dermatoglyphic variables where, for example, a particular pattern cannot occur without its corresponding particular triradius, and much 'noise' is inevitably included if one attempts to process all the available information. However, perhaps it should be remembered that, although one is attempting to discriminate between populations, one is, or should be, only attempting to do this if the differences actually exist, and not to create artificial differences. Thus, the containing quantitative and qualitative aspects, and with many variables being inter-correlated, does not easily lend itself to a reliable statistical interpretation. A series of studies employing different sorts of distance statistic have already been discussed and it has been indicated that, in fact, they are relatively robust procedures, especially the Generalised Distance Statistic (D^2) developed mainly by Mahalanobis. The use of D^2 in this thesis is justified in the light of much professional agreement with this last statement, including the S.P.S.S. manual itself.

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This discussion has so far indicated at least some of the shortcomings of the present piece of research. They have been considered because, for any comparative studies to be made, it is extremely important that only the true comparisons should be made and that those based on false or different premises should be excluded.

However, bearing these points in mind, several conclusions can be made with regard to the present study. Firstly, the univariate results indicate consistently that certain demographic traits are relatively homogeneous amongst the groups studied, and that others vary in frequency quite considerably. There are no appreciable differences encountered amongst the various sub-populations, for example, in the mean values for the atd angle or the relative frequencies and distribution of finger to finger of digital pattern types. Dennis (1977b), however, finds heterogeneity in mean values for atd angles in his north Pennine sample though, correspondingly, very little in mean total palmar ridge count which proved, in this study, the best discriminator between local populations.

The results also largely disagreed with regard to palmar variables, Dennis finding area II, axial triradius 't', and main line A (not included in the present study) to be good local discriminators, while in the present study area II only appeared to vary consistently on the right hand, and 't' on both hands of the Welsh group. In this study, differential patterning in palmar area III appeared more important, as did the frequencies of absent palmar digital triradii.

Thus, it would appear that even in British populations, there is no real agreement between those dermatoglyphic traits which vary systematically and provide the best descrimination between groups - except, perhaps, that digital pattern types do not.

The multivariate results are also interesting. From the percentage of known cases correctly classified (72.6% vis-a-vis 46.7%), it would appear that birthplace of grandparents gives better discrimination between the three major groupings of the sample than does surname analysis. However, the possibility should not be ignored that the higher percentage of correctly classified cases in the former analysis is as much to do with unequal sample size as indicating a real difference. This is because birthplace analysis produces an extremely large 'Welsh' group when compared with that produced by surname analysis. In fact, out of the 2509 individuals used in the multivariate birthplace analysis, 1825 (73%) were 'Welsh' and 418 (17%) half-Welsh, leaving only 266 (10%) in the non-Welsh category.

The picture for local differences also shows some interesting features. When birthplace analysis is used, two local populations in particular appear more peripheral than the rest, though no population can be shown to be extreme. These two are Port Talbot and Aberdare, both on the boundaries of the survey area. Also on the edge of the group centroid scatter are Gower and Llanelli, both also 'boundary' geographic populations. When residence analysis is used, the picture somewhat alters. Now the group centroid plots have a much less even distribution and new relationships are demonstrated. Aberdare, however, still remains on the periphery of the group, a position which it also occupies in the picture of A B O blood group variation in the area. Gower, or rather Gowerton which takesup only the northern part of the original Gower area, also remains on the periphery; but Port Talbot moves much closer into the mainstream of variation. The conclusions which can be drawn from these comparisons can only be tentative. It is true, as Dennis observed in his study, that the most diverse populations are also at the lower end of the continuum of sample size, though it should be mentioned here that the local populations they are drawn from are not themselves large. It is also true that although they are on the edges of the distribution the populations involved are by no means extremely or even obviously, diverse. However, it is apparent that genetic liminality corresponds quite closely to the real geographic situation, that the limitations imposed by the environment do appear to be important.

The genetic inter-relationships demonstrated by the multivariate analysis do not fit in easily with the historical demography of the area. Beddoe's two races of Welsh 'not completely amalgamated' are not obviously in existence or discriminated between; neither are Fleure and James' various anthropometric sub-types. The populations from the coalfield do not seem in any way distinguishable, using dermatoglyphic variables, from those from the non-coalfield parts of the area studied. However, Watkin's A B O blood group studies do indicate a similar pattern of heterogeneity to the present study.

If the present pattern of local variation which undoubtedly exists in the area cannot be explained historically, how best can it be explained? The answer probably lies in the geographic structure of the area. Perhaps the one most important feature of the area is that it is primarily a coalfield, and a coalfield dominated by sharply cut, narrow valleys connected by inhospitable moorland. It is probably true that the type of community or population is largely determined by its economic activity. This is amply demonstrated in the social structure of primitive communities, let alone mining communities in other areas both of Britain (see in particular D. H. Lawrence's works on the Nottinghamshire coalfield) and the world. Mining everywhere seems to engender close-knit communities, let alone when the physical structure of the countryside also encourages it.

Coupled with this essentially inward-looking pattern of economic life and settlement patterns, is the recent industrial history of the region. Until relatively recently, coal, iron and steel were the major sources of employment in the area and recessions in any one of these industries, or a desire not to be employed in them, meant movement elsewhere. Thus, census returns for the area show a relatively stable population in the traditional coalmining areas and more influx of population in the south of the area, largely associated with special sorts of employment, like the establishment of the Royal Mint at Llantrisant, or with movement of a managerial middle class. However, the overall pattern gives a remarkably stable picture for such a heavily urbanised and industrialised area, remembering that 73% had at least three grandparents born in the South Wales area.

Within this picture of a relatively stable population, the major movements of people being away from the area, one can begin to understand local heterogeneity. Barnicot et al. (1972) explained local variation among the Hadza of Tanzania in terms of genetic drift in small, relatively isolated populations leading to the erosion of variability in dermatoglyphic traits. The same explanation appears equally applicable to the South Wales material. It is interesting, however, that studies of dermatoglyphic variation in rural areas (e.g. particularly the studies by Coope and Dennis) have not produced nearly the same degree of local heterogeneity as has the present study or that one might have expected from a rural area. The only explanation appears to be that at least these rural communities are not as inward-looking as one might have intuitively imagined and that inbreeding in particular is not so common. Perhaps the area of the South Wales Coalfield is unusual in its combination of physical geography and economic activity in positively encouraging the formation of relatively isolated, inbreeding, local populations, where the actions of genetic drift have produced, in these populations, a picture of local heterogeneity within a heavily populated, industrialised area.

This study, therefore, has shown that even in an urban, industrialised area, local variability exists, in this case with regard to dermatoglyphic traits. This statement has at least two major implications. Firstly, that 'general' figures for countries or widely scattered populations are probably meaningless and should not be employed in the analysis of racial variation. Secondly, that if dermatoglyphics is to become the major diagnostic tool it promises to be with regard in particular to chromosome and single gene disorders (though evidence for other sorts of inherited abnormalities and diseases does exist), a pattern of local variation must be obtained, and used as a 'rule of thumb' against which the researcher can then estimate abnormal dermatoglyphic frequencies in these various medical conditions.

Future research thus has two main avenues of approach. Firstly, local variation in any genetic trait must be investigated and the causes of it explained where possible; and secondly, studies of inherited disorders which attempt to employ dermatoglyphic variables as diagnostic aids should only do so in the geographic context of the individuals involved. This will, in many cases necessitate the reformulation of some of the 'frequency data' already obtained.

APPENDICES

APPENDIX 1

SCHOOLS VISITED
FOR
COLLECTION OF DATA

APPENDIX 1

SCHOOLS VISITED FOR COLLECTION OF DATA

Location	School
Gowerton	Boys' Grammar School
	Girls' Grammar School
Penclawdd	Secondary Modern (Mixed)
Swansea	Dumbarton Mixed (Private)
	Llwyn-y-Bryn Senior Comprehensive (Girls)
	Townhill Junior Comprehensive (Mixed)
Llanelli	St. John Lloyd Roman Catholic Comprehensive
	Stradey Secondary Modern
	Coleshill Secondary Modern (Boys)
	Coleshill Secondary Modern (Girls)
Burry Port	The Secondary School
Merthyr Tydfil	Afon Taf High School
	Cyfarthfa High School
	Vaynor and Penderyn Comprehensive School
Cardiff	Glan Ely High School
	Willows High School
	Cae'r Castell High School
Neath	Boys' Grammar School
	Girls' Grammar School
Port Talbot	Dyffryn Comprehensive School
	Sandfields Comprehensive School
	Glan Afan Comprehensive School
Bridgend	Bryntirion Comprehensive School
	Brynteg Comprehensive School
Ystradgynlais	The High School
Treorchy	Upper Rhondda Comprehensive School
Porth	Grammar Technical Mixed School
Cymmer Afan	Comprehensive School
Maesteg	Comprehensive School
Porthcawl	Comprehensive School
Aberdare	Sample donated by Richard Suggett (collected as part of a B.A.Hons. Dissertation in Anthropology in 1971)

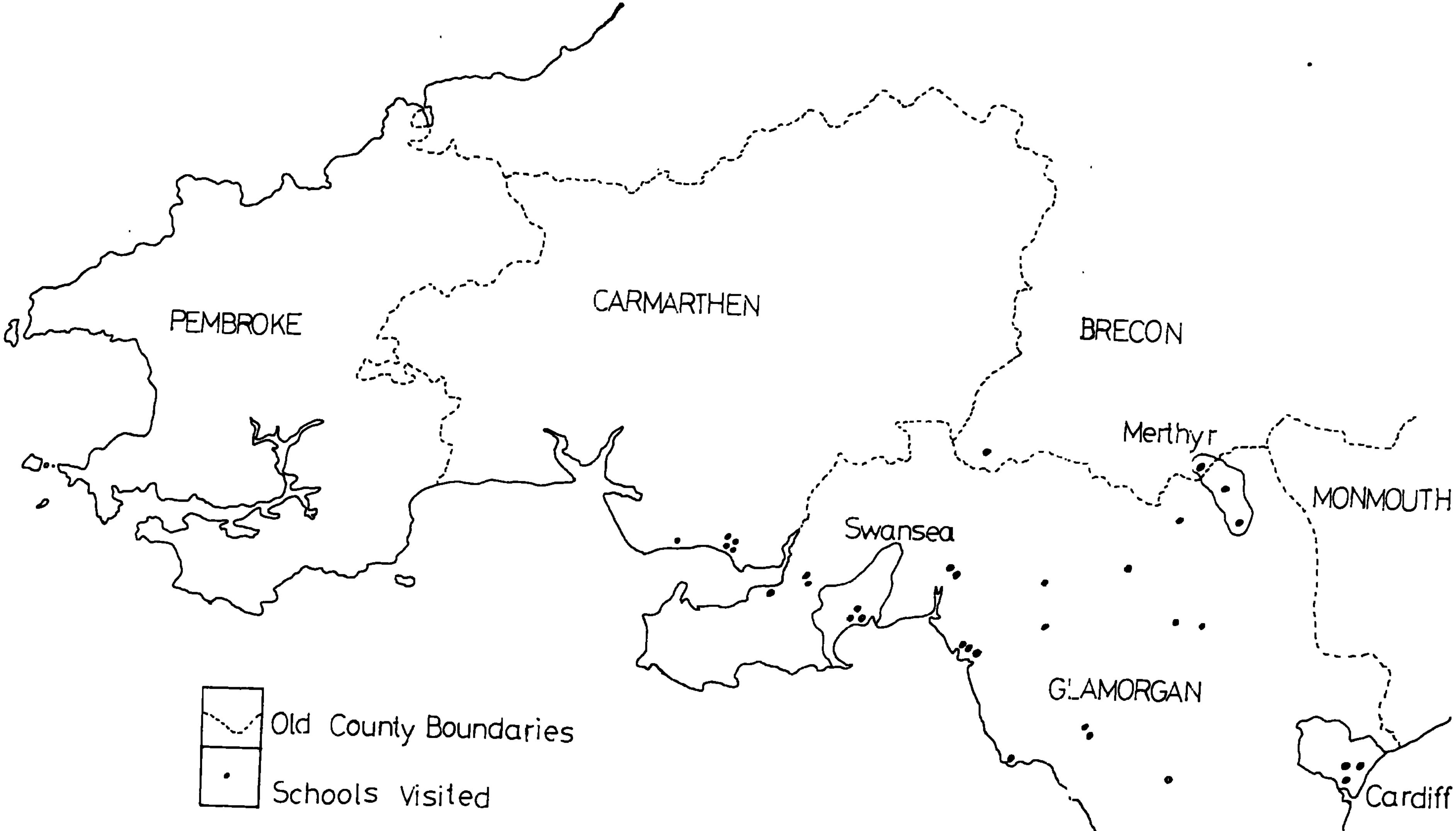

Figure13: Location of Schools sampled in present study

APPENDIX 2

SURNAME ANALYSIS

APPENDIX 2

SURNAME ANALYSIS

Dr. D. J. B. Ashley has undertaken extensive studies of the use of the Welsh surname as a genetic marker, and I am considerably indebted to him both for access to his findings and for permission to use them in conjunction with my own results.

As previously mentioned in this thesis, the dividing line between what is Welsh and what is non-Welsh is often extremely difficult to place, especially since, in common with many other 'newcomers', non-Welsh immigrants to Wales often become more 'Welsh' than the Welsh themselves. Even though an attempt has been made to outline population movements and to show the parentage of the present coalfield dwellers, it must be accepted that the tracing of birthplace of secondary school-children back to grandparent level usually does not take us back further than 1900 - after much of the population upheaval had taken place.

It is this sense of inadequacy that leads us to search for another means of deciding on 'Welshness' and which turns our attention to the use of surnames. There are a limited number of surnames which are recognised as being Welsh and which are typically patronymics. (see Table XXX)

To understand the nature of Welsh surnames themselves, one must first comprehend that, until relatively recently, Wales was organized on a tribal basis. Thus, an individual did not have a surname at all in the accepted sense, but his name recorded his genealogical history. This emphasis on genealogy arose partly from racial pride and partly from the practice of 'gavelkind' (the opposite of primogeniture and where an inheritance is divided equally among all male heirs), where

TABLE XXX

List of Welsh Surnames

(after Ashley & Davies.
J. Med. Genet. 1966)

Adda
Anwyl
Baynham
Bevan
Beddoe
Bellis
Beynon
Bithel
Blythin
Bowen
Breese
Cadarn
Caddell
Cadwallader
Craddock
David
Davies
Dilwyn
Edmonds
Edmunds
Edwards
Elias
Ellis
Evans
Eynon
Foulk
Foulkes
Francis
George
Gethin
Glyn
Gough
Griffith
Gronow
Gwatkin
Gwilt
Gwilym
Gwyn
Gwyther
Harries
Hopkin
Howell
Hughes
Humphries
Idris
Ithell
James
Jenkin
John
Jones
Joseph
Kenwyn
Kyffin
Lewis
Leyshon
Llewellyn
Lloyd
Loughor
Machen
Maddock
Mainwaring
Mathias
Meredith
Meyrick
Morgan
Morris
Owen
Parry
Phillip
Powell
Powis
Price
Pritchard
Probert
Probyn
Prosser
Protheroe
Prytherch
Pugh
Rees
Richards
Roberts
Rogers
Rosser
Rowlands
Thomas
Treharne
Trevethan
Tudor
Vaughan
Walters
Watkins
Welsh
Williams
Wyn
Yorath

such details were necessary. Thus, until the reign of Henry VIII, when English jurisdiction was extended into Wales, a man was known by his Christian name followed by that of his father, e.g. Evan ap William (Evan, son of William). When, in the sixteenth century, Welshmen were forced to adopt surnames, they usually took the name nearest to their own, i.e. Evan ap William would become Evan Williams, explaining why some names are so common in Wales and why the range of variation is not as great as in other areas.

Possession of a Welsh surname does not of course guarantee Welshness in the present day, but it does at least indicate with a degree of certainty some amount of Welsh blood, and if that person is also resident in Wales, the 'level of Welshness' must surely be regarded as high enough to be designated 'Welsh'.

To illustrate this point Ashley (1968) has compiled a table taken from a 2% study of electoral registers which shows the close association of the frequencies of Welsh speaking people with those who possess Welsh surnames (see Table XXXI). This table also indicates the proportions of Welsh names in the counties and county boroughs of Wales.

Ashley and Davies (1966) divided a sample of people living in Wales into Welsh and non-Welsh using their surnames as a marker, and found various genetic differences between the two groups. Those with Welsh names had a higher frequency of blood group B and a lower frequency of Rhesus negative, as well as darker hair colour than those with non-Welsh names. No differences between the two groups were found in height, weight, secretor status, ability to taste P.T.C. (phenylthiourea) or in eye colour. Studies also were carried out (Ashley, 1968) to see if a genetic difference in the incidence of disease could be demonstrated between the Welsh and non-Welsh people of Wales, again using the surname as a marker. It was first ascertained that differences

TABLE XXXI

Frequency of Welsh Speaking and of Welsh Names in Wales (1968)

	% Welsh Speaking	% Welsh Names
Merioneth	76.3	75.5
Anglesey	75.5	73.0
Cardigan	75.0	76.0
Carmarthen	74.9	73.0
Caernarvon	68.5	69.0
Denbigh	34.8	58.5
Montgomery	32.0	70.5
Brecon	27.1	58.0
Pembroke	24.5	54.0
Merthyr Tydfil	19.8	54.0
Flint	19.0	43.0
Glamorgan	17.3	57.0
Swansea	17.3	44.0
Cardiff	4.7	25.0
Radnor	4.5	53.0
Monmouth	3.4	34.0
Newport	2.1	23.5

in disease frequencies could not be explained by differences in environment, or distribution of occupations between the two groups. An enhanced susceptibility to gastric cancer, prostatic hyperplasia, coronary thrombosis, diabetes and cerebrovascular disease was found among the Welsh. No difference between the Welsh and non-Welsh was found in respect to lung cancer and bronchitis and it is suggested that their above average incidence in Wales is due to the predominant coalmining industry.

With this background of the use of the surname as a genetic marker, and the fact that its use had been successful in demonstrating appreciable differences between the two ethnic groups thus created, it was felt appropriate to employ the surname as a methodological tool in the present study. Thus, each child who participated in the survey was asked for both his surname and that of his maternal grandparents (i.e. his mother's maiden name). However, both surnames were not always available for a variety of reasons, and out of a possible sample of 5032, 3844 individual surnames were recorded (see Table XXXII).

TABLE XXXII

Distribution of Surnames in Present Study

	Number	%
Possible surnames	3844	
Different surnames	1605	100.00
Surnames occurring only once	1084	67.54
Surnames occurring only twice	263	16.38
Occurrences of Welsh surnames	2281	
Occurrences of non-Welsh surnames	1563	
Welsh surnames recorded	63	

Of the 63 Welsh surnames which occurred in the sample, some were obviously more common than others (see Table XXXIII and Table XXXIV). However, some Welsh names were completely absent from the present study (see Table XXXV).

N.B. The close correlation between the most common Welsh names in the present study and those ascertained from a 2% sample of the Electoral Registers for South East Wales indicate that the present sample must be truly representative of the general population.

TABLE XXXIII

Frequency of Welsh Surnames in Present Study

Name	No. of Occurrences	Name	No. of Occurrences
Bevan	19	Lloyd	26
Beynon	8	Mainwaring	3
Bowen	28	Mathias	5
David	7	Meredith	4
Davies	234	Meyrick	2
Edmonds	1	Morgan(s)	77(4)
Edmunds	2	Morris	40
Edwards	59	Owen(s)	19(8)
Ellis	8	Parry	13
Evans	169	Phillip(s)	(42)
Eynon	1	Powell	21
Foulkes	1	Powis	2
Francis	9	Price	35
George	14	Pritchard	10
Gough	2	Probert	4
Griffith(s)	3(60)	Prosser	8
Gronow	1	Protheroe	2
Gwilym	2	Pugh	6
Gwyn	1	Rees	91
Harris(e)	37(11)	Richards	49
Hopkin(s)	(20)	Roberts	42
Howell(s)	6(22)	Rogers	14
Hughes	34	Rosser	3
Humphries	1	Rowland(s)	2(9)
James	66	Thomas	183
Jenkin(s)	(55)	Treharne	1
John(s)	29(6)	Tudor	2
Jones	272	Vaughan	7
Joseph	5	Walters	7
Lewis	108	Watkin(s)	1(18)
Leyshon	5	Williams	201
Llewellyn	14		

TABLE XXXIV

Most Common Welsh Names in Wales

North	S.W.	S.E.	Present Study (predominantly coalfield)
Jones	Davies	Jones	Jones
Williams	Jones	Davies	Davies
Roberts	Thomas	Williams	Williams
Hughes	Evans	Thomas	Thomas
Davies	Williams	Evans	Evans
Evans	Rees	Lewis	Lewis
Owen	Lewis	Morgan	Rees
Thomas	Morgan	Griffiths	Morgan
Edwards	Griffiths	James	James
Griffiths	Jenkins	Jenkins	Griffiths

TABLE XXXV

Welsh Names Absent from Present Study

* Adda
* Anwyl
Baynham
Beddoe
Bellis
Bithel
Blythin
Breese
* Cadarn
* Caddell
Cadwallader
Craddock
* Dilwyn
Elias
* Foulk
Gethin
* Glyn
Gwatkin
* Gwilt
Gwyther
* Idris
Ithell
Kenwyn
* Kyffin
Loughor
Machen
Maddock
Probyn
Prytherch
* Trevethan
Welsh
Wyn
Yorath

* Also absent from Ashley's 2% Electoral Register Study of 1968

APPENDIX 3

BASIC DATA TABLES

APPENDIX 3

BASIC DATA TABLES

Table 1.1 Total Sample: Incidence of digital pattern types: Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.002	.743	.001	.192	.041	.001	.020	.000	1177
2	.003	.345	.202	.271	.115	.047	.008	.009	1177
3	.002	.712	.018	.154	.088	.018	.006	.003	1177
4	.002	.609	.003	.297	.038	.003	.003	.046	1177
5	.002	.863	.000	.105	.019	.003	.001	.008	1177

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.003	.600	.003	.362	.020	.000	.009	.002	1177
2	.003	.287	.218	.319	.112	.048	.006	.008	1177
3	.002	.686	.025	.180	.086	.009	.003	.009	1177
4	.002	.472	.008	.449	.031	.001	.002	.035	1177
5	.002	.802	.000	.161	.017	.000	.002	.016	1177

Table 1.2 Total Sample: Incidence of digital pattern types: Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.728	.002	.195	.063	.000	.011	.001	1389
2	.000	.329	.179	.281	.154	.035	.014	.009	1389
3	.001	.664	.027	.147	.134	.017	.006	.004	1389
4	.000	.598	.005	.307	.049	.004	.002	.036	1389
5	.000	.851	.001	.105	.036	.001	.000	.006	1389

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.677	.001	.278	.032	.000	.012	.001	1389
2	.000	.357	.156	.308	.132	.030	.006	.010	1389
3	.000	.758	.008	.124	.091	.010	.004	.006	1389
4	.001	.537	.004	.374	.036	.001	.003	.044	1389
5	.000	.843	.001	.117	.027	.000	.000	.011	1389

Table 1.3 Total Sample: Incidence of digital pattern types.

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.001	.735	.002	.194	.053	.000	.015	.001	2566
2	.002	.336	.189	.276	.136	.040	.011	.009	2566
3	.001	.686	.023	.150	.113	.017	.006	.004	2566
4	.001	.603	.004	.302	.044	.003	.002	.041	2566
5	.000	.851	.001	.105	.036	.001	.000	.006	2566

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.002	.641	.002	.316	.027	.000	.011	.002	2566
2	.001	.325	.184	.313	.123	.038	.006	.009	2566
3	.000	.758	.008	.124	.091	.010	.004	.006	2566
4	.001	.507	.006	.409	.034	.001	.002	.040	2566
5	.001	.824	.001	.138	.023	.000	.001	.013	2566

Table 1.21: Total palmar ridge counts: Main divisions of sample

Area	Left Hand			Right Hand		
	mean	sd	N	mean	sd	N
Divided by birthplace:						
Non-Welsh	93.77	12.95	274	94.50	12.16	273
Half-Welsh	94.42	13.91	427	95.36	13.52	427
Welsh	93.56	13.80	1858	94.68	12.89	1862
Divided by surname:						
Non-Welsh	94.46	13.76	858	95.39	13.18	860
Half-Welsh	93.53	13.66	1138	94.65	12.83	1138
Welsh	93.02	13.80	563	94.09	12.67	564
Total Sample	93.73	13.73	2559	94.78	12.92	1562

Table 1.31: Total atd angle : Main divisions of sample: Male and Female combined

Area	Left Hand			Right Hand		
	mean	sd	N	mean	sd	N
Divided by birthplace:						
Non-Welsh	41.22	5.61	271	41.11	5.82	269
Half-Welsh	41.69	6.09	424	41.47	6.03	421
Welsh	41.60	6.12	1849	41.47	6.17	1840
Divided by surname:						
Non-Welsh	41.60	6.04	852	41.28	5.75	855
Half-Welsh	41.49	5.99	1130	41.54	6.10	1122
Welsh	41.71	6.26	562	41.44	6.64	553
Total Sample	41.58	6.07	2544	41.43	6.11	2530

Table 4.1: Incidence of palmar pattern I: Main divisions of sample: Males and Females combined

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Divided by birthplace:								
Non-Welsh	.960	.022	.018	274	.986	.007	.007	274
Half-Welsh	.935	.026	.048	427	.977	.007	.016	427
Welsh	.949	.019	.031	1864	.989	.004	.008	1865
Divided by surname:								
Non-Welsh	.952	.016	.030	859	.991	.005	.005	860
Half-Welsh	.940	.026	.034	1141	.983	.006	.011	1141
Welsh	.957	.016	.027	565	.986	.002	.012	565
Total Sample	.948	.021	.031	2565	.966	.005	.009	2566

Table 4.2: Incidence of palmar pattern I^r: Main divisions of sample: Males and Females combined

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Divided by birthplace:								
Non-Welsh	.949	.051	.000	274	.978	.022	.000	274
Half-Welsh	.974	.026	.000	427	.979	.021	.000	427
Welsh	.965	.035	.000	1864	.976	.024	.000	1865
Divided by surname:								
Non-Welsh	.955	.045	.000	859	.974	.026	.000	860
Half-Welsh	.969	.031	.000	1141	.978	.022	.000	1141
Welsh	.972	.028	.000	565	.979	.021	.000	565
Total Sample	.965	.035	.000	2565	.977	.023	.000	2566

Table 4.3: Incidence of palmar pattern II: Main divisions of sample: Males and Females combined

Area	Left Hand				Right Hand			
Divided by birthplace:	Abs	1	2	N	Abs	1	2	N
Non-Welsh	.978	.022	.000	274	.964	.036	.000	274
Half-Welsh	.981	.019	.000	427	.953	.047	.000	427
Welsh	.985	.015	.000	1865	.947	.052	.000	1865
Divided by surname:								
Non-Welsh	.979	.021	.000	860	.950	.050	.000	860
Half-Welsh	.988	.012	.000	1141	.950	.050	.000	1141
Welsh	.982	.018	.000	565	.950	.048	.000	565
Total Sample	.984	.016	.000	2566	.950	.050	.000	2566

Table 4.4: Incidence of palmar pattern III: Main divisions of sample: Males and Females combined

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Divided by birthplace:								
Non-Welsh	.803	.197	.000	274	.485	.515	.000	274
Half-Welsh	.702	.218	.000	427	.480	.520	.000	427
Welsh	.736	.264	.000	1865	.472	.527	.001	1865
Divided by surname:								
Non-Welsh	.772	.228	.000	860	.501	.499	.000	860
Half-Welsh	.756	.244	.000	1141	.470	.529	.001	1141
Welsh	.708	.292	.000	565	.446	.554	.000	565
Total Sample	.751	.249	.000	2566	.475	.525	.000	2566

Table 4.5: Incidence of palmar pattern III^T: Main divisions of sample: Males and Females combined

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Divided by birthplace:								
Non-Welsh	.785	.215	.000	274	.931	.069	.000	274
Half-Welsh	.794	.206	.000	427	.925	.075	.000	427
Welsh	.830	.170	.000	1865	.925	.075	.000	1865
Divided by surname:								
Non-Welsh	.799	.201	.000	860	.917	.083	.000	860
Half-Welsh	.825	.175	.000	1141	.937	.063	.000	1141
Welsh	.839	.161	.000	565	.917	.083	.000	565
Total Sample	.819	.181	.000	2566	.926	.074	.000	2566

Table 4.6: Incidence of palmar pattern IV: Main divisions of sample: Males and Females combined

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Divided by birthplace:								
Non-Welsh	.388	.599	.015	274	.537	.460	.004	274
Half-Welsh	.456	.543	.021	427	.597	.400	.002	427
Welsh	.416	.555	.028	1865	.567	.429	.004	1865
Divided by surname:								
Non-Welsh	.396	.581	.022	860	.555	.442	.003	860
Half-Welsh	.500	.568	.022	1141	.563	.433	.004	1141
Welsh	.458	.503	.037	565	.602	.395	.004	565
Total Sample	.416	.558	.025	2566	.569	.428	.004	2566

Table 4.7: Incidence of palmar pattern H: Main divisions of sample: Males and Females combined

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Divided by birthplace:								
Non-Welsh	.898	.098	.004	274	.899	.102	.000	274
Half-Welsh	.914	.084	.000	427	.908	.092	.000	427
Welsh	.898	.102	.001	1865	.892	.108	.001	1865
Divided by surname:								
Non-Welsh	.880	.116	.001	860	.886	.114	.000	860
Half-Welsh	.915	.085	.001	1141	.892	.108	.000	1141
Welsh	.904	.097	.000	565	.918	.081	.002	565
Total Sample	.901	.099	.001	2566	.895	.105	.000	2566

Table 4.8: Incidence of palmar pattern $\hat{H}$: Main divisions of sample: Males and Females combined

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Divided by birthplace:								
Non-Welsh	.759	.237	.004	274	.741	.256	.004	274
Half-Welsh	.802	.194	.002	427	.787	.213	.000	427
Welsh	.789	.211	.001	1865	.751	.247	.003	1865
Divided by surname:								
Non-Welsh	.789	.208	.002	860	.735	.264	.001	860
Half-Welsh	.797	.203	.001	1141	.760	.238	.002	1141
Welsh	.771	.240	.000	565	.778	.216	.007	565
Total Sample	.790	.210	.001	2566	.755	.242	.003	2566

Table 4.9: Incidence of palmar patterns H^r and A^r: Main divisions of sample: Males and Females combined

Area	Left Hand				Right Hand			
	Abs	H^r	A^r	N	Abs	H^r	A^r	N
Divided by birthplace:								
Non-Welsh	.989	.007	.004	274	.956	.018	.026	274
Half-Welsh	.991	.007	.002	427	.930	.033	.037	427
Welsh	.981	.009	.010	1865	.954	.018	.028	1865
Divided by surname:								
Non-Welsh	.986	.007	.007	860	.950	.024	.026	860
Half-Welsh	.979	.010	.011	1141	.944	.023	.033	1141
Welsh	.987	.009	.004	565	.962	.011	.027	565
Total Sample	.983	.009	.008	2566	.950	.021	.029	2566

Table 5.1: Incidence of palmar triradius ef (combined) : Main divisions of sample: Male and Females combined

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Divided by birthplace:								
Non-Welsh	.957	.040	.009	274	.979	.018	.001	274
Half-Welsh	.947	.037	.015	427	.977	.015	.007	427
Welsh	.955	.030	.013	1865	.982	.014	.002	1865
Divided by surname:								
Non-Welsh	.952	.032	.014	860	.981	.016	.001	860
Half-Welsh	.950	.036	.014	1141	.979	.016	.004	1141
Welsh	.961	.026	.013	565	.984	.011	.005	565
Total Sample	.954	.033	.014	2566	.981	.015	.004	2566

Table 5.2: Incidence of palmar triradius t: Main divisions of sample: Males and Females combined

Area	Left Hand						Right Hand					
	t	t'	t''	t'''	t^b	N	t	t'	t''	t'''	t^b	N
Divided by birthplace:												
Non-Welsh	169	101	27	2	72	274	154	109	33	1	86	274
Half-Welsh	240	189	34	5	88	427	207	197	46	4	122	427
Welsh	1087	745	187	19	439	1865	989	801	222	25	557	1865
Divided by surname:												
Non-Welsh	508	342	97	12	196	860	448	383	107	11	276	860
Half-Welsh	646	483	97	11	261	1141	566	516	133	16	341	1141
Welsh	342	218	54	3	142	565	336	208	61	3	148	565
Total Sample	1496	1043	248	26	599	2566	1350	1107	301	30	765	2566

Table 5.3: Incidence of palmar triradii z'and z'': Main divisions of sample: Males and Females combined

Area	Left Hand				Right Hand			
	Abs	z'	z''	N	Abs	z'	z''	N
Divided by birthplace:								
Non-Welsh	.912	.051	.036	274	.949	.033	.018	274
Half-Welsh	.895	.052	.054	427	.939	.035	.026	427
Welsh	.900	.019	.080	1865	.940	.013	.047	1865
Divided by surname:								
Non-Welsh	.915	.024	.060	860	.952	.020	.028	860
Half-Welsh	.894	.032	.074	1141	.942	.019	.039	1141
Welsh	.892	.150	.081	565	.922	.016	.062	565
Total Sample	.901	.028	.071	2566	.941	.019	.040	2566

Table 5.4: Incidence of digital triradii: Main divisions of sample: Males and Females combined

Area	Left Hand							
	Abs	3	4	5	6	7	8	N
Divided by birthplace:								
Non-Welsh	.004	.062	.777	.139	.015	.000	.004	274
Half-Welsh	.000	.082	.794	.105	.012	.005	.002	427
Welsh	.002	.069	.789	.128	.011	.001	.001	1865
Divided by surname:								
Non-Welsh	.002	.060	.785	.131	.014	.003	.003	860
Half-Welsh	.003	.071	.803	.112	.011	.000	.000	1141
Welsh	.000	.085	.765	.143	.007	.000	.000	565
Total Sample	.002	.071	.788	.125	.011	.001	.001	2566

Table 5.5: Incidence of digital triradii: Main divisions of sample: Males and Females combined

Area	Right Hand							
	Abs	3	4	5	6	7	8	N
Divided by birthplace:								
Non-Welsh	.004	.044	.814	.131	.007	.000	.000	274
Half-Welsh	.000	.056	.852	.073	.014	.002	.002	427
Welsh	.001	.048	.824	.103	.023	.002	.000	1865
Divided by surname:								
Non-Welsh	.000	.044	.835	.098	.020	.001	.001	860
Half-Welsh	.001	.043	.838	.096	.019	.003	.000	1141
Welsh	.002	.067	.795	.115	.021	.000	.000	565
Total Sample	.001	.049	.827	.101	.020	.002	.000	2566

Table 5.6: The relative frequency of unusual palmar pattern elements: Main divisions of sample: Males and Females

Pattern	Left Hand			Right Hand		
	No	freq.	N	No	freq.	N
palmar $\widehat{II}$	0	.000	2566	1	.001	2566
palmar $\widehat{III}$	5	.002	2566	5	.002	2566
palmar $\widehat{IV}$	26	.010	2566	7	.003	2566
palmar V composites	12	.005	2566	16	.006	2566

All other palmar pattern elements were absent:

i.e. II^T IV^T IV^u T^u T^c T^r Pa t^r t^u

SAMPLE DIVIDED ACCORDING TO ORIGINS OF SURNAMES

SURNAME	N	%
Non-Welsh (i.e. no Welsh surname)	860	33.5
Half-Welsh (i.e. one Welsh surname)	1141	44.5
Welsh (i.e. two Welsh surnames)	565	22.0
TOTAL SAMPLE	2566	100.0

Table 2.1 Sample divided by surname: Incidence of digital pattern types: Non-Welsh

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.001	.743	.001	.186	.052	.001	.015	.000	860
2	.002	.353	.192	.263	.140	.035	.009	.006	860
3	.002	.694	.015	.144	.122	.017	.002	.002	860
4	.001	.624	.007	.277	.042	.002	.003	.043	860
5	.001	.852	.001	.109	.028	.002	.001	.005	860

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.001	.627	.003	.322	.029	.000	.015	.002	860
2	.000	.322	.191	.288	.138	.045	.006	.009	860
3	.000	.722	.020	.155	.087	.008	.002	.006	860
4	.001	.512	.009	.394	.033	.000	.005	.047	860
5	.000	.821	.000	.143	.023	.000	.000	.013	860

Table 2.2 Sample divided by surname: Incidence of digital pattern types: Half-Welsh

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.001	.732	.003	.195	.053	.000	.014	.002	1141
2	.002	.338	.184	.274	.137	.040	.011	.014	1141
3	.001	.692	.024	.140	.109	.019	.011	.004	1141
4	.001	.604	.002	.300	.046	.004	.003	.042	1141
5	.001	.861	.000	.103	.025	.001	.000	.010	1141

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.002	.663	.001	.301	.025	.000	.008	.000	1141
2	.002	.341	.176	.315	.117	.035	.006	.008	1141
3	.001	.735	.011	.133	.096	.011	.003	.010	1141
4	.001	.519	.005	.404	.033	.001	.002	.035	1141

Table 2.3 Sample divided by surname: Incidence of digital pattern types: Welsh

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.729	.000	.202	.051	.000	.018	.000	565
2	.000	.306	.196	.301	.129	.048	.014	.005	565
3	.000	.660	.034	.179	.106	.012	.004	.005	565
4	.000	.568	.004	.347	.044	.004	.000	.034	565
5	.000	.855	.000	.101	.035	.002	.000	.007	565

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.002	.619	.002	.340	.025	.000	.009	.004	565
2	.002	.297	.191	.347	.112	.034	.007	.011	565
3	.002	.708	.018	.175	.074	.011	.007	.005	565
4	.002	.476	.004	.441	.037	.002	.000	.039	565
5	.002	.805	.002	.136	.030	.000	.000	.025	565

SAMPLE DIVIDED ACCORDING TO PLACE OF BIRTH

AREA	CODE	N	%
Non-Welsh	0	274	10.7
Half-Welsh	1	427	16.6
Welsh	2	1865	72.7
Welsh (no definite area)	2	801	31.2
Port Talbot	3	67	2.6
Bridgend	4	109	4.2
Merthyr Tydfil	5	124	4.8
Llanelli	6	84	3.3
Cardiff	7	125	4.9
Neath	8	63	2.5
Aberdare	9	60	2.3
Swansea Urban	10	230	9.0
Rhondda	11	69	2.7
Swansea Valley	12	42	1.6
Gower	13	34	1.3
Treorchy	14	25	1.0
Porth	15	11	0.4
Tonypandy	16	11	0.4
Carmarthen	17	10	0.4
TOTAL SAMPLE		2566	100.0

Table 3.1 Sample divided by birthplace: Incidence of digital pattern types: Non-Welsh

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.763	.004	.186	.036	.000	.011	.000	274
2	.004	.369	.179	.255	.146	.036	.000	.011	274
3	.000	.672	.036	.131	.135	.026	.000	.000	274
4	.000	.628	.004	.270	.044	.000	.000	.055	274
5	.000	.865	.004	.091	.029	.004	.000	.007	274

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.004	.690	.000	.255	.029	.000	.018	.004	274
2	.004	.328	.168	.296	.157	.040	.004	.004	274
3	.004	.730	.015	.153	.084	.011	.004	.000	274
4	.004	.522	.007	.372	.036	.000	.004	.055	274
5	.004	.818	.000	.135	.022	.000	.000	.022	274

Table 3.2 Sample divided by birthplace: Incidence of digital pattern types: Half-Welsh

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.724	.000	.204	.054	.000	.016	.002	427
2	.000	.361	.176	.281	.131	.037	.007	.007	427
3	.000	.700	.014	.162	.089	.028	.005	.002	427
4	.000	.614	.002	.295	.035	.002	.002	.049	427
5	.000	.876	.000	.094	.014	.002	.002	.012	427

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.002	.607	.005	.356	.021	.000	.009	.000	427
2	.000	.344	.192	.316	.094	.028	.009	.016	427
3	.000	.707	.026	.164	.082	.005	.005	.012	427
4	.000	.494	.012	.431	.026	.000	.002	.035	427
5	.000	.850	.000	.122	.019	.000	.000	.009	427

Table 3.3 Sample divided by birthplace: Incidence of digital pattern types: Welsh

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.001	.734	.002	.192	.055	.001	.016	.001	1865
2	.002	.326	.194	.278	.136	.041	.013	.010	1865
3	.002	.685	.023	.150	.115	.013	.008	.005	1865
4	.001	.597	.004	.309	.046	.004	.003	.036	1865
5	.001	.851	.000	.109	.031	.001	.000	.006	1865

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.001	.642	.002	.316	.027	.000	.010	.002	1865
2	.001	.320	.185	.315	.125	.040	.006	.008	1865
3	.001	.728	.013	.146	.091	.011	.003	.008	1865
4	.001	.508	.005	.409	.035	.001	.002	.039	1865
5	.001	.819	.001	.142	.024	.000	.001	.013	1865

Table 3.311 Sample divided by birthplace: Incidence of digital pattern types: Port Talbot: Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.050	.700	.000	.250	.000	.000	.000	.000	20
2	.100	.350	.150	.150	.150	.100	.000	.000	20
3	.050	.750	.000	.100	.100	.000	.000	.000	20
4	.050	.500	.000	.300	.100	.000	.000	.050	20
5	.050	.700	.000	.200	.050	.000	.000	.000	20

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.450	.000	.550	.000	.000	.000	.000	20
2	.000	.250	.200	.300	.100	.150	.000	.000	20
3	.000	.800	.000	.100	.100	.000	.000	.000	20
4	.000	.600	.000	.350	.050	.000	.000	.000	20
5	.000	.750	.000	.250	.000	.000	.000	.000	20

Table 3.312 Sample divided by birthplace: Incidence of digital pattern types: Port Talbot: Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.596	.000	.298	.106	.000	.000	.000	47
2	.000	.319	.213	.277	.128	.043	.021	.000	47
3	.000	.638	.064	.170	.106	.000	.021	.000	47
4	.000	.574	.000	.383	.043	.000	.000	.000	47
5	.000	.851	.000	.106	.021	.000	.000	.000	47

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.450	.000	.550	.000	.000	.000	.000	47
2	.000	.340	.191	.319	.128	.021	.000	.000	47
3	.000	.766	.000	.149	.085	.000	.000	.000	47
4	.000	.468	.000	.468	.021	.000	.000	.043	47
5	.000	.745	.000	.191	.043	.000	.000	.021	47

Table 3.313 Sample divided by birthplace: Incidence of digital pattern types: Port Talbot: Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.015	.627	.000	.284	.075	.000	.000	.000	67
2	.030	.328	.194	.239	.134	.060	.015	.000	67
3	.015	.672	.045	.149	.104	.000	.015	.000	67
4	.015	.552	.000	.358	.060	.000	.000	.015	67
5	.015	.806	.000	.134	.030	.000	.000	.015	67

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.463	.000	.463	.060	.000	.015	.000	67
2	.000	.313	.194	.313	.119	.060	.000	.000	67
3	.000	.776	.000	.134	.090	.000	.000	.000	67
4	.000	.507	.000	.433	.030	.000	.000	.030	67
5	.000	.746	.000	.209	.030	.000	.000	.015	67

Table 3.321 Sample divided by birthplace: Incidence of digital pattern types: Bridgend: Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.638	.000	.310	.034	.000	.017	.000	58
2	.000	.293	.155	.414	.103	.034	.000	.000	58
3	.000	.672	.000	.172	.103	.034	.017	.000	58
4	.000	.569	.000	.379	.017	.000	.017	.017	58
5	.000	.862	.000	.086	.000	.017	.000	.034	58

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.500	.000	.466	.017	.000	.000	.017	58
2	.000	.224	.345	.293	.121	.000	.000	.017	58
3	.000	.690	.000	.155	.121	.000	.000	.034	58
4	.000	.534	.000	.431	.017	.000	.000	.017	58
5	.000	.828	.000	.155	.000	.000	.000	.017	58

Table 3.322 Sample divided by birthplace: Incidence of digital pattern types: Bridgend: Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.765	.000	.157	.059	.000	.020	.000	51
2	.000	.294	.176	.333	.157	.020	.020	.000	51
3	.000	.667	.039	.137	.157	.000	.000	.000	51
4	.000	.569	.000	.314	.078	.000	.000	.039	51
5	.000	.882	.000	.078	.039	.000	.000	.000	51

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.667	.000	.314	.020	.000	.000	.000	51
2	.000	.224	.345	.293	.121	.000	.000	.170	51
3	.000	.824	.000	.118	.059	.000	.000	.000	51
4	.000	.588	.000	.333	.020	.000	.000	.059	51
5	.000	.961	.000	.020	.000	.000	.000	.020	51

Table 3.323 Sample divided by birthplace: Incidence of digital pattern types: Bridgend: Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.697	.000	.239	.046	.009	.018	.000	109
2	.000	.294	.165	.376	.128	.028	.009	.000	109
3	.000	.670	.018	.156	.128	.018	.009	.000	109
4	.000	.569	.000	.349	.046	.000	.009	.028	109
5	.000	.872	.000	.083	.018	.009	.000	.018	109

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.578	.000	.394	.018	.000	.000	.009	109
2	.000	.303	.239	.312	.128	.009	.000	.009	109
3	.000	.752	.000	.138	.092	.000	.000	.018	109
4	.000	.560	.000	.385	.018	.000	.000	.037	109
5	.000	.890	.000	.092	.000	.000	.000	.018	109

Table 3.331 Sample divided by birthplace: Incidence of digital pattern types: Merthyr Tydfil

Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.821	.018	.107	.054	.000	.000	.000	56
2	.000	.339	.232	.304	.089	.018	.000	.018	56
3	.000	.732	.036	.125	.089	.018	.000	.000	56
4	.000	.643	.000	.232	.071	.000	.000	.054	56
5	.000	.929	.000	.054	.018	.000	.000	.000	56

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.714	.000	.250	.036	.000	.000	.000	56
2	.000	.268	.196	.304	.143	.089	.000	.000	56
3	.000	.679	.000	.179	.125	.000	.000	.018	56
4	.000	.607	.000	.304	.036	.000	.000	.054	56
5	.000	.839	.000	.107	.036	.000	.000	.018	56

Table 3.332: Sample divided by birthplace: Incidence of digital pattern types: Merthyr Tydfil

Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.765	.000	.162	.074	.000	.000	.000	68
2	.000	.379	.176	.265	.191	.044	.015	.029	68
3	.000	.676	.000	.103	.206	.000	.000	.015	68
4	.000	.647	.000	.279	.015	.000	.000	.059	68
5	.000	.882	.000	.088	.029	.000	.000	.000	68

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.721	.000	.279	.000	.000	.000	.000	68
2	.000	.397	.176	.265	.132	.015	.000	.015	68
3	.000	.809	.000	.103	.059	.015	.000	.015	68
4	.000	.647	.000	.294	.015	.000	.000	.070	68
5	.000	.897	.000	.088	.015	.000	.000	.000	68

Table 3.333: Sample divided by birthplace: Incidence of digial pattern types: Merthyr Tydfil

Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.790	.008	.137	.065	.000	.000	.000	128
2	.000	.306	.202	.282	.145	.032	.008	.024	128
3	.000	.702	.016	.113	.153	.008	.000	.008	128
4	.000	.645	.000	.258	.040	.000	.000	.056	128
5	.000	.903	.000	.073	.024	.000	.000	.000	128

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.718	.000	.266	.016	.000	.000	.000	128
2	.000	.339	.185	.282	.137	.048	.000	.008	128
3	.000	.750	.000	.137	.089	.008	.000	.016	128
4	.000	.629	.000	.298	.024	.000	.000	.048	128
5	.000	.871	.000	.097	.024	.000	.000	.008	128

Table 3.341: Sample divided by birthplace: Incidence of digital pattern types: Llanelli: Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.805	.000	.098	.073	.000	.024	.000	41
2	.000	.293	.317	.195	.098	.098	.000	.000	41
3	.000	.707	.024	.146	.098	.024	.000	.000	41
4	.000	.683	.000	.220	.024	.024	.000	.049	41
5	.000	.854	.000	.098	.049	.000	.000	.000	41

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.683	.000	.268	.024	.000	.024	.000	41
2	.000	.220	.171	.341	.098	.122	.024	.024	41
3	.000	.610	.049	.220	.098	.024	.000	.000	41
4	.000	.561	.000	.415	.024	.000	.000	.000	41
5	.000	.756	.000	.195	.024	.000	.000	.024	41

Table 3.342: Sample divided by birthplace: Incidence of digital patterns: Llanelli: Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.860	.000	.093	.023	.000	.023	.000	43
2	.000	.302	.116	.326	.163	.070	.023	.000	43
3	.000	.581	.047	.163	.116	.023	.047	.023	43
4	.000	.512	.000	.349	.070	.000	.023	.047	43
5	.000	.860	.000	.093	.047	.000	.000	.000	43

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.744	.000	.233	.023	.000	.000	.000	43
2	.000	.372	.140	.419	.070	.000	.000	.000	43
3	.000	.558	.023	.279	.093	.023	.000	.023	43
4	.000	.548	.000	.381	.036	.000	.000	.036	43
5	.000	.791	.000	.116	.070	.000	.000	.023	43

Table 3.343: Sample divided by birhplace: Incidence of digital pattern types: Llanelli: Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.833	.000	.095	.048	.000	.024	.000	84
2	.000	.298	.214	.262	.131	.083	.012	.000	84
3	.000	.643	.036	.155	.107	.024	.024	.012	84
4	.000	.595	.000	.286	.048	.012	.012	.048	84
5	.000	.857	.000	.095	.048	.000	.000	.000	84

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.714	.000	.250	.024	.000	.012	.000	84
2	.000	.298	.155	.381	.083	.060	.012	.012	84
3	.000	.583	.036	.250	.095	.024	.000	.012	84
4	.000	.548	.000	.381	.036	.000	.000	.036	84
5	.000	.774	.000	.155	.048	.000	.000	.024	84

Table 3.351: Sample divided by birthplace: Incidence of digital pattern types: Cardiff: Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.729	.000	.186	.051	.017	.017	.000	59
2	.000	.356	.186	.271	.119	.068	.000	.000	59
3	.000	.763	.017	.119	.102	.000	.000	.000	59
4	.000	.712	.000	.203	.051	.017	.000	.017	59
5	.000	.797	.000	.169	.034	.000	.000	.000	59

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.576	.000	.390	.034	.000	.000	.000	59
2	.000	.254	.220	.271	.169	.051	.000	.034	59
3	.000	.695	.017	.136	.119	.017	.000	.017	59
4	.000	.525	.017	.390	.017	.000	.000	.051	59
5	.000	.797	.000	.169	.017	.000	.000	.017	59

Table 3.352: Sample divided by birthplace: Incidence of digital pattern types: Cardiff: Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.576	.000	.273	.106	.000	.030	.015	66
2	.000	.303	.182	.348	.106	.045	.000	.015	66
3	.000	.652	.000	.227	.091	.015	.015	.000	66
4	.000	.515	.030	.364	.061	.000	.015	.015	66
5	.000	.758	.000	.182	.061	.000	.000	.000	66

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.652	.000	.318	.015	.000	.015	.000	66
2	.000	.273	.212	.348	.106	.045	.000	.015	66
3	.000	.788	.000	.167	.030	.000	.015	.000	66
4	.000	.424	.015	.439	.030	.000	.015	.076	66
5	.000	.788	.000	.182	.015	.000	.000	.015	66

Table 3.353: Sample divided by birthplace: Incidence of digital pattern types: Cardiff: Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.648	.000	.232	.080	.008	.024	.008	125
2	.000	.328	.184	.312	.112	.056	.000	.008	125
3	.000	.704	.008	.176	.096	.008	.008	.000	125
4	.000	.608	.016	.288	.056	.008	.008	.016	125
5	.000	.776	.000	.176	.048	.000	.000	.000	125

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.616	.000	.352	.024	.000	.008	.000	125
2	.000	.264	.216	.312	.136	.048	.000	.024	125
3	.000	.744	.008	.152	.072	.008	.008	.008	125
4	.000	.472	.016	.416	.024	.000	.008	.064	125
5	.000	.792	.000	.176	.016	.000	.000	.016	125

Table 3.361: Sample divided by birthplace: Incidence of digital pattern types: Neath: Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.872	.000	.077	.051	.000	.000	.000	39
2	.000	.308	.282	.256	.128	.026	.000	.000	39
3	.000	.744	.026	.179	.051	.000	.000	.000	39
4	.000	.667	.000	.256	.051	.000	.000	.026	39
5	.000	.897	.000	.077	.026	.000	.000	.000	39

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.026	.692	.000	.256	.026	.000	.000	.000	39
2	.026	.231	.256	.256	.128	.103	.000	.000	39
3	.026	.667	.051	.154	.077	.026	.000	.000	39
4	.026	.462	.000	.385	.051	.000	.000	.077	39
5	.026	.769	.000	.179	.026	.000	.000	.000	39

Table 3.362: Sample divided by birthplace: Incidence of digital pattern types: Neath: Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.583	.000	.292	.125	.000	.000	.000	24
2	.000	.292	.167	.250	.208	.083	.000	.000	24
3	.000	.625	.042	.208	.125	.000	.000	.000	24
4	.000	.542	.000	.375	.083	.000	.000	.000	24
5	.000	.833	.000	.042	.083	.000	.000	.042	24

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.625	.042	.250	.083	.000	.000	.000	24
2	.000	.250	.125	.458	.167	.000	.000	.000	24
3	.000	.750	.000	.083	.167	.000	.000	.000	24
4	.000	.250	.000	.542	.125	.000	.000	.083	24
5	.000	.667	.000	.208	.125	.000	.000	.000	24

Table 3.363: Sample divided by birthplace: Incidence of digital pattern types: Neath: Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.762	.000	.159	.079	.000	.000	.000	63
2	.000	.302	.238	.254	.159	.048	.000	.000	63
3	.000	.698	.032	.190	.079	.000	.000	.000	63
4	.000	.619	.000	.302	.063	.000	.000	.016	63
5	.000	.873	.000	.063	.048	.000	.000	.016	63

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.016	.667	.016	.254	.048	.000	.000	.000	63
2	.016	.238	.206	.333	.143	.063	.000	.000	63
3	.016	.698	.032	.127	.111	.016	.000	.000	63
4	.016	.381	.000	.444	.079	.000	.000	.079	63
5	.016	.730	.000	.190	.063	.000	.000	.000	63

Table 3.371: Sample divided by birthplace: Incidence of digital pattern types: Aberdare: Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.657	.000	.229	.086	.000	.029	.000	35
2	.000	.200	.200	.400	.086	.086	.000	.029	35
3	.000	.657	.029	.229	.029	.029	.000	.029	35
4	.000	.571	.000	.371	.000	.000	.000	.057	35
5	.000	.857	.000	.143	.000	.000	.000	.000	35

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.629	.000	.343	.029	.000	.000	.000	35
2	.000	.314	.200	.429	.000	.057	.000	.000	35
3	.000	.600	.057	.257	.029	.000	.000	.057	35
4	.000	.429	.000	.514	.000	.000	.000	.057	35
5	.000	.829	.000	.171	.000	.000	.000	.000	35

Table 3.372: Sample divided by birthplace: Incidence of digital pattern types: Aberdare: Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.800	.000	.200	.000	.000	.000	.000	25
2	.000	.360	.280	.160	.200	.000	.000	.000	25
3	.000	.640	.040	.200	.080	.040	.000	.000	25
4	.000	.600	.000	.360	.040	.000	.000	.000	25
5	.000	.800	.000	.120	.080	.000	.000	.000	25

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.760	.000	.200	.000	.000	.040	.000	25
2	.000	.280	.120	.320	.160	.040	.000	.080	25
3	.000	.720	.000	.160	.120	.000	.000	.000	25
4	.000	.520	.000	.440	.000	.000	.000	.040	25
5	.000	.800	.040	.080	.000	.000	.000	.080	25

Table 3.373: Sample divided by birthplace: Incidence of digial pattern types: Aberdare: Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.717	.000	.217	.050	.000	.017	.000	60
2	.000	.267	.233	.300	.133	.050	.000	.017	60
3	.000	.650	.033	.217	.050	.033	.000	.017	60
4	.000	.583	.000	.367	.017	.000	.000	.033	60
5	.000	.833	.000	.133	.033	.000	.000	.000	60

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.683	.000	.283	.017	.000	.017	.000	60
2	.000	.300	.167	.383	.067	.050	.000	.033	60
3	.000	.650	.033	.217	.067	.000	.000	.033	60
4	.000	.467	.000	.483	.000	.000	.000	.050	60
5	.000	.817	.017	.133	.000	.000	.000	.033	60

Table 3.381: Sample divided by birthplace: Incidence of digitalpattern types: Swansea Urban

Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.806	.000	.139	.056	.000	.000	.000	72
2	.000	.361	.194	.264	.083	.069	.014	.014	72
3	.000	.819	.028	.097	.056	.000	.000	.000	72
4	.000	.653	.000	.319	.014	.000	.000	.014	72
5	.000	.889	.000	.097	.014	.000	.000	.000	72

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.014	.667	.000	.292	.028	.000	.000	.000	72
2	.000	.278	.222	.319	.097	.083	.000	.000	72
3	.000	.750	.028	.167	.042	.014	.000	.000	72
4	.000	.569	.000	.357	.014	.000	.000	.042	72
5	.000	.847	.000	.139	.000	.000	.014	.000	72

Table 3.382: Sample divided by birthplace: Incidence of digital pattern types: Swansea Urban

Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.766	.000	.177	.051	.000	.006	.000	158
2	.000	.291	.215	.291	.133	.032	.019	.019	158
3	.000	.658	.019	.158	.120	.025	.006	.013	158
4	.000	.582	.000	.323	.051	.000	.006	.038	158
5	.000	.861	.000	.101	.038	.000	.000	.000	158

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.684	.000	.278	.013	.000	.025	.000	158
2	.000	.342	.165	.297	.133	.038	.013	.013	158
3	.000	.785	.000	.095	.095	.013	.006	.006	158
4	.000	.595	.000	.316	.038	.000	.013	.038	158
5	.000	.835	.000	.127	.019	.000	.000	.019	158

Table 3.383: Sample divided by birthplace: Incidence of digital pattern types: Swansea Urban

Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.778	.000	.165	.052	.000	.004	.000	230
2	.000	.313	.209	.283	.117	.043	.017	.017	230
3	.000	.709	.022	.139	.100	.017	.004	.009	230
4	.000	.604	.000	.322	.039	.000	.004	.030	230
5	.000	.870	.000	.100	.030	.000	.000	.000	230

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.004	.678	.000	.283	.017	.000	.017	.000	230
2	.000	.322	.183	.304	.122	.052	.009	.009	230
3	.000	.774	.009	.117	.078	.013	.004	.004	230
4	.000	.587	.000	.335	.030	.000	.009	.039	230
5	.000	.839	.000	.130	.013	.000	.004	.013	230

Table 3.391: Sample divided by birthplace: Incidence of digital pattern types: Rhondda: Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.735	.000	.118	.059	.000	.088	.000	34
2	.000	.471	.206	.176	.059	.059	.029	.000	34
3	.000	.735	.000	.088	.176	.000	.000	.000	34
4	.000	.588	.000	.324	.059	.000	.000	.029	34
5	.000	.794	.000	.206	.000	.000	.000	.000	34

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.618	.000	.265	.029	.000	.088	.000	34
2	.000	.382	.206	.324	.059	.029	.000	.000	34
3	.000	.647	.000	.176	.176	.000	.000	.000	34
4	.000	.500	.000	.382	.059	.000	.000	.059	34
5	.000	.706	.000	.294	.000	.000	.000	.000	34

Table 3.392: Sample divided by birthplace: Incidence of digital pattern types: Rhondda: Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.714	.000	.229	.029	.000	.029	.000	35
2	.000	.429	.257	.171	.143	.000	.000	.000	35
3	.000	.743	.057	.143	.057	.000	.000	.000	35
4	.000	.657	.000	.286	.000	.000	.000	.057	35
5	.000	.829	.000	.171	.000	.000	.000	.000	35

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.714	.000	.286	.000	.000	.000	.000	35
2	.000	.429	.086	.314	.143	.029	.000	.000	35
3	.000	.829	.086	.057	.029	.000	.000	.000	35
4	.000	.514	.029	.371	.029	.000	.000	.057	35
5	.000	.857	.000	.114	.000	.000	.000	.029	35

Table 3.393: Sample divided by birthplace: Incidence of digital pattern types: Rhondda: Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.725	.000	.174	.043	.000	.058	.000	69
2	.000	.449	.232	.174	.101	.029	.014	.000	69
3	.000	.739	.029	.116	.116	.000	.000	.000	69
4	.000	.623	.000	.304	.029	.000	.000	.043	69
5	.000	.812	.000	.188	.000	.000	.000	.000	69

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.667	.000	.275	.014	.000	.043	.000	69
2	.000	.406	.145	.319	.101	.029	.000	.000	69
3	.000	.739	.043	.116	.101	.000	.000	.000	69
4	.000	.507	.014	.377	.043	.000	.000	.058	69
5	.000	.783	.000	.203	.000	.000	.000	.014	69

Table 3.3101: Sample divided by birthplace: Incidence of digital pattern types: Swansea Valley

Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.739	.000	.174	.000	.000	.087	.000	23
2	.000	.261	.043	.478	.087	.000	.043	.087	23
3	.000	.783	.000	.130	.043	.000	.043	.000	23
4	.000	.565	.000	.348	.043	.000	.000	.043	23
5	.000	.913	.000	.087	.000	.000	.000	.000	23

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.565	.000	.435	.000	.000	.000	.000	23
2	.000	.217	.261	.435	.087	.000	.000	.000	23
3	.000	.783	.000	.174	.043	.000	.000	.000	23
4	.000	.478	.000	.478	.043	.000	.000	.000	23
5	.000	.826	.000	.087	.043	.000	.000	.043	23

Table 3.3102: Sample divided by birthplace: Incidence of digital pattern types: Swansea Valley

Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.684	.000	.211	.105	.000	.000	.000	19
2	.000	.474	.053	.263	.105	.053	.000	.053	19
3	.000	.579	.000	.263	.105	.000	.000	.053	19
4	.000	.526	.000	.421	.053	.000	.000	.000	19
5	.000	.737	.000	.211	.053	.000	.000	.000	19

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.632	.000	.316	.053	.000	.000	.000	19
2	.000	.368	.053	.474	.105	.000	.000	.000	19
3	.000	.684	.000	.263	.053	.000	.000	.000	19
4	.000	.474	.000	.526	.000	.000	.000	.000	19
5	.000	.789	.000	.211	.000	.000	.000	.000	19

Table 3.3103: Sample divided by birthplace: Incidence of digital pattern types: Swansea Valley

Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.714	.000	.190	.048	.000	.048	.000	42
2	.000	.357	.048	.381	.095	.024	.024	.071	42
3	.000	.690	.000	.190	.071	.000	.024	.024	42
4	.000	.548	.000	.381	.048	.000	.000	.024	42
5	.000	.833	.000	.143	.024	.000	.000	.000	42

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.595	.000	.381	.024	.000	.000	.000	42
2	.000	.286	.167	.452	.095	.000	.000	.000	42
3	.000	.738	.000	.214	.048	.000	.000	.000	42
4	.000	.476	.000	.500	.024	.000	.000	.000	42
5	.000	.810	.000	.143	.024	.000	.000	.024	42

Table 3.3111: Sample divided by birthplace: Incidence of digital pattern types: Gower: Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.810	.000	.095	.095	.000	.000	.000	21
2	.000	.286	.286	.143	.190	.095	.000	.000	21
3	.000	.524	.000	.190	.190	.095	.000	.000	21
4	.000	.667	.000	.190	.095	.000	.000	.048	21
5	.000	.810	.000	.143	.048	.000	.000	.000	21

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.714	.000	.286	.000	.000	.000	.000	21
2	.000	.143	.190	.238	.238	.143	.000	.048	21
3	.000	.714	.000	.143	.095	.048	.000	.000	21
4	.000	.571	.000	.381	.048	.000	.000	.000	21
5	.000	.857	.000	.143	.000	.000	.000	.000	21

Table 3.3112: Sample divided by birthplace: Incidence of digital pattern types: Gower: Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.769	.000	.321	.000	.000	.000	.000	13
2	.000	.308	.077	.077	.538	.000	.000	.000	13
3	.000	.692	.000	.000	.308	.000	.000	.000	13
4	.000	.692	.000	.154	.154	.000	.000	.000	13
5	.000	.846	.000	.000	.154	.000	.000	.000	13

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.769	.000	.321	.000	.000	.000	.000	13
2	.000	.321	.077	.321	.385	.077	.000	.000	13
3	.000	.692	.000	.000	.321	.077	.000	.000	13
4	.000	.769	.000	.321	.000	.000	.000	.000	13
5	.000	.846	.000	.077	.077	.000	.000	.000	13

Table 3.3113: Sample divided by birthplace: Incidence of digital pattern types: Gower: Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.794	.000	.147	.059	.000	.000	.000	34
2	.000	.294	.206	.118	.324	.059	.000	.000	34
3	.000	.588	.000	.118	.235	.059	.000	.000	34
4	.000	.676	.000	.176	.118	.000	.000	.029	34
5	.000	.824	.000	.088	.088	.000	.000	.000	34

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.735	.000	.265	.000	.000	.000	.000	34
2	.000	.176	.147	.235	.294	.118	.000	.029	34
3	.000	.706	.000	.088	.147	.059	.000	.000	34
4	.000	.647	.000	.324	.029	.000	.000	.000	34
5	.000	.853	.000	.118	.029	.000	.000	.000	34

Table 3.3121: Sample divided by birthplace: Incidence of digital pattern types: Treorchy: Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.533	.000	.467	.000	.000	.000	.000	15
2	.000	.400	.200	.267	.000	.133	.000	.000	15
3	.000	.667	.000	.333	.000	.000	.000	.000	15
4	.000	.600	.000	.400	.000	.000	.000	.000	15
5	.000	.733	.000	.267	.000	.000	.000	.000	15

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.467	.000	.533	.000	.000	.000	.000	15
2	.000	.267	.067	.600	.000	.067	.000	.000	15
3	.000	.667	.000	.333	.000	.000	.000	.000	15
4	.000	.533	.000	.467	.000	.000	.000	.000	15
5	.000	.800	.000	.200	.000	.000	.000	.000	15

Table 3.3122: Sample divided by birthplace: Incidence of digital pattern types: Treorchy: Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.600	.000	.300	.100	.000	.000	.000	10
2	.000	.400	.100	.300	.100	.100	.000	.000	10
3	.100	.800	.000	.000	.100	.000	.000	.000	10
4	.000	.600	.100	.200	.100	.000	.000	.000	10
5	.000	.800	.000	.200	.000	.000	.000	.000	10

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.700	.000	.300	.000	.000	.000	.000	10
2	.000	.100	.200	.500	.200	.000	.000	.000	10
3	.000	.800	.000	.100	.100	.000	.000	.000	10
4	.000	.400	.000	.500	.000	.000	.000	.100	10
5	.000	.900	.000	.100	.000	.000	.000	.000	10

Table 3.3123: Sample divided by birthplace: incidence of digital pattern types: Treorchy: Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.560	.000	.400	.040	.000	.000	.000	25
2	.000	.400	.160	.280	.040	.120	.000	.000	25
3	.040	.720	.000	.200	.040	.000	.000	.000	25
4	.000	.600	.040	.320	.040	.000	.000	.000	25
5	.000	.760	.000	.240	.000	.000	.000	.000	25

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.560	.000	.440	.000	.000	.000	.000	25
2	.000	.200	.120	.560	.080	.040	.000	.000	25
3	.000	.720	.000	.240	.040	.000	.000	.000	25
4	.000	.480	.000	.480	.000	.000	.000	.040	25
5	.000	.840	.000	.160	.000	.000	.000	.000	25

Table 3.3131: Sample divided by birthplace: Incidence of digital pattern types : Porth: Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.800	.000	.200	.000	.000	.000	.000	5
2	.000	.400	.200	.000	.200	.000	.200	.000	5
3	.000	.800	.000	.200	.000	.000	.000	.000	5
4	.000	.600	.000	.400	.000	.000	.000	.000	5
5	.000	.800	.000	.200	.000	.000	.000	.000	5

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.800	.000	.200	.000	.000	.000	.000	5
2	.000	.600	.200	.200	.000	.000	.000	.000	5
3	.000	1.000	.000	.000	.000	.000	.000	.000	5
4	.000	.400	.000	.600	.000	.000	.000	.000	5
5	.000	.600	.000	.400	.000	.000	.000	.000	5

Table 3.3132: Sample divided by birthplace: Incidence of digital pattern types: Porth: Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.833	.000	.167	.000	.000	.000	.000	6
2	.000	.500	.000	.333	.167	.000	.000	.000	6
3	.000	.833	.167	.000	.000	.000	.000	.000	6
4	.000	.667	.000	.333	.000	.000	.000	.000	6
5	.000	1.000	.000	.000	.000	.000	.000	.000	6

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.667	.000	.333	.000	.000	.000	.000	6
2	.000	.500	.000	.333	.167	.000	.000	.000	6
3	.000	1.000	.000	.000	.000	.000	.000	.000	6
4	.000	.500	.000	.500	.000	.000	.000	.000	6
5	.000	1.000	.000	.000	.000	.000	.000	.000	6

Table 3.3133: Sample divided by birthplace: Incidence of digital pattern types: Porth: Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.818	.000	.182	.000	.000	.000	.000	11
2	.000	.455	.091	.182	.182	.000	.091	.000	11
3	.000	.818	.091	.091	.000	.000	.000	.000	11
4	.000	.636	.000	.364	.000	.000	.000	.000	11
5	.000	.909	.000	.091	.000	.000	.000	.000	11

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.727	.000	.273	.000	.000	.000	.000	11
2	.000	.545	.091	.273	.091	.000	.000	.000	11
3	.000	1.000	.000	.000	.000	.000	.000	.000	11
4	.000	.455	.000	.545	.000	.000	.000	.000	11
5	.000	.818	.000	.182	.000	.000	.000	.000	11

Table 3.3141: Sample divided by birthplace: Incidence of digital pattern types: Tonypandy: Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.667	.000	.167	.000	.000	.167	.000	6
2	.000	.500	.333	.167	.000	.000	.000	.000	6
3	.000	.833	.000	.167	.000	.000	.000	.000	6
4	.000	.833	.000	.167	.000	.000	.000	.000	6
5	.000	1.000	.000	.000	.000	.000	.000	.000	6

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.500	.000	.500	.000	.000	.000	.000	6
2	.000	.500	.333	.000	.167	.000	.000	.000	6
3	.000	1.000	.000	.000	.000	.000	.000	.000	6
4	.000	.333	.000	.667	.000	.000	.000	.000	6
5	.000	1.000	.000	.000	.000	.000	.000	.000	6

Table 3.3142: Sample divided by birthplace: Incidence of digital pattern types: Tonypandy: Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.400	.000	.400	.200	.000	.000	.000	5
2	.000	.000	.000	.600	.200	.000	.000	.200	5
3	.000	.800	.000	.000	.200	.000	.000	.000	5
4	.000	.600	.000	.400	.000	.000	.000	.000	5
5	.000	.800	.000	.200	.000	.000	.000	.000	5

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.400	.000	.600	.000	.000	.000	.000	5
2	.000	.200	.400	.400	.000	.000	.000	.000	5
3	.000	.800	.000	.000	.200	.000	.000	.000	5
4	.000	.400	.000	.600	.000	.000	.000	.000	5
5	.000	.800	.000	.200	.000	.000	.000	.000	5

Table 3.3143: Sample divided by birthplace: Incidence of digital pattern types: Tonypandy: Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.545	.000	.273	.091	.000	.091	.000	11
2	.000	.273	.182	.364	.091	.000	.000	.091	11
3	.000	.818	.000	.091	.091	.000	.000	.000	11
4	.000	.727	.000	.273	.000	.000	.000	.000	11
5	.000	.909	.000	.091	.000	.000	.000	.000	11

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.455	.000	.545	.000	.000	.000	.000	11
2	.000	.364	.364	.182	.091	.000	.000	.000	11
3	.000	.909	.000	.000	.091	.000	.000	.000	11
4	.000	.364	.000	.636	.000	.000	.000	.000	11
5	.000	.909	.000	.091	.000	.000	.000	.000	11

Table 3.3151: Sample divided by birthplace: Incidence of digital pattern types: Carmarthen: Males

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.500	.000	.500	.000	.000	.000	.000	4
2	.000	.000	.000	.500	.250	.000	.000	.250	4
3	.000	.750	.000	.000	.250	.000	.000	.000	4
4	.000	.500	.000	.250	.000	.000	.000	.250	4
5	.000	.750	.000	.250	.000	.000	.000	.000	4

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.500	.000	.500	.000	.000	.000	.000	4
2	.000	.250	.000	.250	.250	.250	.000	.000	4
3	.000	.750	.000	.250	.000	.000	.000	.000	4
4	.000	.500	.000	.250	.250	.000	.000	.000	4
5	.000	.250	.000	.250	.250	.000	.000	250	4

Table 3.3152: Sample divided by birthplace: incidence of digital pattern types: Carmarthen: Females

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.833	.000	.167	.000	.000	.000	.000	6
2	.000	.167	.167	.167	.167	.167	.000	.167	6
3	.000	.500	.167	.000	.167	.167	.000	.000	6
4	.000	.667	.000	.167	.000	.167	.000	.000	6
5	.000	1.000	.000	.000	.000	.000	.000	.000	6

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.833	.000	.167	.000	.000	.000	.000	6
2	.000	.333	.167	.167	.167	.167	.000	.000	6
3	.000	1.000	.000	.000	.000	.000	.000	.000	6
4	.000	.833	.000	.167	.000	.000	.000	.000	6
5	.000	1.000	.000	.000	.000	.000	.000	.000	6

Table 3.3153: Sample divided by birthplace: Incidence of digital pattern types: Carmarthen: Total

Left Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.700	.000	.300	.000	.000	.000	.000	10
2	.000	.100	.100	.300	.200	.100	.000	.200	10
3	.000	.600	.100	.000	.200	.100	.000	.000	10
4	.000	.600	.000	.200	.000	.100	.000	.100	10
5	.000	.900	.000	.100	.000	.000	.000	.000	10

Right Hand

digit	Abs	L^u	L^r	W	A	TA	TL	CPL	N
1	.000	.700	.000	.300	.000	.000	.000	.000	10
2	.000	.300	.100	.200	.200	.200	.000	.000	10
3	.000	.900	.000	.100	.000	.000	.000	.000	10
4	.000	.700	.000	.200	.100	.000	.000	.000	10
5	.000	.700	.000	.100	.100	.000	.000	.100	10

Table 3.301: Total palmar ridge counts: Area summary statistics: Males and Females

Area	Left Hand			Right Hand		
	mean	sd	N	mean	sd	N
Port Talbot	88.46	15.52	65	91.15	13.75	67
Bridgend	92.14	13.10	109	94.07	12.52	109
Merthyr Tydfil	98.04	12.93	124	97.31	12.17	124
Llanelli	94.00	12.38	84	94.67	11.95	84
Cardiff	95.10	13.10	125	96.12	13.04	125
Neath	90.51	15.53	63	92.95	14.26	62
Aberdare	96.20	13.55	60	97.65	13.26	60
Swansea Urban	95.90	13.02	230	96.51	13.09	229
Rhondda	88.07	14.89	69	90.51	13.14	69
Swansea Valley	92.26	11.33	42	92.67	11.03	42
Gower	96.41	10.38	34	96.59	9.55	34
Treorchy	91.08	15.02	24	91.72	13.99	25
Porth	92.36	9.93	11	91.73	8.93	11
Tonypandy	82.27	21.32	11	84.73	18.59	11
Carmarthen	97.70	14.08	10	96.00	18.18	10

Table 3.302: atd angle: Area summary statistics: Males and Females combined

Area	Left Hand			Right Hand		
	mean	sd	N	mean	sd	N
Port Talbot	41.63	7.53	63	41.00	6.07	64
Bridgend	41.60	5.76	109	42.63	7.09	107
Merthyr Tydfil	42.49	6.81	122	42.69	8.10	124
Llanelli	40.71	4.62	83	41.36	5.73	81
Cardiff	41.30	5.91	125	41.13	5.10	123
Neath	42.03	6.73	63	41.87	6.76	62
Aberdare	40.83	6.25	60	40.17	5.95	60
Swansea Urban	41.49	6.70	227	41.46	6.61	225
Rhondda	41.68	5.32	69	41.32	5.05	69
Swansea Valley	40.12	6.14	42	40.55	8.65	42
Gower	40.50	4.67	34	40.09	5.54	33
Treorchy	41.92	4.76	24	40.60	4.60	25
Porth	40.82	4.07	11	41.36	4.59	11
Tonypandy	39.73	6.15	11	39.36	3.61	11
Carmarthen	42.40	5.42	10	43.70	6.60	10

Table 3.3031: Incidence of palmar pattern types: Area Summary Statistics: Males

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.950	.050	.000	20	1.000	.000	.000	20
Bridgend	.932	.069	.000	58	1.000	.000	.000	58
Merthyr Tydfil	.964	.036	.000	56	1.000	.000	.000	56
Llanelli	.975	.025	.000	41	1.000	.000	.000	41
Cardiff	.983	.017	.000	59	1.000	.000	.000	59
Neath	.898	.103	.000	39	1.000	.000	.000	39
Aberdare	1.000	.000	.000	35	1.000	.000	.000	35
Swansea Urban	.986	.014	.000	72	1.000	.000	.000	72
Rhondda	1.000	.000	.000	34	1.000	.000	.000	34
Swansea Valley	1.000	.000	.000	23	1.000	.000	.000	23
Gower	1.000	.000	.000	21	1.000	.000	.000	21
Treorchy	.933	.067	.000	15	1.000	.000	.000	15
Porth	1.000	.000	.000	5	1.000	.000	.000	5
Carmarthen	.750	.250	.000	4	1.000	.000	.000	4
Tonypandy	.833	.167	.000	6	1.000	.000	.000	6

Table 3.3032: Incidence of palmar pattern type I: Area Summary Statistics: Female

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.978	.021	.000	47	1.000	.000	.000	47
Bridgend	1.000	.000	.000	51	1.000	.000	.000	51
Merthyr Tydfil	1.000	.000	.000	68	1.000	.000	.000	68
Llanelli	.973	.023	.000	43	1.000	.000	.000	43
Cardiff	.985	.015	.000	66	1.000	.000	.000	66
Neath	1.000	.000	.000	24	.958	.042	.000	24
Aberdare	1.000	.000	.000	25	1.000	.000	.000	25
Swansea Urban	.962	.038	.000	158	1.000	.000	.000	158
Rhondda	1.000	.000	.000	35	.971	.029	.000	35
Swansea Valley	1.000	.000	.000	19	1.000	.000	.000	19
Gower	1.000	.000	.000	13	1.000	.000	.000	13
Treorchy	1.000	.000	.000	10	1.000	.000	.000	10
Porth	1.000	.000	.000	6	1.000	.000	.000	6
Tonypandy	1.000	.000	.000	5	.800	.200	.000	5
Carmarthen	1.000	.000	.000	6	1.000	.000	.000	6

Table 3.3033: Incidence of palmar pattern I: Area Summary Statistics: Total

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.970	.030	.000	67	1.000	.000	.000	67
Bridgend	.963	.037	.000	109	1.000	.000	.000	109
Merthyr Tydfil	.984	.016	.000	124	1.000	.000	.000	124
Llanelli	.976	.024	.000	84	1.000	.000	.000	84
Cardiff	.984	.016	.000	125	1.000	.000	.000	125
Neath	.937	.063	.000	63	.984	.016	.000	63
Aberdare	1.000	.000	.000	60	1.000	.000	.000	60
Swansea Urban	.970	.030	.000	230	1.000	.000	.000	230
Rhondda	1.000	.000	.000	69	.986	.014	.000	69
Swansea Valley	1.000	.000	.000	42	1.000	.000	.000	42
Gower	1.000	.000	.000	34	1.000	.000	.000	34
Treorchy	.960	.040	.000	25	1.000	.000	.000	25
Porth	1.000	.000	.000	11	1.000	.000	.000	11
Tonypandy	.909	.091	.000	11	.909	.091	.000	11
Carmarthen	.900	.100	.000	10	1.000	.000	.000	10

Table 3.3041: Incidence of palmar pattern I^r: Area Summary Statistics: Males

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.850	.150	.000	20	.850	.150	.000	20
Bridgend	.897	.103	.000	58	.987	.017	.000	58
Merthyr Tydfil	1.000	.000	.000	56	.982	.018	.000	56
Llanelli	.926	.074	.000	41	.976	.024	.000	41
Cardiff	.898	.102	.000	59	.966	.034	.000	59
Neath	.847	.153	.000	39	.923	.077	.000	39
Aberdare	.886	.114	.000	35	.943	.057	.000	35
Swansea Urban	.947	.053	.000	72	.972	.028	.000	72
Rhondda	.941	.059	.000	34	.971	.029	.000	34
Swansea Valley	1.000	.000	.000	23	1.000	.000	.000	23
Gower	.952	.048	.000	21	1.000	.000	.000	21
Treorchy	1.000	.000	.000	15	1.000	.000	.000	15
Porth	1.000	.000	.000	5	1.000	.000	.000	5
Tonypandy	1.000	.000	.000	6	1.000	.000	.000	6
Carmarthen	1.000	.000	.000	4	1.000	.000	.000	4

Table 3.3042: Incidence of palmar pattern I^r: Area Summary Statistics: Females

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.958	.042	.000	47	.957	.043	.000	47
Bridgend	.941	.059	.000	51	.980	.020	.000	51
Merthyr Tydfil	.971	.029	.000	68	.985	.015	.000	68
Llanelli	.954	.046	.000	43	.953	.046	.000	43
Cardiff	.894	.106	.000	66	.970	.030	.000	66
Neath	.917	.083	.000	24	.958	.042	.000	24
Aberdare	.960	.040	.000	25	1.000	.000	.000	25
Swansea Urban	.930	.070	.000	158	.987	.013	.000	158
Rhondda	1.000	.000	.000	35	.971	.029	.000	35
Swansea Valley	.947	.053	.000	19	.947	.053	.000	19
Gower	.846	.154	.000	13	.923	.077	.000	13
Treorchy	.900	.100	.000	10	1.000	.000	.000	10
Porth	1.000	.000	.000	6	1.000	.000	.000	6
Tonypandy	.800	.200	.000	5	1.000	.000	.000	5
Carmarthen	1.000	.000	.000	6	1.000	.000	.000	6

Table 3.3043: Incidence of palmar pattern I^r: Area Summary Statistics: Total

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.925	.075	.000	65	1.000	.000	.000	67
Bridgend	.917	.083	.000	109	.982	.018	.000	109
Merthyr Tydfil	.984	.016	.000	124	.984	.016	.000	124
Llanelli	.940	.060	.000	84	.964	.036	.000	84
Cardiff	.896	.104	.000	125	.968	.032	.000	125
Neath	.873	.127	.000	63	.937	.063	.000	63
Aberdare	.917	.083	.000	60	.967	.033	.000	60
Swansea Urban	.934	.066	.000	230	.983	.017	.000	230
Rhondda	.971	.029	.000	69	.971	.029	.000	69
Swansea Valley	.976	.024	.000	42	.976	.024	.000	42
Gower	.912	.078	.000	34	.971	.029	.000	34
Treorchy	.960	.040	.000	25	1.000	.000	.000	25
Porth	1.000	.000	.000	11	1.000	.000	.000	11
Tonypandy	.909	.091	.000	11	1.000	.000	.000	11
Carmarthen	1.000	.000	.000	10	1.000	.000	.000	10

Table 3.3041: Incidence of palmar pattern II: Area Summary Statistics: Males

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.950	.050	.000	20	.950	.050	.000	20
Bridgend	1.000	.000	.000	58	.966	.034	.000	58
Merthyr Tydfil	.982	.018	.000	56	.946	.054	.000	56
Llanelli	.976	.024	.000	41	.927	.073	.000	41
Cardiff	.983	.017	.000	59	.949	.051	.000	59
Neath	.974	.026	.000	39	.949	.051	.000	39
Aberdare	.943	.057	.000	35	.914	.086	.000	35
Swansea Urban	1.000	.000	.000	72	.944	.056	.000	72
Rhondda	.941	.059	.000	34	.853	.147	.000	34
Swansea Valley	1.000	.000	.000	23	.957	.043	.000	23
Gower	1.000	.000	.000	21	.952	.048	.000	21
Treorchy	.933	.067	.000	15	.867	.133	.000	15
Porth	1.000	.000	.000	5	1.000	.000	.000	5
Tonypandy	1.000	.000	.000	6	.833	.167	.000	6
Carmarthen	.750	.250	.000	4	1.000	.000	.000	4

Table 3.3042: Incidence of palmar pattern II: Area Summary Statistics: Females

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.979	.021	.000	47	.957	.043	.000	47
Bridgend	.980	.020	.000	51	.961	.039	.000	51
Merthyr Tydfil	1.000	.000	.000	68	.956	.044	.000	68
Llanelli	1.000	.000	.000	43	.930	.070	.000	43
Cardiff	.970	.030	.000	66	.970	.030	.000	66
Neath	1.000	.000	.000	24	.875	.125	.000	24
Aberdare	1.000	.000	.000	25	1.000	.000	.000	25
Swansea Urban	.987	.013	.000	158	.975	.025	.000	158
Rhondda	1.000	.000	.000	35	1.000	.000	.000	35
Swansea Valley	1.000	.000	.000	19	.947	.053	.000	19
Gower	.846	.154	.000	13	.923	.077	.000	13
Treorchy	1.000	.000	.000	10	.800	.200	.000	10
Porth	1.000	.000	.000	6	1.000	.000	.000	6
Tonypandy	1.000	.000	.000	5	.800	.200	.000	5
Carmarthen	1.000	.000	.000	6	1.000	.000	.000	6

Table 3.3043: Incidence of palmar pattern II: Area Summary Statistics: Total

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.970	.030	.000	67	.955	.045	.000	67
Bridgend	.991	.009	.000	109	.963	.037	.000	109
Merthyr Tydfil	.992	.008	.000	124	.952	.048	.000	124
Llanelli	.988	.012	.000	84	.929	.071	.000	84
Cardiff	.976	.024	.000	125	.960	.040	.000	125
Neath	.984	.016	.000	63	.921	.079	.000	63
Aberdare	.967	.033	.000	60	.950	.050	.000	60
Swansea Urban	.991	.009	.000	230	.965	.035	.000	230
Rhondda	.971	.029	.000	69	.928	.072	.000	69
Swansea Valley	1.000	.000	.000	42	.952	.048	.000	42
Gower	.941	.059	.000	34	.941	.059	.000	34
Treorchy	.960	.040	.000	25	.840	.160	.000	25
Porth	1.000	.000	.000	11	1.000	.000	.000	11
Tonypandy	1.000	.000	.000	11	.818	.182	.000	11
Carmarthen	.900	.100	.000	10	1.000	.000	.000	10

Table 3.3061: Incidence of palmar pattern III: Area Summary Statistics: Males

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.700	.300	.000	20	.250	.750	.000	20
Bridgend	.672	.328	.000	58	.517	.483	.000	58
Merthyr Tydfil	.768	.232	.000	56	.482	.518	.000	56
Llanelli	.829	.171	.000	41	.537	.463	.000	41
Cardiff	.746	.254	.000	59	.508	.492	.000	59
Neath	.769	.231	.000	39	.385	.615	.000	39
Aberdare	.829	.171	.000	35	.286	.714	.000	35
Swansea Urban	.806	.194	.000	72	.472	.528	.000	72
Rhondda	.500	.500	.000	34	.294	.706	.000	34
Swansea Valley	.696	.304	.000	23	.391	.609	.000	23
Gower	.857	.143	.000	21	.619	.381	.000	21
Treorchy	.400	.600	.000	15	.333	.667	.000	15
Porth	.600	.400	.000	5	.400	.600	.000	5
Tonypandy	.833	.167	.000	6	.167	.833	.000	6
Carmarthen	1.000	.000	.000	4	.750	.250	.000	4

Table 3.3062: Incidence of palmar pattern III: Area Summary Statistics: Females

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.617	.383	.000	47	.447	.553	.000	47
Bridgend	.706	.294	.000	51	.530	.451	.020	51
Merthyr Tydfil	.691	.309	.000	68	.456	.544	.000	68
Llanelli	.767	.233	.000	43	.582	.418	.000	43
Cardiff	.818	.182	.000	66	.500	.500	.000	66
Neath	.583	.417	.000	24	.250	.750	.000	24
Aberdare	.680	.320	.000	25	.360	.640	.000	25
Swansea Urban	.781	.209	.000	158	.564	.436	.000	158
Rhondda	.743	.257	.000	35	.600	.400	.000	35
Swansea Valley	.737	.263	.000	19	.421	.579	.000	19
Gower	.769	.231	.000	13	.615	.385	.000	13
Treorchy	.400	.600	.000	10	.300	.700	.000	10
Porth	1.000	.000	.000	6	.333	.667	.000	6
Tonypandy	.400	.600	.000	5	.200	.800	.000	5
Carmarthen	.833	.167	.000	6	.500	.500	.000	6

Table 3.3063: Incidence of palmar pattern III: Area Summary Statistics: Total

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.662	.358	.000	67	.700	.300	.000	67
Bridgend	.688	.312	.000	109	.523	.468	.009	109
Merthyr Tydfil	.726	.274	.000	124	.468	.532	.000	124
Llanelli	.798	.202	.000	84	.560	.440	.000	84
Cardiff	.784	.216	.000	125	.504	.496	.000	125
Neath	.698	.302	.000	63	.333	.667	.000	63
Aberdare	.767	.233	.000	60	.317	.683	.000	60
Swansea Urban	.796	.204	.000	230	.535	.535	.000	230
Rhondda	.623	.377	.000	69	.435	.565	.000	69
Swansea Valley	.714	.286	.000	42	.405	.595	.000	42
Gower	.824	.176	.000	34	.618	.382	.000	34
Treorchy	.400	.600	.000	25	.320	.680	.000	25
Porth	.909	.091	.000	11	.364	.636	.000	11
Tonypandy	.636	.364	.000	11	.182	.818	.000	11
Carmarthen	.900	.100	.000	10	.600	.400	.000	10

Table 3.3071: Incidence of palmar pattern III^T: Area Summary Statistics: Males

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.850	.150	.000	20	.950	.050	.000	20
Bridgend	.966	.034	.000	58	.983	.017	.000	58
Merthyr Tydfil	.714	.286	.000	56	.839	.161	.000	56
Llanelli	.756	.244	.000	41	.927	.073	.000	41
Cardiff	.881	.119	.000	59	.898	.102	.000	59
Neath	.821	.179	.000	39	.974	.026	.000	39
Aberdare	.714	.286	.000	35	.914	.086	.000	35
Swansea Urban	.639	.361	.000	72	.917	.083	.000	72
Rhondda	1.000	.000	.000	34	1.000	.000	.000	34
Swansea Valley	.739	.261	.000	23	.977	.043	.000	23
Gower	.667	.333	.000	21	.972	.048	.000	21
Treorchy	.933	.067	.000	15	1.000	.000	.000	15
Porth	.800	.200	.000	5	1.000	.000	.000	5
Tonypandy	.833	.167	.000	6	1.000	.000	.000	6
Carmarthen	.250	.750	.000	4	1.000	.000	.000	4

Table 3.3072: Incidence of palmar pattern III^T: Area Summary Statistics: Females

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.957	.043	.000	47	.979	.021	.000	47
Bridgend	.941	.059	.000	51	.980	.020	.000	51
Merthyr Tydfil	.765	.235	.000	68	.868	.132	.000	68
Llanelli	.791	.209	.000	43	.930	.070	.000	43
Cardiff	.773	.227	.000	66	.909	.091	.000	66
Neath	.750	.250	.000	24	1.000	.000	.000	24
Aberdare	.760	.240	.000	25	.920	.080	.000	25
Swansea Urban	.848	.152	.000	158	.924	.076	.000	158
Rhondda	.731	.229	.000	35	.971	.029	.000	35
Swansea Valley	.789	.211	.000	19	.789	.211	.000	19
Gower	.923	.077	.000	13	.846	.154	.000	13
Treorchy	1.000	.000	.000	10	1.000	.000	.000	10
Porth	1.000	.000	.000	6	1.000	.000	.000	6
Tonypandy	1.000	.000	.000	5	1.000	.000	.000	5
Carmarthen	.667	.333	.000	6	1.000	.000	.000	6

Table 3.3073: Incidence of palmar pattern III^T: Area Summary Statistics: Total

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.925	.075	.000	67	.970	.030	.000	67
Bridgend	.954	.046	.000	109	.982	.018	.000	109
Merthyr Tydfil	.742	.258	.000	124	.855	.145	.000	124
Llanelli	.774	.226	.000	84	.929	.071	.000	84
Cardiff	.824	.176	.000	125	.904	.096	.000	125
Neath	.794	.206	.000	63	.984	.016	.000	63
Aberdare	.733	.267	.000	60	.917	.083	.000	60
Swansea Urban	.783	.217	.000	230	.922	.078	.000	230
Rhondda	.884	.116	.000	69	.986	.014	.000	69
Swansea Valley	.762	.238	.000	42	.881	.119	.000	42
Gower	.765	.235	.000	34	.912	.088	.000	34
Treorchy	.960	.040	.000	25	1.000	.000	.000	25
Porth	.909	.091	.000	11	1.000	.000	.000	11
Tonypandy	.909	.091	.000	11	1.000	.000	.000	11
Carmarthen	.500	.500	.000	10	1.000	.000	.000	10

Table 3.3081: Incidence of palmar pattern IV: Area Summary Statistics: Males

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.400	.500	.100	20	.700	.300	.000	20
Bridgend	.293	.689	.017	58	.517	.483	.000	58
Merthyr Tydfil	.464	.518	.018	56	.696	.286	.018	56
Llanelli	.390	.537	.049	41	.537	.463	.000	41
Cardiff	.356	.576	.068	59	.508	.492	.000	59
Neath	.462	.513	.026	39	.590	.411	.000	39
Aberdare	.371	.629	.000	35	.657	.343	.000	35
Swansea Urban	.514	.444	.042	72	.556	.444	.000	72
Rhondda	.500	.441	.059	34	.676	.324	.000	34
Swansea Valley	.435	.522	.043	23	.609	.391	.000	23
Gower	.429	.524	.048	21	.524	.476	.000	21
Treorchy	.333	.667	.000	15	.600	.400	.000	15
Porth	.200	.600	.200	5	.400	.600	.000	5
Tonypandy	.500	.500	.000	6	.833	.167	.000	6
Carmarthen	.750	.250	.000	4	.500	.500	.000	4

Table 3.3082: Incidence of palmar pattern IV: Area Summary Statistics: Females

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.426	.574	.000	47	.582	.418	.000	47
Bridgend	.333	.627	.039	51	.471	.510	.020	51
Merthyr Tydfil	.456	.515	.029	68	.618	.382	.000	68
Llanelli	.395	.581	.023	43	.395	.605	.000	43
Cardiff	.455	.530	.015	66	.591	.409	.000	66
Neath	.500	.458	.042	24	.750	.250	.000	24
Aberdare	.680	.320	.000	25	.760	.240	.000	25
Swansea Urban	.373	.589	.038	158	.468	.506	.025	158
Rhondda	.429	.571	.000	35	.400	.571	.029	35
Swansea Valley	.579	.421	.000	19	.842	.158	.000	19
Gower	.231	.769	.000	13	.462	.538	.000	13
Treorchy	.400	.600	.000	10	.400	.600	.000	10
Porth	.000	1.000	.000	6	.667	.167	.167	6
Tonypandy	.400	.600	.000	5	.600	.400	.000	5
Carmarthen	.667	.333	.000	6	.667	.333	.000	6

Table 3.3083: Incidence of palmar pattern IV: Area Summary Statistics: Total

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.418	.552	.030	67	.582	.418	.000	67
Bridgend	.312	.661	.028	109	.495	.495	.009	109
Merthyr Tydfil	.460	.516	.024	124	.653	.339	.008	124
Llanelli	.393	.560	.036	84	.464	.536	.000	84
Cardiff	.408	.552	.040	125	.552	.448	.000	125
Neath	.508	.460	.032	63	.651	.349	.000	63
Aberdare	.500	.500	.000	60	.700	.300	.000	60
Swansea Urban	.417	.544	.039	230	.495	.487	.017	230
Rhondda	.464	.507	.029	69	.536	.449	.014	69
Swansea Valley	.500	.476	.024	42	.714	.286	.000	42
Gower	.353	.618	.029	34	.500	.500	.000	34
Treorchy	.360	.640	.000	25	.520	.480	.000	25
Porth	.091	.818	.091	11	.545	.364	.091	11
Tonypandy	.455	.545	.000	11	.727	.273	.000	11
Carmarthen	.700	.300	.000	10	.600	.400	.000	10

Table 3.3091: Incidence of palmar pattern H: Area Summary Statistics: Males

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.850	.150	.000	20	.936	.064	.000	20
Bridgend	.880	.120	.000	58	.897	.103	.000	58
Merthyr Tydfil	.879	.121	.000	56	.839	.161	.000	56
Llanelli	.927	.049	.024	41	.952	.048	.000	41
Cardiff	.915	.085	.000	59	.882	.119	.000	59
Neath	.871	.129	.000	39	.898	.102	.000	39
Aberdare	.914	.086	.000	35	.885	.115	.000	35
Swansea Urban	.847	.153	.000	72	.862	.138	.000	72
Rhondda	.971	.029	.000	34	.941	.059	.000	34
Swansea Valley	.957	.087	.000	23	.913	.087	.000	23
Gower	.905	.095	.000	21	.904	.096	.000	21
Treorchy	.733	.267	.000	15	.866	.134	.000	15
Porth	1.000	.000	.000	5	1.000	.000	.000	5
Tonypandy	.833	.167	.000	6	1.000	.000	.000	6
Carmarthen	.750	.250	.000	4	1.000	.000	.000	4

Table 3.3092: Incidence of palmar pattern H: Area Summary Statistics: Females

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.958	.042	.000	47	.936	.064	.000	47
Bridgend	.941	.059	.000	51	.941	.059	.000	51
Merthyr Tydfil	.897	.103	.000	68	.897	.103	.000	68
Llanelli	.907	.093	.000	43	.790	.210	.000	43
Cardiff	.894	.106	.000	66	.924	.076	.000	66
Neath	.917	.083	.000	24	.875	.125	.000	24
Aberdare	.840	.160	.000	25	.800	.200	.000	25
Swansea Urban	.912	.088	.000	158	.905	.095	.000	158
Rhondda	.914	.086	.000	35	.857	.143	.000	35
Swansea Valley	.895	.105	.000	19	.842	.158	.000	19
Gower	.923	.077	.000	13	.846	.154	.000	13
Treorchy	1.000	.000	.000	10	.800	.200	.000	10
Porth	1.000	.000	.000	6	1.000	.000	.000	6
Tonypandy	1.000	.000	.000	5	.600	.400	.000	5
Carmarthen	1.000	.000	.000	6	1.000	.000	.000	6

Table 3.3093: Incidence of palmar pattern H: Area Summary Statistics: Total

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.925	.075	.000	67	.940	.060	.000	67
Bridgend	.908	.092	.000	109	.918	.082	.000	109
Merthyr Tydfil	.887	.113	.000	124	.871	.129	.000	124
Llanelli	.917	.071	.012	84	.869	.131	.000	84
Cardiff	.904	.096	.000	125	.904	.096	.000	125
Neath	.889	.111	.000	63	.889	.111	.000	63
Aberdare	.884	.116	.000	60	.850	.150	.000	60
Swansea Urban	.892	.108	.000	230	.891	.109	.000	230
Rhondda	.943	.057	.000	69	.899	.101	.000	69
Swansea Valley	.929	.071	.000	42	.881	.119	.000	42
Gower	.912	.088	.000	34	.883	.117	.000	34
Treorchy	.840	.160	.000	25	.840	.160	.000	25
Porth	1.000	.000	.000	11	1.000	.000	.000	11
Tonypandy	.909	.091	.000	11	.909	.091	.000	11
Carmarthen	1.000	.000	.000	10	1.000	.000	.000	10

Table 3.3101: Incidence of palmar pattern H: Area Summary Statistics: Males

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.900	.100	.000	20	.787	.213	.000	20
Bridgend	.810	.190	.000	58	.828	.172	.000	58
Merthyr Tydfil	.807	.193	.000	56	.696	.304	.000	56
Llanelli	.927	.073	.000	41	.805	.195	.000	41
Cardiff	.797	.203	.000	59	.729	.271	.000	59
Neath	.718	.282	.000	39	.667	.307	.026	39
Aberdare	.829	.171	.000	35	.799	.172	.029	35
Swasea Urban	.819	.181	.000	72	.750	.250	.000	72
Rhondda	.796	.204	.000	34	.706	.294	.000	34
Swansea Valley	.913	.087	.000	23	.739	.261	.000	23
Gower	.714	.286	.000	21	.716	.284	.000	21
Treorchy	.800	.200	.000	15	.867	.134	.000	15
Porth	1.000	.000	.000	5	1.000	.000	.000	5
Tonypandy	1.000	.000	.000	4	.500	.500	.000	4
Carmarthen	.750	.250	.000	6	1.000	.000	.000	6

Table 3.3102: Incidence of palmar pattern H: Area Summary Statistics: Females

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.702	.298	.000	47	.787	.213	.000	47
Bridgend	.725	.275	.000	51	.824	.176	.000	51
Merthyr Tydfil	.750	.250	.000	68	.764	.236	.000	68
Llanelli	.860	.140	.000	43	.814	.186	.000	43
Cardiff	.758	.242	.000	66	.803	.197	.000	66
Neath	.792	.208	.000	24	.792	.208	.000	24
Aberdare	.720	.280	.000	25	.720	.280	.000	25
Swansea Urban	.829	.171	.000	158	.709	.291	.000	158
Rhondda	.743	.257	.000	35	.715	.285	.000	35
Swansea Valley	.895	.105	.000	19	.841	.106	.053	19
Gower	.769	.231	.000	13	.692	.308	.000	13
Treorchy	.700	.300	.000	10	.600	.400	.000	10
Porth	.833	.167	.000	6	.667	.167	.167	6
Tonypandy	.800	.200	.000	5	.600	.400	.000	5
Carmarthen	1.000	.000	.000	6	.833	.167	.000	6

Table 3.3103: Incidence of palmar pattern H: Area Summary Statistics: Total

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.761	.239	.000	67	.761	.239	.000	67
Bridgend	.771	.229	.000	109	.826	.174	.000	109
Merthyr Tydfil	.775	.225	.000	124	.734	.266	.000	124
Llanelli	.893	.107	.000	84	.809	.191	.000	84
Cardiff	.776	.224	.000	125	.768	.232	.000	125
Neath	.746	.254	.000	63	.731	.269	.000	63
Aberdare	.784	.216	.000	60	.766	.217	.017	60
Swansea Urban	.827	.173	.000	230	.722	.278	.000	230
Rhondda	.769	.231	.000	69	.710	.290	.000	69
Swansea Valley	.905	.095	.000	42	.785	.191	.024	42
Gower	.735	.265	.000	34	.706	.294	.000	34
Treorchy	.760	.240	.000	25	.760	.240	.000	25
Porth	.909	.091	.000	11	.818	.091	.091	11
Tonypandy	.909	.091	.000	11	.545	.091	.364	11
Carmarthen	.900	.100	.000	10	.900	.100	.000	10

Table 3.3111: Incidence of palmar triradius ef (combined): Area Summary Statistics: Males

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.925	.075	.000	20	.925	.075	.000	20
Bridgend	.913	.060	.027	58	.991	.009	.000	58
Merthyr Tydfil	.982	.018	.000	56	.991	.009	.000	56
Llanelli	.927	.036	.025	41	.988	.012	.000	41
Cardiff	.941	.042	.017	59	.975	.025	.000	59
Neath	.846	.128	.026	39	.962	.038	.000	39
Aberdare	.943	.057	.000	35	.957	.043	.000	35
Swansea Urban	.972	.021	.007	72	.993	.007	.000	72
Rhondda	.971	.029	.000	34	.985	.015	.000	34
Swansea Valley	1.000	.000	.000	23	1.000	.000	.000	23
Gower	.976	.000	.024	21	1.000	.000	.000	21
Treorchy	.967	.033	.000	15	1.000	.000	.000	15
Porth	1.000	.000	.000	5	1.000	.000	.000	5
Tonypandy	.917	.083	.000	6	1.000	.000	.000	6
Carmarthen	.875	.125	.000	4	1.000	.000	.000	4

Table 3.3112: Incidence of palmar triradius ef (combined): Area Summary Statistics: Females

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.968	.021	.011	47	.979	.021	.000	47
Bridgend	.971	.010	.020	51	.990	.010	.000	51
Merthyr Tydfil	.985	.015	.000	68	.993	.007	.000	68
Llanelli	.942	.058	.000	43	.977	.012	.011	43
Cardiff	.932	.053	.015	66	.985	.008	.007	66
Neath	.958	.042	.000	24	.958	.042	.000	24
Aberdare	.980	.020	.000	25	1.000	.000	.000	25
Swansea Urban	.946	.032	.022	158	.994	.006	.000	158
Rhondda	1.000	.000	.000	35	.971	.029	.000	35
Swansea Valley	.974	.026	.000	19	.974	.026	.000	19
Gower	.923	.039	.038	13	.962	.038	.000	13
Treorchy	.950	.000	.050	10	1.000	.000	.000	10
Porth	1.000	.000	.000	6	1.000	.000	.000	6
Tonypandy	.900	.000	.100	5	.900	.100	.000	5
Carmarthen	1.000	.000	.000	6	1.000	.000	.000	6

Table 3.3113: Incidence of palmar triradius ef (combined): Area Summary Statistics: Total

Area	Left Hand				Right Hand			
	Abs	1	2	N	Abs	1	2	N
Port Talbot	.955	.037	.008	67	.963	.037	.000	67
Bridgend	.940	.037	.023	109	.991	.009	.000	109
Merthyr Tydfil	.984	.016	.000	124	.992	.008	.000	124
Llanelli	.952	.030	.018	84	.982	.012	.006	84
Cardiff	.936	.048	.016	125	.980	.016	.004	125
Neath	.889	.095	.016	63	.960	.040	.000	63
Aberdare	.958	.042	.000	60	.975	.025	.000	60
Swansea Urban	.954	.028	.018	230	.993	.007	.000	230
Rhondda	.986	.014	.000	69	.978	.022	.000	69
Swansea Valley	.988	.012	.000	42	.988	.012	.000	42
Gower	.956	.015	.029	34	.985	.015	.000	34
Treorchy	.960	.020	.020	25	1.000	.000	.000	25
Porth	1.000	.000	.000	11	1.000	.000	.000	11
Tonypandy	.909	.045	.046	11	.955	.045	.000	11
Carmarthen	.950	.050	.000	10	1.000	.000	.000	10

Table 3.3121: Incidence of palmar triradius t: Area Summary Statistics: Males

Area	Left Hand						Right Hand					
	t	t'	t''	t'''	t^b	N	t	t'	t''	t'''	t^b	N
Port Talbot	8	11	1	0	3	20	7	12	1	0	7	20
Bridgend	41	23	1	0	11	58	33	25	4	1	14	58
Merthyr Tydfil	32	18	10	1	14	56	37	14	10	2	21	56
Llanelli	35	7	4	0	5	41	28	9	3	0	12	41
Cardiff	43	14	8	0	12	59	32	24	7	1	18	59
Neath	24	15	4	1	11	39	27	11	4	1	12	39
Aberdare	17	16	3	1	7	35	14	21	3	0	9	35
Swansea Urban	38	35	7	2	14	72	26	44	13	2	21	72
Rhondda	19	15	1	0	8	34	20	12	3	1	12	34
Swansea Valley	15	9	0	1	2	23	16	3	1	0	6	23
Gower	10	11	1	0	7	21	12	7	3	0	7	21
Treorchy	11	6	2	0	3	15	7	7	3	0	3	15
Porth	3	2	0	0	0	5	2	3	0	0	0	5
Tonypandy	5	2	0	0	0	6	4	2	0	0	3	6
Carmarthen	2	2	1	0	1	4	1	2	1	0	0	4

Table 3.3122: Incidence of palmar triradius t: Area Summary Statistics: Females

Area	Left Hand						Right Hand					
	t	t'	t''	t'''	t^b	N	t	t'	t''	t'''	t^b	N
Port Talbot	23	19	6	1	16	47	18	21	3	2	17	47
Bridgend	20	28	5	1	14	51	20	26	6	1	12	51
Merthyr Tydfil	41	24	10	1	20	68	41	19	14	0	21	68
Llanelli	31	11	6	0	7	43	29	10	13	0	9	43
Cardiff	28	34	12	0	17	66	25	19	9	0	17	66
Neath	14	7	4	1	5	24	10	11	5	0	6	24
Aberdare	15	11	3	0	7	25	13	12	4	0	8	25
Swansea Urban	86	71	11	3	33	158	85	66	18	2	55	158
Rhondda	18	14	6	0	9	35	18	16	5	0	11	35
Swansea Valley	14	5	2	0	2	19	16	4	3	0	3	19
Gower	9	5	0	0	3	13	11	3	1	0	4	13
Treorchy	6	4	0	0	3	10	7	3	1	0	4	10
Porth	6	0	0	0	1	6	5	2	0	0	2	6
Tonypandy	3	2	0	0	1	5	2	3	1	1	2	5
Carmarthen	4	2	0	0	0	6	4	2	0	0	1	6

Table 3.3123: Incidence of palmar triradius t: Area Summary Statistics: Total

Area	Left Hand						Right Hand					
	t	t'	t''	t'''	t^b	N	t	t'	t''	t'''	t^b	N
Port Talbot	31	30	7	1	19	67	25	33	4	2	24	67
Bridgend	61	51	6	1	25	109	53	51	10	2	26	109
Merthyr Tydfil	73	42	20	2	34	124	78	33	24	2	42	124
Llanelli	66	18	10	0	12	84	57	19	16	0	21	84
Cardiff	71	48	20	0	29	125	57	63	16	1	35	125
Neath	38	22	8	2	16	63	37	22	9	1	18	63
Aberdare	32	27	6	1	14	60	27	33	7	0	17	60
Swansea Urban	124	106	18	5	47	230	111	110	31	4	76	230
Rhondda	37	29	7	0	17	69	38	23	8	1	23	69
Swansea Valley	29	14	2	1	4	42	32	12	4	0	11	42
Gower	19	16	1	0	10	34	23	10	4	0	11	34
Treorchy	17	10	2	0	6	25	14	[illegible]	4	0	7	25
Porth	9	2	0	0	1	11	7	5	0	0	2	11
Tonypandy	8	4	0	0	1	11	6	5	1	1	5	11
Carmarthen	6	4	1	0	1	10	5	4	1	0	1	10

Table 3.3131: Incidence of palmar triradii z' and z'' : Area Summary Statistics: Males

Area	Left Hand				Right Hand			
	Abs	z'	z''	N	Abs	z'	z''	N
Port Talbot	1.000	.000	.000	20	1.000	.000	.000	20
Bridgend	.966	.000	.034	58	.948	.000	.052	58
Merthyr Tydfil	.893	.000	.107	56	.929	.000	.071	56
LLanelli	.927	.000	.073	41	.927	.000	.073	41
Cardiff	.847	.000	.153	59	.932	.000	.068	59
Neath	.846	.000	.154	39	.974	.000	.026	39
Aberdare	.886	.000	.114	35	1.000	.000	.000	35
Swansea Urban	.917	.014	.069	72	.986	.014	.000	72
Rhondda	.882	.000	.118	34	.941	.000	.059	34
Swansea Valley	.957	.000	.043	23	.870	.000	.130	23
Gower	.952	.000	.048	21	.952	.000	.048	21
Treorchy	1.000	.000	.000	15	1.000	.000	.000	15
Porth	1.000	.000	.000	5	1.000	.000	.000	5
Tonypandy	.833	.000	.167	6	.833	.000	.167	6
Carmarthen	1.000	.000	.000	4	.750	.000	.250	4

Table 3.3132: Incidence of palmar triradii z' and z'': Area Summary Statistics: Females

Area	Left Hand				Right Hand			
	Abs	z'	z''	N	Abs	z'	z''	N
Port Talbot	.830	.000	.170	47	.915	.000	.085	47
Bridgend	.824	.020	.157	51	.863	.020	.118	51
Merthyr Tydfil	.926	.000	.074	68	.956	.000	.044	68
LLanelli	.907	.023	.070	43	1.000	.000	.000	43
Cardiff	.894	.000	.106	66	.939	.000	.061	66
Neath	.917	.000	.083	24	.875	.000	.125	24
Aberdare	.800	.000	.200	25	.880	.000	.120	25
Swansea Urban	.892	.000	.108	158	.937	.000	.063	158
Rhondda	.886	.000	.114	35	.914	.029	.057	35
Swansea Valley	.842	.000	.158	19	.947	.000	.053	19
Gower	.923	.000	.077	13	.923	.000	.077	13
Treorchy	.800	.000	.200	10	1.000	.000	.000	10
Porth	1.000	.000	.000	6	1.000	.000	.000	6
Tonypandy	1.000	.000	.000	5	1.000	.000	.000	5
Carmarthen	.833	.000	.167	6	.833	.000	.167	6

Table 3.3133: Incidence of palmar triradii z' and z'': Area Summary Statistics: Total

Area	Left Hand				Right Hand			
	Abs	z'	z''	N	Abs	z'	z''	N
Port Talbot	.881	.000	.119	67	.940	.000	.060	67
Bridgend	.899	.009	.092	109	.908	.009	.083	109
Merthyr Tydfil	.911	.000	.089	124	.944	.000	.056	124
LLanelli	.917	.012	.071	84	.964	.000	.036	84
Cardiff	.872	.000	.128	125	.936	.000	.064	125
Neath	.873	.000	.127	63	.937	.000	.063	63
Aberdare	.850	.000	.150	60	.950	.000	.050	60
Swansea Urban	.900	.004	.096	230	.952	.004	.043	230
Rhondda	.884	.000	.116	69	.928	.014	.058	69
Swansea Valley	.905	.000	.095	42	.905	.000	095	42
Gower	.941	.000	.059	34	.941	.000	.059	34
Treorchy	.920	.000	.080	25	1.000	.000	.000	25
Porth	1.000	.000	.000	11	1.000	.000	.000	11
Tonypandy	.909	.000	.091	11	.909	.000	.091	11
Carmarthen	.900	.000	.100	10	.800	.000	.200	10

Table 3.3141: Incidence of digital triradii: Area Summary Statistics: Males

Area	Left Hand Abs	3	4	5	6	7	8	N
Port Talbot	.100	.000	.700	.150	.050	.000	.000	20
Bridgend	.000	.064	.789	.119	.028	.000	.000	58
Merthyr Tydfil	.000	.056	.790	.137	.016	.000	.000	56
Llanelli	.000	.060	.798	.143	.000	.000	.000	41
Cardiff	.000	.088	.760	.144	.008	.000	.000	59
Neath	.000	.016	.857	.111	.016	.000	.000	39
Aberdare	.000	.083	.817	.083	.017	.000	.000	35
Swansea Urban	.000	.078	.783	.130	.009	.000	.000	72
Rhondda	.000	.087	.754	.130	.014	.014	.000	34
Swansea Valley	.000	.095	.786	.119	.000	.000	.000	23
Gower	.000	.059	.706	.206	.029	.000	.000	21
Treorchy	.000	.040	.640	.240	.080	.000	.000	15
Porth	.000	.000	.818	.182	.000	.000	.000	5
Tonypandy	.000	.091	.818	.091	.000	.000	.000	6
Carmarthen	.000	.100	.800	.100	.000	.000	.000	4

Table 3.3142: Incidence of digital triradii: Area Summary Statistics: Females

Area	Left Hand							
	Abs	3	4	5	6	7	8	N
Port Talbot	.000	.149	.660	.191	.000	.000	.000	47
Bridgend	.000	.098	.706	.157	.039	.000	.000	51
Merthyr Tydfil	.000	.059	.765	.162	.015	.000	.000	68
Llanelli	.000	.070	.814	.116	.000	.000	.000	43
Cardiff	.000	.091	.818	.076	.015	.000	.000	66
Neath	.000	.000	.792	.208	.000	.000	.000	24
Aberdare	.000	.160	.800	.040	.000	.000	.000	25
Swansea Urban	.000	.082	.785	.120	.013	.000	.000	158
Rhondda	.000	.086	.771	.143	.000	.000	.000	35
Swansea Valley	.000	.158	.789	.053	.000	.000	.000	19
Gower	.000	.077	.692	.154	.077	.000	.000	13
Treorchy	.000	.100	.600	.300	.000	.000	.000	10
Porth	.000	.000	1.000	.000	.000	.000	.000	6
Tonypandy	.000	.000	.800	.200	.000	.000	.000	5
Carmarthen	.000	.167	.833	.000	.000	.000	.000	6

Table 3.3143: Incidence of digital triradii: Area Summary Statistics: Total

Area	Left Hand							
	Abs	3	4	5	6	7	8	N
Port Talbot	.030	.104	.672	.179	.015	.000	.000	67
Bridgend	.000	.064	.789	.119	.028	.000	.000	109
Merthyr Tydfil	.000	.056	.790	.137	.016	.000	.000	124
Llanelli	.000	.060	.798	.143	.000	.000	.000	84
Cardiff	.000	.088	.760	.144	.008	.000	.000	125
Neath	.000	.016	.857	.111	.016	.000	.000	63
Aberdare	.000	.083	.817	.083	.017	.000	.000	60
Swansea Urban	.000	.078	.783	.130	.009	.000	.000	230
Rhondda	.000	.087	.754	.130	.014	.014	.000	69
Swansea Valley	.000	.095	.786	.119	.000	.000	.000	42
Gower	.000	.059	.706	.206	.029	.000	.000	34
Treorchy	.000	.040	.640	.240	.080	.000	.000	25
Porth	.000	.000	.818	.182	.000	.000	.000	11
Tonypandy	.000	.091	.818	.091	.000	.000	.000	11
Carmarthen	.000	.100	.800	.100	.000	.000	.000	10

Table 3.3151: Incidence of digital triradii: Area Summary Statistics: Males

Area	Right Hand							
	Abs	3	4	5	6	7	8	N
Port Talbot	.000	.000	.900	.050	.050	.000	.000	20
Bridgend	.000	.034	.897	.069	.000	.000	.000	58
Merthyr Tydfil	.000	.054	.875	.071	.000	.000	.000	56
Llanelli	.000	.049	.829	.122	.000	.000	.000	41
Cardiff	.000	.051	.763	.169	.017	.000	.000	59
Neath	.026	.026	.821	.103	.000	.026	.000	39
Aberdare	.000	.000	.857	.057	.086	.000	.000	35
Swansea Urban	.000	.014	.861	.125	.000	.000	.000	72
Rhondda	.000	.059	.676	.206	.059	.000	.000	34
Swansea Valley	.000	.087	.739	.174	.000	.000	.000	23
Gower	.000	.048	.857	.048	.048	.000	.000	21
Treorchy	.000	.000	.867	.067	.067	.000	.000	15
Porth	.000	.000	.800	.200	.000	.000	.000	5
Tonypandy	.000	.167	.500	.333	.000	.000	.000	6
Carmarthen	.000	.250	.750	.000	.000	.000	.000	4

Table 3.3152: Incidence of digital triradii: Area Summary Statistics: Females

Area	Right Hand							
	Abs	3	4	5	6	7	8	N
Port Talbot	.000	.064	.787	.149	.000	.000	.000	47
Bridgend	.000	.098	.706	.176	.000	.020	.000	51
Merthyr Tydfil	.000	.029	.853	.088	.015	.015	.000	68
Llanelli	.000	.000	.907	.023	.070	.000	.000	43
Cardiff	.000	.045	.894	.045	.015	.000	.000	66
Neath	.000	.083	.708	.167	.042	.000	.000	24
Aberdare	.000	.120	.800	.080	.000	.000	.000	25
Swansea Urban	.000	.057	.785	.127	.032	.000	.000	158
Rhondda	.000	.086	.771	.143	.000	.000	.000	35
Swansea Valley	.000	.053	.895	.053	.000	.000	.000	19
Gower	.000	.000	.923	.000	.077	.000	.000	13
Treorchy	.000	.000	.700	.100	.200	.000	.000	10
Porth	.000	.000	.833	.167	.000	.000	.000	6
Tonypandy	.000	.000	.800	.000	.200	.000	.000	5
Carmarthen	.000	.167	.833	.000	.000	.000	.000	6

Table 3.3153: Incidence of digital triradii: Area Summary Statistics: Total

Area	Right Hand							
	Abs	3	4	5	6	7	8	N
Port Talbot	.000	.045	.821	.119	.015	.000	.000	67
Bridgend	.000	.064	.807	.119	.000	.009	.000	109
Merthyr Tydfil	.000	.040	.863	.081	.008	.008	.000	124
Llanelli	.000	.024	.869	.071	.036	.000	.000	84
Cardiff	.000	.048	.832	.104	.016	.000	.000	125
Neath	.016	.048	.778	.127	.016	.016	.000	63
Aberdare	.000	.050	.833	.067	.050	.000	.000	60
Swansea Urban	.000	.043	.809	.126	.022	.000	.000	230
Rhondda	.000	.072	.725	.174	.029	.000	.000	69
Swansea Valley	.000	.071	.810	.119	.000	.000	.000	42
Gower	.000	.029	.882	.029	.059	.000	.000	34
Treorchy	.000	.000	.800	.080	.120	.000	.000	25
Porth	.000	.000	.818	.182	.000	.000	.000	11
Tonypandy	.000	.091	.636	.182	.091	.000	.000	11
Carmarthen	.000	.200	.800	.000	.000	.000	.000	10

APPENDIX 4

APPLICATIONS OF DERMATOGLYPHICS

APPENDIX 4

APPLICATIONS OF DERMATOGLYPHICS

Dermatoglyphics have long been recognised as extremely useful as an aid to diagnosis. Palmists have believed for centuries that they can use the lines on the palm to diagnose an individual's personality and predict his future. More recently, scientists have discovered the usefulness of the patternings on the palms and fingers in diagnosing paternity when it is questioned; of determining zygosity in twins; of the association of handedness and lateral dominance with particular configurations; and perhaps most importantly with the diagnosis of medical condition, with particular reference to inherited abnormalities and diseases. However, the most well known application of the study of dermatoglyphics should not be forgotten - that is as a means of personal identification, usually closely associated with criminal detection.

A. Questioned Paternity

Weninger (1965) advocated the use of dermatoglyphics in legal cases of questioned paternity in the same way as blood groups are used. However, since the mode of inheritance of dermal configurations is not yet fully understood, nor extensive family studies undertaken, it would seem that this application of dermatoglyphics has no viable scientific basis at present. Indeed, it would appear that Weninger herself is the only person who seems to advocate this particular line of research.

B. Twin Diagnosis

Twins are used for numerous purposes in biology and medicine, including genetical research. Their value in all cases depends upon an accurate assessment of zygotic type, i.e. whether a twin pair is monozygotic or dizygotic. When the members of a pair differ in sex they are almost certainly dizygotic, but when of the same sex they may be either monozygotic or dizygotic. Even when tests are made with all the available blood antigens there may be ambiguities, if, for example, the parents have identical blood antigens. Thus other inherited characteristics have to be taken into account when determining zygotic type. Rife (1933) used a similarity method where diagnosis is based on assembling observations on a variety of traits, which are, preferably, non-linked in inheritance. He used finger ridge count as one of his eight criteria because the heritability of this trait is better understood than that of most other dermatoglyphic traits.

Newman (1930) believed that in monozygotic twins, one or both hands resemble those of the other twin more closely than do opposite hands of the same individual and that this could be used as a criterion for diagnosis, since the reverse is true for dizygotic twins. In 1931, however, Newman was less sure and qualified this earlier work by maintaining that dermatoglyphics could not be used as the sole decider in zygosity but should be used in conjunction with other traits in a 'similarity method'. MacArthur (1938) considered finger print patterns to be more reliable than palmar characteristics in the similarity method and found finger ridge counts particularly useful - an observation echoed by Nylander (1971).

Numerous workers have compared differences in total finger ridge count between monozygotic pairs with those between dizygotic pairs.

Holt (1952) shows that at least 8% of monozygotic twin pairs have differences not exceeding 20 ridges, while in dizygotic twins differences as low as this are considerably less than half as frequent. Gedda and Parisi (1962) maintain that the dividing line may be set at 11 ridges and that the probability of error is then only 0.14. Differences can also be ascertained using discriminant functions (Slater, 1963) though this involves complicated statistical procedures; and also by the theory of probability (Maynard Smith and Penrose, 1955) when well-defined or measurable inherited characters are considered. This last method seems very little different from the similarity method advocated by Rife and Newman in earlier publications.

Other multiple births can also consist of genetically identical individuals, though this is rare, particularly where quadruplets and quintuplets are involved. However, some identical sets have been studied, the Morlok quadruplets (MacArthur and MacArthur, 1937) and also the famous Dionne quintuplets (MacArthur and Ford, 1937). Both sets showed striking similarities, the Dionne sisters having a difference between them in total finger ridge count of only 3 ridges.

It should be noted that the dermatoglyphics of conjoined or 'Siamese' twins are less alike than is usual in separate monozygotic pairs (Cummins and Mairs, 1934). This would appear to be at least in part due to differences in expression of a disturbed developmental environment within the united embryo.

C. Lateral Dominance

Only in a very general way is the human body bilaterally symmetrical. An internal organ which is paired, like lung or kidney, shows dissimilarity of form, size and position between the left and right partners. Thus, it is important to approach bilateral symmetry and asymmetry in dermatoglyphics with an understanding that these features are neither exceptional in presenting differences on the two sides nor in showing frequencies of specific variants greater on one side than another.

Most authors e.g. Cummins, Leche, McClure (1931); Leche (1933); Pons (1962); Holt (1968) and Rostron and Mittwoch (1977) agree that right and left hands differ in ridge breadth, pattern size and pattern intensity. On right hands there is a tendency for patterns to be large and patterns in the hypothenar and second and third interdigital areas are more common. On left hands, thenar and fourth interdigital patterns are more common and the finger ridges tend to be finer. Also, whorls and radial loops are more common on the fingers of right hands, and ulnar loops and arches on those of the left hand.

The fact that these bimanual differences do exist has caused some authors to look for associations between pattern frequencies and functional handedness. One of the major difficulties in this field is determining at which point in the continuum of ambidexterity that a person becomes left or right handed. The definition will obviously have a great bearing on the results obtained. One of the most widely used methods of diagnosis of handedness is that invented by Rife (1943). When all the following acts (writing, throwing, sewing, hammering, sawing, shooting marbles, use of knife, bowling, use of scissors and spoon) was performed with the right hand the subject was classed as right-handed, and if the left hand was used once or more often, the subject was classed as left-handed.

Studies by Newman (1934); Cummins (1940); Rife (1941) (1943) (1955) and Cromwell and Rife (1942) agree that there is an association between dermatoglyphics and functional handedness but there is often considerable disagreement as to the details of its manifestation. However, all have shown an increase of third interdigital patterns on the left hands of left-handers, as contrasted with the right hands of right-handers; and an increase in the occurrence of thenar/first interdigital patterns in left-handers. Trends towards greater bilateral symmetry among groups of left-handers have also been discovered.

The differences between the pattern frequencies of right and left handers are slight as compared with the bimanual differences which exist within individuals. Nevertheless, they are consistent and, in view of the fact that dermatoglyphics are formed early in foetal development, possibly indicate the existence of an anatomical basis for functional handedness.

D. Medical Condition

As dermal ridge arrangements are determined early in foetal life, they reflect growth disturbances taking place at this time. It is now well-established that such disturbances cause modifications of the ridge arrangements and that palmar patterns, in particular, are sensitive indicators of developmental abnormalities. Moreover, it is known that ridge configurations show significant distortion in cases where chromosomal abnormalities are present.

However, caution must be exercised in the use of dermatoglyphics as a diagnostic tool for several reasons. Firstly, no one feature is pathognomonic; secondly, dermatoglyphic standards are arrived at statistically for populations and not individuals, and not always with the greatest of regard for sampling methods. Thirdly, chance alone might explain correlations of dermatoglyphic traits with specific conditions, especially, if, as before, geographical and sexual variations are not taken into account.

A more exact means of 'diagnosis' has been suggested by Penrose and Loesch (1971a and b). They maintain that in certain chromosomal anomalies (e.g. D, E, G trisomies and B short arm deletion) the dermal ridge patterns are sufficiently specific to enable them to be used, in the form of discriminant weightings, for diagnostic purposes, making use of the presence or absence of all possible loops and of certain triradii as constituent characters. The relative probability that a given diagnosis is correct can then be calculated. The simplest method is to weight the score of each character chosen for discrimination by the difference between its percentage frequencies in normal and abnormal samples. A separate set of weightings is required for each disease in which diagnostic testing by discrimination is carried out. The dermatoglyphic pattern of any given patient can then be tested separately on each discriminant and the probabilities of each diagnosis compared. Such a method is of particular interest when applied to a case of doubtful diagnosis or of chromosomal mosaicism.

(i) Inherited Abnormalities

The dermatoglyphics of various inherited abnormalities of the extremities have been studied, and it has been shown that the ridge distortions which occur in these syndromes are directly related to the type of deformity occurring.

Cummins (1926 and 1932) studied supernumerary digits in man and discovered that even when these extra digits had been spontaneously am putated before birth, the fact of their existence was indicated by an extra digital triradius.

Syndromes such as Anonychia (congenital absence of the nail on digits II and III, often on I and much diminished on IV) and the similar Nail Patella Syndrome (where the nails are less severely affected) show that in the absence of a nail or nailbed, the ridged skin will continue round the whole surface of the distal phalange, a pattern occurring on the dorsal surface in the same way as one normally occurs on the finger tip.

Skeletal malformations of the extremities show even more bizarre ridge patterns, and seem mainly due to the action of autosomal dominant genes. In cases of inherited apical dystrophy, where the distal phalanges of the fingers are absent, the ridges on the extreme ends of the digits are arranged in peculiar patterns (MacArthur and McCullough, 1932) which would seem to be comparable with configurations found on the apices of fingers in anonychia. In cases of syndactyly (fusion of the bones of digits) alterations of ridge arrangement also occur. Palm prints show a distal displacement of the digital triradii associated with the fused digits, finger prints often have unusual patterns, and sometimes supernumerary digits occur (Holt, 1968). In brachydactyly the phalanges of the fingers, and to a lesser extent toes, are reduced in length. In family studies (Battle et al., 1973) a large number of fingers possessed the simple arch pattern.

In more extreme cases of skeletal deformities such as ectrodactyly (sometimes called 'lobster-claw deformity'), even more unusual dermal patterns occur, though once again conforming to the topography of the hand. MacKenzie and Penrose (1951) found disturbances in ridge arrangements so great that the digital triradii were scarcely recognisable. However, when digits were missing, the number of triradii was reduced, and when there was syndactyly, extra triradii appeared.

Holt (1972) studied the effect of the absence of a thumb in palmar dermatoglyphics, found in cases of thalidomide poisoning with radial dysplasia and also in the hands of patients with varying chromosome aberrations, in particular ring-D chromosome. In these cases the ridge configurations in the proximal palm are distorted, there is no thenar eminence, thus no 't' triradius, and ridges run transversely across the palm.

Thus, it can be seen that the dermal patterning of the hands and feet of people suffering from the inherited abnormalities described above are sensitive indicators of the growth disturbances which have taken place and bear a direct relationship to the abnormal topography of the hand or foot.

(ii) Malformations Caused by Autosomal Aberration

Each living cell of a normal person contains 46 chromosomes, consisting of 22 pairs of autosomes and 2 sex chromosomes. In males, the sex chromosomes are of different size, the smaller being named Y and the larger X. In females two X chromosomes are present. Seven groups of chromosomes are recognised, based on their relative size: 1 - 3 (A) being the largest through 4 - 5 (B), 6 - 12 (C), 13 -15 (D), 16 - 18 (E), 19 - 20 (F) and 21 - 22 (G) the smallest. The X chromosome approximates to group C (6 - 12) while the Y chromosome is slightly larger than group G (21 - 22).

Abnormalities can occur in the chromosome complement and involve either the autosomes or the sex chromosomes. An extra chromosome may be present (trisomy), one may be missing (monosomy) or the chromosomes may be structurally aberrant. Such abnormalities usually lead to gross deformities and are often associated with irregularities in the dermatoglyphics of the individual involved.

(a) Autosomal Trisomies

The most well known and best documented autosomal trisomy studied so far is that called Down's Syndrome or Mongolism (trisomy 21). However, others have been documented, including trisomies 18, 15 and 8 (see Table XXXVI for summary of information).

Cummins (1939) first demonstrated the abnormalities in the dermatoglyphics of patients with Down's Syndrome. He found an increase in digital loop patterns (at the expense of whorls); a high axial triradius t'' associated with a heightened tendency to transverse alignment of the palmar ridges; and an increase in the frequency of patterns in the hypothenar and interdigital areas II and III with a corresponding decrease in the frequencies of patterns in both the thenar and IVth interdigital areas. These observations were confirmed by Snedeker (1948); Penrose (1949, 1954); Cummins, Talley and Platou (1950); Fang (1950); Walker (1957); Heller (1957); Häkkinen and Lundell (1959); Beckman et al., (1960); Holt (1964); and Thompson and Bandler (1973) amongst many others.

Holt (1964) points out that there is less variation in finger print pattern type amongst mongols than in the general population. In her British sample, comprising mongols of both sexes, over 80% of fingers had ulnar loops (as compared with 60% of controls) and the frequencies of both whorls and arches were only about half those in normal subjects. Radial loops were also less frequent but over 70% of those occurring did so on digits IV of right and left hands, unusual in normal subjects.

Now that the dermatoglyphic stigmata of mongolism has been extensively established, attention has turned to the palmprints of relations to see if they exhibit any similarities to the palmprints of their affected relatives. Priest (1969) and Priest, Verhulst

TABLE XXXVI

Dermatoglyphics Associated with Autosomal Aneuploidy

	Clinical Disorder	Reference	Dermatoglyphic Abnormality
I	TRISOMY 21 (Down's Syndrome)	Beckman, Gustavson & Norring (1963); Uchida & Soltan (1963) etc.	Excess ulnar loops, increased radial loops on digits IV & V; simian line; atd angle greater than 57°; inter-digital patterns increased at II & III but decreased at IV and Thenar/I. Hypothenar usually $\hat{H}$ & H^R; small loop distal or arch tibial hallucal pattern; single flexion crease on 5th digit; IV inter-digital pattern on sole. Walker index greater than +3.
II	TRISOMY 18	Gibson, Uchida & Lewis (1963); Uchida & Soltan (1963)	Excess arches on digits, usually 76; single flexion crease on digits; simian line.
III	TRISOMY 15	Uchida, Patau, Smith (1962); Lee et al., (1966)	Increased thenar patterns, atd angle; simian line, arch fibular/arch fibular-S pattern on hallux.
IV	TRISOMY 21 with XXX	Yunis, Hook, Alter (1964)	8 L^u, 1 W, 1 A on fingers. Arch tibial on both hallucal areas.
V	46/48 (TRISOMY 18/21) Mosaic	Hsu et al., (1965)	Simian line, distal C, single flexion crease on 5th digit, 10 simple arches on fingers.
VI	46/47 (TRISOMY 21) Mosaic	Reisman, Shipe & Williams (1966)	As in trisomy 21.
VII	TRISOMY 8	Penrose (1972)	High pattern intensity.

and Sirkin (1973) have shown that parents of offspring with Down's Syndrome do show dermal 'microsymptoms' when compared to the general population. A Walker dermal index score in the overlap range (-2.99 to +3.00) is more likely to occur in fathers of age-dependent mongolism cases (mean parental age 40, range 24-54) and in Down's Syndrome mothers than in the general population. The relative risk for these fathers to have a dermal index in the overlap range is twice the risk for male controls; and for mothers 1.6 that for female controls. Thus such an overlap score may be used to indicate a group of parents at higher risk for occurrence and recurrence of trisomy 21 offspring.

Attention has also been turned to the study of more complicated conditions where mongolism occurs, i.e. to mosaic mongols and cases where a patient is a mosaic for more than one chromosome abnormality. Penrose (1963) has shown that mosaics exhibit some of the features of 'full' mongoloids, but, when taken as a group, they tend to be intermediate between normals and mongols in dermatoglyphic patternings. However, Loesch (1974) found them to be closer in pattern frequencies to true mongols. Penrose also pointed out after analysing familial data, that mosaicism may be present, though undetected, in 10% of all mothers of mongol patients. Loesch and Smith (1976) have attempted a discriminant diagnosis in the hope of detecting such individuals, but with limited success.

Soltan and Clearwater (1965) made dermatoglyphic comparisons between translocation and trisomic Down's Syndrome in order to ascertain if either a small deletion or a position effect would be reflected in dermatoglyphic differences between the two 'types' of mongolism. They hoped such differences would exist in order to locate loci determining various dermal configurations on specific chromosomes or parts of chromosomes, but the only differences occurred in the hallucal area of the sole.

Several attempts have been made to refine what is known about the dermatoglyphic patterns of mongols into an easily applicable formula which can be confidently used as a diagnostic aid. The first attempt, made by Cummins and Platou (1946) was largely based on 'rule of thumb'. Walker (1957) adopted a more scientific approach. She made an attempt to summarise statistically the information provided by different dermatoglyphic traits into an index showing the probability of the child being a mongol. The different dermal areas and the frequencies of the different patterns were determined and a ratio of the frequency of the patterns in Down's Syndrome patients and in normal controls was calculated. The indices for all ten fingers were combined, plus indices for two palmar traits and one plantar trait (both right and left sides) were included to form a single score or index. This index, expressed by its logarithm, was found to give a good discrimination of mongols from normals.

Beckman, Gustavson and Norring (1965) modified this by using a simple scale. On this each trait was assigned the score numbers one, two or three depending on the magnitude of the difference between mongols and normals. Sex and bilateral variations when present were also taken into account and the different partial scores added together. A score of less than fifteen (average five) would indicate a normal individual and one greater than fifteen a mongol. A schizophrenic sample included in the calculations proved indistinguishable from the normal subjects.

Other authors have attempted to standardise the notation attached to various of the dermatoglyphic traits characteristic of mongolism. As mentioned earlier much work has been done in an attempt to standardise the naming of the position of the axial triradius 't' and its subtended 'atd' angle. Plato, Cereghino and Steinberg (1973) have studied the sub-classifications of interdigital patterns and C-line terminations, and found these of value in the investigation of clinical data by offering further diagnostic criteria not revealed by gross dermatoglyphic evaluation.

Attention has also been paid to the various classifications and definitions of the so-called 'simian' crease. Rashad, Morton and Scally (1964) showed that a simian crease occurs in 52% of mongols; 10% of other defectives and only 1% of normal controls, being most common among mongol males. LeStrange (1969) studied its geographical distribution in Europe. Davies (1966) found a simian crease to be present in 3.7% of 6,299 newborn infants, being twice as common in males as in females. She also found a higher incidence of increased maternal age, parity, previous stillbirth, toxaemia, hypertension and of infants of low birth weight for their gestation, amongst the group with single creases as compared with the normal individuals. Bhanu (1973) attempted to examine critically the definitions and classifications forwarded by various authorities on the simian crease. He put forward a new definition:

> "Either of the two flexion creases distal and proximal, independently or in combination, traversing both radial and ulnar margins of the palm, may be called a simian or transverse crease."

and a new classification, including thirteen transitional variations. However, work has yet to be undertaken to ascertain if these different forms of simian crease have any relationship to medical condition or that they are inherited and, until some connection is proved, their differentiation seems superfluous. One interesting observation is that several statues of Buddha show uplifted hands displaying a simian crease, the most obvious answer being that this phenomena is more common in the East.

Dar and Winter (1970) found an association between transitional forms of the simian crease and familial deafness. The statistical findings suggested that in a family with members suffering from familial deafness, a newborn showing bilateral forms of the simian crease may be regarded as having a greater risk of being deaf. However, this association is of the most tentative nature.

Menser and Purvis Smith (1969) also drew an association between a transitional form of simian crease, called by them the Sydney line, and childhood leukaemia. Much debate has ensued since this first publication and many authors remain sceptical of the viability of the Sydney line as a diagnostic tool, though others strongly advocate its usefulness.

(b) Other Abnormalities of the Autosomes

Chromosome aberrations can also occur as structural modifications. These may take the form of duplications, deficiencies, translocations, inversions, isochromosomes, ring chromosomes etc. These aberrations result from chromosome breakage and reunion in various patterns different from the normal sequence of loci. In most cases, especially the 'spontaneous' instances, the cause of chromosome breaks is unknown, but many extraneous agents have been demonstrated experimentally to be efficacious in inducing fragmentation. Foremost among these agents is ionising radiation, but many chemical substances and viruses have been implicated.

Palm and sole prints have been obtained by investigators studying a variety of chromosomal aberrations. It would appear that when a chromosomal abnormality is associated with growth disturbances involving the hands and feet, distortions in ridge arrangement occur, but when the extremities appear normal so do the dermatoglyphics. At present, the value of dermal prints in such cases is the help they may provide the cytologist in identifying an aberrant chromosome. Those abnormal dermatoglyphics which have been found associated with

TABLE XXXVII

Dermatoglyphics Associated with Structural Aberrations

A. TRANSLOCATIONS

Clinical Disorder		Reference	Dermatoglyphic Abnormality
(i)	4/9	Edwards et al. (1962)	Low finger ridge count; simian line.
(ii)	Satellites both arms of small acrocentric	Ellis, Marshall and Penrose (1962)	Loops increased.
(iii)	6/9	Rohde and Catz (1964)	Simian line, single crease on 5th digit.
(iv)	3/8	Clarke et al. (1964)	Excess arches, e & f triradii in hallucal area, joined C & D main line on palm.
(v)	2/3	Lee et al. (1964) Summitt (1966)	Excess arches.
(vi)	6/22 (C/G)	Hoefnagel et al. (1963) Yanagisawa and Kuraoke (1971)	Excess arches; L^R Ist & Vth digit. Simian crease, single crease on 5th digit, absence of digital triradius 'b' or 'c', increase ulnar loops.
(vii)	13-15 (or duplication 13-15)	Wolf et al. (1964)	Hypoplastic ridges on several fingers, soles and hypothenar area. Distal axial triradius.
(viii)	15/21 (D/G) with 45 chromosomes	Matsunga et al. (1963)	Simian crease, increased atd angle, creases disrupt pattern in hypothenar area.
(ix)	15/21 (D/G)	Penrose and Delhanty (1961)	Distal 't'; hypothenar patterns small loops, interdigital III. (N.B. balanced carriers also had high axial triradius.)
		Zergollen et al (1964)	As in Trisomy 21 but balanced carrier father had normal dermatoglyphics. Karotypically normal mother had 10 L^u + hypothenar patterns.
		Soltan et al. (1965)	As Trisomy 21 but tendency to larger loop distal pattern in hallucal area.
(x)	21/21 (G/G)	Soltan et al.(1965)	As Trisomy 21.
(xi)	13-15/17-18 (D/E) with 45 chromosomes	Townes and Ziegler (1965)	Whorls on all fingers; simian line; open field in interdigital III & IV, arch carpal hypothenar pattern.
(xii)	13-15/17-18 (D/E) with trisomy 21	Breibart et al. (1964)	Whorls on 3 fingers; simian line.
(xiii)	18/21-22 (E/G)	Uchida et al. (1964)	Excess arches; simian line; single flexion crease on fingers (N.B.balanced carrier had simian line).

TABLE XXXVII (Cont.)

	Clinical Disorder	Reference	Dermatoglyphic Abnormality
(xiv)	18/?	Hoefnagel et al. (1963)	Excess arches, distal 't' single flexion crease on 5th digit, absence of 'c' digital triradius.
(xv)	4/5 (B/B)	Shaw et al. (1965)	Simian lines.
B.	DELETIONS		
(i)	Short arm of 5 (Cri du chat syndrome)	Hijmans and Shearin (1965) Gibbs (1967)	Simian line, increased atd angle, digital arches and whorls, increased atd angle.
(ii)	Short arm of 18	Kajii et al. (1966)	increased atd angle.
(iii)	Long arm of 18	de Grouchy (1965) Mavalwala et al. (1970)	Excess whorls; simian line. Affects distal area of hand, composites on fingers.
(iv)	Ring-18 (deletion on both arms)	de Grouchy (1965)	Excess whorls, increased atd angle, loop radial hypothenar pattern.
(v)	Ring-D	Adams (1965)	Absent 't', horizontal palmar ridges.
(vi)	Deletion short arm of X		Vertical palmar main line; L^u hypothenar pattern. 10 whorls on fingers (N.B. similar features in karotypically normal relatives
(vii)	Long arm of 15	Lele, Penrose, Stallard (1963)	Excess arches, thenar pattern on left hand. N.B. subject also had retinoblastoma.
(viii)	Deletion 21-22 (Philadelphia chromosome)	Kontras et al. (1966)	Simian line, Walker index = -0.27.
(ix)	Ring autosome	Barbeau et al. (1965)	Simian line.
C.	MISCELLANEOUS		
(i)	Enlarged satellites on acrocentric	Jacobsen et al. (1964)	Excess arches.
(ii)	Isochromosome G	Mukerjie et al. (1966)	Simian lines.
(iii)	Autosomal isochromosome	Stevenson et al. (1966)	Distal axial triradius, simian lines.

cases of structural aberrations are summarised in Table XXXVII, but it should be pointed out that the numbers involved in each condition are often extremely small and that the associations found are by no means proven or even well-established.

(iii) Dermatoglyphics in Sex Chromosome Aberrations

Anomalies in dermal configurations associated with abnormal sex chromosomes are not usually as immediately obvious as those found in individuals trisomic for autosomes. Nevertheless, they are discernable and may be emphasised by the use of statistical methods (see Table XXXVIII). The great majority of cases with aberrant sex chromosomes are associated with two syndromes: Turner's syndrome and Klinefelter's syndrome, resulting in the fact that it is the dermatoglyphics of these two conditions which have been most extensively studied.

(iv) Dermatoglyphics Associated with Single Gene Disorders

Dermatoglyphics have also been studied in relation to other inherited disorders, the main aim being to ascertain a place for dermatoglyphics in the diagnostic process. In this area various conditions have been studied and the results are summarised in Table XXXIX. However, it would appear that, on the whole, single gene disorders have fewer and less striking anomalies of ridge development than those resulting from gross chromosomal defects. Also, care must be used to distinguish between those single gene disorders which manifest themselves before birth, i.e. during the time the epidermal ridges are forming and able to reflect disturbances in the womb environment; and those, such as phenylketonuria, which is not manifest until after birth. However, the possibility should also not be ruled out that the ridge configurations could show a

TABLE XXXVIII

Dermatoglyphics Associated with Sex Chromosome Aneuploidy

	Clinical Disorder	Reference	Dermatoglyphic Abnormality
A.	Turner's Syndrome: (XO; XO/XX(i); XO/XY XX(i), XO/XXd, XX/XXd, Xy)	Holt and Lindsten (1964) Fang (1949) Lindsten et al. (1963) Fraccaro et al. (1966) Uchida and Soltan (1963)	Increased whorls on fingers, loops on thumbs, radial loops on digit II; simian line, atd angle increased; S hypothenar pattern; a-b ridge count increased, 'b' digital triradius shifted towards ulnar border.
B.	Klinefelter's Syndrome (XXY)	Forbes (1964)	Digital loops with low ridge counts; excess digital arches, coarse ridges with transverse alignment.
C.	XXYY	Uchida, Miller and Soltan (1964) Alter et al. (1966)	Ulnar triradius in hypothenar area associated with radial arch, radial loop, carpal loop and carpal arch patterns. Excess arches on fingers. Simian lines, increased atd angle.
D.	XXXXY	Farquhar and Walker (1964)	Excess digital arches, low finger ridge count.
E.	Penta X	Kesaree and Woolley (1963)	Simian lines.
F.	Hyperploidy of X and/or Y	Alter (1965)	Excess arches, low finger ridge count.
G.	XYY	Saldana-Garcia (1973)	Excess digital arches, low TFRC, proximal displacement of 't', low H loops, zygodactylous tendencies, reduced pattern intensity.

TABLE XXXIX

Dermatoglyphics Associated with Single Gene Disorders

	Clinical Disorder	Reference	Dermatoglyphic Abnormality
1.	Wilson's Disease (Hepatdenticular degeneration)	Hodges and Simon (1962)	Excess whorls on thumb, index and ring finger.
2.	Neurofibromatosis	Blotevogel (1933)	Excess CPL on 4th & 5th digits.
3.	Pseudo and pseudo-pseudo hypoparathyroidism	Forbes (1964)	Excess arches; fewer radial loops in index fingers with fine vertical ridge orientations, lower TFRC; transitional interdigital patterns and hallucal patterns increased.
4.	Pheynylketonuria	Hirsch (1964)	Reduced patterns in interdigital III & IV & hypothenar. C main line absent/reduced.
		Rosner et al. (1967)	Agree + simian line.
		Alter (1967)	Decreased whorls, increased atd (only female).
5.	Huntington's Chorea	Barbeau et al.(1965)	Whorls slightly increased.
6.	De Lange Syndrome	Silver (1964) Smith (1966)	Simian line, ridge disruption. Increased L^R, reduced W; increased thenar patterns, 't' distally displaced, 'c' missing.
7.	Anomalies of face, skeleton and male genetalia	Pinsby and di George (1965)	Excess whorls, increased finger ridge count, simian line; increased atd angle.
8.	Birdheaded dwarfism	Seckel (1960)	Simian crease.
9.	Stub thumbs	Goodman et al. (1965)	Whorls on stub thumbs.
10.	Ellis Van-Creveld Syndrome	Goor et al. (1965)	Simian line.
11.	Holt-Oram Syndrome	Gall et al. (1966) Rosner; Aberfeld (1970)	Distal axial triradius; increased W, simian line, no axial 't'.
12.	Ectodermal dysplasia	Basan (1965)	Ridge dysplasia.
13.	Cooley's anaemia	Rosner; Spriggs (1969)	Increased whorls, increased atd angle, decreased a-b ridge count.
14.	Tuberous sclerosis	David (1972)	No differences observed.

propensity to a particular gene disorder, even before that disorder manifested itself.

(v) Dermatoglyphics in Conditions where Genetic Transmission is Uncertain

Another large group of medical conditions where associated dermal ridge configurations have been studied is that in which the mode of genetic transmission of the condition is, as yet, uncertain (see Table XL). The most common diseases in this category are the various forms of congenital heart disease. The associated dermatoglyphics have been extensively studied, by Hale, Phillips and Burch (1961); Sanchez Cascos (1964, 1965 and 1968); Takashina and Yorifuji (1966); Burguet and Collard (1968); David (1969) and Preus, Frazer and Levy (1970) amongst others. There are two main obstacles to this sort of study. Firstly, there are many different kinds of congenital heart disease, each of which must be carefully differentiated; and secondly, congenital heart disease is often associated with other inherited disorders, in particular mongolism, and great care must be taken in deciding which aspects of the palmar and digital patternings are due to which disorder.

The genetic transmission of leukaemia is also uncertain and efforts have also been made in this disease to discover dermatological stigmata. In this condition, the main argument, which started in 1969 with the publication of a paper in 'Lancet' by Menser and Purvis Smith, revolves around the use of the so-called Sydney line (a variant of the simian crease) as a diagnostic aid, a hypothesis partially supported by Wertelecki et al. (also in 1969). However the Sydney line was completely dismissed as useful by Dubowitz (1969). Since then, researchers seem divided into pro- and anti- Sydney-liners, with Rosner (1969) 'anti'; Verbov (1970) and Zahalkova and

TABLE XL

Dermatoglyphics in Conditions where Genetic Transmission Uncertain

	Clinical Disorder	Reference	Dermatoglyphic Abnormality
A.	CONGENITAL HEART DISEASE	Sanchez Cascos (1964)	
	(1) Pulmonary stenosis		Increased atd angle, excess arches.
	(2) Ventricular septal defect		Excess ulnar loops.
	(3) Atrial septal defect		Excess radial loops.
	(4) Tetralogy of Fallot		Increased whorls.
	(5) Aortic coarctation		Increased whorls.
	(6) Aortic stenosis		Increased whorls.
	(7) Myocardial infarction	Rashad and Mi (1975)	Increased whorls, high ridge counts.
B.	SCHIZOPHRENIA	Raphael and Raphael (1962)	Ridge distortions; some report excess whorls, others excess arches on digits.
C.	PSORIASIS	Cummins; Midlo (1961) Steinberg et al. (1951) Bettman (1932)	Simian line, increased frequency of interdigital IV patterns.
		Gibbs (1967)	Increased digital whorls.
		Verbov (1968a & b)	Increased arches.
D.	POLIOMYELITIS	Blotevogel (1934)	Increased whorls, decreased arches in males. Whorls and arches both increased in females.
E.	RUBINSTEIN-TAYBI SYNDROME	Robinson et al. (1966)	Thenar/I patterns increased; simian crease.
		Simpson et al. (1973)	Decreased ulnar loops.
F.	EPILEPSY AND RETARDATION	Brown et al. (1940)	Excess arches on digits.
		Rosner et al. (1969)	Increased simian line, low pattern intensity.
G.	CRANIOFACIAL DYSPLASIA	Wolf et al. (1964)	Longitudinal main lines on palms.
H.	ARTHROMYOGRYPOSIS MULTIPLEX	Wolf et al. (1964)	Longitudinal main lines on palms.
I.	ANENCEPHALY	Hilman (1953)	Bimanual variation decreased, transverse palmar ridges.
J.	IDIOPATHIC MENTAL RETARDATION	Hirson; Giepel (1960)	Excess arches, low TFRC; simian line, thenar/I and hypothenar patterns increased, decreased a-b ridge count.

TABLE XL (Cont.)

	Clinical Disorder	Reference	Dermatoglyphic Abnormality
K.	CONGENITAL ASYMMETRY	Johnson and Penrose (1966)	Different patterns on larger and smaller limbs (depending on foetal age of onset).
L.	ORAL-FACIAL-DIGITAL SYNDROME	Tucker et al. (1966)	Simian lines, single crease on 5th digit.
M.	DIABETES MELLITUS	Verbov (1973)	Females: decreased whorls, increased arches. Males: high interdigital IV patterning.
N.	LEUKAEMIA	Menser and Purvis Smith (1972, 1969) Dubowitz (1969) Verbov (1970)	Increased palmar creases (Simian and Sydney). Most say increased TFRC, some reduced TFRC.

Belusa (1970) 'pro'. There is also corresponding disagreement as to the possible use of dermatoglyphics as a diagnostic aid in this condition, though the weight of opinion now seems to rest slightly more heavily on the negative side. Part of the confusion again seems to have arisen out of a failure to differentiate the different types of leukaemia.

There is also considerable argument over the association of dermatoglyphics and schizophrenia, which is not particularly surprising when one remembers that it is by no means fully understood how much schizophrenia is genetically determined and how much it is caused by environmental influences and pressures. However, some authors do claim to have found statistically significant differences between the dermal configurations of schizophrenics and normal subjects (Beckman and Norring, 1963; Zavala and Nunez, 1970; and Sank, 1968) in relation to childhood schizophrenics.

(vi) Dermatoglyphics in Conditions Resulting from Toxic or Traumatic Factors

The medical conditions in this section are those which have been brought about by a tetrogenic or traumatic effect acting on the foetus during the first few months of gestation. This usually either takes the form of a toxic agent as in thalidomide poisoning, or of a virus, as in rubella. When, as in thalidomide poisoning, the limbs are severely affected, the dermal patterning will be similarly affected in the same way as was earlier explained for electrodactyly. Dermatoglyphics have also been shown to be modified by the rubella virus by Alter and Schulenberg (1966): Achs, Harper and Siegel (1966); Purvis Smith and Menser (1968, 1973);Purvis Smith, Howard and Menser (1969), and Hook, Achs and Harper (1971). (For a summary of results and associations, see Table XLI.) Qazi and Thompson (1971) have also shown that the condition known as congenital vitilizing adrenal hyperplasia is due to the abnormal secretory activity of the adrenal cortex which begins in the individuals affected in the third month of intra-uterine life. This condition particularly affects females and is reflected in significant differences in the dermal configurations of the affected females.

(vii) Unusual Dermatoglyphic Syndromes

David first postulated the existence of inherited dermatoglyphic syndromes which had no association with a particular disease, but which existed in their own right in 1971 when he first described the "ridges-off-the-end" syndrome in a family from Dorset. This syndrome appears to be inherited in an autosomal dominant and consists of ridges running vertically off the end of finger and toe prints instead

TABLE XLI

Dermatoglyphics in Conditions Caused by Toxic or Traumatic Factors

	Clinical Disorder	Reference	Dermatoglyphic Abnormality
1.	Thalidomide	Davies and Smallpiece (1963)	Simian lines.
2.	Cerebral diplegia	Martin et al. (1960)	Walker index similar to trisomy 21.
3.	Rubella	Achs et al. (1966)	Simian line increased, distal 't'. Excess radial loops other than digit II.
		Alter; Schulenberg (1966)	Excess whorls.
		Menser, Purvis Smith (1968)	Increased whorls, abnormal palmar creases (simian and Sydney).
		Aleksandrowicz et al. (1966)	Increased L^R in males; W in females.
4.	Virilizing adrenal hyperplasia	Qazi; Thompson (1971)	Females have increased total finger ridge count, a-b count and whorls.

of forming the normal patterns. There is a tendency for the fingertip patterns to partly cross the distal interphalangeal flexion crease, with the triradius on or below the flexion crease, and also for the patterns to take their exit on the radial border of the fingers. There is a complete absence of arches, whorls, twinned loops, lateral pocket loops and composites in every affected member. Interdigital patterns tend to extend more proximally on the palm than is normal and there is a considerable distal displacement of the 't' triradius to a t'' or t''' position. There is also a peculiar vertical 'crack' in the ridges on the hypothenar eminence above the hypothenar pattern.

In 1973 David described additional families with 'ridges-off-the-end' syndrome and another, similar syndrome, called by him the Nelson syndrome. This syndrome also appears to be inherited as an autosomal dominant trait and also has the hypothenar 'crack' - which David believes may be related to an underlying muscle anomaly. Also present is the proximal extension of the interdigital patterns and the considerable distal displacement of 't'.

David also described other common ridge malformations (David, 1973). The first of these is ridge aplasia consisting of congenital absence of epidermal ridges over the entire palmar and plantar surfaces. The palmar and interphalangeal flexion creases remain normal, but there is a great excess of very small creases on the skin and the palmar and plantar areas do not sweat. Baird (1964) described a kindred in America suffering from this trait when it appeared to be inherited as an autosomal dominant trait. The affected members of this kindred also had transient congenital milia and bilateral flexion contractures of some fingers and toes. David, however, believes that the condition may be a generalised disorder of keratin production and this would agree with the principles of his findings on the dermatoglyphics of patients with coeliac disease (David, Ajdukiewicz and Read, 1970), where a high degree of correlation existed between ridge atrophy and changes in the clinical state of the patient.

David also describes a condition known as ridge hypolasia where the ridges are not absent but are reduced in height and often combined with a great excess of 'white lines' on the print. This condition appears to be inherited as an autosomal dominant trait and is also sometimes present in patients with chromosomal abnormalities, particularly those with autosomal aneuploidies.

In the condition known as ridge dissociation, the ridges instead of running in more or less parallel lines, are broken up into short ridges which tend to be curved and completely disorganised. It is most commonly found on the thumbs and in the region of the axial 't' triradius on the palm. Ridge dissociation appears to be an heterogeneous condition which can be inherited as an autosomal dominant trait or it can be sporadic.

Cherrill (1950) also described the presence of 'white lines' on finger prints. He believed that the number of these lines on the fingers increased with the progress of disease, especially on the fourth and fifth digits of the left hand, mentioning that the left hand appears to be more susceptible to change under postmortem conditions than the right hand. Thus, he argued, a prolonged analysis of finger prints could, in some cases, supply evidence of incipient disease and its progress. However, the only work which appears to have been undertaken on these lines is David's work on coeliac disease described above (David, Ajdukiewicz and Read, 1970).

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