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A STUDY OF DERMATOGLYPHIC VARIABILITY IN THE POPULATIONS OF CENTRAL WALES AND SHROPSHIRE

W. R. WILLIAMS

Thesis submitted for the degree of Doctor of Philosophy

Department of Anthropology

University of Durham

1978

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ABSTRACT

The research topic undertaken involved a dermatoglyphic investigation of the mid-Wales borderland of Powys and Salop. The material was presented in the following manner.

Section One contained a summary of Welsh history, particularly of Powys (Montgomeryshire) and western Salop. Attention was drawn to the evidence of migration and invasions. Available data on genetic studies in Wales and the borders were considered and a brief review of multivariate analysis on dermatoglyphic material made.

Section Two gave the methodology used in reading the prints collected as well as the scheme followed in collecting the data. Definitions of three partitioning parameters were given, these being the child's birthplace, parent's common birthplace and ancestry as defined by surname. Further information on dermographic variables as drawn from the collected questionnaires was reported.

Section Three gave univariate statistical results for all the variables available, when the data set was partitioned by single parameters and when the parameters were in combination. Evidence was given as to which parameter was most "efficient" as a divisor and how this related to other parameters. The ability of the various variable sets to give statistical differences between subsets was reported. Geographical variation was investigated by a one way analysis of variance subsequent to definition of how regionalisation was obtained. Both parametric and non-parametric statistics were used and a summary of the univariate statistical results made.

Section Four dealt with multivariate statistical results. First the theory of Discriminant function analysis was given and a short consideration of distance coefficients made. Non-metric Multidimensional scaling and clustering techniques were considered. Using the same parameters

as in Section Three, distance coefficients between various combinations of these divisiors were made. The resulting regionalisation obtained was compared with the univariate statistical results and the D^2 between regions compared with predictors by bivariate and multiple regression techniques.

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W. R. Williams, M.Sc.

AIMS AND OBJECTIVES

The present research thesis was initiated with the following aims:-

(1) To investigate by means of Dermatoglyphics the possibility that the populations of Montgomery (Powys) and Salop have separate gene pools.

(2) To try to produce regions which exhibit homogeneity within themselves and heterogeneity between, and to try to relate any such distribution to demographic variables such as migration or marriage movement and to existing evidence, mainly ABO gene frequencies.

(3) To see which of four parameters were best able to partition the data sets, or which combination of parameters, the four being:

(a) The child's birth place

(b) The parent's common birth place

(c) Ancestry, as defined by surname

(d) Linguistic ability

CONTENTS

Aims and Objectives:

Section (1)

Historical Background: 1

Palaeolithic/Neolithic: 1
Middle Bronze Age: 5
Roman/Saxon Period: 9
Norman Period Onward: 15

Genetic Studies in Wales: 29

Anthropometry: 29
Serology: 34
P.T.C. Tasting: 38
Colour Blindness: 39
Dermatoglyphics: 40

Literary Review: 41

Section (2)

Methodology: 45

Finger Pattern Types: 45
Finger Ridge Counts: 47
Finger Triradii: 47
Palmar Patterns: 47
Palmar Ridge Counts: 47
ATD Angles: 48
Palmar Mainlines: 49

Method of Sampling: 51

Introduction to Partitioning Parameters: 55

Comparison of Ancestry, Birthplaces and Grandparents' Birthplaces: 58

Degree of Welshness - Child's Birthplace - Parent's Birthplace: 62

Partitioning Criteria; Further considerations: 65

Dual Partitioning Combinations: 67

Demography: 70

Birth Locations: 70
Birth Location Relationships, Child/Parents/Grandparents: 74
Family Surnames: 76
Religion: 77
Social Class: 78
Language: 79
Language - Birth Location - Surname: 81

Section (3)

Transformation: 83

Univariate Statistical Results

Unilateral Maximum Finger Ridge Counts: 84

Ranking: 84

Males: 86

Right Finger One to Left Finger Five: 86
Bimanual Comparisons: 91

Females: 91

Right Finger One to Left Finger Five: 91
Bimanual Comparisons: 97

Sex Comparisons: 97

General Conclusions 97

Absolute Finger Ridge Counts: 100

Summation of Finger Ridge Counts, Totals: 101

Males: 101

Right/Left/Total Finger Ridge Counts: 101

Females: 102

Right Finger Ridge Counts: 102
Left Finger Ridge Counts: 103
Total Finger Ridge Counts: 104

Absolute Finger Ridge Counts: 105

Right/Left/Total Absolute Finger Ridge Counts: 105

Bilateral Comparisons : 106

Sex Comparisons: 106

Child's/Parent's Birthplace - Comparison of Ridge Counts: 106

Palmar Ridge Counts: 107

Males: 108

Right/Left AB-BC-CD Ridge Counts: 108

Females: 109

Right AB Ridge Count: 109
Right BC Ridge Count: 110
Right CD Ridge Count: 110
Left AB Ridge Count: 111
Left BC-CD Ridge Count: 112

Bimanual Comparisons: 113

Sex Comparisons: 113

Summation of Palmar Ridge Counts, Totals: 113

Males: 113

Right/Left/Total Palmar Ridge Count: 113

Females: 114

Right/Left/Total Palmar Ridge Count: 114

Bimanual Comparisons: 115

Sex Comparisons: 115

Conclusions relating to Finger and Palmar Ridge Counts: 115

Radial and Ulnar Counts: 116

Males: 116

Right Hand Radial Count to Total Ulnar Count: 116

Females: 119

Right Hand Radial Count to Total Ulnar Count: 119

Sex Comparisons: 121

Investigation of Variability: 122

Females: 122

Males: 123

Recoded Data: 123

Finger Triradii: 125

Females: 126

Right Digit One to Left Digit Five: 126
Overall Conclusions: 130

Males: 131

Right Digit One to Left Digit Five: 131
Overall Conclusions: 135

Sex Comparisons: 135

Finger Pattern Intensity Indices: 136

Females: 136

Right/Left/Total Pattern Intensity Indices: 136

Males: 137

Right/Left/Total Pattern Intensity Indices: 137

Sex Comparisons: 138

Palmar Triradii: 138

Females: 139

Axial Triradii: TR, TL: 139
Axial Triradii: T1R, T1L: 140
Axial Triradii: T2R, T2L: 140
Border Triradii: 141
Thenar Triradii: 141
Accessory Triradii: 142

Males: 143

Axial Triradii: TR, TL: 143
Axial Triradii: T1R, T1L: 144
Axial Triradii: T2R, T2L: 144
Border Triradii: 145
Thenar Triradii: 146
Accessory Triradii: 147

Sex Comparisons: 148

Combinations of Axial Triradii: 149

Females: 149
Males: 150

ATD Angles: 150

Females: 151

Right/Left ATD Angles: 151
Bimanual Comparisons: 152
Geographical Variation: 152

Males: 153

Right/Left ATD Angles: 153
Bimanual Comparisons: 154
Geographical Variation: 154

Sex Comparisons and Conclusions: 155

Age Dependence: 156

Palmar Patterns: 157

Females: 157

Peripheral Thenar Loop Right: 157
Peripheral Thenar Loop Left: 158
Radial Thenar Loop Right: 159
Radial Thenar Loop Left: 160
Peripheral Second Loop Right: 160
Peripheral Second Loop Left: 161
Peripheral Third Loop Right: 162
Peripheral Third Loop Left: 163
Peripheral Third Tented Loop Right: 163
Peripheral Third Tented Loop Left: 164
Peripheral Fourth Loop Right: 165
Peripheral Fourth Loop Left: 166
Peripheral Hypothenar Loop Right: 166
Peripheral Hypothenar Loop Left: 167
Central Hypothenar Loop Right: 167
Central Hypothenar Loop Left: 168
Radial Hypothenar Loop Right: 168
Radial Hypothenar Loop Left: 169
Parathenar Loop Right: 169
Parathenar Loop Left: 170
Rare Patterns: 170

Males: 171

Peripheral Thenar Loop Right: 171
Peripheral Thenar Loop Left: 171
Radial Thenar Loop Right: 172
Radial Thenar Loop Left: 173
Peripheral Second Loop Right: 173
Peripheral Second Loop Left: 173
Peripheral Third Loop Right: 174
Peripheral Third Loop Left: 174
Peripheral Third Tented Loop Right: 175
Peripheral Third Tented Loop Left: 175
Peripheral Fourth Loop Right: 176
Peripheral Fourth Loop Left: 176
Peripheral Hypothenar Loop Right: 177
Peripheral Hypothenar Loop Left: 177
Central Hypothenar Loop Right: 178
Central Hypothenar Loop Left: 178
Radial Hypothenar Loop Right: 178
Radial Hypothenar Loop Left: 179
Parathenar Loop Right: 179
Parathenar Loop Left: 179
Rare Patterns: 180

Sex Comparisons: 180

Finger Pattern Types: 182

Females: 184
Males: 185

Quantitative Finger Patterns: 188

True Arches: 188
Tented Arches: 189
Ulnar Loops: 189
Radial Loops: 189
True Whorls: 189
Double Loop: 190
Ulnar C.P. Loops: 190
Radial C.P. Loops: 190

Amalgamated Patterns: 190

Arches: 190
Loops: 191
Whorls: 191

Data Partitions: 191

Females: 191
Males: 192

Sex Comparisons: 192

Mainline Terminations: 194

Males: 195
Females: 196

Mainline A Right: 196
Mainline A Left: 197
Mainline B Right: 197
Mainline B Left: 198
Mainline C Right: 198
Mainline C Left: 199
Mainline D Right: 199
Mainline D Left: 200
Mainline Index Right: 200
Mainline Index Left: 201

Review: 201

One-way Analysis of Variance: 204

Geographical Partitioning: 204
One-way Analysis of Variance - Results: 209

Summary of Univariate Statistical Analysis: 216

Section (4)

Distance Coefficients in Multivariate Analysis: 218

Non-metric Multidimensional Scaling: 225

Cluster Analysis: 226

Single Link Clustering: 227
Complete Link Clusters: 227
Average Link Clusters: 228

Format of Multivariate Analysis: 228

Multivariate Analysis Results:

Child's Birthplace; Salop/Powys: 231

Females: 231
Males: 232

Parent's Birthplace; Salop/Powys: 233

Females: 233
Males: 234

Comparison of Child's with Parent's Birthplace: 236

Degree of Welshness; Ancestry: 238

Females: 238
Males: 239

Language: English/Welsh: 240

Females: 240
Males: 240

Ancestry; All Categories: 241

Females: 241
Males: 243

Child's Birthplace x Ancestry: 245

Females: 245
Males: 247

Parents' Common Birthplace x Ancestry: 248

Females: 248
Males: 250

Child's Birth Location x Ancestry x Language: 252

Females: 253
Males: 255

Parents' Common Birthplace x Ancestry x Language: 257

Females: 258
Males: 259

Discussion: 261

Regional Multivariate Analysis: 263

Child's Birthplace: 263

Females; Reduced Matrix: 263
Females; Complete Matrix: 263

Parent's Common Birthplace: 269

Child's Birthplace: 270

Males; Reduced Matrix: 270
Males; Complete Matrix: 272

Parent's Common Birthplace: 275

Comparison of Regional Differentiation for each Sex: 275

Redefined Regions: 278

Females: 280

Child's Birthplace; Reduced Matrix: 280
Child's Birthplace; Complete Matrix: 281
Parent's Common Birthplace; Reduced Matrix: 281
Parent's Common Birthplace; Complete Matrix: 282

Discussion: 282

Males: 284

Child's Birthplace; Reduced Matrix: 284
Child's Birthplace; Complete Matrix: 285
Parent's Common Birthplace; Reduced Matrix: 286
Parent's Common Birthplace; Complete Matrix: 286

Sex Comparison: 287

Definition of New Locations: 290

New Location x Language x Ancestry:

Females:

Child's Birthplace; Complete Matrix: 292

Males:

Child's Birthplace; Complete Matrix: 294

Sex Comparison: 296

Comparison with Univariate Distributions: 297

General Multivariate Conclusions: 297

Marriage Distances: 301

Relationships of D^2 with Geographical Distance and Marriage Index: 307

Interpretation of Geographical Variation: 309

Multiple Regression Analysis: 318

References Cited and Bibliography: 322

Supplementary Information and Cited Results: 329

Supplementary Information and Cited Results

Letter to Headteachers: 329

Letter to Parents, English: 330

Letter to Parents, Welsh Translation: 331

Questionnaire, English: 332

Questionnaire, Welsh Translation: 333

General Relief and Principal Towns of the Sampled Region: 334

List of Headteachers and Schools involved in the Survey: 335

Regional Samples: 338

Distribution of Schools in the Powys-Salop Borderland: 341

Regions Defined, Contained Parishes and Codes: 342

Parish Code Numbers, Powys: 346

Parish Code Numbers, Salop: 347

Secondary Schools Catchment Areas with Associated Name and Code, Powys: 348

Secondary Schools Catchment Areas with Associated Name and Code, Salop: 349

Cantrefi and Contained Parishes: 350

List of Welsh Surnames: 353

List of Occupations and Associated Social Class: 354

Distribution Frequencies of Spoken Welsh, Powys: 357

Distribution Frequencies of Spoken Welsh, Salop: 358

Card Position, Abbreviation and Name of Dermatoglyphic Variables: 359

Dermatoglyphic Coding Sheet: 364

Definition of "Type" Distributions 365

Birthplace Frequencies of Family Members within the Sample: 366

Social Class Frequencies: 368

Language Ability Frequencies: 368

Birth Location Frequencies, Salop/Powys: 369

Child's Birthplace x Number of Parents born in Powys/Salop: 369

Child's Birthplace x Number of Grandparents born in Powys/Salop: 369

Parent's Birthplace x Grandparent's Birthplace, Powys/Salop: 370

Language (English/English-Welsh) x Surnames (English/Welsh)

x Birthplace (Salop/Powys): 370

Table Abbreviations: 371

Transformation Lambda: 373

Finger Pattern Frequencies

Males: 374

Females: 374

Females. Finger Pattern Frequencies, Partition A: 375

Females. Finger Pattern Frequencies, Partition B: 376

Females. Finger Pattern Frequencies, Partition C: 377

Dual Breakdown. Child's Birthplace. Females. Finger Pattern Frequencies: 378

Dual Breakdown. Parent's Birthplace. Females. Finger Pattern Frequencies: 379

Males. Finger Pattern Frequencies, Partition A: 380

Males. Finger Pattern Frequencies, Partition B: 381

Males. Finger Pattern Frequencies, Partition C: 382

Dual Breakdown. Child's Birthplace. Males. Finger Pattern Frequencies: 383

Dual Breakdown. Parent's Birthplace. Males. Finger Pattern Frequencies: 384

Quantitative Finger Patterns. Summation over all Fingers

Males: 385

Females: 385

Quantitative Finger Patterns. Means on Partition A.B.C.D.E

Females: 386

Males: 386

Ranking of Unilateral Maximum Finger Ridge Counts over Digits

Males: 387

Females: 387

Finger and Palmar Ridge Counts. Basic Parameters, mean, s.d., g2, g1, g2(T)

Males: 388

Females: 388

Palmar Triradii Frequencies

Males: 389

Females: 389

Combinations of Palmar Triradii, Frequencies

Males: 390

Females: 390

Finger and Palmar Intensity Indices, Frequencies

Males: 390

Females: 390

Finger and Palmar Intensity Indices, Means

Males: 391

Females: 391

Palmar Pattern Frequencies

Males: 392

Females: 392

Mainline Termination Frequencies

Males: 393

Females: 393

Mainline Indices

Males: 393

Females: 393

Probability of Heterogeneity between Subsets on A t-test, Finger and Palmar Ridge Counts, Partitions A.B.C.D.E. Raw and Transformed Data

Males: 394

Females: 394

Finger and Palmar Ridge Counts, t-test Probabilities, Single Parameters and Selected Populations

Males: 395

Females: 395

Finger and Palmar Ridge Counts, Mann-Whitney Probabilities, Single Parameters

Males: 396

Females: 396

Finger and Palmar Ridge Counts, t-test Probabilities, Dual Partition

Females: 397

Finger and Palmar Ridge Counts, Mann-Whitney Probabilities, Dual Breakdown

Females: 398

Finger and Palmar Ridge Counts, t-test Probabilities, Dual Breakdown

Males: 399

Finger and Palmar Ridge Counts, Mann-Whitney Probabilities, Dual Breakdown

Males: 400

Quantitative Finger Patterns, t-test and Mann-Whitney Probabilities

Females: 401

Males: 401

Ulnar and Radial Finger Ridge Counts, Single Partition, t-test Probabilities

Females: 402

Males: 402

Least ATD Angles, Single Parameters, t-test and Mann-Whitney Probabilities

Females: 402

Males: 402

Finger Triradii; X_2^2, Mann-Whitney and t-test Probabilities

Females: 403

Males: 404

Palmar Triradii; X_2^2, Mann-Whitney and t-test Probabilities

Females: 405

Males: 405

Palmar Patterns; X_2^2 , Mann-Whitney Probabilities

Females: 406

Males: 407

Finger and Palmar Intensity Indices; X_2^2, Mann-Whitney Probabilities

Females: 408

Males: 408

Mainline Terminations and Indices; Mann-Whitney Probabilities

Females: 409

Males: 409

Finger and Palmar Ridge Counts; Oneway Analysis of Variance Probabilities; Parametric Test

Females: 410

Males: 410

Finger Triradii; Oneway Analysis of Variance Probabilities; Parametric Test

Females: 411

Males: 411

Ulnar and Radial Finger Ridge Counts; Oneway Analysis of Variance Probabilities; Parametric Test

Females: 411

Males: 411

Least ATD Angles; Oneway Analysis of Variance Probabilities; Parametric Test

Females: 411

Males: 411

Finger and Palmar Intensity Indices; Oneway Analysis of Variance Probabilities; Parametric Test

Females: 412

Males: 412

Palmar Triradii; Oneway Analysis of Variance Probabilities; Parametric Test

Females: 412

Males: 412

Kruskal-Wallis Oneway Analysis of Variance Probabilities;

Finger and Palmar Ridge Counts;

Finger and Palmar Intensity Indices;

Finger and Palmar Triradii;

Ulnar and Radial Ridge Counts;

Palmar Mainlines;

Least ATD Angles;

Palmar Patterns;

Females: 413

Males: 413

Mean Total Finger Ridge Counts over 15 Regions

Females: 414

Males: 415

DISCRIMINANT FUNCTION ANALYSIS

Child's Birthplace, Salop/Powys,

General Results; Females; Reduced Matrix: 416

Females; Complete Matrix: 417

Males; Reduced Matrix: 418

Males; Complete Matrix: 419

Parent's Common Birthplace, Salop-Powys,

General Results; Females; Reduced Matrix: 420

Females; Complete Matrix: 421

Males; Reduced Matrix: 422

Males; Complete Matrix: 423

Ancestry, English-Welsh,

General Results; Females; Reduced Matrix: 424

Females; Complete Matrix: 425

Males; Reduced Matrix: 426

Males; Complete Matrix: 427

Ancestry, All Categories, Complete Matrix:

General Results; Females: 428

General Results; Males: 429

D^2 and F Matrices; Females: 431

D^2 and F Matrices; Males: 431

Minissa M.D.S. Plot; Females: 432

Minissa M.D.S. Plot; Males: 432

Linguistic Ability, English-English and Welsh,

General Results; Females; Reduced Matrix: 433

Males; Reduced Matrix: 434

Child's Birthplace (Salop-Powys) X Ancestry (English-Welsh),

General Results; Females; Reduced Matrix: 435

Parent's Common Birthplace (Salop-Powys) X Ancestry (English-Welsh),

General Results; Females; Reduced Matrix: 436

Child's Birthplace (Salop-Powys) x Ancestry (English-Welsh) x
Child's Linguistic Ability (English-English and Welsh),
General Results; Females; Reduced Matrix: 437
Parents' Common Birthplace (Salop-Powys) x Ancestry
(English-Welsh) x Child's Linguistic Ability
(English-English and Welsh),
General Results; Females; Reduced Matrix: 438
D^2 and F Matrices;
Females; Reduced Matrix;
Child's Birthplace x Ancestry: 439
Child's Birthplace x Ancestry x Linguistic Ability: 439
Parent's Birthplace x Ancestry: 439
Parent's Birthplace x Ancestry x Linguistic Ability: 439
Principal Function Plots; Females; Reduced Matrix;
Child's Birthplace x Ancestry: 440
Parent's Common Birthplace x Ancestry: 440
Minissa M.D.S. Plot; Females; Reduced Matrix;
Child's Birthplace x Ancestry x Linguistic Ability: 441
Parent's Common Birthplace x Ancestry x Linguistic Ability: 441
Child's Birthplace (Salop-Powys) x Ancestry (English-Welsh),
General Results; Males; Reduced Matrix: 442
Parent's Common Birthplace (Salop-Powys) x Ancestry (English-Welsh),
General Results; Males; Reduced Matrix: 443
Child's Birthplace (Salop-Powys) x Ancestry (English-Welsh) x
Child's Linguistic Ability (English-English and Welsh),
General Results; Males; Reduced Matrix: 444
Parent's Common Birthplace (Salop-Powys) x Ancestry (English-Welsh) x
Child's Linguistic Ability (English-English and Welsh),
General Results; Males; Reduced Matrix; 445

D^2 and F Matrices;

Males; Reduced Matrix;

Child's Birthplace x Ancestry: 446

Child's Birthplace x Ancestry x Linguistic Ability: 446

Parent's Birthplace x Ancestry: 446

Parent's Birthplace x Ancestry x Linguistic Ability: 446

Principal Function Plots; Males; Reduced Matrix;

Child's Birthplace x Ancestry: 447

Parent's Common Birthplace x Ancestry: 447

Minissa M.D.S. Plot; Males; Reduced Matrix;

Child's Birthplace x Ancestry x Linguistic Ability: 448

Parent's Common Birthplace x Ancestry x Linguistic Ability: 448

Child's Birthplace; Four New Redefined Regions;

General Results; Females; Reduced Matrix: 449

General Results, Females; Complete Matrix: 450

Parent's Common Birthplace; Four New Redefined Regions;

General Results; Females; Reduced Matrix: 451

General Results; Females; Complete Matrix: 452

Child's Birthplace; Four New Redefined Regions;

Females; Reduced Matrix; D^2 and F Matrices: 453

Females; Reduced Matrix; Maximum Link Clusters: 453

Females; Reduced Matrix; Single Link Clusters: 453

Females; Complete Matrix; D^2 and F Matrices: 453

Females; Complete Matrix; Maximum Link Clusters: 453

Females; Complete Matrix; Single Link Clusters: 453

Parent's Common Birthplace; Four New Redefined Regions;

Females; Reduced Matrix; D^2 and F Matrices: 453

Females; Reduced Matrix; Maximum Link Clusters: 453

Females; Reduced Matrix; Single Link Clusters: 453

Females; Complete Matrix; D^2 and F Matrices: 453

Females; Complete Matrix; Maximum Link Clusters: 453

Females; Complete Matrix; Single Link Clusters: 453

Child's Birthplace; Four New Redefined Regions;

Females; Minissa M.D.S. Plot; Reduced Matrix: 454

Females; Minissa M.D.S. Plot; Complete Matrix: 454

Parent's Common Birthplace; New Redefined Regions;

Females; Minissa M.D.S. Plot; Reduced Matrix: 455

Females; Minissa M.D.S. Plot; Complete Matrix: 455

Child's Birthplace; Four New Redefined Regions;

General Results; Males; Reduced Matrix: 456

General Results; Males; Complete Matrix: 457

Parent's Common Birthplace; Four New Redefined Regions;

General Results; Males; Reduced Matrix: 458

General Results; Males; Complete Matrix: 459

Child's Birthplace; Four New Redefined Regions;

Males; Reduced Matrix; D^2 and F Matrices: 460

Males; Reduced Matrix; Maximum Link Clusters: 460

Males; Reduced Matrix; Single Link Clusters: 460

Males; Complete Matrix; D^2 and F Matrices: 460

Males; Complete Matrix; Maximum Link Clusters: 460

Males; Complete Matrix; Single Link Clusters: 460

Parent's Common Birthplace; Four New Redefined Regions;

Males; Reduced Matrix; D^2 and F Matrices: 460

Males; Reduced Matrix; Maximum Link Clusters: 460

Males; Reduced Matrix; Single Link Clusters: 460

Males; Complete Matrix; D^2 and F Matrices: 460

Males; Complete Matrix; Maximum Link Clusters: 460

Males; Complete Matrix; Single Link Clusters: 460

Child's Birthplace; Four new Redefined Regions;

Males; Minissa M.D.S. Plot; Reduced Matrix: 461

Males; Minissa M.D.S. Plot; Complete Matrix: 461

Parent's Common Birthplace; Four New Redefined Regions;

Males; Minissa M.D.S. Plot; Reduced Matrix: 462

Males; Minissa M.D.S. Plot; Complete Matrix: 462

Child's Birthplace; Four New Redefined Regions x Ancestry;

General Results; Females; Reduced Matrix: 463

General Results; Males; Reduced Matrix: 463

D^2 and F Matrices; Females; Reduced Matrix: 465

D^2 and F Matrices; Males; Reduced Matrix: 465

Minissa M.D.S. Plot; Females; Reduced Matrix: 466

Minissa M.D.S. Plot; Males; Reduced Matrix: 466

Maximum Link Clusters; Females; Reduced Matrix: 467

Maximum Link Clusters; Males; Reduced Matrix: 467

Child's Birthplace; New Locations x Ancestry x Child's Language;

General Results; Females; Complete Matrix: 468

General Results; Males; Complete Matrix: 469

D^2 and F Matrices; Females; Complete Matrix: 471

D^2 and F Matrices; Males; Complete Matrix: 472

Minissa M.D.S. Plot; Females; Complete Matrix: 473

Minissa M.D.S. Plot; Males; Complete Matrix: 473

Single Link Clusters; Females; Complete Matrix: 474

Single Link Clusters; Males; Complete Matrix: 474

Maximum Link Clusters; Females; Complete Matrix: 475

Maximum Link Clusters; Males; Complete Matrix: 475

Child's Birthplace; 15 Regions;

Females; General Results; Reduced Matrix: 476

Females; D^2 and F Matrices; Reduced Matrix: 477

Females; Minissa M.D.S. Plot; Reduced Matrix: 478

Females; Maximum Link Clusters; Reduced Matrix: 479

Females; Single Link Clusters; Reduced Matrix: 479

Parent's Common Birthplace; 15 Regions;

Females; General Results; Complete Matrix: 480

Females; D^2 and F Matrices; Complete Matrix: 482

Females; Minissa M.D.S. Plot; Complete Matrix: 483

Females; Maximum Link Clusters; Complete Matrix: 484

Females; Single Link Clusters; Complete Matrix: 484

Child's Birthplace; 15 Regions;

Males; General Results; Reduced Matrix: 485

Males; D^2 and F Matrices; Reduced Matrix: 486

Males; Minissa M.D.S. Plot; Reduced Matrix: 487

Males; Maximum Link Clusters; Reduced Matrix: 488

Males; Single Link Clusters; Reduced Matrix: 488

Parent's Common Birthplace; 15 Regions;

Males; General Results; Complete Matrix: 489

Males; D^2 and F Matrices; Complete Matrix: 491

Males; Minissa M.D.S. Plot; Complete Matrix: 492

Males; Maximum Link Clusters; Complete Matrix: 493

Males; Single Link Clusters; Complete Matrix: 493

Marriage Movement Matrix; Two Generations Combined; Matrix: 494

Marriage Movement Matrix; Minissa M.D.S. Plot: 495

Marriage Movement Matrix; Maximum Link Clusters: 496

Marriage Movement Matrix; Single Link Clusters: 497

Correlation Matrices between Biological, Marriage and Geographical Distances for 15 Regions;

Pearson Correlation Coefficient Matrix: 498

Spearman Correlation Coefficient Matrix: 498

Kendal τ Correlation Coefficient Matrix: 498

Multiple r^2 between D^2 and Predictor Variables;

Females; Reduced Matrix: 499

Females; Complete Matrix: 499

Males; Reduced Matrix: 499

Males; Complete Matrix: 499

Means and Standard Deviations for Breakdown Groups of New Locations x Ancestry x Language (Child's birthplace);

Females; means: 500

Females; S.D. : 503

Males; means: 506

Males; S.D. : 509

Computer Programme Description;

FM. Programme to read an F matrix produced by the Discriminant Function Programme in S.P.S.S.: 512

MCON. Programme to convert the F values from the Discriminant analysis to Mahalanobis' D^2. : 514

SIMI. Programme to produce a matrix of associations from an input matrix of marriage linkages: 516

Section (1)

HISTORICAL BACKGROUND

PALAEOLITHIC/NEOLITHIC

Before the onset of the penultimate (Riss) glaciation Wales showed very little evidence of human occupation. A Middle Acheulian hand axe found near Cardiff would seem to be the only direct evidence which links to similar rare finds in the Severn and Trent Valleys. It has been speculated that the inhabitants of these lands were only transitory hunters, living in small bands and travelling at seasonal or intermittent intervals. The Cotswolds region has revealed large numbers of similar hand axes, and it seems reasonable to speculate that these hunters would be attracted to the southern valleys and downs, having little desire to penetrate too far into the hills, especially as they are considered to be lowland and riverside people as the ground pattern of settlement tends to indicate.

When the last glaciation finally began to recede, small groups of people began to move into these islands, concurrent with the population of Europe expanding, along with improved hunting and manufacturing techniques. At this time it will also be remembered that the English Channel was not as it is now, but could be crossed on foot, allowing for the probability that it was covered with marsh and bogland. This initial crossing of small groups of people made little impact on Wales and the only known site is that of Paviland on the Gower Peninsula. A speculative find has also been made in Carmarthenshire, and it may be that small groups of people lived in the mid Severn Valley and slowly moved northward to north east Wales.

The onset of the Mesolithic period saw a rise in temperature, and an increase in dampness, which encouraged afforestation of the country

and eliminated the game animals of the late Palaeolithic period. To survive, men may have become, at least on a small scale, food gatherers, while fishing and hunting small game.

Sites which show signs of occupation at the time include King Arthur's cave at Ross-on-Wye from which small flints and post Pleistocene Fauna have been found; at Paviland, and at Gop Cave in north Wales, indications of the industries which characterise the Continent are found in Wales, but are confined to the cliff tops or to places within easy reach of them. Burry Holm is early Mesolithic (early Tardenoisian), while finds at Aberystwyth and Nab Head are late Tardenoisian. Prestatyn shows evidence of late Mesolithic occupation, while in the south west there is evidence of Maglemosean influence (Denmark). Whether the Mesolithic people added significantly to the later prehistory of Wales is not known, but they may well have survived through the Neolithic period and into the Bronze Age.

Towards the end of the 3rd millenium B.C. new groups of people began to arrive in Britain by two main routes. These Neolithic people either came overland across the still passable English Channel, and into south eastern England, or they were of a more seafaring nature and travelled out of the Mediterranean area, up the coast, and reached the west of Britain and Wales. It was these seafarers from which Wales received its most important input. This latter group sailed first to Cornwall and then travelled up the coast, and eventually traversed the northern tip of Scotland, and on to Scandinavia. The material remains of these peoples are the Megaliths, which occur along the western seaboard of Britain. These Megaliths occur in Wales on the south coast, as well as in Pembrokeshire, Lleyn and the north Wales coast, including Anglesey. A site is also found in the Black Mountains of Breconshire. During this period the climate was changing, and geological movements resulted in a

rise in sea level as well as a sinking of the land - all of which caused a loss of coastal sites. The distribution of the Megaliths shows that these people neglected the upland interior, with the exception of the Black Mountains, although this last site is still below the modern tree line. Fox considered that much material may exist from Neolithic settlements below the present low water mark, and the presence of a few sites found during excavations of dockland tend to support this theory. The distribution of Megaliths suggests a colonisation by people with a preference for lowlands and foothills, and with a social organisation and technical ability which could not deal with considerable natural obstacles. In mid Wales the Ardudwy coast is the main site of settlement, a lesser one being found at the Breiddin at Ffridd Faldwyn, Montgomeryshire.

Foster and Daniel consider the settlement of Wales during the Neolithic period to have been essentially on three sides, with penetration up the valleys into the main mass of the country, and along the eastern border to a lesser extent, with penetration again by way of valleys, but with settlements limited to lower, and not upland, areas.

At approximately 1400-1800 B.C. Britain received a new wave of immigration and invasion by people, characterised by their pots and urns, known as the Beaker People, and with them the British Bronze Age is thought to have begun. The initial invasion of Beaker folk in fact started before the introduction of bronze, and it was a later migration which brought the knowledge of metals. Burial chambers are the main source of information and material about the Beaker people and they contain metal objects of gold, and even copper, along with flint implements. They have a wide distribution which suggests to Williams "a mobile folk of hunters and pastoralists" who may have even acted as overlords of the native Neolithic element. They undoubtedly traded with the Continent from which they came and imported metal objects prior to making their own.

Three types of Beakers are recognised; A, B, and C, with a sub-division of the B. The A and B were brought to Britain from the Rhineland and north west Germany. The B_2 type is also from north western Europe, but B_1 appears to have come from Brittany.

Chronologically, A is later than B_2, the C type arriving at a later date. The distribution of the Beakers is widespread, and the description as it applies to Wales and western Shropshire only will be given.

B type Beakers are found around Llanyblodwel and Llan Llwchaiarn, while the Dovey Valley and the area around Penegoes shows A and C Beakers. Later on, undifferentiated material also occurs around Llanyblodwel, the Tanat Valley, Severn Valley, and at the base of the Breidden Hill. The Severn plain near Shrewsbury and the upper Severn Valley at Llanidloes, together with north west Plynlimon, also show undifferentiated Bronze Age material. That the Beaker folk were not the only people to make up the Bronze Age population must not be forgotten. The Beaker people arrived to find a Neolithic culture already established, mainly Neolithic type A (Williams), with its highland and Continental association which, in north Wales, were Neolithic type B colonies having associations with the north east of England. After the initial colonisation by the Beaker people, the subordinate position of the Neolithic groups appeared to be lost, and the re-emergence of a Neolithic culture influenced the Middle Bronze Age. Trade with Ireland was a prime influence, Neolithic in origin, affecting Britain as a whole, and Wales specifically, the latter being the through route to eastern and southern Britain via the north Wales coast or via the central Wales valleys of the Severn, Dee, Wye and Conway, and consequently connections with Yorkshire and North Wales were established for the Neolithic B culture.

The pottery of the non-Beaker folk of this early stage was known collectively as food vessels and falls into two broad classes; a northern and eastern (Yorkshire) series, and a western (Irish) series, both of which have the native Neolithic cultures as the dominant influence. In Wales the main factor is the Irish influence. In the south west of Wales, Plynlimon and Disgwylfa-fawr (Cardiganshire) there are vessels showing a distinct Irish connection. Penegoes has its Irish influence proved by pots made in Wales, but with a definite Irish cultural background.

A clearly recognised eastern type occurs in mid and northern Wales along the borders of Denbighshire, Montgomeryshire and the eastern margin.

The southern Montgomeryshire areas of the Severn Valley, the Shropshire valleys of the Teme, Clun, and Usk, the western valley of north Cardigan, with the Ystwyth and Rheidol, define an area also showing Neolithic food vessels.

The end result of this activity was a rise in Neolithic influence, with north Wales looking towards Yorkshire, and south Wales to England, while Irish influence was felt especially in Lleyn by the second millenium. Thus the Bronze Age began in Britain.

Middle Bronze Age

The first people to use Bronze have been termed the "Wessex Culture" and appear to have come from Brittany, probably by way of southern England.

By the Middle Bronze Age, metal was being processed in Britain itself. The tools made at first were only imitations of stone tools, but eventually new types of bronze implements were developed. The native and Beaker cultures finally emerged, and evidence of a native culture spread over all Wales, but with Irish influence now appearing.

An initial movement of the Wessex people into Glamorgan is certain, but finds show that the native Neolithic/Beaker people at least traded with them. Eventually this Wessex culture moved into Wales and fused with the existing culture, as the Beakers did before. The expansion of the Wessex culture from south Wales is similar to that of the Beakers before them, in that they travelled up the west coast and settled, at least in mid Wales, on the northern edge of Barmouth Bay. By the end of this middle period, agriculture on the lowland of Wales, in the form of wheat and barley, had been established, circa 1100 B.C. When new and possibly revolutionary bronze implements began to reach Britain about 1000 B.C. it signified the late Bronze Age. Initially it was probably trade which brought material, but later it developed into a migration, hordes of foreign materials being found at Guilsfield in mid Wales, and at Chirk in Salop, both probably the material of traders. Similar materials found east of Cemmaes Road probably had a comparable origin, while Irish influence is seen in south Wales, and again in north Wales on the Lleyn. Pottery finds have shown that the native culture continued to develop and left its mark on the bronze industry, producing a composite effect of native and foreign, with local variants arising as a result of this interaction. North east Wales had a good connection with Ireland (some gold objects), but did not seem to develop much local industry, seeming to rely on the product of travelling smiths or on imports from Ireland or Yorkshire.

The fact that a corded type of pottery had a wide distribution over all Wales is taken as evidence of migration over the province.

Again, later Bronze Age finds confirm a north Wales/Yorkshire connection, but this is thought to be limited to trade with little migration or settlement. By the end of the Bronze Age, south Wales had again become the point of advancement in Wales, where new migrants tended initially to arrive and move away from.

That movement into mid Wales was via the south Wales/east Wales border route and not as today, across Shropshire, was a consequence of the large forest and marshland area which existed in the lowland of north Shropshire. These settlers found swamp and forest a formidable barrier, a place which harboured disease and wild animals - altogether to be avoided.

The Bronze Age was replaced by the Iron Age, again by immigration from the Continent, Wales receiving its migrants via the lowlands of south England, although there is a suggestion that a direct route from the Continent into north Wales via the sea may have existed.

A second phase of Iron Age migration into Wales from Brittany about 200 B.C. is known, starting initially in Cornwall and moving up the west Wales coast and the Severn Valley. Finally a third Iron Age migration comprised the Belgae, again the initial entry into Wales being in the south and then via the Severn northwards. This final arrival was only just in advance of the Romans and had little time to establish itself.

By the early Christian era the Celtic tribes were securely established through Wales, with settlements on the strong points around the river valleys, the uplands remaining unoccupied.

At the dawn of the Roman invasion, Wales as a nation did not exist as such, and would not do so officially for another 1500 years.

The area which was to become Wales was under the influence of a people who extended their area of rule into what became Shropshire, as well as within the now defined territory of Wales.

I have tried to show that Wales has been subject to successive migrations and invasion, leaving her with a population which was a result of mixing and intermarriage. Later I will consider the anthropometric work of Fleure in Wales, but first I will briefly discuss the two broad categories of Welshmen found to this day, with reference to their place in the migration set out from archaeological evidence already given.

The people who we now call "Celtic" have much in common with the English, the difference between the two being the varying proportions which each accumulated as a result of successive invasions.

The Roman writers recognised at least two distinct people in Britain:-

The tall fair, blue eyed Celts related to the tribes of Gaul, and the short, dark, wavy haired types of south Wales (Silures).

The short, dark stock is similar to the Basques of France and Spain, the dark Irish, the short, dark Scottish Highlander and the short, dark Cornish, Devon, Yorkshire and Derbyshire men. This once more extensive race has been termed Iberian, and is probably the Neolithic element discussed earlier. The Neolithic Revolution is agricultural and the Iberic element introduced it to Britain. They introduced a civilisation based on agricultural practice, spinning and weaving, mining, domestication of the horse, farming of sheep etc.

While Britain was occupied by these people a new element was spreading over Europe, superior in fighting power to the Iberians. This was the Celtic race, the tall fair element which had developed iron implements, and who ultimately conquered all of western Europe and who held out for a time in Gaul against the Romans.

That the Iberian settlement in Britain should also have fallen under the Celtic invasion is not really surprising, and evidence of the Celtic presence exists. What is perhaps more surprising is that some Iberian element survived and in Wales fused to a greater or lesser extent with these Celts, giving a population in which both elements were clearly discernible. Initially the flow of metal implements was by trade with the Continent, but later it was made locally. More efficient clearing of forests could now occur.

This first Celtic invasion was by Celts who spoke Gaelic in some form. A second Celtic invasion of Brythonic speaking Celts not only gave rise to modern Welsh, but introduced iron, i.e. the Belgic tribes. The Iberic language in Wales was thus replaced by the Goidelic, which in turn gave way to Brythonic.

Wales and the adjacent west of England was, at the time of the Roman invasion, populated by a people of composite origin organised into tribal units. The Silures of south Wales were the short, dark stock so characteristic of the Iberians already described, while Pembrokeshire was occupied by the Demetae - related to the Silures. The Gangani were found in Lleyn, while a smaller tribe, the Deceangli, occupied Flintshire. What is now Gwent and Gloucestershire was in the hands of the Dobunni, while Cheshire was under the Cornovii. This leaves mid Wales, which was controlled by a tribe termed Ordovices. They held a very large area which included all of mid Wales into Snowdonia and western Shropshire.

The available papers on Roman writings describe only the Silures as dark, short men, and make no mention of the other tribes, but we would expect the Celtic element to be present in other areas of Wales in view of the language now spoken, as well as the Iberian influence, especially as it is described by Roman writers as being present in the "English" people.

Roman/Saxon Period

The invasion of Britain by Romans began in 43 A.D. and progressed across southern England, reaching the Welsh Marshes at about 50 A.D., via the Midlands, north east Wales being captured after the defeat of a refugee Celtic prince from Essex. The southern tribe of Silures were never completely defeated in military terms even though a fort was built and a legion established in their midst, circa 78 A.D. In about 60 A.D.

Anglesey was overrun, but trouble in eastern England with Boadicea caused a temporary reprieve for the rest of Wales, and mid Wales was not subdued until 71-74 A.D. Finally, in 79 A.D., mid Wales was put under Roman control with the almost complete extinction of the Ordovician Tribe. Thus when Roman forces had proved their superiority over the natives, the policing of Wales began. While England was in the Roman civil zone with all the trappings of Roman civilisation, Wales remained a military area with the exception, to some extent, of south east Wales.

The subjection of the Welsh natives was maintained by the establishment of forts at strategic points around the country from which legions could be sent at a moment's notice. A border as such did not exist between England and Wales, but the change from English lowland to Welsh mountain proved a natural divide upon which the division of Roman military and civil zones was established. This "Front Line" was held by forts connected by road, and having established these it is quite probable that the native and Roman way of life carried on with little connection between the two, and after the initial invasion the natives were allowed to continue their own affairs provided that they did not impinge on the Roman dictate to any extent.

The forts at Chester, Caernarvon, Caerleon and Carmarthen would attract traders and settlers, retired soldiers as well as accompanying women and children. The influence of the Romans on the natives is an unmeasurable factor, but undoubtedly some gene flow occurred into the native population, and vice versa, especially when much of the labour in such cities and forts must have been drawn from the native population. Thus Wales seems to have settled down to Roman occupation in a state of subjection, but every now and again raids were made on a Roman position by the Welsh. Even after 100 years, it was still thought necessary to rebuild and reinforce forts to increase the hold on Welsh Wales. While

south Wales was developing a civil zone, mid Wales was left to its own devices. Probably much of this was due to the fact that while the Roman was a valley dweller who sought wooded slopes and banks of settled streams, the native element preferred (or at least existed in) the upland areas, windy and free from extensive vegetation (Wheeler), this separation helping to reduce much of the potential conflict.

While occupying Wales, the Romans mined for metals and sometimes coal, using native labour. Lead was mined in Flintshire, Denbighshire, Monmouthshire, copper from Anglesey, iron from the Forest of Dean, Monmouthshire and Glamorgan, while gold and silver were taken from Merionethshire and north Carmarthenshire.

The next threat to Roman Wales came from the Irish in about 270 A.D. Movement of the Irish to Wales had carried on from early times but in 270 A.D. the Deisi Tribe were driven out of their land, and they migrated to Pembrokeshire, and from that time onwards the invasion threat to the fertile south Wales coast increased.

Initial resistance by Roman troops diverted the migrants to the western coastline, and these initially undefended coasts were now fortified to defend the areas that they had earlier attempted to subjugate.

This rebuilding seems to have taken its time and is put at around 355/365 A.D., but by then Roman influence was in its last phase, and by the end of the fourth century this decline was being felt in the Welsh outposts.

In 383 A.D. Britain was drained of her best troops, with only a few remaining in north Wales. By 400 A.D. no troops remained and Wales was thrown open to periods of internal conflict between the native tribes and the Irish settlers.

Thus, with the removal of Roman influence, Celtic culture could start to develop to an extent which was not possible under Roman rule. The fifth, sixth and seventh centuries constituted a time of resurgence for Celtic culture. In Britain, the Celtic people controlled the area from the Clyde southward to Brittany, but by 600 A.D. the invading Anglo Saxons had travelled from their initial invasion point in eastern England across southern England and northward to reduce the Celtic area of influence to Wales and its borders, north west England, the south west Peninsula, and parts of Scotland. Thus Wales had pressure from two sides, Anglo Saxon from the east, and Irish from the west. The Celtic Renaissance of these times is evident in many aspects of life, in craftmanship, poetry, political life and the spread of Christianity. The tribes also gained increased definition in the western areas, initiated partly by the devolution of power in the late Roman period, as well as by an increased Celtic vigour. These tribes in fact later became the kingdoms of Wales and England.

To what extent these divisions went their separate ways as regards settlement and economy is obscure, but their separation is significant in both this late period of Celtic independence and the succeeding centuries.

Another factor in the movement of people was the spread of Celtic Christianity, perpetuated initially by saints from Strathclyde. They travelled south, initially in the late Roman period, to expel the Irish, settled in the west, and by the 5th century had a hold on north Wales and down the west coast to Cardigan, the Irish frequently still being found in Pembrokeshire and, to a lesser extent, Anglesey, while they were almost non-existent in the north Wales and Border areas.

Until the mid sixth century this migration continued into north Wales and eventually there were two distinct cultural provinces within

Wales, northern and southern, the southward limit of northern Christianity being in Radnorshire. A south east and south west culture could also be detected. This Celtic church progressed into the border areas, but how far is difficult to assess as the Norman church re-dedicated many churches in later times, the earlier associations being forgotten. Bowen's map shows them well into the borders, but there remains a gap between the eastern limit of Celtic dedications and the western edge of the pagan Anglo Saxon cemeteries (pre 7th century), but evidence shows Saxon influence had moved further west than their cemeteries and must either have become converts, or were not present in very large numbers.

Thus, by the early 7th century, most of Shropshire was under Anglo Saxon influence. In trying to establish the dominant element in the borderland, place names have been investigated. It is evident of course that the present border between England and Wales did not exist, nor any other politically acclaimed border, there being evidence that the Celtic people in these areas extended well east of the present line. Considering the Montgomeryshire/Shropshire border, the map shows Celtic names spread well into Shropshire, roughly dividing it into east and west, although this is a blurred division, but it can be seen in general that the western half is, as would be expected, more under the influence of the Celtic people than the eastern side.

It all suggests that the Celtic folk may have first cleared the woodland in the lowland areas and were later ousted by the incoming Mercians. This movement of Celts eastward probably began during the late Roman period and continued until the Mercian advance was met. In pre-Roman times, this area had been colonised by a Brythonic people in any case.

With the increased Anglo Saxon advance, much of Shropshire came under English rule. The advance into these western areas came in three phases. The initial thrust came from the south east where the Anglo Saxons

had been halted in Herefordshire by forest. Later a second attempt was made by Northumbrians to advance into Wales by way of the Mersey and Chester, but a battle at Chester, and later at Oswestry in 641 A.D., (this latter with the Mercians), stopped their progress. The Mercians, between 626-655 A.D., overcame opposition in the north west of England and down the borderland as far as Shrewsbury, and by the 8th century were in control of all middle England up to the Welsh Hills, the Welsh finally being cut off from their relatives in the north west of England and the south west peninsula.

The final advance of the Mercians was marked on its westward edge by the building of a dyke in 757 A.D. and 796 A.D. by the king of the Mercians - Offa. This was not meant to be a military boundary but a structure which was a visible barrier to the Welsh as to the extent of Mercian territory. The steep side always faced Wales and was over 140 miles long. It begins high on a plateau in Flintshire at a point west of the 1284 boundary between England and Wales. The Dyke crosses to Wrexham, over Denbighshire, and continues southward to Llanymynech, then to Forden via Long Mountain. Next it travels south via the Clun Forest to Knighton, across the plain of Hereford, and keeping east of the Wye goes down to the river mouth.

Thus Wales was not invaded by the westward migration of Mercians but again held its own identity intact in the mountain massif. It was during this period that the people of Wales began to call themselves Cymry (compatriots), a name which was later adopted by all the Welsh in Wales.

At the time of the conquest by the Normans, the Borderland had therefore taken on three basic divisions:-

(a) "the Welsh lands were totally Welsh, covered by Welsh place names"

(b) "the greater part of the English border counties where English covered a basic foundation of Celtic names"

(c) "an intermediate zone where English and Welsh are intermixed"

Norman Period

Prior to the arrival of the Normans, the Welsh tribes had been emerging into stronger kingdoms and principalities. The mid Wales area was in an ancient kingdom of Powys - the name reintroduced, of course. This kingdom, based on Montgomeryshire, would periodically expand and contract, moving north to include Flintshire and Denbighshire, or south to Radnorshire, movement being the result of inter-tribal disputes, marriages etc., but the middle bulk remained fairly intact.

The conquest by the Normans began in earnest in 1066, but by 1071 the mixed group of Normans, Bretons and Flemings were in control of the borderlands. The comparatively few Normans established manors along the borders which acted as a buffer zone between the Welsh and the English areas. These manors were eventually to exert their influence for a distance into the Welsh Hills, the marcher lords ruling their lands as virtually autonomous kingdoms. As earlier invaders had found, the best way to gain entry into the mid Welsh hills is by way of the Severn and Vyrnwy, the Norman presence here being evident by their numerous manors.

That the Welsh were in conflict with these new invaders is indicated by the abundance of Mottes and Bailes which are distributed through the border counties, three quarters of all those in the British Isles being found in the Welsh borderlands.

The rise of Welsh resistance was initiated by Gruffydd who by an alliance with the Mercians began to oppose the Normans, but which made, at most, no impact on the Norman advance and only regained a few Mercian settlements west of Offa's Dyke for the Welsh. In general, the Welsh armies did not penetrate far across the lowlands, and the confrontation of old, with the Welsh Hills versus the occupied lowlands, was again established. It was a slow and steady struggle but eventually the Normans established an influence over all the borderlands and into Wales, although the areas of land over which their manors and immediate influence extended was less than the land over which they had lordship.

In the mid border, the Severn Vale was the furthest that the manors extended and over which their influence was felt. This westward movement penetrated as far as Llanidloes and the Cantrefi of south Montgomeryshire. The more outwardly lying lands over which they had lordships were generally left to their own devices, but made to pay dues to their manor lord. These Marcher lordships were almost independent entities, and although the lord would give allegiance to the king they tended to be a law unto themselves, feuds between the manors not being uncommon. The result was the establishment of a belt of land between the Welsh highlands of the west and the Norman lowlands to the east, the latter being controlled by the king. This area of Marcher manors sandwiched between the two elements contained a hybrid people with Anglo Saxon/Norman/Celtic ancestry, the area of greatest Norman influence being around the manor itself, and the lowland fields in which they were generally built.

The most important and influential seat of a manor lord was at Montgomery - the lordship taking this name - but smaller manors were also present in the mid borders. Welshpool had one, as well as Newtown, Caersws and Trefeglwys, significantly the latter three being in the south

of the Welsh area, but still in the Severn Valley where Norman control appeared to have made its greatest inroad into Wales. The furthest outpost of influence would appear to be a manor around the Llanbrynmair area, this being the main route across the mountains from the upper Severn Valley to Caersws, and on to Cemmaes Road on the Dovey. Shrewsbury had a castle along with Oswestry, Clun, Ellesmere and Whittington, and many additional manors were in the safer eastern edge of the border counties. The movement of Norman manors into Wales took time and it was only when Norman influence and confidence increased that manors could be built away from the immediate vicinity of the castles and make inroads into the Severn Vale.

The invasion of the Normans was the last invasion which Wales was to feel by a conquering army, and internal politics were to determine the path which the people of Wales and the borderland were subsequently to take.

The March lordships established many market towns, set up under a charter from the King when it was realised that they were a good source of revenue to the lords of the Manor. Many have since fallen out of use but some still exist. Examples in the mid-borderland include Oswestry, Ellesmere, Wem, Shrewsbury, Church Stretton, Bishop's Castle and Ludlow, to name a few. These markets acted as focal points of activity and would attract population and trade although their suitability to the latter would have depended on the ease with which lines of communication could be established to them, and those still in existence all now lie on the main lines of access into and out of Wales.

Outside the "English" areas the Welshries had fewer market towns, Welshpool being an exception in that it was in Wales, but still within an English manor. The impression gained is that the Welsh in the hill lands contained within lordships were left alone and their tribal customs allowed

to remain. They were still of course paying dues to the manor lord but continued to exist with a dispersed pastoral life. The village, town and castle, so typical of the English lowland, were (and to some extent still are) absent from the Welsh hills. Slowly though, it became apparent that the tribal system was beginning to break down and the family unit was beginning to dominate, this in many ways signalling the way for Wales as a country to develop, for while one tribe was pitted against another, national feeling was virtually absent, and it was not until the tribe had gone and the family had become the basic unit that the higher order of association - Nationalism - could develop.

Thus the Norman influence in mid Wales, while significant in part, was again limited in its extent and, as the Saxons had done before them, had virtually stopped at the edge of the hills, with the exception this time of the Norman inroad into the south Montgomeryshire lowland. In the east March area of Shropshire the Norman influence was much greater. Initially they had just moved into the lowlands of northern Shropshire, already Saxon controlled. Here, either they merged or overran the Saxon land owners in a manner similar, no doubt, to the way the Saxons must have ousted the Celtic/Roman element, but a second and most characteristic phase of settlement occurred in Norman Salop. This was the clearance and settlement of previously virgin woodland. Even so, much woodland had been cleared by the Saxons and it is mainly in eastern Shropshire that this later colonisation had taken place. Where previously there had been strong Anglian and Celtic settlement, these tended to remain, and the Norman influence is seen mainly in the later cleared "woodland" areas. Though much of northern Shropshire was depopulated, by 1086 the vale of Shrewsbury and the land south of the Severn was the more important area. Sylvester (1969) describes the Norman settlements as an "infilling on the Anglo Saxon ground-work, and apart from the market centres of Shropshire

and the area immediately around the manor, the Anglo Saxon population was still present in an active form." The middle Marchland was a hybrid area, with Wales still, as before, left very much alone, fending for itself with subservience to new masters, Norman, not Roman, this time.

By the late 12th century a certain amount of tolerance of the English by the Welsh existed and the development of trade and peaceful co-existence was beginning to develop. Many market towns were initiated in the Norman period, and of 66 market towns in Salop, 60 emerged before 1330 - evidence of a change in attitude along the borderland. Many have since become extinct and only 9 now exist.

Within Wales, nationalism was rising and a leader arose to unite Wales under one banner. This leader, "Llywellyn the Great", succeeded in 1199 in pushing the Normans back to Chester. He gained control of Gwynedd and had the allegiance of the Welsh tribal king of Powys and managed at least to regain much of Powys back for the Welsh, save the centre of Kerry in south Montgomeryshire, although the centres of Cydewain to the north of Kerry were soon back in English hands.

Over the next two centuries there were many uprisings of Welsh leaders and land in Powys came under several leaderships, but never did the Welsh progress significantly eastward over the present border of Wales. Nor, save for the two contrefi mentioned, did the Normans hold much for any length of time within Powys.

Towards the end of the 14th century the economic advances, which had been slowly taking place despite the battle between Norman and Welsh, suffered two more important setbacks. First, the Black Death of 1349, which affected English and Welsh alike, and, secondly, the revolt by Owain Glyndŵr in 1400-1403.

The main result of these events was to reduce the population of the borderlands by between 25-40%. From the late 14th century the manors

began to decline, and there emerged a middle class in Wales who bought small areas of land and established farms which would be of much value when the Act of Union was passed.

After the disruption of the Owain Glyndwr revolt and the aftermath of the War of the Roses, many more lawless people headed for shelter in Wales, and the ensuing lawlessness in the borderland prompted a Council of the March to be initiated to control this "Welsh" element. The council succeeded in its task and in doing so took away much of the power of the Marcher Lords, paving the way for the Act of Union between England and Wales by removing one of the last objects in its path. The Act of Union in 1536 and 1542 brought an end to the power and independent rule of the Marcher lordships and the King now ruled England and Wales under a common law. At this time the final counties of Wales were initiated.

The shires of Anglesey, Caernarvon and Merioneth had been established in 1284, with Flint a result of the statute of Rhuddlan. Cardiganshire and Caermarthenshire were also 13th century products, but the Act of 1536 created the final shires of Denbighshire, Montgomeryshire, Radnorshire, Breconshire, Glamorganshire, Monmouthshire and Pembrokeshire.

These Acts of Union signalled an end to the phase of invasion to which Wales and the borderlands were exposed, and the factors which now determined migration became economic and not military in expression.

From now on I will only consider the development of Montgomeryshire and western Shropshire and I will try to show what factors could have influenced migration into or out of these areas, if indeed any can be found.

Montgomeryshire is mainly an agricultural county at present and has been so since the Act of Union brought it into being. There have been, and still are, areas where mining has taken place, and the service industries which go with any population have developed, but the nature of the countryside and the lack of any major natural resources have seldom attracted anybody, save the farmer, in any numbers, with the exception of those associated with the woollen industry.

The tribal disputes made a settled agricultural policy difficult to maintain, pastoralism being the main use of the land prior to the Act of Union, but with the establishment of more peaceful times, crops could be cultivated, and much land in the lowlands of the valley of the Severn have gradually been given over to wheat, peas, beans, hay etc., and forestry is now expanding in some parts and is a useful source of employment.

The difficulty of attracting any industry to Montgomeryshire was no doubt bound up with the emphasis on agricultural practice, and the lack and difficulty of making and maintaining roads, and of general communication. There are no navigable rivers save the Severn, no communication by sea, and initially no real roads. The first real road was probably of Roman origin, to Llanidloes from the Wye Valley. Roman roads also went from Caersws, south of Newtown, to Wroxeter, another passed through the Aberhafesp and Tregynon districts straight across to the Berwyn Hills and out to the Dee Valley, while another joined Machylleth to Carno. These roads, of Roman origin, were left unrepaired after their departure, due either to lack of interest or motivation.

When in the 16th and 17th centuries the turnpike roads were being developed, Montgomeryshire fared very poorly, and although later wagons used the roads, they were described as the worst roads in the kingdom. Lead mining was taking place at this time in north Montgomeryshire around the Berwyns and in the hills around Llanidloes, but it was of so little importance as to do little to stimulate road building. The nearest mining area of importance was north Cardiganshire on the western slopes of Plynlimon, but the ore was probably moved down the coast to south Wales where coal was more abundant.

Throughout the 1700s the turnpike roads improved communication a little - mainly in the lowland Severn Valley. The first turnpikes were between Oswestry, Llanymynech and Welshpool, built in 1756, this being nearly 100 years after the first act was passed for a turnpike in England. Later roads were:-

1758, Welshpool to Shrewsbury,

1768, Welshpool to Montgomery and Bishops Castle,

and by 1773, most of the turnpike roads were completed, few as they were.

A regular stage coach system was established between Welshpool, Newtown and Llanidloes, and later on between Welshpool and Aberystwyth via Llanfair Caereinion, Llanerfyl, Mallwyd and Machynlleth. In 1870 the southern route over the mountains via Caersws, Carno, Llanbrynmair to Machynlleth came into being. These routes are still followed by the road and rail systems today for the ways in and out of the Severn Basin are limited.

The traditional craft industries never established themselves on any large scale in this agricultural area. Tradesmen would travel around from farm to farm, or possibly have a small display at a market or fair, while the native farmer might travel to local towns to buy such luxuries as he could afford. The farmer would sell his excess beef or

mutton to dealers who would drive the animals to the English markets using the ancient drover's roads, and the farmer for his own part remained self-sufficient. When farming on a subsistence level, two crafts which demanded self-sufficiency were spinning and weaving, and this provided the basis for the nearest Montgomeryshire got to an Industrial Revolution.

With many farms producing sheep, wool was an exportable commodity - one of the few the farming community had, and the best was sent away to Yorkshire or to south west England, while some was undoubtedly woven locally for home consumption. While only the larger farms would have a weaving shed, every croft had a spinning wheel and could no doubt barter with whoever owned the weaving shed to have their produce woven up into what was quite a famous Welsh flannel. Many of the poorer farmers found, in fact, an increasing dependence in hard times on the money gained from spinning and weaving, and would need the extra, in many years, to see them through the winter. Some farmers, though, were quite prosperous and would live in the market towns, their presence no doubt providing the impetus for better roads in the lowland areas.

Exactly why a cottage industry should have developed into a factory system is difficult to determine, but it has been associated with the Civil War and the demand for a hardwearing flannel blanket. Also in 1678 a law was passed which said that all corpses should be buried in woollen cloth. The good quality of the flannel produced meant increased demand and caused more of the wool of Montgomeryshire to stay in the county and even began to attract wool from south east Wales. No doubt much of the skill in weaving and manufacture was due to the Flemish influence introduced into the county by Edward III, around the middle of the 14th century.

Although the 17th and 18th centuries saw the woollen industries flourish in Montgomeryshire, it was still a cottage industry. The only factory process involved was that of fulling - a process introduced by the Flemish people of Pembrokeshire who gradually moved during the 16th century to mid and north Wales. The Flemings seemed to have settled in the Llanbrynmair area where, in the 18th century, there were five fulling mills, the word "Pandy" as a name being an important pointer to the position of such mills, e.g. Pandy, Pennant and Pandy Bach in Llanbrynmair Parish.

The woollen trade prior to 1621 had been centred on Shrewsbury but the monopoly of the draper's company was broken by a Royal proclamation on 10 July 1621. Oswestry then gained some importance, but by 1633 this had died and Shrewsbury again reigned supreme, even without the legal monopoly. By 1790, Shrewsbury itself had again fallen to Oswestry, Welshpool and Wrexham in the distribution of wools and flannels.

The development of the Montgomeryshire woollen industry took a turn towards a more factory-based activity when in the late 1700s and early 1800s carding and spinning machines were developed. These machines were run on water-power, and Montgomeryshire had lots of this from its hill rivers and springs. Being near to the centres of wool production, the necessary step to the introduction of a factory in 1797 (at Welshpool) was quick in coming. The development of more factories along the valleys of the Banwy and Severn increased up to the 1850-52 period. At the same time the centre of importance moved from Welshpool to Newtown - initiated by the introduction of the powered looms, and improved by the building of the Montgomeryshire canal, to reach Newtown in 1821. This process continued when weaving machines were introduced early in the second half of the 19th century and Llanidloes gained importance as the centre of the woollen industry.

The rise of the industry as a factory system is reflected in the rise in population of the woollen centres (Table T1). People were mainly drawn from local sources and many were agricultural workers as well as woollen manufacturers and would return to the land in the harvest season.

NEWTOWN

Table T1

Date	Population
1721	c. 800
1801	990
1811	2000
1821	3490
1831	4500

Thus we have up to the second half of the 19th century a rise in the concentration of factories in the Montgomeryshire lowland, but at the height of its prosperity decline suddenly set in, due to three factors.

First, water driven machinery gave way to steam power and although there was plenty of water available, there was no coal to turn it into steam. Yet there was no lack of fuel in the Lancashire or Yorkshire towns with which Montgomeryshire was in competition. The coalfields were too far away to make the movement of coal to the valleys of wool production profitable.

Second, the Lancashire woollen industry had taken the Welsh flannel and started to produce an imitation of poorer quality, and the reputation of the Welsh product suffered as a consequence.

Third, with the arrival in 1861 in the Severn Valley of the railways it was thought that a new market would open up, but the reverse turned out to be true. Cheap Lancashire-made woollens flooded Wales,

the home-produced cloth could not compete, and slowly the industry declined. Undoubtedly investment at the right time from the mill owners was lacking, as much of the money made from their factories left Wales to go to England, an example being Lloyds Bank which was established using capital raised from Montgomeryshire woollen factories. Towards the 1850s a few power looms were introduced into Newtown and Llanidloes, but the situation was such that they were never used. In 1880 a slight revival did occur with Newtown having a population of over 4000 again, but this did not last and slowly the nearest that Montgomeryshire got to having an industry based on wool manufacturing died. They could not cope with competition from England. Thus, at its height, an estimated 4000 persons were working in Montgomeryshire in woollen factories; by 1921 a total of 327 is recorded.

Montgomeryshire returned to an agricultural shire with no major factories and it is only within the last few years that positive efforts have been made to attract industry to this area of Wales, an example being the development around Newtown which has arisen since the 1964 government report.

Shropshire

The emphasis in the previous section has been on the development of Wales, especially Montgomeryshire, but much of the history of mid Wales has involved the west of Salop, being in many ways an extension of the Severn Valley into agricultural lowlands or of the Kerry Hills into the south Salop Hills. The division into two counties was not delimited until the building of Offa's Dyke or, more formally, until the Act of Union in 1536. The following is therefore a brief description pertaining to events along this narrow strip of land west of Shrewsbury.

The north of Salop is a flat plain divided into two by the River Severn, a major route into and through the county into Wales. The southern region is an extension of the Welsh Massif, forming the uplands of the Long Mynd, Breidden Hills and Wenlock Edge, although the latter area is further east than the present sample area.

In terms of invasions, those which affected mid Wales passed through Salop en route - these being, in order: Neolithic, Goidelic (Celtic) and Brythonic (Celtic). There is little evidence of a Palaeolithic stock in this region prior to the Iberic element arriving. Evidence of the invasion can be found along the Severn Valley in the lowland north, but the ease of entry gives an explanation as to why few stone implements are found, while Celtic remnants are more common. The upland areas of Clun and Much Wenlock tend to reveal more Neolithic implements.

During the Roman occupation, Salop was part of the civil zone and developed villas and farms of a type not seen further west. The impact of the Romans on Salop was considerably greater than in Wales, but even so it is not rich in Roman remains. The main centre of population was at Wroxeter, but lead mines were developed in the southern hills, doubtless with native labour, but, apart from the few villas present which testify to the civil nature of Salop, the remains were spread fairly thinly over the county and probably intruded very little into the life of the natives. No doubt much of the lack of interest by this and later invasive elements was a paucity of anything to attract them. The northern land tended to be undrained marsh and the southern hills have little of worth. The main influence on native life would have been by way of trade and a slow cultural change and, no doubt, gene flow.

Reference to the Saxon and Norman influence in Salop has been made earlier when considering the specific effects of the invasions on mid Wales. Development of industries in later centuries akin to the

Montgomeryshire woollen industry did not occur. Iron and steel production in the Coalbrookdale region is east of the present survey area and will not be considered further. Salop is, and always has been, essentially an agricultural county with associated service industries, its main town, Shrewsbury, acting as a focus of trade and commerce for much of mid Wales, as well as the surrounding Shropshire farmlands.

GENETICAL STUDIES IN WALES

Anthropometric Studies

Fleure, in 1915/1916, presented a report on a study of physical characteristics in Welshmen which remains the largest collection of such parameters in the Principality to date. He measured between 30-40 characters on each individual, each chosen as being of rural origin, adult male and, as far as could be judged, having an ancestry from the area they then occupied.

He identified a type of man which is characteristic of many parts of Wales, and, indeed, present in certain areas of England and the Continent. This type is short, dark-haired and long-headed, being found in the Teifiside region of west Wales from Llandysul up to Llanbyther. A similar type is seen on Plynlimon, further north in Ardudwy (but inland on the moorland area), and possibly in isolated areas of the Lleyn peninsula.

This type is postulated to represent the descendants of the Neolithic people who inhabited Wales from the Stone Age onward. Slight variants of the basic type were found, as on Plynlimon, the valleys of Glamorgan and the Mynydd Hiraethog area of Denbighshire, upland regions among the most remote in Wales. The hypothesis put forward is that Neolithic man lived mainly on windswept moorland or near the coast if they were free from trees, and later cleared the forested valley bottoms and expanded to the cleared lowlands.

The above areas fit the hypothesis of being clear upland moor with valleys cutting into them, and are neither by the sea nor on through routes. Other upland areas which do not have these characteristic types, such as the uplands of Montgomeryshire, Breconshire, Radnorshire and south Salop, are thought to be too high and inhospitable. Fleure also showed

that other upland areas of Britain which have a relatively isolated position (at least in the past) also have the remains of this postulated Neolithic stock.

Evidence for the above connection of dark, long heads with the Neolithic stock comes from three sources:-

(1) The Romans described the Silures of south Wales as short dark people.

(2) The measurements taken from skeletons considered to be examples of Neolithic man compare very favourably with those of their postulated descendants.

(3) The type is also found today in the Mediterranean lands and western France, i.e. those areas which, for other reasons, have been postulated as the origin areas of Britain's Neolithic stock.

Having decided that this does indeed represent the Neolithic element, it is necessary to consider why the type should have persisted for so long in an area such as south Wales. For this latter region three possible reasons can be speculated:-

(1) The "coal fields" are isolated from the rest of Wales by the Forest of Dean and the swampy Severn valley (Fleure and James 1916).

(2) Towards Bristol, an extensive forest was thought to have existed (Fleure and James, ibid.).

(3) The Mediterranean types may withstand industrial life rather better than their Nordic counterparts (Fleure and James, ibid.).

Migration into this area from the western uplands of Wales may indeed have accentuated the type in later times. For the remaining areas of Wales isolation is still the key factor in the persistence of the Neolithic element and it would seem that isolation has been sufficient to preserve the stock up to the present day. In north west Wales the type still persists, but it is slightly taller, while the Plynlimon populations are thought to be even pre-Neolithic, i.e. Paleolithic.

An example of an area illustrating the Neolithic element is Lancashire, or more precisely the valleys which cut into the western side of the Pennines. This area was isolated from the south in ancient times by the swampy midland area - a barrier which proved an obstacle to movement for many centuries.

Fleure gives a value of 20-26% of the population in four upland areas of Wales as being short, dark and long-faced.

Another type identified by Fleure is a dark broad head found from the Ardudwy coast northward. It has a coastal distribution in Carmarthenshire and is rarely found inland save for the Bala cleft. Additionally, it is present at Newquay in north Pembrokeshire and in coastal south Glamorgan. This type is possibly a migrant from the Mediterranean lands and may have carried with it a knowledge of metal. There also appears to be a correlation between this type and the distribution of dolmens in western Wales. Broad-headed people are also known from eastern Britain, but these tend to have fair hair and their relationship to the dark broad heads remains obscure.

The Bala cleft shows tall fair broad heads which probably reached the region in the Bronze Age and mixed with the dark broad heads further west. These Bronze Age people were the forbears of the Celts and as previously speculated may have introduced the Goidelic languages into Britain. Subsequently the tall fair or red-haired people arrived

in the Iron Age and probably brought the Brythonic language which, in Wales at least, ousted the Goidelic language. Fleure thinks that they would not have reached Wales much in front of the Romans and made little impact on the established Bronze Age population, but Peake suggests that they may have had a greater effect, moving into Wales up the Severn and West Valleys. Von Eickstedt notes that while the Mediterranean type exists in the Kerry hills in south Montgomeryshire, in the Severn valley the proportion of tall, fair, broad/medium-headed people is significantly increased over the number in the former area. A similar observation is also made by Fleure on the Salop/Montgomeryshire borders. It seems reasonable that a migration that probably led to a change in the language produced more than a passing effect on the gene pool of Wales, particularly the central region. The fair, long-headed element represents 7-10% of the population in this moorland region, a high proportion of dark, long heads also being found. If fair, medium heads are included, the percentage rises to 13-19%, this evidence supporting the hypothesis of the movement of the Celtic element into Wales, be it in small amounts.

The Bala cleft shows slightly taller, fair people, though Denbighshire has a large number of dark broad heads, blonds being at a low frequency (4%). The Ardudwy and Eifionydd areas show 30% broad heads, while dark long heads occur at frequencies similar to other coastal areas of around 17%. In Lleyn, the frequency of blond people rises to 12-14%, while on the Gower peninsula it is up to 18%. Anglesey has about 21% dark, long-headed people, with about 15% fair, long heads, and represents a bit of a mixture, although it has similarities to Lleyn.

Locally the frequency of these elements can rise considerably. In Plynlimon, for example, there is a dark-haired people with an accentuated long head, these also occurring in the Bala cleft and Denbighshire, and possibly also above the Teifi valley. The short dark broad element is

similar in having very high frequencies in localised areas of Ardudwy and Lleyn. The tall fair element in Gower tends to have large measurements with frequencies of up to 48% locally, and while the fringes of the moorlands show fair elements of up to 18% of the population, it can rise to 30% in Lleyn, and is characteristic of maritime projections, but caution must be applied because of the Viking element in these locations.

Peate (1925) who did a more detailed study of the Dyfi basin showed a division of the basin into a northern and southern part on the basis of head measurements. The northern half contained a greater proportion of broad heads while the southern half exhibited a higher proportion of narrow heads. He could also detect a linguistic difference between the two sides of the basin and speculated that the valley bottom would have been forest and marsh land in the past and would thus, as proposed elsewhere, have been an effective barrier to movement between the north and south of the basin.

Jones (1956) in his study of south Wales states that the people of Tredegar, Ebbw Vale and Brynmawr are more closely related to the populations of central Wales than to those of the moorland fringe.

The association of moorland does not always imply dark long heads of the ancient type; south east Carmarthenshire, for example, has a high proportion of fair long heads, while Bowen (1926) thinks that red hair is a characteristic ancient trait in Llanelly.

In conclusion it can be said that an association of physical characteristics of the head and body seem to be related to the early migrations into Wales and that these characteristics have been maintained up to the present century. Movement of people and invasions have probably increased the variability in any particular area beyond that which existed prior to the migration, although in south Wales the converse is suspected. The association of moorland with the Neolithic characters is hypothesised,

while the Celtic invasion(s) are thought to have brought the fair haired and taller people into Wales, these in general frequenting the lowland or coastal regions.

As regards Salop, no research comparable to the above has been made to date and a study should prove instructive to see if it is possible to separate pockets of Neolithic or Celtic elements. Here we are involved much more with the additional Roman/Saxon/Norman elements than in Wales.

Serology

An analysis of the blood group frequencies in Wales and the borderlands has shown that there is systematic variability over the area. The only systems for which Welsh data are available are ABO: Rh and MNS, the latter showing much less variability in gene frequencies over Wales than the former.

Mourant and Watkin (1952) give the frequencies of the ABO genes for western Europe as:- A. 30 B. 05 O. 65, Wales in comparison showing an elevation in the frequency of the O gene. Watkin (1956) gives A. 23, B. 07, O. 70 for all Wales, but with differences between the north and the south.

North	A. 21	O. 72	B. 07
South	A. 25	O. 67	B. 08

Fraser Roberts (1941/2) gives the north Wales counties the following value:- A. 19 O. 76 B. 05, these being for north Walians with Welsh surnames. In Ardudwy and the Penrhyndeudraeth region of north west Wales, similar high frequencies of O are found, while the mountains of east Wales, Rhinog and the surrounding area are lower but still elevated above the western European mean.

The lower frequency in south Wales of the O gene is suggestive of differential migration into north and south Wales. High B frequencies may be associated with very early settlements and reach their greatest values in populations which, on anthropometric grounds, are suggested to have very ancient origins (Palaeolithic). The Mynydd Hiraethog region of Denbighshire is lower in B than the southern massif (Plynlimon) or the Black Mountains of Carmarthenshire, but the former region has been indicated by Fleure not to contain such ancient populations as the latter two areas. In the Severn basin, whose area contains a population of mixed origins, the B frequency approaches that for southern England. The overall suggestion is that the B gene is a very old element in Wales, possibly associated with the Palaeolithic population, and thus entered Wales prior to the O and A waves. The O gene attains its highest values in north Wales and is suggestive of having connections with the Neolithic migrants, especially as the association between the high O and the megaliths is quite strong.

The Shropshire lowlands have low B frequencies comparable to the combined value for all England and Wales. The high O frequency of Wales is shown to extend into northern Shropshire in Mourant and Watkin's early papers (1952) with an extension of low B and high A into south Montgomeryshire. Watkin, in a later paper, shows that this extension of low O and high A into Wales is more marked in Radnorshire and Breconshire than the southern area of Montgomeryshire, but his data suggest that the southern area of Montgomeryshire to the east of the Severn does, in fact, show elevated values for A/A+O ratio in just the regions that the Norman manors had their firmest extension into Wales (the Cantrefi of Kerry and Gedewain). The association of high O with megaliths is shown for the Black Mountains of Breconshire, while the Black Mountains of Carmarthenshire have an elevation of B and a low O frequency. The graduation from low to high O also occurs

in England when moving northward, but for any given latitude the frequency of O in Wales is higher than for England. The A2 allele appears with unusually high frequency in the Kerry Hills of mid Wales and if the A/A+O ratio is examined in Montgomeryshire, it is found that the towns east of the Severn show higher values than do those to the west. The locations in the upper reaches of the valleys in the Severn basin also show the highest B frequencies for the county.

In analysing the Salop/Montgomeryshire borderland, Watkin (1963) showed that a significant difference in ABO gene frequencies between the two locations was present and although within Salop no difference between the north and south or the east and west of the county could be detected, he did note a difference between the populations with either English or Welsh surnames. He makes two further suggestions:-

(1) That the Welsh population of western Shropshire may be an admixture drawn from the nearby Welsh counties.

(2) There was not a sudden migration into Salop but a constant movement over the border, probably occurring from 1800 onward.

His conclusion, that the English element in the region is probably Norman, is not altogether surprising, although it may be possible to find the Saxon element with closer examination.

Blood group analysis in south Wales (Watkin 1965) again shows a difference between those groups having English or Welsh surnames, with an overall B frequency higher than that in England, the highest values in the region being found in the upland hill valleys on the edge of the moorland.

In Pembrokeshire, the northern area is characteristically Welsh in its blood group frequencies and in the occurrence of Welsh surnames. South of the Landsker in "Little England beyond Wales", Watkin (1960)

could detect the presence of a Viking influence in the high A frequency, thus supporting the historical evidence, the Welsh area north of the Landsker being much lower in A. In northern Pembrokeshire, the O frequency, though higher than that found in England, does not match the high values found in north Wales, but is very similar to the levels found in the neighbouring region of west Carmarthenshire. Watkin has suggested that the Black Mountains of Carmarthenshire have very high B frequencies. Further work by Garlick and Pantin (1957) showed that the reported values were too high and that taking into account family relationships (which Watkin had not done) lowered the frequency, but left it still at an elevated level compared with England, although only slightly higher than shown in west Wales.

It has also been suggested by Watkin (1956) that the high O areas are those that received the Neolithic, or at least the pre-Celtic, population borders, the lower-medium A gene frequency being indicative of an Anglo-Saxon population. This would agree with the differential movement of the Celtic element into Wales and accounts for the values of the A gene in south Wales, an area which had little Anglo-Saxon influence. The lower A frequencies in mid Wales must be the result of a Neolithic/ Celtic mixture giving an A value now lower than the adjoining Salop region.

A comparison with Scotland and Ireland shows that these countries, which were under similar migrational influences to Wales, also have elevated frequencies of the O gene. In Scotland, Brown (1965) found large variation in the O gene frequencies (75.9% - 65.0%) with a mean above that for England. An association of megaliths with high B frequencies is speculated for Scotland. Ireland has a high value for the O gene, while areas with high A are known to have had substantial migration from England.

The Continental countries show a distinct lack of similarity with Wales which to some extent is expected, the countries noted above having had

similar migrational histories to Wales. The suggestion that the Neolithic invasions of western Britain were of Mediterranean origin seem to be supported by finding similar frequencies on islands in the Mediterranean, and a close linkage between the Basques and the Neolithic element would seem to be supported by the blood group values.

Little work has so far been published on the analysis of other blood group systems, but Garlick and Pantin (ibid.) produced results for the Black Mountains on the MNS and Rh systems and concluded that the MS chromosome frequency is above that for England and that the Rh chromosomes are similar to the English estimates although the frequency of the ccDE combination may be slightly raised. Kopeć (1970) gives 16.38% Rh- for Wales as a whole, with regional variations, possibly a decrease of the D frequency across the south Wales coalfields from east to west. Compared with Ireland, these figures are very similar, Kopeć again giving 16.92% Rh- but she gives a higher value for Scotland, with regional variations again present (18.5% - 19.8%). The relationship of the Basques is strengthened by their possessing very high frequencies of the Rh- genes.

P.T.C. Phenylthiocarbamide

The ability to taste P.T.C. was investigated in Wales by Beach (1953) with a comparison of the Plymlimon population and the main Welsh population. He concluded that the former plateau shows a higher frequency of non-tasters than the general Welsh population and suggests that this may have been an anomalous result, mainly based on environmental effects. The frequency of non-tasters given by Tanner et al. (1964) for the English population is comparable with the sample taken from Plynlimon.

Partridge, Zeki and Sunderland (1962) tested for P.T.C in the Black Mountains, the frequency of non-tasters found being high, 43.3%, much greater in fact than the 30.6% recorded on Plynlimon by Beach, while

the surrounding areas had values more comparable to England and north west Europe, 35.1%. Further investigations across the Landsker line in Pembrokeshire by Pullin and Sunderland (1963) showed no statistical difference between the two regions, but gave the northern Welsh region a larger frequency of non-tasters than the south, 40.2% and 34.1% respectively. Examination of the general frequencies of non-tasters throughout England given by Cartright and Sunderland (1967) showed that considerable regional variation was present, but in no case was the frequency greater than 40.3%, the majority having values well below this level.

Unpublished results from Fraser-Smith and Sunderland for north Wales show much lower numbers of non-tasters than reported above, < 20.5%, similar to the north Irish frequency of 14.0%. This paper proposed, as does Watkin, that north Wales represents a distinct population, long-established. That the Welsh in south Wales have a high frequency of non-tasters seems possible judging from data from Pembrokeshire. Information for mid Wales, though, is not at present available.

Colour Blindness

Colour blindness across the Landsker was found not to be significantly different between the north and south, the mean frequency being 6.98%. Pickford (1947) gave a frequency for Scotland of 7.8% with values for western Europe being comparable at 8.0% (Wright 1953). That regional variability is present was suggested by Vernon and Straker (1943) with values ranging from 5.27% in west Scotland to 9.47% in south west England. Kherunian and Pickford (1959) show a decreasing gradient outward from Devon and Cornwall while Fraser-Smith and Sunderland (unpublished) support this in part, giving high frequencies of colour blindness in Anglesey (10.0%), with Caernarvonshire having 11.6%, although they give much lower values for north Wales as a whole. Post (1963)

suggested that the distribution of colour blindness may, in general, be related to the elapsed time since the populations were hunter-gathering cultures, although how this could be applied to Wales is uncertain at the present time.

Dermatoglyphics

The study of regional variability for dermatoglyphic traits is a comparatively new venture within the British Isles although frequencies for individual traits in a general English sample have been given by Cummins and Midlo in their publication (1943). Little will be gained at this time by repeating these individual frequencies except to note that some figures are available. On a local scale three reports are worthy of note. First, the work by Roberts and Coope (1972) who could show a regional pattern of variation in the Oxfordshire and Berkshire regions for total finger ridge count which was reasonably consistent over sex. Second, Dennis (1977b), working on the Yorkshire Dales, concluded that little variability was detected by Multivariate Techniques that could not be ascribed to random sampling, while, third, Fraser-Smith and Sunderland (ibid.) showed that there were no differences between the north Wales counties for a limited number of dermatoglyphic traits.

In further unpublished work, Williams and Dennis linked their computer files for Wales and the Yorkshire Dales and found a sufficient number of cases with both parents born in the same interviewing counties could be obtained to allow discriminant function analysis to be performed. We could show that at this preliminary level a pattern of inter-county relationships could be produced which had geographic significance, although there are reservations about the result, mostly centred around the inclusion of the axial triradii t, t', t''.

CONSIDERATIONS OF DERMATOGLYPHIC LITERATURE

At present the amount of literature on dermatoglyphics is extensive, amounting to over 3500 titles (Mavalwala 1975, 1977). Apart from the numerous papers on methodology and population studies this includes material on formal genetics, twin diagnosis, chromosomal and disease screening. The introduction of computers has allowed new multivariate techniques to be brought to bear on dermatoglyphic problems.

There seems little point in reviewing this literature in depth as most of it has little direct bearing on the present thesis except insofar as it contributes to the evolution of the methodology as used. Similarly, many of the population studies do little more than give univariate statistics for mean differences, in many cases without qualification as to whether the data satisfy the underlying assumptions implicit in their use.

Consideration of the available multivariate research papers gives the main divisions mentioned later in this work (page 218), and as factor analysis and principal component analysis have not been applied to the present dermatoglyphic data, the available papers need not be considered either. This leaves the few papers which deal with discriminant function analysis or the production of distance coefficients between populations based on dermatoglyphics. The following brief review is not meant to be exhaustive, but will indicate some of the conclusions reached by the use of distance coefficients.

Crawford et alia (1973) used D^2 with finger triradii, ridge counts and palmar ridge counts and could correctly designate 48.4% of males and 45.0% of females in four Tlaxcaltocan populations while showing that the sex difference would give between 63 and 73% of cases correctly classified by sex. In terms of geography the populations furthest apart

had the greater D^2 between them, but the overall relationship between D^2 and geographic distance was not investigated.

Other workers have shown that D^2 could be related to geographic separation, examples being White and Parsons (1973) for Australian Aborigines, while linguistic separation also gave reasonable, though slightly less, agreement. Similarly, Rudan (1977), using Penrose's C^2H, showed a significant correlation of miles with the shape component, but only in males, and speculates that social organisation between his villages can influence the distribution of dermatoglyphic characters.

The distances obtained by dermatoglyphics have been compared with those obtained using other characteristics. Loesch and Lisewicz (1976), using a modified D^2, termed D_K^2 (Constandse-Westermann 1972), compared serological and dermatoglyphic distances between two populations. They showed that serology gave a greater degree of separation than did dermatoglyphics although this was mainly due to inclusion of the Duffy system, the ABO and Rh together giving a more comparable distance. In addition, sole prints gave a larger distance than palm prints, and although the former characters tended to have lower heritabilities than the latter, no particular relationship of population difference and heritability was apparent.

Anthropometric characters were compared with dermatoglyphic by Chai (1972) who showed that between five groups the former measures could give 64.5% correct classification of cases, while the latter data set could only manage 39.9% for 22 variables. He considers that the use of D^2, by decorrelating the dispersion matrix, reduced the effects of pleiotropy of genes and that multivariate analysis "must be accepted as the best method" of handling large numbers of variables measured by anthropologists. He further thinks that the greater D^2 encountered for anthropometric variables compared with dermatoglyphics is due to selection acting on the former but not the latter, the correlation with geographic distance being again greater for the former than the latter.

Rothammer et alia (1977) again used serology and dermatoglyphics and showed that using a gene diversity measure (G_{JI}) the correlation (Kentall's τ) for distances based on the two data sets showed little agreement at a village level ($\tau = 0.162$), but much greater agreement at the racial level ($\tau = 0.822$).

Friedlander (1975), comparing 17 village populations on 28 dermatoglyphic variables, using D^2, indicated a disappointing series of inter-village relationships generated by a discriminant analysis, with only limited agreement between sexes.

Comparing populations which are widely separated in space, Coope (1971) showed that the magnitude of the D^2 between the populations, using the twenty finger ridge count variables, was related to the geographical distance between the groups. In addition, the D^2 between sexes within each group were always smaller than the between group distances, the relationship of the populations in space being more clearly defined in females than males.

Finally Dennis (1977b) used both D^2 and E^2 on dermatoglyphic variables and compared 13 populations of the Yorkshire Dales. He found a high correlation between the two distance measures but that in a multiple regression the magnitude of these measures could be predicted with over 86% explained variance, by far the greatest component predictor being an estimate of sample variance ($var = N_1 + N_2/N_1 \cdot N_2$).

The brief review given above shows that in many instances the magnitude of a distance measure between populations was related to the geographic distance apart of these populations. There are indications however that the level of resolution may be a factor to be taken into account. Both Rothammer (1977) and Friedlaender (1975) show little meaningful relationships at a village level, Dennis (1977b) giving comparable results. At a lower degree of resolution, more distant populations do give relationships in terms of D^2.

Part of the aim of the present thesis is to produce a series of D^2 between populations (at essentially a village level), attempt to relate these distances to demographic predictors and to see if the inter-relationships produced both prior and subsequent to amalgamations can be interpreted in any meaningful manner in terms of historical or demographic parameters.

Section (2)

METHODOLOGY

From the early pioneering work on dermatoglyphics by Galton (1892) several workers have put forward methods by which the patterns generated by the presence of epidermal ridges on the hands and feet could be formulated for analysis. Notable among these researchers were Wilder (1922), Bonnevie (1924) and the publication in 1943 by Cummins and Midlo of their memorable book "Fingerprints, Palms and Soles." In more recent times Penrose (1968) and Penrose and Loesch (1970) have produced classification procedures which draw on these earlier workers and develop further their methodology. Between the earliest and most recent authors, many workers have contributed to dermatoglyphic studies. They are not listed here simply because space and time preclude one from doing so efficiently.

The method of dermatoglyphic classification used in this thesis has been formulated by Dennis (1977a) and draws on two main sources. The palmar dermatoglyphics were an extension to the topological system of Penrose and Loesch (1970), additional standardisation being taken from Penrose (1968). The complete method, directions and instructions are given in a paper by Dennis (1977a) and there is thus little constructive use in giving full details again. Consequently only a brief outline of the features used will be given, and readers should consult the more complete documentation.

Finger Pattern Types

The patterns on the finger tips were categorised into eight different classes, a record for each digit being made.

(a) True Arches: Reference to true arches involves those patterns devoid of a triradial point, the ridges running across the digit, roughly at right angles to the digit long axis.

(b) Tented Arches: These encompass patterns which exhibit a single triradius but with the distal radiant ending blindly with no tendency to loop backward in either an ulnar or radial direction.

(c) Ulnar Loops: Ulnar loops have a single triradius with a number of ridges bending round on themselves to terminate at the same edge of the digit from which they started. The opening of the loop is towards the ulnar side of the hand.

(d) Radial Loops: These correspond exactly to the former pattern except that the triradius is on the ulnar side of the digit and the opening of the loop is towards the radial side of the hand.

When two triradii occur together on a digit then a number of possible patterns can result, the present work recognising four individual types.

(e) True Whorls: If the ridge system forms concentric rings or a spiral within the limits of their corresponding triradii then a whorl is said to exist. Counting the ridge system on both the radial and ulnar sides of the pattern (Penrose 1968) gives two values. If the smaller of these two is <u>greater</u> than half the larger count then a true whorl is recorded.

(f) Ulnar C.P. Loop: In a manner exactly comparable to the previous pattern, we count the ridges, but if the ulnar count is less than or equal to half the radial count, then an ulnar centre pocket loop is defined (Ulnar C.P. Loop).

(g) Radial C.P. Loop: Should the radial count be less than or equal to half the ulnar count, a radial centre pocket loop is recorded (Radial C.P. Loop).

(h) Double Loop or Twin Loop: When two triradii exist but the cores of the ridge systems do not form a circle or spiral but rather two separate loops, their courses lying side by side, then the pattern is classified as a double loop.

Rarely, patterns are encountered that have three triradii. These usually appear as a small whorl or centre pocket loop together with a loop, either radial or ulnar, their presence being recorded as an accidental. These occurred at very low frequencies and in all subsequent analyses were recorded as missing data, casewise deletion being operative.

Finger Ridge Counts

Individual ridge counts were taken from a triradius to the core of the pattern, the triradius and the central ridge not being included in the count. Both radial and ulnar counts were recorded and calculations later based on both unilateral maximum and absolute ridge counts. Summation of the counts for each hand and for both simultaneously were made.

Finger Triradii

The number of triradii on each digit was recorded separately. Patterns termed accidentals were recoded as missing, the range of values encountered thus being between 0 and 2 on each digit. Summation of the triradii over hands and for both together was made producing finger intensity indices.

Palmar Patterns

The pattern system on the palms was classified using the topological system of Penrose and Loesch (1970). All whorls were thus subdivided into two loops, usually central and peripheral in direction.

Palmar Ridge Counts

The only ridge counts made on the palms were the traditional ones: a-b, b-c and c-d. Each was recorded separately but when one of the triradii was missing, usually the c triradius, the distance b-d was

independently formulated and used when the total palmar ridge counts were computed.

Palmar Triradii

The classification of axial triradii used the 14% and 40% breakpoints given by Penrose (1968) and delimit the presence of t, t' and t'' respectively. When more than one type occurred each was recorded independently as well as multiple occurrences of any single type. Border triradii (t^b) were recorded with space made available for hypothenar ulnar (t^u) and radial (t^r) triradii, but with no objective method of determination available these latter two were rarely recorded as being present.

Triradii in the thenar/1st region were not identified separately as e or f but recorded as a combined e/f variable.

Accessory triradii were not recorded independently for each interdigital area but were combined into a single value for each hand.

The pattern intensity index was calculated using all palmar triradii on each hand and a total for each individual computed.

ATD angles

The quantitative measures of axial triradii displacement were recorded by means of the ATD angle, this being the angle subtended by the axial triradii (t, t' or t'') with the interdigital triradii a and d. When more than one axial triradius is present then two measurements are made. The angle formed by the most proximal axial triradius (from the wrist crease) was recorded as the least ATD angle while the most distal triradius gave the maximum ATD angle. With three axial triradii the middle angle is not recorded and when a single axial triradius occurs this is listed as equivalent to a least ATD angle. The presence of a hypothenar radial arch meant that no angle could be measured, no axial triradius being present.

Palmar Mainlines

The mainline terminations were recorded for the a, b, c and d subdigital triradii using the marginal values given by Cummins and Midlo (1943) and later Penrose (1968). These methods suffer in the hypothenar region from an increased probability of misclassification of 3 and 5' by having region 4 taken as a midpoint of a line from the most proximal line of the subdigital crease on digit 5 to the most distal line drawn along the wrist crease. As a consequence a region 4 is redefined around the midpoint of the same line, which is equally divided around the midpoint and is in total ¼ of the total length of the line (1/8th of the total distance on each side of the midpoint). This new region is now region 4. Region 3 is from the axial triradii (position 2) to the most proximal edge of this new region 4, while 5' is from the most distal edge of 4 to the distal transverse wrist crease normally defined. All other termination points follow those given by Penrose (1968) except that 13' and 13'' were combined into a single class 13.

One major change from previous methods concerned the formulation of the mainlines (mainly A and B) when a hypothenar pattern was present, more particularly when a whorl or central hypothenar loop occurred. When the mainlines encountered such patterns, usually the latter, they either looped round it to return to their origin in region 9, 11 or 13, or entered the loop to end blindly within it or in the centre of a concentric whorl. For recording the mainline index in such instances as the latter, Dennis (1977a) suggested that a line from the appropriate triradius be drawn through the apex of the central core of the pattern and the position at which this cuts the ulnar border be taken as the termination. This straight line was taken to indicate the general direction of the mainline course.

In cases where a complete loop around the pattern was made to position 13 etc, the author feels that such a formulation distorts the magnitude of the indices generated as well as the general direction of the mainlines across the hand. It was deemed more appropriate to use the method of drawing the straight line through the core in such cases to indicate the general direction of the mainlines. As a consequence no recorded terminations in position 11 or 13 for mainlines A or B were made.

Cummins' mainline index for the A and D termination points was calculated using the same specified values (Cummins and Midlo 1943) on the slightly changed termination points.

Two points are worthy of note. First, Dennis only suggests the use of the drawn straight line when calculating the mainline index, and, secondly, both he and the author used the mainlines in an exploratory nature only. Of all the variables measured, the mainlines suffer most from subjective decisions and are thus the weakest set of variables used in terms of precise formulation.

A complete list of all variables recorded, together with the associated abbreviations used throughout this thesis, are given in Table 7.

METHOD OF SAMPLING

In order to collect finger and palm prints from a sample of the mid-Wales and Shropshire populations it was decided to use schools as the unit from which samples could be obtained. Dennis (1977b) gives theoretical reasons why using schools fits with the theory laid down by geographers for sampling a population and will not be considered further. The practical advantage of using schools is that they represent a "captive" sample from the population within specified age limits. It is a stratified sample and obviously excludes those families with children either too young or too old to attend school or those families with no children at all, but until selection with age has been shown to affect the frequencies of dermatoglyphic variables this is not thought to be a biasing factor.

Initially approaches were made to the Directors of Education of Shropshire and Powys for permission to contact headmasters with a view to sampling within their schools. Permission was obtained and subsequently a letter was sent to every school in north Powys. It is necessary to make clear that the region of Wales most heavily sampled was the county which had been termed Montgomeryshire prior to reorganising and renaming on 1st April 1974, but for comparison one school was included in what was Radnorshire, this being at Rhayader. Not every school replied to the initial request, and to those schools from which no reply had been obtained a second identical letter was sent. It was later discovered that many schools included in this second group had not received the initial request, but did the second. Thus attempts were made to contact every school in north Powys regardless of size or age range of the pupils, and of the 64 schools initially approached, 47 eventually gave permission to allow samples to be taken among their pupils.

In Shropshire the procedure was slightly different due to there being less time available for sampling. Consequently the schools approached were selected as being the largest available and having an adequate distribution over the county. A line drawn from North to South through Shrewsbury was taken as an Eastward limit of the sample area, no school in Shrewsbury being approached. In total, 15 schools in Salop agreed to participate, giving a grand total of 62 schools in all available for sampling in both counties.

The method of obtaining permission to print the pupils was identical in all schools. When the request to use a school had been made to a headmaster/headmistress, copies of two forms were enclosed. These took the form of a letter to the pupils' parents explaining the nature of the research topic in easily understood terms, provision being made for the lower part of the form to be returned to the school with an acceptance or rejection of the request. In addition, a questionnaire was included asking for demographic data concerning the family. Examples of both the letters and questionnaires are given in the appendix. When requested, bilingual forms in English and Welsh were provided, the decision as to whether to do so being left to the head teacher of each school. In some cases a small number of bilingual forms were requested and selectively distributed by the head teacher.

After obtaining permission from each head teacher, the school was visited, both to take the letters and questionnaires and to have the opportunity to discuss further with each head teacher the research work and the method of distribution and collection of forms from the pupils. In addition, the requirements of the school at particular times were considered. For example, examination timetables or sportsday activities. Each headmaster was asked to present the children within the school with a copy of the letter and questionnaire for their parents. No account of

family relationships, i.e. brothers or sisters, was made. Subsequently the replies were obtained and held by the schools who, after a suitable intervening period contacted the writer at the Department of Anthropology, University of Durham, giving the number of positive replies, this being necessary in order to plan an efficient use of time during the collection of prints. Each headmaster was asked to arrange the questionnaire in class/form/tutorial group depending on the format of the school. This facilitated finding the individual pupils at a later date. Each school was asked to provide a suitable place where a class of pupils could wait while prints were taken so that they did not interfere with the remainder of the school and were easily accessible for a continuous process of print taking. We also asked for two pupils to be made available to move around the school finding classes, directing them to the appropriate room, and generally organising the participants. Every pupil for whom permission was obtained had prints taken, no account of family relationships being made. It was felt that to ask for only a single member of each sex per family would have adversely affected the sampling, while the complete approach used gave additional data of sib-sib correlations not presented in the present thesis. Each child had their questionnaire returned to them in order that a particular set of prints could be matched with the appropriate form. Only a common number was placed on the prints taken and the associated questionnaire, thus securing confidentiality of the prints. The prints and questionnaire were kept separate and not united again until they were back at the University of Durham. Confidentiality of information and prints was impressed on the headmasters and parents at all times during the research.

By these methods a total of 3697 sets of finger and palm prints for both hands of both sexes were obtained using the 'Kleen Print' method. All questionnaires and explanatory letters were printed by the Reprographics Unit at the University of Durham.

During sampling certain factors tended to reduce slightly the number of prints collected; these included:-

: A flu epidemic - approximately one-third of some school samples were lost.

: Questionnaires not being arranged in class units.

: My car broke down - only 50 sets of prints lost due to a return visit to the school not being made.

: Retiming of a sports day.

These collections were made between January 1975 and June 1976 and it must be emphasised that in every school the head teacher and staff were extremely co-operative and helpful, sometimes at the expense of their own lessons. Without such co-operation the sample collected would have been reduced considerably or taken much longer to collect.

A complete list of schools used, head masters and sample sizes is given in Tables 1 & 2.

INTRODUCTION TO PARTITIONING PARAMETERS

The overall pattern frequencies were calculated using all the data for the males or females collected in the sample after removal of sibs, and was thus based on 1548 males and 1614 females, no selection or partitioning being applied to the data. Subsequently the data were divided into subsets using several criteria. First, the birthplace of the pupil was used as a criterion for inclusion into further analysis (CBPA). Particularly, any child born outside the border region delimited was excluded. This selected subsample of the original data set could first be used to estimate the overall pattern frequencies in the borderlands. This may or may not deviate from the initial estimate detailed above, depending on the mean frequency of patterns in the excluded or migrant population. There was no prior reason to expect that these excluded cases should have a frequency either higher, the same, or lower than the subsample due to the general non-availability of data on dermatoglyphic traits for the remaining areas of England and Wales not sampled in the present work.

An alternative parameter is to use the parent's birthplace to subdivide the data. If we limit the possibilities to those pupils with both parents born in the borderland region, then in the simplest level we can exclude those pupils with one or both parents born outside the region, this obviously resulting in a reduced sample size. If we were to compare Salop with Powys, the parameter (PFA) would exclude those pupils with one parent born in each region, only those pupils with both parents born in either Powys or Salop being retained. This is the common parental birth location.

The third method of selection is based on the ancestry of the pupil, the surname of the members of the family now being used. I have previously detailed that the questionnaire asked for the maiden names of

the three women present in each family unit, knowing the surname of the pupil. A list of Welsh names has previously been obtained and we can thus access how many Welsh inputs, as defined by the surnames being English or Welsh, each pupil has. If a pupil has four grandparents with Welsh surnames, then his/her ancestral input would be four Welsh. The same would be true for a pupil with four English grandparental surnames, the amount of Welsh input being zero. The range of values for this parameter, termed "Degree of Welshness" (DOW), is from four (most Welsh) to zero (most English). If a grandparental surname was not given, then the maximum value for a pupil was reduced. However, this was not considered in producing the index due to the reduction in sample numbers that would have resulted. Consequently, the parameter is a measure of the known degree of Welshness. In general, only one or at maximum two surnames were not given, which tended to reduce the error. Because of the way this index was developed, classes with DOW=4 and DOW=3 were amalgamated into a single class which indicated Welsh ancestry. Similarly, classes DOW=0 and DOW=1 were combined to give a single class indicating English ancestry. The remaining DOW=2 section was removed from the analysis when the parameter ancestry (DOW) was used, except for the single multivariate analysis performed on all five classes (page

These methods of selecting or partitioning the data allow the dermatoglyphic variables to be expressed with their association in Salop or Powys, based on the parent's birthplace (PFA) or the pupil's (CBPA), without reference to other criteria or, alternatively, between English and Welsh based on ancestry (DOW). As has been previously indicated, there is a strong degree of association of Welsh ancestry (as defined above) and a birthplace in Powys, similarly for birth location in Salop and English ancestry. Because of this we would expect that the presence of a particular dermatoglyphic mean or pattern variable which showed an

association with birth location would also have a consistent relationship with the ancestry (DOW) classes. Examination of the data shows that this does sometimes occur and can be investigated further by producing simultaneous breakdowns, "dual breakdowns", by ancestry (DOW) and either the child's (CBPA) or parent's (PFA) birthplaces. This obviously results in a reduction of sample size in some cells but is unavoidable if any detailed investigations are to be made. This last series of divisions allows the frequency of pattern elements or means to be estimated for pupils of English or Welsh ancestry separately within Powys and Salop. We want consistent associations of the greater or least values, the possible combinations being considered later (page 65).

In such dual breakdowns two factors can affect the results. First, because of the smaller numbers involved in all classes, random factors may produce changes in relative frequencies that obscure any underlying relationships. Second, the frequencies calculated compare a division into Salop and Powys which ignores geographical variability within each county. If such variability were of the same order as differences produced by using ancestry alone, then the unequal distribution of the sample could obscure any fundamental association of dermatoglyphic variability associated with ancestry.

It should be noted that many of the frequencies found within dual breakdowns do not produce significant associations in a statistical sense when measured by $x^2_{(1)}$ and it is then the trend which is being considered rather than the magnitude of the variation. Alternatively, a significant $x^2_{(1)}$ does not necessarily mean that the distribution of dermatoglyphic elements makes sense in terms of ancestry or birth locations.

Comparison of Ancestry (DOW), birthplace (CBPA), PFA) and Grandparents' birthplace

In breaking down the data we have noted the necessity to define which criteria will be used in order to decide what constitutes a Welshman or Englishman, this obviously being necessary if we want to identify a Welsh or English gene pool.

In using the birthplace of the pupil it is apparent that because of migration of families, especially from the Midlands, North West or London, a pupil may have been born in the mid-borderland but his family in fact comes from another locality and should be removed from the sample and not thought of as part of the "local" population. Similarly, pupils may have been born outside the borderland but have a family background from it. For this reason the use of the common parental birthplace constitutes a refinement beyond that of using the child's birth location as a partitioning parameter.

Because of the information asked for on the questionnaire we can go a stage further and consider the birthplaces of the grandparents of each pupil. In a similar manner to the parents we can remove every case having either one or more grandparents born outside the borderlands or for whom data were not given. Five classes could then be distinguished depending on the relative number of grandparents born in Salop or Powys, these being made up as follows:-

Class (1)	No grandparent(s)	born in	Powys	- 4	born in	West	Salop
Class (2)	1	,,	,,	,,	- 3	,,	,,	,,
Class (3)	2	,,	,,	,,	- 2	,,	,,	,,
Class (4)	3	,,	,,	,,	- 1	,,	,,	,,
Class (5)	4	,,	,,	,,	- None	born in	West	Salop

It is of course apparent that "pure" English or, more particularly, the west Salop population would be represented by class (1) while "pure" Welsh or Powys, are those in class (5), at least when grandparental birth location is the only criterion used.

The division into three classes on the basis of the parent's birthplace (page 55) allows similar names to be given to the extreme classes, i.e. both parents born in west Salop represent "pure" English while both born in Powys represent "pure" Welsh. The groups which show admixtures of birth locations are intermediate between the extremes and it would be hoped show intermediate positions in terms of dermatoglyphic pattern frequencies or means. However, genetic factors arising from heterosis must not be forgotten.

These partitioning procedures were performed on each sex separately, it being felt that amalgamation was not really justified even when no sex difference was found for any particular dermatoglyphic variable.

The advantage of using the birthplace of grandparents to give representatives of the "native" population for a region has to be balanced against the reduced sample size which naturally follows such selection. In the initial breakdown using the child's birthplace (CBPA) the loss in sample size was due mainly to removing those pupils who were born outside the region under investigation.

Table T2

	Total No.	No. born in Powys	No. born in Salop	No. born outside border	%
Female	1614	706	445	453	28.06
Male	1548	733	403	412	26.01

Very few cases within the sample failed to give data for the above table, those that did being in the last column. In females, 28.06% were not included in the analysis when birthplace was used, with 26.01% in males.

Moving to the classes formed by considering the parents' birthplaces not unnaturally caused a reduction in sample size due to three possible causes. Either one parent was born outside the border or one was born in Powys and the other in Salop, or data were not provided.

Table T3

	Total No.	Both parents born in Powys	One parent born in Powys/one born in Salop	Both parents born in Salop	Born elsewhere in U.K. or missing
Females	1614	437	98	165	914
Males	1548	424	105	136	883

The above list shows that 56.62% of females and 57.04% of males are lost from the analysis when the common parents' birthplace is used as a partitioning criterion, more than twice the number lost from the previous criterion (CBPA).

Taking this a stage further we can investigate the number of cases within each class generated when the grandparents' birth locations are used as a dividing parameter. Because we again have an increased number of people included in the parameter, there is an increased chance that one or more of the grandparents will be born outside the region, or not have the data available for them, in either case this excluding the associated pupil from further consideration. We need to know the birthplace of all four grandparents involved in order to assign a pupil to a particular class, this, for the reasons given above, reducing the numbers remaining in the analysis.

Table T4

	Total No.	Class (1)	Class (2)	Class (3)	Class (4)	Class (5)	No. Lost	% Lost
Female	1614	32	14	37	27	198	1306	80.91
Male	1548	29	15	35	29	200	1240	80.10

The number lost again increases both from when the parent's and child's birthplace was used as a partitioning criterion. While the best criterion for division would be the last one examined, it is apparent that the major disadvantage is the drastic reduction in cases which occurs on the above; too low to give reliable estimates, especially when variables with several alternative states are considered, as for finger patterns or mainline terminations.Using the final class on its own would be possible when looking for geographical variability by combining classes (1) and (2) into a single group and also classes (4) and (5) to increase class frequencies. Even doing this would give class numbers considered to be too small for statistical analysis in the former group and the process and parameter was thus rejected in further analysis.

Having decided not to use grandparents, except possibly for brief comparisons, we move back to a parameter based on the parents' birthplaces even though we have a reduction of nearly 60% in sample size and to using the child's birthplace with larger samples and a reduction of 30% of the total sample. That this movement "backwards" will not produce a lack of sensitivity in partitioning, and that the use of the pupil's birthplace is reasonable, is seen if the cross tabulations between the classes for each birth criterion are produced. In all cases the comparisons give highly significant associations based on x^2, with probabilities of < 0.001 in both males and females. This suggests that although we cannot use a partitioning criterion based on the grandparents' birthplaces, we can have every confidence that the results obtained are highly comparable for these based on the parents' birthplaces and also possibly the child's (see page 236 for discussion of what the child's and parents' birth location criteria may be reflecting).

Examination of the frequencies of association between the parent's birthplace (PFA) and the pupil's (CBPA) shows that of the pupils born in Powys, 86% had both parents also born in Powys, while of pupils born in

Salop, 65.4% had both parents also born in Salop. For those families with one parent born in each location the child has an equal chance of being born in either Powys or Salop. These frequencies of course only apply to families with the birth location of both parents known to lie within the mid-borderland, but this sample only constitutes 41% of the total within each sex, the remaining 59% having either one or more parents born outside the region or for whom parental data are missing.

If these comparisons were applied to the grandparental population then we find a reduced sample size down to less than 75% of the total, if we require to know the exact location of birth of each, and being within the mid-borderlands. Within the available 25% of cases, 80% of pupils born in Powys also have all four grandparents born there, while over 90% have at least three born in Powys. If the child was born in Salop there is however a far greater chance that his grandparents will have a Welsh contributor, only 40% having all four born in Salop and less than 55% with a minimum of three born there. These results, however, must be affected by the larger area of Powys compared with western Salop in which the Welsh birth locations were situated, but must undoubtedly reflect the movement of population from Powys into Salop rather than in the reverse direction.

Degree of Ancestry (DOW) Class Numbers

The parameter Degree of Welshness (DOW), has been previously defined and has extensive use in this thesis as one of the partitioning criteria under investigation. The number of pupils in each of the original five categories is given overleaf:-

Table T5

	Total No.	DOW(0)	DOW(1)	DOW(2)	DOW(3)	DOW(4)
Female	1614	256	350	363	357	288
Male	1548	261	311	377	349	250
Female	1614	606		363	645	
Male	1548	572		377	599	

It is evident that the greatest class number is in DOW(2). This is not surprising when the method of producing the index is remembered, there being more ways to combine four grandparental surnames to have two Welsh and two English than for any of the other classes. This is true only when the frequency of English and Welsh surnames is equal. Should one be in excess, we would expect a shift in the frequencies in the DOW category which corresponded to the greater surname presence. We have a slight excess of cases with Welsh surnames (page 55) in the sample, this being reflected in the slightly greater number of cases in classes DOW(3) and (4) rather than DOW(0) and (1).

If the parameter is broken down by sex then there is no difference between the two, this being as expected, the surname of the child being unaffected by its sex.

Degree of Welshness (DOW) - Child's Birthplace (CBPA) - Parent's Birthplace (PFA)

Because ancestry is defined by the surnames of the family members and the names themselves are deemed to be characteristic of Wales or England it is to be expected that a high degree of association between the ancestry of the child and his birth location exists. Breakdown within both the males and females gives a highly significant association between ancestry and birthplace, the strength of the relationship being similar in both sexes.

Table 16

	DOW/CBPA $x^2_{(1)}/N$	DOW/PFA $x^2_{(1)}/N$	$p = <0.001$ in all cases
Males	127.98/827	67.72/417	
Females	109.73/878	55.59/463	

It was shown that in 69.8% of females and 72.2% of males, knowing their birth location, would allow one absolutely to predict ancestry when the child's birthplace is used. The different numbers are shown in Table The difference between concomitance for English and Welsh reflects the imbalance of sampling between the two regions, although a slight excess of Welsh in Salop cannot be accounted for by such an explanation. This difference, amounting to 13.8% in females and 12.8% in males may well result from the general migration from Powys into Salop rather than the reverse, this being borne out by the excess of Welsh in Salop compared with English in Powys. Of the total number of pupils born in Salop, 38.9% are Welsh by ancestry, while for the sample born in Powys only 25.1% are English. These figures are for females, but males are similar. In addition, it is recalled that the frequency of Welsh and English names is roughly equal in the sample.

Comparing ancestry with the parent's birthplace (PFA) showed that when both parents are born in either Powys or Salop, then 79.2% of females and 79.6% of males can have their ancestry exactly predicted. These values are, as expected, higher than those based on the child's birthplace alone.

What is surprising is given that both parents are born in Salop the chance that their ancestry is Welsh or English is about equal; in males English ancestry is slightly favoured, while in females it is Welsh ancestry. In view of the method by which ancestry is defined, these results are strange and can only reflect migration into Salop from Powys. The corresponding subset of Powys born parents shows no such imbalance, Welsh ancestry predominating in both sexes.

Even though these tables reveal highly significant associations between the three parameters, sufficient non-concomitance exists to warrant separate partitioning by each, when possible. The information in terms of pattern frequencies carried on the minor diagonal of the tables may be distorting the relationships sufficiently to give conflicting results between divisions, consistency between the partitioning criteria being really under investigation.

Partitioning Criteria - Further Considerations

The criteria available for use as partitioning elements have been well described and constitute three basic approaches, ancestry (DOW), child's birthplace (CBPA) or common parent's birthplace (PFA). Using grandparents has been considered and rejected (page 60). Using ancestry gave two classes termed "English" or "Welsh", while birth location, CBPA or PFA, gave subsets of Powys or Salop. A refinement in the use of ancestry initially involved removing pupils not born in Salop or Powys and then partition by ancestry. This constituted the "selected" population, the criteria for entry being either the child's or parent's birthplace. This process would, of course, remove mainly the English people, based on DOW, who had birth locations outside the borderland and constitutes the removal of "migrants" and maintains a "local" population.

For much of the univariate analysis the breakdown of the raw data is made in terms of the five criteria noted previously, the two processes of selecting for a local population giving the additional two. There is obviously a degree of correlation between the various parameters and it is a function of the present study to investigate these criteria and their interactions to see if sny single one, or combination, can divide the data into subsets that reflect geographical and ancestral fractions, and that have, if possible, differences that attain statistical

significance. It is apparent in much of the following analysis that differences between subsets rarely attain a magnitude that is statistically significant. While large differences are desirable, a facet which should not be overlooked is the trend observed as regards which subset contains the greatest frequency of a particular pattern or variable mean. In dividing the data we are looking for consistency between the parameters in the frequency of pattern occurrence. Consistency occurs when two dividing criteria are constant in which subset exhibits the greater frequency of a pattern. We have two basic criteria of "Welshness" or "Englishness", that of birthplace in either Powys or Salop, and ancestry where a pupil is either English or Welsh. To be consistent in an association, the greater frequency of occurrence of the pattern must be in both the Welsh and in Powys or in the English and in Salop. Any two partitions will be called consistent if these requirements are met. The use of either the child's or parent's birthplaces to define subsets of Powys and Salop is allowed. Should one breakdown exhibit the greater frequency of a pattern in (say) Powys, and another partition have the greater value in the English, the relationship is said to be reversed. The actual frequencies shown in the various subsets may not be reported, especially where there are many alternative pattern types, as in finger patterns. It is the direction of the greater frequency which is being looked for, together with any statistical tests performed on the data. The above relates to division, using the criteria one at a time, but when two or more are used in combination, this constitutes a dual breakdown and usually concerns ancestry (DOW) and one of the two birth location parameters CBPA or PFA. These combinations will be considered in the following section of this introduction.

The various parameters used for breaking down the data are all to some extent related, as I have already shown, but the amount of non-concomitance shown varies according to the pair of criteria being compared.

Consideration of the child's birthplace with the parent's showed that 65.4% of those pupils born in Salop had both parents born there also, similarly for Powys the figure was 86.0%. A comparison of subsets generated using the two criteria separately obviously contains a large number of cases in common, but it may be that it is the 35% of cases which have dichotomous elements that may be obscuring or producing the differentiation found between the subsets. Patterns which have large environmental variance components may be related only to the child's birthplace and not to any facet of the parents (page 236). Corresponding arguments can be examined concerning interrelationships of the selected samples and the division based on ancestry. These parameters all show statistically significant associations but this does not detract from using them all either singly or in conjunction in a dual partition. Differences between the various subsets do exist, with inconsistency being found. However, the degree to which inconsistency can result by chance alone, there still being a real association between "Englishness" or "Welshness" and a raised pattern frequency, cannot be statistically formulated. Every pattern variable will be considered in turn, and comments and speculations made at the appropriate place in the analysis.

Dual Partitioning Combinations

When the pattern types on the palms are investigated, or the ridge counts on fingers or palms, the dual breakdown involves either the child's or parent's birthplace together with ancestry. Thus it is possible to produce a 2 x 2 table which gives either the frequency of pattern occurrence or a pattern mean for each of the four cross-tabulated cells given overleaf:

BIRTHPLACE (CBPA) (PFA)

		SALOP	POWYS
Ancestry (DOW)	English	A	B
	Welsh	C	D

The format of the chart is such that if we have a higher incidence of a pattern or mean associated with "Welshness", that is, born in Powys with Welsh ancestry (D), then for a consistent relationship we require that the frequency or mean associated with "Englishness" or in pupils born in Salop with English ancestry (A), have the lowest value in the table. Interchanging pupil's birthplace for the parent's does not alter the requirement. We have no prior evidence as to the frequency of the minor diagonal elements (B) and (C) but for consistency they must be between (A) and (D). We thus require the following

$A < B, C < D$ type 8

$D < B, C < A$ type 1

When this does not occur we do not have true consistency of the pattern frequency with either "Englishness" or "Welshness". In order to simplify description of the particular distribution of frequencies or means in any given table, the combination of possibilities is given in Figure 8. The relative frequency of the minor diagonal elements is ignored in classifying the distribution. There are 12 types recognised, each of which is referred to as type (1) or type (8) etc., consistency as described above only being shown for these two combinations. In Figure 8 the number over each frame gives the distribution type, while the letters H and L show the particular cells with either the highest or lowest pattern frequency or

mean occurrence respectively. Blank spaces indicate intermediate values. If there are two equal cell frequencies then the distribution can be of more than one type and will be given a dual formulation, e.g. type (1)/(3) if both (C) and (D) are equivalent with the lowest frequency of the distribution.

The term 'Dual Partition' indicates that two parameters are being used to partition the data simultaneously, usual into four distinct classes corresponding to the individual cell elements, A, B, C and D given above.

DEMOGRAPHY

Birth Locations

In total 3697 sets of prints were taken which, after removal of sibs, left 3162 individuals, comprising 1614 females and 1548 males, with information on the birth location of the pupil, his or her parents and grandparents, the religion of the family, and the occupation of the father. In addition, the maiden names of the three females in each unit were asked for, together with the linguistic capacity of the family members back to grandparents, and the occupation (or if dead, former occupation) of the two grandfathers. This latter aspect of social class was not used in the analysis.

Examination of the birthplace of the pupils showed that of the 3162 cases involved in all further analysis, only 47 pupils did not give their place of birth. For the vast majority of pupils for whom information was available, 73.8% were born within the region under consideration, that is Montgomeryshire and the north of Radnorshire (now north Powys), and the western parishes of Salop. The remaining 26.2% were born outside this region, in the remainder of the British Isles or abroad. In fact, only 0.5% came from outside the British Isles, England being the main contributor to the non-local pupils. Reference to the "local population" in later pages means those pupils who were born within the region previously delimited, while the "migrant" population includes those pupils born outside the region regardless of location.

The origin of these migrant pupils covers a wide area and every county in England has its representatives, but certain localities stand out as being important points of input to the region. Not surprisingly, the counties closest to this mid-border land supply the greatest number of migrants to the area. The eastern region of Salop, east of the north-south

line drawn through Shrewsbury, constituted 2.2% (60 cases) of the total sample. Herefordshire to the south supplied 1.1% (30 pupils), while Cheshire, which abuts Salop on its northern edge, contributes a further 1.0%. As the distance from the borderland into England increases, so the number of pupils born away from the area but now residing within it reduces to below 1.0%, with the following exceptions. Because of the encouragement of the public administration to promote the border region through the Mid Wales Development Board, the major urban regions which are closest to the borders are especially fruitful in their contributions to the population. Manchester and Liverpool supply a total of 1.3%, with Birmingham giving a higher contribution of 2.1%. London, no doubt because of its size, supplied 1.6%, but no other county in England managed to produce in excess of 1.0% of the sample population. The adjoining Welsh county of Clwyd was especially prominent as a source of migrants, there being 2.3% of the sample from this county, the highest number from any single county in England or Wales. To the south of the region, the remaining area of Powys comprising Breconshire and Radnorshire had a surprisingly small contribution to make to the sample, only 0.4% originating in these counties, while Glamorgan in south Wales was much higher with 1.0%, this latter probably reflecting the larger population of Glamorgan compared with southern Powys. The only other Welsh county to give a significant contribution to the sample was the north Wales county of Gwynedd with 1.2%.

The parents and grandparents of those pupils who were included in the sample have as wide a distribution of birthplaces as the pupils themselves, but with the number of migrants being greater than for the pupils' generation. This was shown by only 58.3% of mothers and 60.6% of fathers having local birth locations, while the grandparents showed firstly that there was a greater number for whom the birthplace was not known, and that for the remainder the number born locally was again reduced from the

parental generation. The mother's mother had 49.3% of the sample born locally and for the mother's father it was 50.5%, while the father's parents revealed 51.5% of mothers and 54.1% of fathers had similar origins. Examination of the frequencies of the members of the family born within Powys or Salop shows that the reduced numbers are mainly associated with lower frequencies in Salop rather than in Powys. This would indicate that the population of Powys has a much smaller contribution from migration than does Salop, and that the families of those pupils remaining in Powys tend to have a more restricted area of origin than does Salop, although it must be remembered that over the last few decades the overall population of Powys has been falling due to outward migration into the surrounding counties. Therefore many pupils born in Salop had family roots in Powys with migration into Powys being restricted to the period of growth of the woollen industry, and then more recently with the establishment of development industries, although these inputs tended, and tend, to be concentrated in the main centres of Welshpool, Newtown and Llanidloes. If the frequencies associated with Newtown are examined, it is apparent that the more recent expansion of the population is reflected in the decreased frequencies of locally born as we move from the pupils to the parents and then grandparents, and although other locations show reductions in a similar manner, that from pupil to parent is only matched by Welshpool, one of the few areas also to show an increased population in the past decade.

The frequency changes between generations do not show any apparent pattern in the different locations within the border region. Some, as we have noted, show decreases in the number of persons born in an area as we move over generations, while others, such as Llanfair Caereinion and Machynlleth have increased frequencies in the grandparental generations with a reduction in the pupils, this possibly indicative of

the decline of the centres over the past two generations. In general, if one examines the frequencies associated with the counties outside the region, there is an increase in numbers born in each as we move down the generations towards the grandparents. This can be exemplified by the figure for Yorkshire from where only 0.6% of the pupils were born, but with 1.55% of the parents and 1.7% of the grandparents originating from there. The reverse, in general, happens inside the border region with a decline over generations of family members being born locally. The figures for all the counties and individual areas within the border are given in Table 8 while the parishes which contribute to each area are given in Table 3. The names allotted to each group of parishes generally represent the main town or city around which the parishes are grouped.

The decline in the population of Montgomeryshire has been occurring since the 1841 census when the greatest numbers of people were recorded in the county, in all, 69,607 compared with the latest census figures taken in 1971 of 43,119. During the same period Salop as a whole showed a fluctuating population size, but an overall increase was experienced. Between 1841 and 1921 the rise was fairly modest overall from 255,820 to 244,156, but in the next forty years a greater rise occurred, until at the 1971 census a population of 337,102 was recorded. If the rural districts of western Salop are examined separately, then a pattern similar to Powys is found, i.e. a declining population since 1841, the only locality to show a rise being Shrewsbury, at least since the 1951 census.

Birth Location Relationships : Child/Parents/Grandparents

Because of the manner in which the data were collected, the sample obtained from Powys was much larger than from Salop and this is reflected in the frequencies of pupils born within each region. Powys had 46.2% of the sample born within its borders, while Salop was much lower at 27.5%. As noted previously, the decline in the number of grandparents recorded as being born within Powys is greater than for Salop, possibly reflecting the greater migration into Salop than into Powys, even though both localities have been showing a net outward movement for many years.

If we now restrict ourselves to consideration of Powys and Salop and examine the relationship of the pupil's birthplace to that of the parents and grandparents and consider the Welsh county as a single unit and western Salop as another, it is apparent that a high degree of association exists between pupil and parents. If the pupil was born in Salop we find that 67.5% of them had both parents also born within Salop. A smaller number, 23.75%, have one parent born in Salop, the other born in Powys, while a much smaller number have both parents born in Powys. Consideration of the pupils born in Powys shows a high percentage, 87.5%, to have both parents also born in Powys, greater than the corresponding value for Salop, while for those pupils with one parent born in each location, the frequency is lower than for Salop, being 11.05%. The final frequency for the child born in Powys, but with both parents born in Salop is again lower than for the reverse situation, at 1.44%. These figures suggest that more people have moved from Powys into Salop than vice versa, as seen by comparison of all percentages, the contribution of Salop birth locations in the Powys sample being lower than the number of Powys birthplaces now in Salop.

The comparison of the pupil with grandparents shows first the reduction in the number of families who have all four grandparents born within the same region compared with both parents, at least for those families for whom we have complete information provided on the questionnaire. The data showed that 41.2% of the total sample had both parents born within either Powys or Salop, this reducing to 18.6% in the grandparental generation. The breakdown was calculated for the grandparents for whom complete family information was available. For such families it is possible to break down the data into five separate groups ranging from those families with all grandparents born in Powys to those with all born in Salop. Examination of Table T4 shows that a surprising number have all four grandparents known to be born in Powys, 62.4% of the 589 families involved, with much lower numbers having all grandparents born in Salop. The numbers associated with the lower number of Welsh grandparents, i.e. 0 - 3, are all similar, with no graduation in either direction. However, within the framework a consistent pattern may be found.

For those pupils born within Powys, 91.7% for whom complete data were available had a maximum of one grandparent born in Salop, while the corresponding situation for the pupil born in Salop showed 74.6% having a maximum of one grandparent born in Powys. If these are considered in terms of the total sample, then the 91.7% above represents 69.6% of the total, while the 74.6% represents 12.9%, emphasising the dichotomy between the Salop and Powys samples and the tendency for migration to be from Powys into Salop. If the data are considered from the point of view of the birthplace of the grandparents, then the pupils with four grandparents born in Salop are almost certain to be born there themselves, 96.8%. The same was true with regard to Powys, 96.5% of pupils with four grandparents born in Powys also being born within it. Additionally, if we move along

the table (10) we can see a reduction from one end to the other in frequencies. What was noticeable was that a pupil who has two grandparents born in Salop and two in Powys was much more likely to be born in Salop than in Powys, 61.2% of those with such ancestry being so, this again reflecting the lesser movement into Powys from Salop in the grandparental generation. The parental generation however does not show such results, for if one parent of a pupil is born in each locality, then the difference between the frequency of pupils born in Powys or Salop is small, 48.7% in the former and 51.3% in the latter. It would seem that at least in the parental generation there has been roughly equal movement between the two sides of the border, reflecting the directives in trying to induce people to move into Powys even though over all the border regions a loss of population was noted between the last two census reports of 1961 and 1971.

If the birthplace of the grandparents outside the borders is considered for those pupils born within it, it is apparent that the pupils whose ancestry has no connection with the borders are much more numerous in Salop than Powys. Roughly twice as many pupils were born in Salop with no grandparents born within the region as were born in Powys, 22.6% as compared with 10.8%, and would again suggest that Salop has had more inward migration from completely outside the region than has Powys. If the difference in sample size from Salop and Powys is considered, then the difference increases, emphasising the dichotomy between the two sides of the border in terms of inward migration.

Family Surnames

The parameter DOW, Degree of Welshness, is based on the surnames of the members of the family (see page 55). The questionnaire asked for the maiden names of the three females associated with each family, together

with the pupil's name, in order to allot an input to each pupil from his grandparents in terms of their surnames being Welsh or not. The list of names used in this thesis is given in Table 5 and is based on data from Guppy (1890), Fraser Roberts (1941-2), Watkin (1956). Anything which is not in the list is taken to mean "not Welsh" but is used to indicate English ancestry, the vast majority of names being, of course, English in origin. The grandfather on the paternal side will have the same surname as the pupil while that on the maternal side is the same as the mother's maiden name. The maiden names of the two grandmothers were asked for directly on the questionnaire.

The overall frequency of pupils with English surnames was 45.77%, the remainder, 54.23%, having Welsh names. A slight difference between the sexes was observed, females having slightly more Welsh names, 56.3%, than males, 53.1%, this in all probability being merely a random sampling effect. In a similar manner to the pupil the frequency of Welsh names amongst the family members is slightly greater than English surnames. The mothers revealed that 51.3% had Welsh maiden names, while 51.5% of their mothers were similar. For the father's mother the corresponding figure was 52.8%. It is perhaps surprising that roughly half the names encountered should be Welsh, when a greater proportion of the sample is taken from Powys. That we have not found an excess of Welsh surnames could reflect the admixture which has taken place over the generations, giving a much more heterogeneous population than originally existed.

Religion

The questionnaire asked for information concerning the religion of the family and in total only 4.8% failed to provide such data. Usually only one religion was given, this then being recorded. However, on

occasion, both the mother's and father's religions were given, when they were in fact different from one another. In such an instance that pertaining to the father was taken for the family.

Examination of the data showed that by far the greatest group was that within the Church of England with 65.7% of the total sample. This group also includes those families who gave Church of/in Wales as their religion. The only other major division used was that given the general name of Nonconformity. It would have been desirable to have examined its component groups separately, but examination of the forms showed that many families were using a general term such as "chapel" or just "Nonconformist" while others were being more specific. Because of the reduction in numbers that removal of the families who gave such generalities would have caused, the amalgamated class was used, this then comprising 30.9% of the sample. Included in this group are Baptists, Methodists, Independents, Chapel, Presbyterian and United Reform Church.

The Roman Catholic Church had a very low representation in the sample, being only 2.7%. A single category was made of all the other groups specified, examples being Quakers, Jehovah's Witnesses, Mormons etc. In total they only contributed .5% to the sample.

The information about religious affinity was not included as a partitioning parameter due to the lack of precision in the individual group formulations.

Social Class

Although the occupation of the father and both grandfathers was asked for, only that of the father was coded on the computer forms. Social class, as defined by the occupation of the father, was divided into five categories corresponding to the division 1 - 5 in the Census Data with the most frequently encountered types given in Table 6 together with the associated class number.

The most frequent class used is 3; 42.8% of the samples falling into it. This group includes skilled manual workers, foremen or people with responsibility, i.e. Drivers, Delivery men. Only slightly lower, 38.3%, is social class 2 which is mainly made up of farmers and teachers, the former being included because they hold land. Next is social class 4, 10.8%, which contains the semi-skilled manual workers, while social class 1 is about half as frequent, 5.25%, and is restricted to professional occupation, needing a higher educational qualification, examples being Doctors, Lawyers, Architects and Vicars. The remaining class is 5, with a frequency of 2.7%, the smallest in the present sample, encompassing the unskilled manual workers or labourers.

The frequencies encountered in the present data agree fairly well with those for the region as a whole obtained from the census data and suggest therefore that the present sample is indeed representative of the population of the border. Only 2.0% of all families approached failed to give the occupation of the father although in a few instances the questionnaire gave information to the effect that the pupil had only one parent looking after him/her and this was the mother, in which instance her occupation was used in place of the absent father.

Like the former parameter, social class was not used in the main body of the analysis. Evidence is already available by Olivier (1971-2) which reports no significant differences between the five social classes for dermatoglyphics.

Language

The ability to speak Welsh is a capacity which has been declining steadily for many decades, the number of people who are monoglot Welsh being reduced to almost zero at the present time. Over Wales, particular counties have been a stronghold of the Welsh language, these being the western regions of Wales, well away from immediate English influence.

Montgomeryshire (N. Powys), being one of the border counties, not unnaturally has seen a gradual loss of the Welsh language with movement of the English language into the county from the east. Williams (1937), Jones and Griffiths (1963), Bowen and Carter (1974) all record the divide between English and Welsh speaking areas to lie roughly along the Severn river, and at the time of the last census Welsh was being maintained but with ever decreasing frequencies in the most westward and upland regions of Powys.

In the present data no linguistic difference was found between males and females and they were consequently amalgamated. The vast majority of pupils in the sample were unable to speak any Welsh at all, 83.2%, 16.3% being bilingual. Seven cases were found of pupils who were monoglot Welsh in the more remote primary schools in the upland areas of western Powys. Because the decline in the Welsh language has been progressive, we can expect to have an increase in the number of people who were capable of bilingualism as we move to older generations within the sample. This is observed for the parents where the percentage of people who were bilingual was greater than among the pupils, being 21.6%. However, only 3 cases of a parent being monoglot Welsh were encountered, but these are slighly suspect in that for at least one of them the questionnaire said that the husband was monoglot English, so I suspect that these three cases are probably a result of error when answering the questions on the form.

The frequency of bilingual grandparents again showed no significant differences between the four, although there was a slight indication that the parents of the father were slightly more bilingual than the mother's parents, this also being shown in the parents themselves, the difference between parents in bilingual frequency being only 0.7%, but in the same direction as the grandparents. The mean frequency of

bilingualism within the grandparental generation was 27.26%, with 0.42% stated as being monoglot Welsh, these being, as expected, greater than either the parental or pupil frequencies.

Language - Birth Location

The relationship between several of the demographic variables can be investigated with, in many cases, a result that it not too unexpected.

The association of language ability and the pupil's birthplace indicates, as we would expect, that the number capable of speaking Welsh is much higher in Powys than in Salop, this also occurring for the remaining members of the family. If each member of the family is considered separately in relationship to their birth location, then it is apparent that in the older generations the amounts of Welsh spoken in Salop is considerably higher than at the present time. This is exemplified by considering the data for grandparents combined, where bilingualism is not only greater than in the pupils or parents, but within these Welsh speakers 25.0% were born in Salop, compared with 8% of parents and 10% of pupils, the latter two being surprisingly similar. This reduction of bilingualism in Salop corresponds to the overall reduction seen in the Welsh language speakers and the encroachment westwards of English into the traditionally Welsh speaking county.

Language - Birth Location - Surname

The associated linguistic ability and surname was examined and found to be highly significant. If a pupil is bilingual, then he/she is most likely to have a Welsh surname, the relative frequencies being 87.5% with a Welsh surname, as against 12.5% with an English name. If there was no relationship we would have obtained 61.6% with Welsh names as being

bilingual. If the pupil can only speak English, then he/she has an increased chance of having an English surname, the data showing 43.4% were in such a class when 38.4% were expected with no relationship at all. These exclusions hold for the parents and grandparents. Indeed it becomes stronger over generations with a graduation from 14.6% being bilingual and with a Welsh surname in the pupils, to 21.6% for the parents and 28.2% for the grandparents.

If the data are divided on the basis of birth location, and the previous relationship examined, and if the strength of the relationship is measured by the Contingency X^2, then it remains similar for all members of the family born in Powys, but for those born in Salop the grandparents show greater X^2 than the parents, indicating that for those born in Salop the strength of the relationship between language and name was stronger than it is now. In fact, for those born in Salop the X^2 was similar to that for the pupils born in Powys.

Section (3)

TRANSFORMATION

For the parametric t-test an underlying assumption is that the variable concerned is normally distributed within the two groups being compared. Frequently biological data do not adhere to this condition although the t-test is robust enough to deal with moderate deviations.

In order to comply with the above requirement it is possible to apply a transformation to the complete raw data set to minimise some predetermined criteria. Transformation in the present thesis was made to minimise the skewness contained in the individual variable distributions, no account of kurtosis being made. The program utilised was termed MINSKEW (Minimum Skewness Program), written by J. Steel and available through the University of Durham.

The transformation calculated λ which when applied in the function:

$$(Y = (x + 1)^{\lambda}$$

minimised the third moment above the mean given by

$$\text{skewness} = \frac{\Sigma (Y - \bar{Y})^3 N}{(N-1)(N-2)S^3}$$

where $\bar{Y}$ is the mean, S the standard deviation of Y and N the sample size. The raw variate (x) has 1 added to remove zero elements from the data set.

The program stops when, for any particular variable:

(1) The dimensionless third moment, after two transformations, is less than 0.0001

or (2) has an absolute value greater than 5

or (3) 20 approximations have failed to achieve the criterion.

Table 13 gives the variables and appropriate transformations utilised in the present thesis.

UNILATERAL MAXIMUM FINGER RIDGE COUNTS

Ranking

A consideration of the data as a whole shows the ranking of the digits for both hands and sexes to be 1>4>5>3>2. Partitioning into five classes (page 65) using the child's or parents' birthplaces and ancestry in selected and unrelated populations revealed that in every case the left hand maintained the above ranking while the right hand exhibited variations limited to the last two digits, their position occasionally being reversed.

Table 17 Right Hand

	Males		Females	
	2>3	3>2	2>3	3>2
English or Salop	4	1	5	0
Welsh or Powys	0	5	1	4
	p = 0.023		p = 0.023	

The variations are shown in the above table, both sexes being similar. It is apparent that"Welshness"is associated with 3>2 while"Englishness" is more related to 2>3. The distributions indicate a significant deviation from randomness on Fisher's exact test for each sex (p = 0.023). The above figures are not strictly true, for each of the five partitions is not independent of the remainder, the division on a selected population being made using the same criteria of ancestry. The results however show a possible trend in the data set that may appear in further regional studies. It would be tempting to suggest that the ranking of 3>2 on the right hand was a feature of"Welshness"but Holt (1964) in her studies gave the same ranking for her English populations, the reverse of which is shown above. The possible significance of the speculative reversed relationship must await further research.

Investigating regional and ancestral variations within the present sample, the finger ridge counts were treated in detail using permutations of the basic partitioning criteria considered earlier. Apart from the basic comparisons using birth location and ancestry singly, the dual partitions gave six possible pairs of subset comparisons for each series of divisions, one series (1) being CBPA with DOW, and the other series (2) being PFA and DOW, both CBPA and PFA having two classes of Powys and Salop, while DOW has two divisions of English and Welsh. The six comparisons are given below:-

One major criticism of the above is that the sample size in any subset may fall to a low level, especially when the parents' birth locations are used to define the birthplace. This feature is less of a restriction when, as in the present section, the data are metric, the use of pattern frequencies however possibly gives exaggerated deviations within the above subsets. The subset comparisons were made using a t-test on both the raw and transformed data sets when division was performed using the criteria alone or after selection for local populations. However, the above six subset comparisons were made using the raw data without transformation. The non-parametric Mann-Whitney U-test was used in the comparisons for all subsets with single or dual criteria breakdown, naturally no transformation being required.

Consider first the distribution associated with each digit (Table 28) prior to transformation. It reveals that there is not a single instance where a curve shows both skewness and kurtosis to exist at a non-significant level in either sex. Particular digits may have

one or other of the two parameters giving non-significance, but never both. Between sexes, consistency was shown by RT2, RT3 and LT2, all having non-significant skew, the only other constant feature being significant deviations on similar digits over sex.

As already explained (page 83), the process of transformation was performed to remove any skew that may have existed without consideration of the effect on kurtosis, consequently the following digits gave normally distributed curves after transformation. In males there were RT1, LT2, while in females the normal curves were associated with RT1, RT2, RT4, LT4, LT5, all the remaining digits having significant amounts of kurtosis still present.

The results of partitioning the data will be given for each digit and sex separately.

MALES

Right Finger One : RT1

For the first digit on the right hand the results showed that none of the partitions made produced any significant differences between the subsets generated, whether considered by a t-test in a raw or transformed state, or non-parametrically on a Mann-Whitney U-test. When initially divided by ancestry, heterogeneity of the within group variance was shown, but this was removed by transformation, the t-test giving comparable probabilities in both cases. The average ridge count was found to be 19.29.

Right Finger Two : RT2

Partitioning, by the child's birthplace and ancestry separately, both gave significant differences between the subsets, a selection procedure based on the former parameter and, divided by the latter, also

gave a significant probability. The magnitude of these differences were comparable, as judged from their 'p' values, in both the raw and transformed data sets using the t-test. The conclusions reached using the non-parametric test were exactly comparable.

Using the parent's birthplace indicated no difference between Powys and Salop, division by ancestry in a selected population also giving non-significant probabilities. This latter result was maintained over the transformation and by the non-parametric test. The consistency between the metric and non-metric statistics indicated that the magnitude of the differences between subsets was sufficient for the former two parameters to be maintained even when both the raw and transformed data sets showed significant kurtosis. It will be shown later that this lack of normality may be the cause of marginal significance between subsets giving probabilities greater than the 5% limit.

The dual partitions revealed that using ancestry with the parents' birthplaces gave no differences between any of the four subsets on either statistic even though ancestry on its own was significant (see above). Substituting the child's birthplace demonstrated that the differences discovered above were only present when the limiting subsets of WP and ES were compared, both the t-test and the U statistic leading to the same conclusion. The subsets WS and WP had probabilities, when compared, that were only just nonlsignificant. Linking this with the low, but non-significant difference between EP and WP suggests that WP may indeed be a subset which is separate from the remainder on both parameters, although statistically so from only ES. The greatest ridge counts were related to WP rather than ES.

Right Finger Three : RT3

Using the usual criteria to partition the data, only ancestry produced a significant difference between subsets of English and Welsh (p=0.035)

on a t-test. The corresponding divisions made on the selected populations gave non-significant values as did the use of the child's or parents' birthplaces. Subsequent to transformation the significance found above, associated with ancestry, was removed, although only just ($p = 0.058$). Examining the original distributions showed that only kurtosis was at a significant level both prior and subsequent to the application of the transformation, skewness being non-significant in both data sets, although the effect of transformation was to remove the highly significant heterogeneity present between the English and Welsh subsets, this being sufficient to remove the difference initially indicated. Using the transformed data set, all divisions now gave non-significance between groups.

That the initial non-normality may have influenced the associated probability estimates is indicated when the same divisions are examined using the non-parametric Mann-Whitney U-test, where all the between-group differences were non-significant.

The dual partitions all gave non-significant differences for all the subset comparisons using both the child's and parents' birthplaces in conjunction with ancestry.

The conclusion reached therefore is that while ancestry produced a greater degree of differentiation than using birthplaces, this difference was not sufficient to give statistical significance, the initial result being influenced by the non-normality of the raw data set.

Right Finger Four : RT4

The raw data showed that both skewness and kurtosis were present in significant amounts, transformation failing to remove the latter.

Partitioning the data gave non-significant differences between subsets for all comparisons made in both single and dual breakdown, for raw or transformed data sets and when both t-tests and U-statistics were applied.

Using ancestry within a selected population based on the parents' birthplace gave a low probability ($p = 0.061$) which was maintained after transformation. The U-statistic however removed this possible difference ($p = 0.84$), again suggesting that non-normality of the original data may have been causing a spurious result.

Right Finger Five : RT5

The fifth digit follows the pattern shown by the previous two on the right hand. The lack of normality of the data distribution was maintained after transformation, none of the partitions giving significant (or even low) probabilities for the comparison of subset means. These conclusions held over both statistics and all divisions of the data in a raw and transformed state.

Left Finger One : LT1

Like the homologue, the first digit on the left hand revealed a normal distribution only after transformation, this process also removing any heterogeneity between the within group variances that division had produced. The similarity was maintained with none of the partitions, using either single or dual criteria, having any significant differences between the subsets generated. The results were the same using both the t-test and the U statistic.

Left Finger Two : LT2

When the raw data were analysed, the second digit on the right hand gave a significant difference between subsets only when ancestry was used as a partitioning criterion ($p = 0.044$), while using the parents' birthplace gave a low but non-significant difference between Powys and Salop.

After transformation a number of factors became clear. The data remained non-normal with significant kurtosis still existing although the heterogeneity found between the English and Welsh subsets was removed. The process also removed the significant difference indicated above ($p = 0.075$), this trend being confirmed in the non-parametric test where the division using ancestry gave non-significant differences between subsets, as did using the parents' birthplace.

All the comparisons made using the dual partitions also gave non-significant differences between subsets for both statistics. The initial significant result would thus seem to be a result of non-normality in the data which both transformation and the non-parametric test could account for.

Left Finger Three,Four, Five : LT3, LT4, LT5

The final three digits on the left hand can be treated under one heading as they all produced similar conclusions.

Non-normality of the data sets was maintained over transformation although this process did remove between-group heterogeneity of the within-group variances. None of the partitions made using single or dual parameters indicated any significant differences between the subsets present. LT5 was an exception, the t-test between WP and ES being significant ($p = 0.042$) using the parents' birth location as a parameter. However, the non-parametric test gave no indication of such a difference, the conclusion being that the resultant significant probability is spurious, arising from non-normality of the data and heterogeneity of the within-group variances.

Bimanual Comparisons

The five homologous comparisons revealed a significant difference between the means in all cases. For digits 1 and 2, the right hand had the greater value, the reverse being found for the remaining digits. The magnitude of the difference could be ranked in the order 1>2>3>5>4, while the bilateral correlation within cases was always highly significant, $r > 0.74$.

FEMALES

Right Finger One : RT1

Prior to transformation this digit showed significant skewness and kurtosis. However, subsequently both were removed to give a statistically normally distributed variable.

Partitioning the data revealed that no significant difference could be detected for any of the subsets in either single or dual partitions for either parametric or non-parametric statistics on raw or transformed data sets.

Right Finger Two : RT2

The second digit had a distribution such that only kurtosis was present. Transformation however removed even this, again giving a statistically normal curve.

The initial partitioning of the raw data gave no indication of any differences between the subsets generated although a low probability ($p = 0.09$) was found using the parents' birthplace. In this raw state however significant heterogeneity between subsets was found when using the child's birthplace or ancestry in a selected population (based on $C^{B}PA$). After transformation the same divisions had homogeneous variances, the

associated t-values still indicating non-significance differences except that using the child's birthplace (CBPA) now revealed a much lower probability ($p = 0.059$), only just non-significant. The view that regional variation may exist was strengthened when the comparable non-parametric test was made, the latter division (CBPA) now giving a significant difference (just) between Salop and Powys ($p = 0.046$).

Progressing to the dual partitionings, combining both the child's and parents' birthplaces with ancestry produced similar results between them. Significant differences were shown between WP and ES and between ES and EP. These latter comparisons were made on the raw data by a t-test, but the resultant probabilities and conclusions were the same when the data were treated non-parametrically. The fact that the parents' birthplace parameter gave results comparable to those using the child's birthplace illustrates how, taken individually, the partitioning parameters need not show significant differences between the subsets they generate, while significance can appear in a dual breakdown of birth locations with ancestry.

Right Finger Three : RT3

Unlike the two previous digits, the third finger did not exhibit a normal distribution either prior or subsequent to transformation, although in both instances skewness was at a non-significant level. The effect of the transform on the heterogeneity, found as a result of partitioning, was to remove it, this in fact being the general result for all digits over both sexes.

Dividing the data using the various criteria singly indicated no significant differences in the mean ridge counts in either the raw or transformed data sets when compared by either the t-test or U statistic. The dual partitions gave exactly comparable conclusions when the child's

birthplace was coupled with ancestry, although using the parents' birth locations gave different results. For both the t-tests and the non-parametric tests the following comparisons produced significant probability estimates, ES against WS and WS against WP. A third comparison of WS against EP had a non-significant probability although it was lower than any of the remaining comparisons and indicates that the subset WS is the one which is statistically deviant from the remaining three, these being relatively homogeneous. This digit illustrates an unusual situation of significance being associated with the parents' birthplace and ancestry, and not with the child's birth location. As for the last digit, however, significance only appeared in a dual partition, no indication of differentiation being present when the parameters were used alone.

Right Finger Four : RT4

This digit showed no significant kurtosis in its distribution but did have significant skewness. Transformation removed the latter while maintaining the former parameter at a low level, giving a statistically normal curve.

None of the partitions produced, using single or dual criteria and treating the data parametrically or non-parametrically, gave any indications of a significant difference between the subsets. The mean ridge count for the digit was 15.76.

Right Finger Five : RT5

The final digit on the right hand contained significant amounts of both skewness and kurtosis, the latter not being removed by transformation, a small increase in fact being noted.

Partitioning the data using the criteria singly revealed that only the child's birthplace gave a significant difference between Salop and

Powys. The within-group variances were homogeneous, transformation maintaining the difference noted above. This result is confirmed, even though the data are not normally distributed, by observing that the U statistic also gives a significant difference between subsets ($p = 0.021$).

The more detailed dual breakdown, using the child's birthplace in conjunction with ancestry, gave a significant difference between the subsets, the following comparisons being involved: WP against ES and ES against EP. Normally such results have been consistent whether the t-test or U statistic is used in an analysis. However, for this digit a dichotomy was noted when WP and ES were tested for a difference in mean ridge count. The t-test indicated a significant difference between them ($p = 0.038$) while the U statistic was just not significant ($p = 0.060$). It is concluded that the two subsets do have a mean difference of an adequate magnitude to producing significance. However, the lack of normality in the distribution curves must be sufficient to produce significance on a t-test but not on the non-parametric test, the latter being distribution free.

Left Finger One : LT1

The first digit on the left hand had significant amounts of kurtosis subsequent to transformation but not prior to it, skewness having the reversed relationship.

Division of the data initially gave no differences in the means of the subsets generated although using the child's birth location very nearly achieved the critical probability ($p = 0.055$). Although the within-group variances were homogeneous, transformation decreased the difference between the subsets on this latter division ($p = 0.078$), presumably as a result of its influence on the shape of the distribution.

Progressing to the dual partitioning revealed that using a t-test produced only one significant probability, comparing WS with WP,

although WP and ES had a probability below 10%. The comparable comparisons made using the parents' birthplace agreed, indicating a significant difference between WS and WP, but now also produced a low probability between ES and WS, this formerly not having been the case. Considering the non-parametric tests showed that none of the comparisons made produced any significant probabilities for either series of division. It would thus seem that the significances noted above were mainly the result of non-normal data distributions acting on marginal probabilities, the U statistic seemingly clearing away the confusion.

Left Finger Two : LT2

Unlike the homologue, the left hand did not have a normal curve subsequent to transformation, kurtosis still being significant although skewness was not present either before or after the transformation.

Partitioning the data using the parameters singly gave no significant differences between any of the subsets although using ancestry produced a low probability ($p = 0.075$) in both the raw and transformed data sets and with the U statistic. Using the child's birthplace in the dual breakdown gave statistical significance to the comparison WP against ES ($p = 0.046$), and ES agains EP ($p = 0.050$). This was unusual in that where this had formerly occurred, as in RT2 and RT5, it was the Salop/Powys division which had initially produced significance and not, as in the present case, the English/Welsh division. The significant differences noted above were consistent over the t-test and the U statistic, making it unlikely that sampling distribution was producing a spurious result.

If the parents' birthplaces are used instead of the child's, none of the subset comparisons produce significant probabilities although on both statistics, WS against WP produced a low value ($p < 0.09$).

Left Finger Three, Four : LT3, LT4

The third and fourth digits will be treated simultaneously as, in general, the conclusions reached are the same for both.

The distribution curves in the raw data showed that neither digit was statistically normal, the former having significant kurtosis, the latter significant skew. Transformation maintained the kurtosis level in both fingers, the lack of skew indicating that the fourth digit was now statistically normal, the third digit not being so.

Partitioning the data using both single and dual criteria, on raw and transformed data sets, produced non-significant comparisons between subsets in all cases for both the t-test and the Mann-Whitney U test.

Left Finger Five : LT5

Examination of the distribution parameters for both the raw and transformed curves showed that the effect of transforming was to give a statistically normal curve, both skewness and kurtosis having formerly existed at a significant level.

The initial division of the data revealed that using the child's birthplace produced highly significant differences between Powys and Salop on the t-test for raw and transformed data sets ($p = 0.002$, $p = 0.003$ respectively), as well as on the U statistic. None of the other parameters gave such significant values.

The dual partitions revealed that significant probabilities were again obtained only when the child's birthplace was used in conjunction with ancestry. The comparisons which produced significant differences were WP against ES and ES against EP, the result being maintained by both the t-test and U statistic. None of the other comparisons produced significance, indicating that it was the subset ES which is differentiating from the remainder.

Bilateral Comparisons

The bilateral homologous comparisons showed that in all but the fifth digit there was a highly significant difference between the right and left hands, for all digits the mean ridge count on the right being greater than on the left. The ranking of the bilateral differences is similar to the males except that the last two digits are reversed, i.e. 1>2>3>4>5. The correlations between hands within cases is highly significant for all homologous pairs, $r > 0.76$.

Sex Comparison

The parametric t-test between the sexes for each digit showed that for all except RT2 there was a highly significant difference. The first digit on both hands showed the greatest difference, although in all instances the probability estimate is $p < 0.001$, apart from RT3 where the corresponding value is $p < 0.05$.

General Conclusions

In view of the relatively high intercorrelations found between homologues it is not too surprising that pairs of digits should have comparable conclusions assigned to them. However, it is apparent that sufficient unique variation exists to make it worthwhile performing the complete series of analysis. It has been shown that it is possibly better to factorise the ridge counts using the twenty separate radial and ulnar counts and to produce a small number, perhaps five, of factors which have the property of being both standardised and orthogonal to each other. This was not done in the present thesis.

Using the initial unilateral maximum ridge counts showed that the lack of normality of the distribution curves can produce spurious significance values between subsets. Transformation in general will

remove both heterogeneity between the within-group variances and skewness but, at least in the present data, produced variable effects on kurtosis. Using the non-parametric Mann-Whitney U statistic has the advantage of being distribution free, but it is not as powerful a test as the parametric method. However, it seems that in instances where the probability was marginal on the t-test, the U statistic gave an estimate that was in the same direction as that produced by the change from raw to transformed data sets. RT2 and LT1 in females provide examples of this process. Provided the subsets have sufficiently large numbers of cases within them, it would seem profitable to omit the parametric t-test and just perform the non-parametric test. Confirmation or rejection of this suggestion must await further analysis of dermatoglyphic material.

Examining the various partitions of the data revealed that in males there were no differences between subsets, only RT2 being thought to produce sufficient evidence to warrant such a relationship. In females the digits RT2, RT5, LT2 and LT5 all indicated differentiation for their ridge counts between the criteria used. In general, using the parents' birthplace or ancestry, or this latter parameter in a selected population, failed to give any subsets which had low probabilities attached to their t-tests. This was especially true for females after transformation. In males, surprisingly, ancestry did give many digits with low but non-significant probabilities, even in selected populations. However, it is noticeable that this tendency is much less marked when the U-statistic is examined and also those digits which show this effect all have significant values for kurtosis after transformation.

Using the child's birthplace was not much more successful as a partitioning parameter, except that the results were consistent after transformation and with the non-parametric test.

The dual partitions using the parents' birth location with ancestry were extremely unsuccessful in producing any subsets with significant mean differences, particularly in males. That this was not merely a result of wayward distribution is shown by examination of the U-statistics, the conclusions agreeing with the t-test. Replacing the child's birthplace for the parents' was more successful, the four digits already noted indicating that some significant differences were present. In females a particular pattern was apparent in that the comparisons which produced significance were the same in the four digits, these being WP against ES and ES against EP. This conclusion was found for both the t-test and the U-statistic.

Figure T1

In general, the probabilities between EP and WP and ES and WS are large, suggesting that the major division is between counties, ancestry contributing to a slight increase in differentiation, but not to a great extent. In males, these two parameters were again unsuccessful in giving consistent differentiation. A further feature worthy of note is that for RT3 in females, significant differentiation is found using the parents' birthplace with ancestry for the comparison of ES with WS and WS against WP, although neither parameter gave significance when used alone. The distribution of these subset differences does not easily fit into the above pattern and will remain an isolated observation at present.

ABSOLUTE FINGER RIDGE COUNTS

The previous analysis was performed on the unilateral maximum finger ridge counts and given in detail mainly because this parameter is so often detailed in the literature. Another measure of digital ridge counts however would be the absolute finger ridge counts attained by the summation of the radial and ulnar counts on each digit, giving a value for each. When the pattern on the finger tips is either an arch or loop (ulnar or radial), the absolute count and unilateral count are identical. It is only where double triradii patterns, such as whorls or centre pocket loops occur that the values are different, the absolute count being greater than the unilateral. The following discussion will be brief and is intended only to investigate an alternative way of measuring ridge count numbers. Both sexes will be considered simultaneously.

The distribution curves associated with each digit are comparable to the unilateral curves, except in having higher means and variations. They do not seem to have a greater number of normal distributions, either prior or subsequent to transformation, than the unilateral measures had, except that prior to transformation skewness is always significant for all digits in both sexes, whereas the unilateral curves had a few digits with no such deviations present.

Partitioning the data again showed that neither ancestry nor the parents' birthplaces produced discrimination within the data set in either sex. The child's birthplace was slightly more successful. However, all the associated probabilities tended to be greater than the previous analysis produced, now giving non-significance where previously marginal significance was indicated. Transformation had similar effects on these probabilities, as already discussed. The non-parametric test showed FR2 in males and FL5 in females to be different in their means between Powys and Salop.

The dual partitions again only gave significant values when the child's birthplace was used with ancestry. However, the probabilities were greater than those previously reported. The subsets which had the significant results were still the same, but the digits which showed them were only FR2 and FL5, the other two digits, FR5 and FL2 having values below 10%, but all in general at a non-significant level. The results are consistent for both the t-test and the Mann-Whitney U-test.

Thus, while there is moderate agreement between the unilateral absolute finger ridge counts, the latter variable shows less significant variability between the subsets generated than the former count. It may well be that using other criteria to partition the data would produce another result, but for the present the former methodology of measuring ridge counts, when analysed in the given form, is the more successful in producing regional differentiation.

SUMMATION OF FINGER RIDGE COUNTS : TOTALS

Having examined the fingers individually, the unilateral values can be combined to give a total for each hand, and finally a grand total per pupil.

MALES

Right Finger Ridge Count : RFRC/Left Finger Ridge Count : LFRC/Total Finger Ridge Count : TFRC

As the conclusions reached are similar for all three variables, they will be considered simultaneously. The distribution curves show that the three totals all had significant skewness, but not kurtosis, prior to transformation, while subsequently they were statistically normal. The greater means were found on the right hand.

Partitioning the data by the usual three parameters showed that no significant difference between any of the subsets generated could be detected. This was true for single and dual partitions in the raw and transformed data sets when either the t-test or Mann-Whitney U-statistic was applied. The single exception was for RFRC when the child's birthplace was a single dividing parameter. The t-test on the raw data showed non-significant differences while the transformation produced a much lower non-significant probability. Although the within-group variances in this particular case were homogeneous, there was sufficient room to produce an improvement in probability, especially when the transformations gave a normal distribution. A significant result was found when the U-statistic was applied, the difference between counts being just significant ($p = 0.043$). This remains an isolated result for males in the present variables. Even though the individual digits showed an almost complete lack of significant variation between the subsets, it was possible that summation of the counts might amplify any consistent differentiation that may have existed. The above results would suggest that none are present, the individual digits acting in a random manner to the partitioning criteria.

FEMALES

Right Finger Ridge Count : RFRC

Although three variables will be examined separately for females, one factor is common; the distribution curves show that both skewness and kurtosis are present at significant levels prior to transformation, the latter remaining at an increased level subsequently.

Partitioning the data using the single criterion showed that only the child's birthplace produced a significant difference between the subsets ($p = 0.028$) on a t-test. Transformation confirmed this, although

the p value was raised slightly. The non-parametric tests gave a non-significant difference between all the subsets in each division. However, this was only marginal for the child's birthplace (p = 0.062). For this latter parameter the change in significance between the t-test and U-statistic is probably the result of the distribution being non-Gaussian whereas the non-parametric test is distribution free.

The dual partitions gave no significant values when the parent's birthplace was used with ancestry but, as with the individual digits, using the child's birth location was more promising. For the t-test only one comparison was statistically significant, that of WP against ES although ES/EP (ES against EP) and WS/WP both had low but non-significant probabilities attached to the comparisons. The non-parametric tests indicated however that these results may be caused by non-normal distributions, for the U-statistic gave only the comparison of ES/EP, a value below 10%, all the others being much less significant.

Examination of the mean counts showed the greater values to be associated with ES and WS, both EP and WP being much lower.

Left Finger Ridge Count : LFRC

The left hand total has much in common with the right in that only the child's birthplace produced a significant difference between its subsets prior to transformation when tested by a t-test (p = 0.049), although this is a marginal result. The effect of transformation was to raise this probability to a non-significant level (p = 0.062) with the U-statistic again showing even less significance (p = 0.079).

Partitioning by the parent's birthplace and ancestry simultaneously gave non-significant values for all the tests made, while the child's birthplace with the latter again gave some indication of differences within the data. The t-test revealed that the comparisons WP/ES and ES/EP both

had significant values associated with their mean differences, this being maintained for the U-statistic. The variable illustrated the point that even when the effects of a transformation and a distribution-free statistic indicates that single parameters may not be producing subsets, with differences not attributable to non-normal data, the more detailed divisions can give consistent significant differences between their subset means or rank means.

The mean ridge counts for these latter subsets again followed the pattern observed in the right hand in that the greater values were associated with ES and WS, both being greater than the means in either EP or WP.

Total Finger Ridge Count : TFRC

Summation of the unilateral totals for each hand gave the total finger ridge count, TFRC. Not unnaturally, it reflected any consistent observations made between the hands. Of the single partitioning parameters, only the child's birthplace showed any significant differences between its subsets and t-test, this probability decreasing in significance when applied to the transformed data set and becoming marginally non-significant on the U-statistic.

The dual partitions again identified the subsets WP/ES and ES/EP as having significant differences on the t-test. However, the U-statistic only revealed the latter comparison to have significance, the former now being marginally not so ($p = 0.066$). These latter results were only shown when the child's birthplace was used in conjunction with ancestry; using the parent's birthplace gave non-significant results in all cases.

The mean ridge counts were again a reflection of the individual hands, the greater mean being found with ES, WS being non-significantly lower but greater than either EP or WP.

ABSOLUTE FINGER RIDGE COUNTS : Totals

Right Finger Absolute Count : RFAC/Left Finger Absolute Count : LFAC/ Total Finger Absolute Count : TFAC

Having given a brief description of the investigation in the use of the absolute finger ridge counts as variables on the individual fingers, the total counts can now be considered in a manner analogous to the unilateral ridge count totals. Due to an oversight, no descriptive statistics for the transformed data set are available for either sex or the partitioning effects in males. What was found was that the distributions were not normally distributed for any of the three variables for the raw data in either sex, skewness always having a significant deviation from normality while kurtosis was always non-significant except for LFAC in males.

The result of partitioning for males was that in every comparison, whether parametric or non-parametric, on single or dual divisions, the associated probabilities were always non-significant. The same exclusions were obtained for females except that the dual partition with the child's birthplace and ancestry gave low probabilities (below 10%) on the t-test between ES/EP for LFAC and TFAC, but only in the former variable was it significant ($p = 0.046$). The non-parametric test, however, gave marginal non-significance to the same subsets ($p = 0.051$), the same results for all other pairs being found so when the t-test was applied.

If the magnitude of the means are examined in the subsets using the child's birthplace with ancestry, then the same associations are obtained as unilateral counts gave, i.e., the greater mean for each variable was in ES, while this subset and WS both had greater mean ridge counts than EP or WP.

Bilateral Comparison

The bilateral comparison made using the t-test showed that for both the unilateral and absolute totals, in both sexes, there was a highly significant difference between hands ($p << 0.001$), the correlations also being large and highly significant ($r > 0.917$).

Sex Comparison

The present data showed that males always have a greater mean number of ridges than females, when measured on both unilateral and absolute counts, the difference being highly significant for each variable ($p << 0.001$).

Child's Birthplace/Parent's Birthplace : Comparison of Ridge Counts

In examining the finger ridge counts, it is apparent that a lack of a significant difference between subsets is more common than the presence, but, in addition, particular parameters seem to produce most of those instances where differences are found. In general, the use of the child's birthplace gave more significant comparisons than ancestry, which in turn is 'slightly better' than using the parent's birthplace. In the dual partitions the combination of these latter two criteria is notable for the lack of significance found in either sex.

If the mean ridge counts are examined between the various divisions, certain consistent associations occur. It is difficult to give statistical backing to the following discussion due to the intercorrelations between both the criteria and the interdigital ridge counts, but these must be remembered when the results are interpreted. Considering the simple division by the child's or parent's birth locations, it is found that the same subset shows the greater mean ridge count in each division, thus in males both criteria showed that Salop had the greater value for three digits,

Powys had the greater value in four, three in turn being opposite. The same result is produced for both unilateral and absolute ridge counts. In females the relationship is even stronger, with agreement shown on nine digits, Salop having the greater mean in each instance, again repeatable over both measures of ridges.

The dual partition shows much less agreement with four possible subsets in which the greater mean could occur. Males showed six instances of agreement out of twenty possible, females only four. In these double breakdowns there was still firm agreement as to which county had the greater mean, and it would seem to be ancestry which was less consistent. The possible differences between the use of the child's or the parent's birthplace will be considered later (page 236).

A final consideration is the number of times a particular subset in the dual partition contains the greater mean. Each sex has forty possible tables to examine, but the minor diagonal seems to contain a disproportionate number, with the greater value, twenty-one, in males and nineteen in females. What this means is uncertain but it could reflect either differential migration from one region to another, or the same effect of genotype/environmental interaction giving an increase in mean value. At present, neither suggestion can be confirmed.

PALMAR RIDGE COUNTS

The three interdigital ridge counts present on each hand were subjected to the same type of analysis as the finger ridge counts described previously, transformation to remove skewness being performed with both parametric and non-parametric tests used to examine subset differences.

MALES

Right/Left AB, Palmar Ridge Counts : RAB/LAB

Right/Left BC, Palmar Ridge Counts : RBC/LBC

Right/Left CD, Palmar Ridge Counts : RCD/LCD

In a raw state the distribution curves for each of the above variables showed significant amounts of both skewness and kurtosis. Transformation removed the skewness but had varying effects on the degree of kurtosis although in two cases, for RBC and LBC it was reduced to a non-significant level giving statistically normal curves. During partitioning of the data, the general effect of the transformation was to increase the homogeneity of the within-group variances, a feature seen when dealing with the finger ridge counts.

Division of the data revealed that in all cases, using both single and dual criteria, on raw and transformed data sets and examining the comparisons by both parametric and non-parametric methods, no significant differences between any of the subsets generated could be found. This was shown for all the variables noted above. Within this analysis certain low probabilities were encountered infrequently, and always greater than 5%, but it was apparent that the parent's birthplace was always involved as one of the partitioning parameters. The subsets particularly affected were WP/ES using a U-statistic, or variables LAB and LBC, both of these also being implicated on a t-test. The impression gained is that if differences do exist between subsets, they are small, at least on the parameters under investigation at present.

Examination of the ridge counts for each variable within the divisions showed that using either the child's or parent's birthplaces as single parameters gave Powys the greater mean for five of the six. The dual partitions however showed much less agreement. Combining the

child's birthplace with ancestry gave WP the greater mean in five variables while substituting the parent's birthplace for the child's showed EP to have the larger value for four. In only two variables, RAB and RCD, did both series agree, although it was again apparent that it was the ancestral component which was most inconsistent between the two divisions.

FEMALES

Right AB, Ridge Count : RAB

The right AB count in females, like males, is statistically non-normal both prior and subsequent to transformation, the only non-significant parameter being skewness after the transformation.

The initial division, using the criteria listed, revealed that transformation tended to increase the within-group heterogeneity between the subsets, particularly when the child's birthplace or ancestry is involved, both divisions showing heterogeneity. In the raw data a significant difference was shown between English and Welsh when ancestry was the partitioning criterion ($p = 0.041$), this being maintained after transformation ($p = 0.034$). That this is not due to sampling distribution is indicated by significance between the same subset being present when the Mann-Whitney test was applied, a statistical difference still being found ($p = 0.014$). In addition, the English/Welsh comparison within a population selected by the child's birthplace being of 'local' origin has a much reduced probability when examined non-parametrically, although the difference is not significant. This latter change would seem to have been produced due to the heterogeneity encountered when applying the t-test. The greater mean ridge count was associated with English ancestry.

In a dual partition, using the parent's birthplace with ancestry never gave any significant comparisons, while using the child's gave a single significant value. This latter example was found on the non-parametric

statistic when comparing EP/EW ($p = 0.041$). The corresponding t-test gave no indication of this difference, it being probable that non-normal distributions are affecting the result of probability estimates. Within both dual breakdowns, the subset having the greater mean was WS.

Right BC Ridge Count : RBC

The BC ridge count on the right hand, like all the interdigital counts, is highly non-normal on both skewness and kurtosis. In a raw distribution, however, transformation to remove skewness also removed kurtosis, giving a statistically normal curve.

Partitioning the data by any combination of the criteria and treating the data both parametrically and non-parametrically all failed to find any significant differences between the subsets generated.

Right CD Ridge Count : RCD

Examination of the distribution parameter for the RCD ridge count showed the curve to be non-normal both prior and subsequent to transformation to remove skewness.

Partitioning the data showed that the raw data had no differences between any of the subsets when the criteria are used singly. Transformation reduced the probability associated with ancestry to a lower, but still non-significant level, while the U-statistic gives a further reduction ($p = 0.066$). The dual partitioning gave no significant differences when the parent's birthplace was coupled to ancestry in either the t-test or the Mann-Whitney U-test, using the child's birthplace with ancestry being equally unsuccessful on a t-test. However, the non-parametric results on this latter series were more promising. Significant differences were indicated between EP/WP ($p = 0.024$) and ES/EP ($p = 0.027$), while WS/EP had a low, but non-significant, difference ($p = 0.069$). This all suggests that the subset EP is the subset

which differs statistically from the remainder, but only when the child's birthplace is used to define the county. That the non-parametric tests should only show such significance reflects the results shown when the partitioning parameters were used alone and must reflect the non-Gaussian nature of the distribution curves.

The mean count for EP is greater than both ES and WP and along with WS reflects the greatest value being on the minor diagonal.

Left AB Ridge Count : LAB

The distribution showed significant amounts of both skewness and kurtosis prior to transformation, the latter remaining after transformation. The effect of the transformation was, in general, to increase heterogeneity between subsets.

Dividing the raw data by single criteria produced a significant difference between subsets based on ancestry ($p = 0.049$). A similar comparison on a selected population based on the child's birthplace gave a low, but non-significant probability ($p = 0.070$). The effect of transformation was to remove the former significant result so as to give marginal non-significance ($p = 0.054$), the latter comparison having a slightly increased difference ($p = 0.058$). The non-parametric test gave the English/Welsh comparison a significant difference ($p = 0.030$) although in a selected population it was still marginal ($p = 0.060$). The small change in these values may be a result either of random factors or of sampling distribution being non-normal, the latter being the most likely.

The dual partitions gave, for all comparisons in both series, non-significant differences except in one instance. The significant difference between English and Welsh found above was discovered only to be present between subsets EP/WP ($p = 0.044$) on a U-statistic, the t-test showing a non-significant probability although it was marginal ($p = 0.060$). Examination of the ridge counts shows that EP has the greater mean value of the four subsets in both series of analysis.

Left BC Ridge Count : LBC

Left CD Ridge Count : LCD

The final two ridge counts have much in common in that their raw distributions both have significant amounts of skewness and kurtosis, but after transformation they become statistically normal. In addition, any heterogeneity between subsets was removed by the transformation.

Partitioning the data gave, for LBC, no indications that difference between subsets existed at a significant level in the single or dual division, treating the data as parametric or non-parametric. For LCD the results for the dual criteria partitions are exactly the same, no significant differences being present. However, using the criteria singly gave a significant probability between English and Welsh based on ancestry with the U-statistic ($p = 0.024$). The t-test showed no such differences in the raw data set, but a low probability ($p = 0.069$) in the transformed data. It is difficult to tell why this non-parametric significance is not reflected in the dual breakdown. It seems that it is not of sufficient magnitude to give significance with the reduced sample size which accompanies subsetting, although differences of less magnitude (as judged from the p values) have been manifest in the double divisions in a consistent manner for other variables. More plausibly, observing that the selected populations also showed no difference between English and Welsh suggested that the differences observed are due to the inclusion in the initial breakdown of migrants from outside the borders, caused mainly by English ancestry, thus altering the mean value of this subset away from the value of the local population (see page 65). It is likely therefore that no real English/Welsh difference within the borderlands exists for LBD.

Bimanual Comparisons

Both sexes show bimanual differences in corresponding interdigital ridge counts to be highly significant ($p < 0.001$), the ranking of the differences being AB>CD>BC for both hands and sexes. The left hand had a greater AB mean than the right, while the BC and CD counts are greater on the right hand than on the left hand. The correlation between hands for homologous counts is always highly significant ($r > 0.59$) in both sexes.

Sex Comparisons

Comparing the sexes by a parametric t-test revealed that none of the interdigital ridge counts on either hand had a significant sex difference, although LAB was marginal in its probability. It is possible that those marginal probabilities would in fact become significant on a non-parametric test. Females had greater interdigital ridge counts for variables RAB, RCD, LAB, LCD, while RBC, LBC were greater in males.

SUMMATION OF PALMAR RIDGE COUNTS : TOTALS

In a manner analogous to the fingers the three interdigital ridge counts can be totalled on each hand in turn and these are then summated to give a total palmar ridge count per pupil.

MALES

Right Palmar Ridge Count : RPTOT

Left Palmar Ridge Count : LPTOT

Total Palmar Ridge Count : TPRC

The three palmar variables all have significant amounts of skewness and kurtosis in their raw distributions, except RPTOT which had no skewness. After the transformation, skewness was removed, but kurtosis remained in all three counts.

Partitioning the data using the three named criteria failed to indicate any significant differences between any of the subsets generated. This was found using single and dual divisions on raw and transformed data sets and treating the data both parametrically and non-parametrically.

FEMALES

Right Palmar Ridge Count : RPTOT

Left Palmar Ridge Count : LPTOT

Total Palmar Ridge Count : TPRC

In much of the analysis the three variables can be treated simultaneously, the conclusions being similar even though values may vary. The three total counts all show significant kurtosis both before and after transformation, while skewness is non-significant on both occasions.

Partitioning the raw data using single criteria gave only one parameter with significant differences between the subsets, this being ancestry,(marginal non-significance resulted in the right hand). RPTOT : ($p = 0.055$), LPTOT : ($p = 0.022$), TPRC : ($p = 0.029$). Transformation made no difference to these probabilities. This is not too surprising if it is remembered that the transformation was intended to minimise skewness which was initially present at only low levels, and consequently the transforming λs were very close to one. The non-parametric U-statistic confirmed the significant results given above, making RPTOT marginally significant ($p = 0.044$) in the process.

Using the parent's birthplace with ancestry gave no significant differences between any of the subsets compared either by a t-test or U-statistic. The child's birthplace, when linked with ancestry, gave the lowest probabilities to the comparison of EP/WP, although this difference was never significant. RPTOT : ($p = 0.081$), LPTOT : ($p = 0.066$),

TPRC : ($p = 0.064$). Treated non-parametrically, however, these differences, for the same comparisons, become significant, RPTOT : ($p = 0.041$) LPTOT : ($p = 0.055$), TPRC : ($p = 0.040$) except LPTOT which is still marginal. The significance shown only by the U-statistic reflects the significant kurtosis affecting the t-tests but not the Mann-Whitney U-test. It would seem that such differences as do exist in the present sample are confined to those pupils born in Powys with either English or Welsh ancestry, those with English ancestry having the greater mean. Considering the mean ridge counts found when division by the child's or parent's birthplace is used, it is apparent that for the RPTOT and TPRC the parameters agree in giving Salop the greater value, LPTOT showing the opposite trend. This was for females, while for males there was complete agreement between criteria, Powys now having the greater values. Clearly consistency of rank association is not present over sex.

Bimanual Comparison

Both sexes show a significant difference between hands ($p < .001$) for all variables, the greater counts being found on the right hand, bimanual correlations being very high ($r > 0.861$).

Sex Comparisons

The sex comparisons were always non-significant although females had greater total values than males.

Conclusions Relating to Finger and Palmar Ridge Counts

It is necessary to consider what, if anything, can be concluded from using ridge counts, both palmar and finger, about the ability of the parameters under test to discriminate. If there were no differences between the hypothetical "English" and "Welsh" populations, they could

of course not generate any. However, finding no difference can only imply that the criteria used to define our population subsets were unsuccessful in their task, but that other parameters or different combinations of the present ones may produce greater discrimination.

In the present survey it appears that the level of variation between the means of the subsets generated is small, and not surprisingly therefore many variable counts show no significant differences. The finger ridge counts identified the subsets ES/EP and WP/ES as having the greater statistical differences, while palmar ridge counts focused more on the subsets EP/WP. The child's birthplace was of greater use in the dual breakdowns than the parent's for both the finger and palmar ridge counts, although ancestry seemed to predominate as a single parameter. As mentioned earlier, if ancestry is only significant as an unselected sample, then this may well be the result of inward migration, particularly of people with English ancestry. The palmar counts confirm an English/ Welsh difference for locally born pupils and, in Powys, the finger ridge counts never giving significance between these subsets.

If it could be shown that particular subset comparisons were associated with low probabilities when not significant, then some assessment of consistent differentiation might have been possible. For example, does the subset EP/WP have low probabilities when compared on finger ridge counts? The answer is no, so it would seem that speculation at this stage is confined to within each variable class and will not extend over classes.

RADIAL AND ULNAR COUNTS

While the analysis to date has involved the finger ridge count, the criteria used have been either the maximum count on each digit or the summation of the ulnar and radial counts on each digit to give an absolute measure. It is feasible however to compute new variables that constitute the summation of the five radial or five ulnar counts present on each hand and, additionally, to add the hands together to give a total radial and total ulnar count in each case. The addition of these latter two variables would naturally give the total absolute finger ridge count, TFAC, already analysed.

MALES

Right Hand Radial Count : RADCR

The summation of the radial counts on the right hand produced a distribution having a mean of 67.79 with significant negative skew but no kurtosis. The range of values was from 0 to 139.0. Transformation of the raw data removed the skewness but increased kurtosis to a highly significant level, the shape of the curves being leptokurtic. This dramatic change is explained by examination of the range of values of the transformed variables, the limits now varying from 1 to 5.12. Clearly a great deal of lateral compression has occurred.

Right Hand Ulnar Count : ULNCR

The ulnar count on the right hand has a much lower mean than the radial, being 25.64, this occurring due to the large number of digits having only ulnar loops and hence zero for the ulnar ridge count. The maximum count found was surprisingly greater than the radial value noted above, being 144.0. However, both skewness and kurtosis were highly

significant. Transformation was capable of removing both these latter two parameters, giving a curve that can be considered statistically normal.

Left Hand Radial Count : RADCL

The mean count for the radial side of the left hand was 67.2, only marginally lower than that found on the right hand, the two, not surprisingly, being non-significantly different on a t-test ($p > 0.50$). The distribution showed a range from zero to 134.0, this maximum being lower than the homologue comparison. The raw data exhibited slight kurtosis, but with a significant amount of skewness. However, while this latter measure was removed by transformation, kurtosis increased to give a significant leptokurtic curve.

Left Hand, Ulnar Count : ULNCL

The left hand, like the right, had a much lower ulnar count than radial but was also lower than the comparable ulnar count on the right, being 18.8, the t-test showing a statistical difference ($p < .001$). Significant amounts of both skewness and kurtosis were present, transformation removing the former and reducing the latter, the amount of kurtosis still showing a significant deviation from normality, but the distribution changing from a leptokurtic to a platykurtic shape. The minimum value found was again zero. However, the maximum, 153.0, was greater than any detailed above.

Total Radial Count : TRC

Summating the right and left radial counts gave the total radial count, a mean of 134.9, the distribution exhibiting significant skewness but not kurtosis. The values ranged from zero to 261.0, and in this case

not having the maximum encountered value on either hand. The effect of transformation was to remove the skewness, but to produce a significant amount of kurtosis, the curve being leptokurtic.

Total Ulnar Count : TUC

The total ulnar count had a mean of 44.5, much lower than TRC, while the curve revealed that both skewness and kurtosis were significant, but could be removed by suitable transformation. The minimum value found was again zero, but the maximum of 297.0 was greater than that for the TRC.

In all the above variables the raw data showed a degree of skewness that could be removed by transformation. However, the effect of such a process on kurtosis was variable. In only one case was kurtosis non-significant in the raw data set (RADCR), while two were normally distributed after transformation (ULNCR, TUC). In all cases the radial count variables had an amount of kurtosis that became significantly leptokurtic upon transformation, having formerly been platykurtic. The ulnar counts showed the reverse trend, starting with leptokurtic curves and becoming platykurtic upon transformation. An exception to the latter comment was ULNCR which remained leptokurtic after transformation but at a non-significant level.

FEMALES

Right Hand, Radial Count : RADCR

The mean value for the radial count on the right hand of females was 64.75, the range varying continuously between zero and 132.0. The amount of skewness shown in the raw data was significant, as was kurtosis but, while the former was removed by transformation, the latter increased to a more significant level, the curve being leptokurtic.

Right Hand, Ulnar Count : ULNCR

The ulnar count of the right hand had a low mean of 20.2, the upper limit of 124.0 being less than the radial count but with the same lower limit of zero. Kurtosis and skewness were both significant, there being positive skew and a leptokurtic curve. Transformation removed the skewness but gave a platykurtic distribution significantly different from normal.

Left Hand, Radial Count : RADCL

The radial count of the left hand was slightly lower than the right, being 61.04, although the maximum value of 134.0 was greater. The distribution showed significant skewness and kurtosis, transformation removing the former, but altering kurtosis such that the curve became significantly leptokurtic, having previously been platykurtic.

Left Hand, Ulnar Count : ULNCL

The mean ulnar count for the left hand is lower than on the right, 18.7, consistency with the radial trend between hands being shown. Both skewness and kurtosis existed at significant levels, transformation removing the skewness but leaving significant negative kurtosis. The values recorded ranged from zero to 105.0, the upper limit being lower than the homologue.

Total Radial Count : TRC

Summation of both radial counts gave a total count with a mean of 125.8, the range extending from zero to 256.0. The curve showed significant skewness and kurtosis, transformation removing the former, but giving a highly significant leptokurtic curve, having formerly been platykurtic.

Total Ulnar Count : TUC

The total ulnar count had a mean much lower than the radial, being 38.9 with an upper limit of 214.6, the lower limit again being zero. The distribution showed significant skewness and kurtosis, the effect of transformation again being to remove the former and to change the latter from a leptokurtic to a significant platykurtic curve.

The variables examined above for females showed that the mean values for the left hand are lower than those for the right, and the upper limits are greater in the radial counts than the ulnar. The raw data always exhibited a significant elevation from a normal curve in both skewness and kurtosis, the radial counts consistently having negative kurtosis, the ulnar always positive. Transforming the raw data enabled all traces of skewness to be removed, the effect of kurtosis being consistent in direction, if not magnitude. Radial curves always became significantly leptokurtic from platykurtic, while ulnar curves showed the reverse trend.

Sex Comparisons

Comparing males and females showed that in both,the right hand had greater values than the left, while the upper limits of the variables revealed a reversed association between sexes. The t-test between sexes was always highly significant for all but ULNCL, males always having the greater mean.

Investigation of Variability

Females

The data were broken down using the usual three criteria of ancestry and birth locations (child's and parent's), in both a raw and transformed condition. The comparisons were made only by the parametric t-test, experience suggesting that the comparable Mann-Whitney U-test would produce the same resultant end conclusions, although for theoretical reasons already outlined this latter method should be preferred.

Of the six variables previously detailed, three produced a significant difference between subsets. These were RADCR, RADCL and TRC (all radial counts), the particular parameter used in division being the child's birthplace, the subsets thus representing Powys and Salop, this being the only parameter to give such significance. The use of ancestry or the parent's birthplace never gave subset differences that attained the level of significance. The differences found were consistent over transformation, the effect being to reduce slightly the associated probabilities for the three variables specified, although this was not a general finding over the remaining three ulnar counts. Although the differences between the two counties were never significant, the use of the parent's birth locations always produced probabilities that were lower than those using ancestry, and are comparable with the significant results given above, except in p-value magnitude.

Examination of the means of the radial counts showed that the greater values were associated with Salop rather than Powys when there was a significant difference between the two. For the remaining partitioning criteria, the same trend was observed, the greater mean always being related to "Englishness" rather than "Welshness", even though the differences never attained statistical significance.

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The ulnar counts never produced a significant probability between subsets on any of the criteria used, and again no consistent association for the greater mean was apparent. The use of birth location, both the child's and the parent's, tended to show that Powys had the larger mean, while using ancestry favoured Salop, neither parameter giving clear-cut relationships.

Males

Partitioning the males showed that none of the variables on any of the criteria gave a significant difference between the subsets generated. No particularly low probabilities on consistencies were apparent except perhaps that transformation tended to reduce such subset differences as did exist. Examination of the means for the subsets over all divisions showed that in all but a single instance all variables had greater means related to "Englishness" rather than "Welshness". Allowing for the inter-correlation between the variables, this would suggest a possible relationship which was at least partly supported by the results for females.

Recoded Data

If the distribution of the ridge counts of the six detailed variables are examined it is apparent that the presence of loops, particularly ulnar, produces many cases which have zero counts. This will affect the curves, producing a high degree of skewness which might influence the results found either by the skewness or kurtosis affecting the probability estimates. It was considered informative therefore briefly to re-examine the data to see if differences between subsets would be maintained after those cases with such zero counts were removed.

Naturally the means for each variable increased within both sexes, each variable also showing a reduction in skewness, while kurtosis was reduced in the ulnar counts, but marginally increased in the radial.

The data were also partitioned by the child's birth location and ancestry, the results obtained producing the same conclusions as reported above. The radial counts for both males and females naturally produced almost identical probabilities over all the parameters. The ulnar counts all had a slight increase in the between group differences, based on the child's birthplace, for both sexes, although this never became significant. Using ancestry produced variable effects on the probability values, no constant direction in magnitude change being seen. The means of the subsets were still always higher when associated with "Englishness" in males, this only being true for radial counts in females. The ulnar counts in this latter sex, as previously, were more variable in their relationships to the partitioning parameters.

The overall conclusion is that removal of the curves with zero counts increased the means, particularly for ulnar counts, but that any regional or subset variability followed a similar pattern to those shown in the initial analysis, the conclusions reached being the same.

TRIRADII

A quantitative measure of the patterns found on the fingers and palms involves recording the number of triradii associated with each pattern. On fingers, the occurrence of between zero and two triradii corresponds to arches, loops and whorls based on the classical interpretation; three triradii correspond to accidentals or combinations of the three types just listed.

The advantage of using triradii as a measure relates directly to the measurement being at an interval level. Considerations of patterns alone only deal with nominal level data and consequently the range of statistics available to compare groups is increased in the former instance; in addition to the t-test and U-statistic the triradii can be treated as categorical data and the strength of the association between groups measured by chi^2.

Because of the chi^2 requirements that no individual cell shall have an expected value of zero, or less than 20% of cells have an expected number of less than 5, the relatively infrequent numbers of accidentals cause the chi^2 assumptions to be violated. Consequently, these few cases with a value of 3 on the fingers were recoded into a class with 2 triradii. Both single and dual partitions were investigated.

FINGER TRIRADII

FEMALES

Digit (1), Right/Left hands : RD1, LD1

Both hands exhibited approximately equal frequencies of single triradii, the main difference between the two frequency distributions being the greater incidence of two triradii patterns, and correspondingly the reduced number of cases with no triradii found in the right hand compared to the left. Skewness was found to exist at a non-significant level in both hands, with kurtosis similar. The right hand required a slightly more severe transformation than the left, the results however being similar in both. Skewness was removed while kurtosis was maintained at a significant level, the right hand exhibiting a reduced amount of the latter after transforming, the left hand slightly more.

A t-test between the homologues showed that there was a significant difference between the two digits ($p = < 0.001$), while a high correlation ($r = 0.60$, $p = < 0.001$) was found.

Consideration of the partitions made using the parametric t-test revealed that none of the divisions exhibited a significant difference between subsets either in a raw or transformed state. In all cases, homogeneity between the within-group variances was shown. The greatest t values were associated with the left hand while the child's birthplace was the partitioning criterion which in both the raw and transformed data produced similar values ($p = 0.076$). The corresponding division using the parent's birthplace, while having lower probabilities than when ancestry was the partitioning criterion, still gave non-significance at a much greater level than when using the child's birthplace.

The non-parametric tests produced similar conclusions with, in addition, the selection procedures not improving discrimination. The left hand maintained a low probability using the child's birthplace ($p = 0.082$), while ancestry, within a selected population based on the parent's birthplace, showed a reduced probability ($p = 0.072$).

Treating the data categorically also showed the right hand to have no evidence of any differences between subsets, the left hand having the only low probabilities, again associated with the child's birthplace, although the dual partitioning showed that the difference between Powys and Salop was confined to those pupils having Welsh ancestry ($p = 0.071$).

The evidence thus suggests that no significant difference between "English" and "Welsh" pupils is present, based on the criteria used, and the various statistical procedures detailed.

Digit Two, Right/Left Hand : RD2, LD2

The mean number of triradii on the right hand is slightly greater than on the left hand, 1.257 and 1.222 respectively, reflecting the greater frequency of arches and loops on the latter hand compared with the former. Transformation removed the slight skewness present in the raw data in both hands, However, kurtosis was made worse by this procedure. The bimanual comparison, while less than in the former digit, still exhibited a significant difference between the two hands ($p = 0.009$), the correlation being slightly less than for the former digit ($r = 0.596$, $p < 0.001$).

Examination of the three types of analysis showed that in both hands and over all partitions of the data the comparison between the subsets gave non-significant differences. In addition, no division produced any t values of sufficient magnitude to give a probability below 10%, the lowest found being 24.7%.

Digit Three, Right/Left Hand : RD3, LD3

The third digit showed a reversed trend from the previous two, or indeed the remaining two, in that the greater number of triradii occurs on the left hand and not the right. Although more arches occur on the former hand, the greater frequency of whorls was sufficient to compensate and raise the triradii mean to a level slightly above that found on the right hand. The correlation between the homologues was highly significant ($r = 0.586$, $p < 0.001$). However, no significant difference between the two hands was observed on a t-test ($p = 0.688$), this being the only digit to show such a result. Significant skewness occurred only in the left hand with kurtosis existing at a significant level in both. As usual, transformation removed the skewness but increased kurtosis.

When ancestry was used as the partitioning criterion, heterogeneity between the within-group variances was located, transformation not removing this in either hand. The three sets of analysis all failed to produce any two subsets which showed a difference sufficient in magnitude to be statistically significant. Neither hand gave probabilities either consistently greater or smaller than the others, while none of the partitioning criteria were likewise constant in having lower probabilities than any of the other dividing parameters.

Digit Four, Right/Left Hand : RD4, LD4

With the greatest number of whorls occurring on the fourth digit, the mean number of triradii, not unnaturally, is greater on this digit than any other, the right hand having the greatest mean value and frequency of whorls. No significant skewness is evident in either hand with highly significant amounts of kurtosis. The fourth digit is alone in that transformation not only removed skewness, but reduced the amount of kurtosis observed, especially in the left hand, that remaining still

however being statistically different from normality. The bimanual comparison of the homologues showed both a highly significant correlation ($r = 0.61$, $p < 0.001$), along with a significant difference between the two means on a t-test ($p < 0.001$). The within-group variances were homogeneous for the t-tests. On partitioning the data, however, the conclusions reached are the same as for the last digit, that is, no significant difference was detected by any of the statistical tests for any of the divisions of the data in either hand.

Digit Five, Right/Left Hand : RD5, LD5

The fifth digit showed the greatest departure from a normal distribution of any digit on either hand, the removing of skewness again increasing the amount of kurtosis to an even more significant level, away from normality. The mean number of triradii was greater on the right hand than the left and corresponded to the greater frequency of whorls, fewer arches being found on the former hand. The mean difference between hands was again highly significant ($p < 0.001$) and while the bimanual correlation was, as usual, highly significant ($r = 0.493$, $p < 0.001$), the magnitude was lower than for the other homologue comparisons. Examination of the within-group variances showed heterogeneity between groups to be the rule for this digit. Transformation did not remove this effect in any instance; indeed it produced a heterogeneous comparison where formerly a homogeneous one was found (partitioning by ancestry in a selected population based on the child's birthplace). The above results are applicable to both hands.

The parametric t-test showed that a significant difference existed between subsets based on the parent's birthplace ($p = 0.014$) for the right hand only, this result being removed by transformation. No other comparison with the t-test gave a significant probability. Treated non-parametrically, the same result was obtained ($p = 0.027$) while x^2 was

also significant ($p = 0.031$). However, the dual partition by parent's birthplace and ancestry gave non-significance for all comparisons with all the statistics. It would seem that if differences exist for this digit, then the magnitude of the difference is such that only a large sample is sufficient to detect it, subdivision into smaller units introducing random elements that swamp the dichotomy. This latter statement is of course true for any type of analysis contained within the present work and is probably true in general. The corresponding partition by the child's birthplace, while having lower probabilities than those obtained using ancestry, never achieved statistically significant levels. The left hand produced no result comparable with the right, every comparison within the three sets of analysis showing no significant difference between subsets on any statistical test.

For the right hand the larger mean value was found in Powys (PFA), which had a greater frequency of whorls than Salop on this digit. The partition using the child's birth location gave a comparable result. Apart from the division noted above, no other partition in either hand gave a statistical difference between the subsets generated.

Overall Conclusions

Examining the data as a whole showed that very little was revealed except that there appeared to be no difference in the mean occurrence of triradii on the fingers between subsets regardless of the digit or partitioning criteria used. Only a single instance of a statistically significant difference was found, this being consistent over the three types of statistic used. Although many of the comparisons made produced non-significant probabilities, it was hoped that one method of division would stand out in giving consistently lower probabilities than the other parameters. No such conclusions were reached, the magnitude of the

probabilities appearing to be random. Similarly, the subset having the greater mean number of triradii was not constantly associated with "Englishness" or "Welshness", the conclusion being that none exists. The three types of analysis all gave comparable results, none being particularly deviant from the other two. The only advantage of using the non-parametric test would seem to be its ability to handle data in a distribution-free manner, although the results obtained using the non-normal raw data with heterogeneous variances between subsets were the same when the Mann-Whitney U test was applied. In a situation of marginal probabilities for significance, the latter statistic may possibly be preferred.

MALES

Digit One, Right/Left Hand ; RD1, LD1

In males the frequency of arches is below that found for the corresponding digit in females. Consequently the mean number of triradii on each finger is greater in the former sex than the latter. For the first digit, in males, the right hand has the greater value, this occurring for all the other digits. Examination of the frequency distributions showed that skewness only existed at a significant level in the left hand, kurtosis being present in both hands. Transformation removed the skewness but increased kurtosis in the left hand and fractionally decreased the latter in the right. Comparing the first digits as homologues showed a significant correlation between hands ($r = 0.543$, $p < 0.001$) accompanied by a significant difference between their means ($p < 0.001$).

The various partitions of the data showed that no division produced a significant difference between subsets for either hand when examined by a t-test. Treated non-parametrically, a low, but non-significant

probability was found for division by ancestry in a selected population based on the child's birthplace. The associated division using the parents' common birth location showed a similar trend, both these effects being confined to the left hand. When considered as categorical data, it was shown that the English/Welsh difference attained statistical significance, but only for those pupils born in Powys. With both parents having a common birth location in Powys the associated probability was low but did not achieve a level of significance, this again only referring to LD1, RD1 revealing much greater values. Returning to the parametric tests, the corresponding division by ancestry, after the child's birthplace had produced a "local" population, gave a reduced but still non-significant difference between subsets for LD1. Transformation reduced the subset dfferences slightly. It is apparent therefore that similar conclusions are reached for both parametric and non-parametric tests, non-normal data not accounting for the reduced probability found. It is only in the last series of analysis that a clear distinction between the English and Welsh was found. I have every reason to expect that both the t-test and Mann-Whitney U-statistic would confirm the significance found between the English and Welsh in a selected population, born in Powys.

Digit Two, Right/Left Hand : RD1, LD1

For the second digit the greater mean number of triradii is found in the right hand, a higher frequency of whorls being the cause. The distribution of triradii gave a curve with both skewness and kurtosis at a non-significant level in the left hand, in the right hand only skewness being non-significant. Transformation removed the slight skewness easily from both hands, the effect on kurtosis being to increase it in the right hand, but to reduce it in the left. Comparison of the means found for each hand showed that they were significantly different ($p = 0.005$), while still

having a high correlation between the homologues ($r = 0.582$, $p < 0.000$).

Partitioning the data and considering it by the three statistics all failed to give any two subsets that exhibited a significant difference on either hand. Division by ancestry gave a low probability on the U-statistic ($p = 0.098$), some similarity to this being shown by the t-test. In the dual partitions comparisons between those pupils born in Salop, for ancestry, had a similar low probability ($p = 0.081$). However, in all other instances the magnitude of the subset differences never approach levels of significance.

Digit Three, Right/Left Hand : RD3, LD3

In common with the last two digits, the third has more whorls on the right than left hand, with a greater mean number of triradii. Skewness and kurtosis were present at significant levels in both hands, the effect of transformation being to remove the former parameter but increase the latter. The mean number of triradii were significantly different between hands ($p = 0.004$) with, as usual, a high positive correlation between the homologues ($r = 0.606$, $p < 0.001$). Division of the data by the three criteria and consideration by the three statistical methods all failed to indicate any two subsets which had a significant difference between their means, on either hand.

Digit Four, Right/Left Hand : RD4, LD4

The trends established for the other digits were maintained on the fourth finger. The right hand had a significantly greater mean number of triradii than the left ($p < 0.001$), with a positive correlation between them ($r = 0.572$, $p < 0.001$). Significant kurtosis was present in both hands, but skewness only in the left. Transformation removed the skewness but decreased kurtosis in both hands.

Examination of the subsets showed no evidence for any significant differences between "Englishness" and "Welshness" within any division or statistic. Within the categorical tests a low probability ($p = 0.077$) was shown between Powys and Salop, based on the parents' birth locations, within the Welsh, however, this was not maintained over the other partitions and must remain an isolated result.

Digit Five, Right/Left Hand : RD5, LD5

The "little finger", in spite of the low frequency of whorls present, has a mean number of triradii comparable with those shown for the third, indicating that the number of whorls alone does not have an overriding influence in determining the resultant means. In both hands the skewness and kurtosis are extreme and significant, transformation causing a slight decrease in the latter on the right hand but increasing it in the left. The difference between the means on the homologous fifth digit was highly significant ($p < 0.001$), the right hand having the greater value, while a high positive correlation again existed ($r = 0.428$, $p < 0.001$).

Throughout all the partitions the right hand gave no indication of differences existing between any of the subsets generated. The left hand was slightly different in that division by the child's birthplace gave consistently low but non-significant probabilities between Powys and Salop. This was found in all three statistical tests, the effect of transformation being to increase the differences as measured by the t-test. The x^2 results were similar except that the Powys/Salop difference was limited to those pupils with English ancestry ($p = 0.010$). In general, the left hand showed no comparable results when the parent's birthplace was the partitioning criterion, the exception occurring in a dual partition on x^2 when, within the Welsh, the difference between subsets rarely reached the level of statistical significance ($p = 0.054$). The conclusion reached is that for the left hand only a difference between subsets may exist when division by birth

location is used. Ancestry seems to be having a slight effect, but less than the former parameters.

Overall Conclusions

The general review of triradii frequencies in males is similar to that in females. No parameter was consistently able to give differences between subsets which were greater than any other parameter or combinations of them. Neither "Welshness" nor "Englishness" was constantly associated with a greater mean number of triradii over the ten digits, only a single case of a significant difference being found. I conclude therefore that in the present data set, and using the three named parameters, no evidence suggests that a difference between "Englishness" and "Welshness" exists in the mean number of triradii occurring on the individual digits of either hand.

Sex Comparisons

The previous analysis indicates that neither sex produced more differences between subsets than the other. Additionally, those particular digits detailed as having low probabilities bore little relationship between the sexes.

A comparison of the mean value on each digit between sexes was initially made on the raw data. This showed that the right hand had more digits with a significant difference between sexes than the left. In the former hand, only digit 2 did not give significance at the 5% level on a t-test, while the latter hand only had the third digit with such a difference.

A comparison of the sexes using $x^2_{(2)}$ showed that three digits had non-significant differences, RD2, RD5 and LD4. In general, the magnitude of the $x^2_{(2)}$ was greater in the right hand than the left, the exception being RD5.

Comparing the present results with those of Dennis (1977b) showed several differences. While his results agree with the present data in that the right hand had greater $x^2_{(2)}$, on no digit is the sex difference ever non-significant, while the present data showed this on three such fingers. In view of the sample size involved in both series (> 3100), it seems unlikely that sampling is a factor in this difference. There also appears to be no relationship between these digits having significant differences or low probabilities between the subsets and those displaying no sex differences. The present work did not examine the magnitude of the sex difference in the various partitions and it would be profitable to pursue this matter to see if there is variability in the sex difference in a manner comparable with that shown for other variables. It is possible that the amalgamation of two gene pools, admittedly very similar, could occasionally give spurious relationships between the sexes.

Finger Pattern Intensity Indices

By summation of the total number of triradii on each hand one obtained an Intensity Index, one for each hand and a total for each case.

Right Finger Pattern Intensity Index : RFPII

Left Finger Pattern Intensity Index : LFPII

Total Finger Pattern Intensity Index : TFPII

FEMALES

The range of values encountered varies from 0 to 10, although individuals with accidentals may produce a greater count than 10 although these individuals were removed by recoding prior to analysis. The mode of the distribution is at 5 in both hands, the mean value being greater in the right than in the left (6.11 and 5.92 respectively). The correlation between hands is high and significant ($r = 0.802$, $p < 0.001$). Neither hand

shows evidence of skewness, but kurtosis is present, a slight transformation to remove such skewness as did exist giving a reduction in kurtosis in the left hand but an increase in the right, both still being statistically significant parameters. It is evident that the distribution around the mode is not equal for either hand with 9.4% of cases having four or fewer triradii on the right hand, while 56.7% had six or more. The corresponding values in the left hand were 13.0% and 54.7%. Totalling both hands reflects both the above distributions with a mode around ten, and related frequencies being 14.2% with nine triradii or fewer, and 64.3% with eleven or more. The distribution parameters for TFPII showed no significant skewness but did have kurtosis, this latter reducing after transformation.

Partitioning the data by the usual parameters showed that none of the divisions or statistics gave any significant differences between the subsets generated. Additionally there were no probabilities low enough to warrant particular consideration. These latter statements were true for both hands considered separately (RFPII, LFPII) and when summated (TFPII). When considered parametrically, heterogeneity was exhibited by the within-group variances when either the child's or parent's birthplace was used as a partitioning parameter. After transformation all three variables still showed such heterogeneity between the groups with the exception of RFPII when the child's birthplace was used. When ancestry was taken as the partitioning parameter, the variances were homogeneous for all variables.

MALES

The distribution of triradii in males has many more features in common than in females. Both hands have the complete range of values with the mode at 5, with TFPII having a mode at 10. Neither hand has significant skewness and only the left has any kurtosis, with TFPII following the pattern of the left hand. In all cases, although no statistical skewness is present,

the greater part of the distribution occurs above the mode. The mean index is again greater in the right hand with a highly significant correlation between hands existing ($r = 0.763$, $p < 0.001$), while the bimanual difference is also statistically significant ($p < 0.001$).

Partitioning the data by the various parameters did not give a single instance of any significant differences between the subsets generated on any statistical test nor were any consistently low probabilities found.

Sex Comparisons

For all three indices, males showed greater means than females. The t-test showed however that only in RFPII and TFPII did the differences reach statistical significance, LFPII having a non-significant t value. Dennis's results (1977b) showed all three indices to have statistically different means between sexes. The disparity between these data and the previous ones result from a greater mean value in LFPII of females in the present work compared to the value reported by Dennis.

PALMAR TRIRADII

The pattern system on the palms, like the fingers, has triradii associated with the loop systems. Axial triradii were defined in terms of Penrose (1968) with 14% and 40% limits defining t, t' and t'', while the thenar elements were all combined into a single class. Individual inter-digital accessory triradii were not classified separately but combined into a single variable for each hand, while border triradii were given a separate specification. The various zygodactylous triradii occurred with such low frequencies that any regional analysis was meaningless. Values for these deltas are given in Table 29.

The data were broken down by the same criteria as previously defined and treated statistically by the non-parametric Mann-Whitney U-test

or by chi^2 when appropriate. The parametric t-test was not used except to compare hands. In addition, no transformation was applied to the raw data to remove skewness, this not being required by the above statistics. In view of the previous analysis, the omission of the parametric tests is considered a valid process. The analysis considers each type of triradius separately as a class regardless of multiple occurrences on a single palm.

FEMALES

Axial Triradii : TR, TL

The most proximal axial triradius was absent more than twice as often as it was present, a single triradius being found on 31.3% of right hands and 33.8% of left hands. A few rare instances with two occurred, particularly in the right hand. The correlation between hands was highly significant ($r = 0.439$, $p < 0.001$) with no bilateral difference in the mean occurrence ($p = 0.183$). The frequency of the triradii gave a distribution with significant amounts of skewness and kurtosis in both hands.

Partitioning the data revealed that no significant difference was found between the subsets generated for any of the criteria used on either hand when analysed by the U-statistic. The use of the child's birthplace alone gave a low probability ($p = 0.052$) for the right hand. However, the value obtained for the parent's birth location was much greater ($p = 0.380$).

When treated categorically the same conclusion was reached. The child's birthplace again had the lowest probability attached to it ($x_1^2 = 0.067$) for only TR, while the dual partitions never produced a probability as low in any subset comparison. I conclude therefore that while there may be a difference between Salop and Powys, based on the child's birthplace, in the frequency of occurrence of TR the magnitude never reached

the level necessary for it to be statistically significant, especially when the dual breakdowns are performed.

T1R, T1L

The occurrence of these triradii is almost reciprocal to the proximal ones described above, the correlation between the variables being -0.782 for TR/T1R and -0.779 for TL/T1L. The number of cases possessing only a single T1R or T1L on the respective hands is equal at 61.3%, a fractional difference between the frequency of cases having no such triradii being found. The correlation between hands is significant, if not particularly high ($r = 0.353$, $p < 0.001$), while no significant difference between the means for each hand was revealed ($p = 0.334$).

Dividing the data by both single and dual criteria produced no significant differences between any of the subset comparisons on the U-test or when treated categorically and assessed by chi^2.

T2R, T2L

Comparing the correlations for this most distal axial triradii with the other two shows that T2L occurs independently from TL but not from T1L, while low, but significant negative associations for T2R with TR and T1R were found. The bimanual correlation for T2R and T2L is again significant ($r = 0.353$, $p < 0.001$), while the difference in their mean occurrences is also significant ($p = 0.012$), the right hand having the greater value. The majority of cases did not have such distal triradii, only 8.6% having a T2R and 7.3% a T2L, while cases with two such triradii were even rarer, only two cases having two T2Rs and two more with two T2Ls. It is not surprising that both kurtosis and skewness existed at highly significant levels.

Division of the data produces conclusions exactly the same as for the axial triradii T1R and T1L listed above.

Border Triradii : TBR, TBL

The border triradii occur in association with either central or radial Hypothenar Loops or Radial Hypothenar Arches. It is not always visible in a print and is then considered "extra limital" provided an appropriate loop is present to warrant such an assumption. Instances of two triradii on a single palm are rare, a single example on each hand being found in the present sample. The frequency of occurrence of TBR is greater than TBL, 35.9% and 29.1% respectively. This difference is statistically significant ($p < 0.001$), the correlation between hands being significant ($r = 0.508$, $p < 0.001$). The three individual patterns detailed will be given individual consideration later. However, it is worth noting that the $x^2_{(1)}$ between hands for both radial and central hypothenar loops is significant, the former element having the greater difference, but with the right hand showing more of both patterns than the left. Radial hypothenar arches are more frequent on the right hand also, but the bimanual difference is only just non-significant, $x^2_1 = 3.38$, $p = 0.055$. Returning to the border triradii, both hands have frequency distributions which show significant skewness and kurtosis.

Partitioning the data by the various parameters in either single or dual combinations gave no subsets which showed a significant difference on either the U-statistic or chi^2, no trends or consistently low probabilities being noted.

Thenar Triradii : TEFR, TEFL

Within the thenar area the occurrence and distribution of triradii are directly correlated with the radial and peripheral thenar loop systems. The present work does not attempt to differentiate between the two individual types of triradii of the Penrose and Loesch system (1970) i.e. E and F, but combines them into a single category on each hand.

This was done in view of the subjective nature of interpretation for these two triradial types. The number of triradii encountered in the thenar area ranges from 0 to 2 on both hands, a single case with three on the left hand being found. The left hand showed a significantly greater mean occurrence than the right hand ($p < 0.001$). This results from having more examples of single and double triradii in the thenar area of the left hand compared with the right. The bimanual correlation is significant ($r = 0.550$, $p < 0.001$), both hands having significant skewness and kurtosis in their distributions.

Partitioning the data showed that no parameter could produce subsets exhibiting a significant difference on either statistic. The lowest probability was found for TEFL between Powys and Salop, based on the child's birthplace, within the English, on a $x^2_{(1)}$, $p = 0.088$, although the divisions based on the parent's birthplace were much less significant.

Accessory Triradii : TDR, TDL

When more than a single loop occurs in the interdigital region the topology of the hand requires that an extra triradius must exist for each extra loop. These accessory triradii were not examined separately for palmar regions II, III and IV, but were combined into a single class of the total number of accessory interdigital triradii per hand. Both hands had a range of values from 0 to 3, a single individual with a right hand which possessed 4 being encountered. The mean frequency was greater on the left hand than the right, the difference being statistically significant ($p = 0.024$), as was the bimanual correlation ($r = 0.510$, $p < 0.001$). The greater mean resulted mainly from having more cases with only an extra triradius on the left hand; indeed, instances with two extra were more frequent on the right hand, the absolute frequency in each class diminishing as the number of triradii increases.

Partitioning the data by the three detailed criteria in both single and dual formulations failed to give any subsets with significantly different means on either the U-statistic or chi^2, no consistent pattern of low probabilities being apparent with any of the criteria used.

MALES

Axial Triradii : TR, TL

These axial triradii, occurring low on the palm, were slightly more frequent on the left hand than the right, the difference between the means not being significant ($p = 0.080$). The values ranged from 0 to 2 although instances with two triradii were rare but present on both hands. Skewness and kurtosis were found, while the bimanual correlation was significant ($r = 0.439$, $p < 0.001$).

Partitioning the data showed that no differences between subsets for TR could be detected on any of the criteria or statistics used. TL however did produce two significant values. Using the parent's birthplace, a difference between Salop and Powys within the Welsh was found ($p = 0.050$), while within Salop the English and Welsh were significantly different ($p = 0.041$). These were based on the non-parametric U-statistic, but were exactly followed by the $x^2_{(1)}$ results, this being true for all this section, and consequently only the U-statistic probabilities are present. Examining the frequency within each class in a dual partition showed that the distributions were not consistent with the postulated model previously detailed (page 67). The greater frequency was found in ES, while WP had the next highest, and not the lowest mean, as would have been hoped. A comparison of ES with WP shows them to be not significantly different ($p >> 0.10$). Considering the probabilities shown when the child's birthplace is used as the dividing criterion revealed that no comparable low probability was shown in either the single or dual partition. The subset ES

still maintained the greater mean frequency with WP next. Although TR has already been shown to have no significant comparisons associated with it, the ranking of the variable means in the four subsets produced in both dual partitions were exactly comparable with those produced for TL, although subset differences were of a smaller magnitude.

T1R, T1L

This second class of axial triradii occurs much more frequently than the other two. The values ranged from 0 to 2 with the left hand exhibiting a single individual with 3. A slightly greater mean value in the right hand results from having more cases with both single and double triradii than on the left, though the mean difference was not significant ($p = 0.310$). A high bilateral correlation was present ($r = 0.371$, $p < 0.001$). Neither hand showed any significant skewness although kurtosis was present in both.

Dividing the data by the various criteria did not produce any subsets which revealed a significant difference on single dual breakdowns for either T1R or T1L. Both the U-statistic and x^2 probabilities were used. A low probability (0.091) was shown for T1L between English and Welsh within Salop, based on the parent's birthplace (on the U-statistic), this reflecting the result shown for TL previously. However, the probabilities found for TL and T1L are not in general comparable in magnitude even though they have an inverse relationship.

For T1R, there is also an inverse relationship with TR.

T2R, T2L

The final class of axial triradii is the least frequent, the right hand having a greater mean value than the left, but not a statistically significant difference ($p = 0.126$). The range of the distribution

is 0 to 1 in both hands, three cases of two T2Rs being found, and significant amounts of both skewness and kurtosis being present. As with the other classes of triradii, the bilateral correlation is highly significant ($r = 0.510$, $p < 0.001$). The association between T2R or T2L with their corresponding axial triradii differs between hands. It has already been shown that both TR/T1R and TL/T1L have inverse relationships. However, the distal triradii are much more loosely tied to the other triradii. TR/T2R and TL/T2L both show independent occurrence (respectively). The comparison of T1R/T2R and T1L/T2L both give significant negative relationships, but the magnitude of this is much lower than between TR/T1R or TL/T1L.

Partitioning the data showed that in a selected local population, based on the child's birthplace, there was a significant difference between the English and Welsh on the U-statistic ($p = 0.037$) for T2L. Without selecting out the migrant population, no difference between English and Welsh was apparent ($p = 0.260$). When considered as categorical data no partition, using single or dual criteria, produced a significant difference between subsets for either T2R or T2L. This suggests that if any difference between the two gene pools associated with "Englishness" and "Welshness" do exist for T2R or T2L, the magnitude of this difference is small and not consistent over statistics or partitioning criteria.

Border Triradii TBR, TBL

The hypothenar border triradii showed a significant difference between hands ($p < 0.001$), the right having a greater mean than the left. The range encountered for TBR and TBL was the same, 0 to 1, no pupil with more than a single such triradius being found in either hand. Significant amounts of skewness and kurtosis were shown for both distributions, the mode being at 0 in both cases. The bilateral correlation was highly

significant ($r = 0.528$, $p < 0.001$). The difference in the means for each hand was seen to be due to variation in the occurrence of radial and central hypothenar loops and radial hypothenar radial arches although only the first and last patterns showed any bilateral asymmetry ($x^2_{(1)} = 13.41$, $p < 0.003$ and $x^2_{(1)} = 6.99$, $p = 0.015$ respectively). The greater number of patterns was, in both cases, in the right hand, the combination producing the final number of triradii.

Partitioning the data gave no significant differences between subsets for any of the criteria or combinations used for either statistic. A low probability for TBL was shown between English and Welsh within Powys (based on the child's birthplace), ($p = 0.074$) on the U-statistic. This was not however maintained on any other comparison made.

Thenar Triradii : TEFR, TEFL

The thenar area of the left hand had more triradii than the right hand, the means being significantly different ($p < 0.001$). The range of values was from 0 to 3 for both hands, the mode being at 0, an increase in triradii being associated with a reduced frequency of occurrence. There was significant skewness and kurtosis present in both distributions, the bimanual correlations again being highly significant ($r = 0.509$, $p < 0.001$).

Division of the data gave no significant differences between subsets for any of the criteria used, either singly or in combination, for both TEFR and TEFL. This latter variable did show a low probability ($p = 0.056$) for an English/Welsh difference on a U-statistic subsequent to migrants being removed. Prior to removal, the comparable probability was $p = 0.124$. When treated categorically $x^2_{(1)}$ gave a comparable significance prior to selection of the data ($p = 0.130$) although the dual partitions all produced probabilities much greater than these latter two, confirming that no real difference would seem to be present between the subsets, at least when based on the detailed partitioning criteria.

Accessory Triradii : TDR, TDL

The accessory triradii in males showed very little difference in the bilateral means ($p = 0.817$), the right hand having the greater value. However, examination of the frequencies for classes within each hand showed that whereas pupils with a single accessory triradius had them most commonly on the left hand, those with two had them most frequently on the right. Hence the compensation in the estimate of the mean. The $x^2_{(1)}$ between hands indicates a difference between the two distributions ($x^2_{(2)} = 6.923$, $p < 0.05$) and exemplifies the possible way in which differences between groups, even for interval data, can be missed. Both hands have a range of values from 0 to 3, the bimanual correlation being significant ($r = 0.530$, $p < 0.001$), although both skewness and kurtosis are present in significant amounts.

Partitioning the data revealed that none of the criteria used could give differences between subsets for the frequency of occurrence of TDR. The left hand was different however in that a significant difference between English and Welsh was found subsequent to selection based on the parent's birthplace ($p = 0.01$). A comparable result was found when the child's birthplace was used as the selection criterion, although the magnitude of the difference was not as large ($p = 0.061$). However, both these are greater than the English/Welsh comparison produced without any selection. These latter probabilities are based on the U-statistic but treating the data as categorical and calculating $x^2_{(2)}$ showed that prior to selection à non-significant difference was shown between ancestral groups ($p = 0.985$). The dual partitioning revealed that the English/Welsh difference was limited to those pupils with both parents born in Salop ($p = 0.007$), those with both born in Powys having a non-significant difference. Using the child's birthplace in the dual partition with ancestry gave no particularly low probabilities, certainly none which approached

the 5% level. This suggests that a difference in the frequency of accessory triradii exists between English and Welsh, but only for those pupils with both parents born in Salop. Using the child's birthplace no comparable results emerge.

Sex Comparisons

The sex difference can be examined either by a t-test or by considering the data as categorical and using $x^2_{(2)}$. In either event the conclusions were similar, with only a single exception. The statistics indicated that T2R, T2L, TBR were significantly different in frequency between sexes, TDR being significant on a t-test but not on $x^2_{(2)}$. The greater means were associated with males for T1L, T2R, T2L, TBR on TBL. Both sexes showed that bimanual correlations were highly significant for all triradii variables, although the mean differences between hands were not always of a comparable magnitude.

A comparison of the results with those of Dennis (1977b) indicated that the same pattern of sex differences was not shown over the palmar triradii and it can again be speculated that the sex difference itself may be a variable which shows regional variability.

Combinations of Palmar Axial Triradii

FEMALES

Previously the palmar triradii were examined in terms of t, t' and t'' as single units without reference to the relative frequencies of these triradii when they occur in combination with each other.

Combining the three axial triradii in various ways gives Table and it is apparent that neither hand shows much difference from the other and that the most frequent combinations of triradii are a single occurrence or pairs, triplets being rare. The right hand has 84.4% of the total

female sample with a single triradius, the major contributor being t'. As a percentage of the total number of pupils for which data were available, 26.8% had a single t, 55.0% a single t', the smallest percentage being for t'' with 2.9%. The left hand follows a similar trend, a single triradius being shown by 87.2% of females, slightly higher than the right. Of these, 28.1% had a single t, 56.0% a single t' and 3.03% a single t''.

This high level of t' is shown up when combinations are considered, for while tt and t''t'' are comparatively rare, those pairs involving t' have greater frequencies. For t't' the right and left palms have similar values of 4.2% and 3.7% respectively, this being the most frequent pair encountered, greater than single t'' in either hand. The next most frequent pair was tt' with right and left percentages being 2.6% and 3.22% respectively. The next most common combination was, surprisingly, when overall frequencies are considered, found to be tt'' for both hands, the frequency being 1.6% on the right hand and 2.29% on the left. Why the left should have the larger number appears to reflect that single t triradii are higher in the left compared with the right. Finally, the combination t't'' was greater in the right hand (3.7%) than the left (1.7%), The loss of numbers in the left hand may be associated with the increased frequency of t compared with the right, resulting in an increase in t, tt' and tt'' for the left hand over the right. As the total number of t'' is lower in the left hand than the right, a general movement down the palm being speculated for the patterns of the hypothenar and triradii of the left hand, compared with the right. The remaining combination of pairs all occurred at low frequencies. Because of the large number of palms having a single triradius it is not surprising that x^2 measures of association are negative, as shown earlier. If the t and t' triradii are examined, their association is still significant when t'' is taken into account. The relationships between t and t'' however are only just significant in the

right palm and highly non-significant in the left. The association of t' with t'' is significantly negative for both hands even when t is taken into account.

If the data are partitioned in terms of the criteria given previously, then the mean frequency of occurrence of the main combination of axial triradii were found not to differ significantly when examined by the U-statistic for any combination of parameters used.

MALES

Frequency tables for males are given in Table 30 and can be considered under the same terms as for females and will not therefore be repeated. The results of the divisions into subsets for the mean frequency using the various parameters provided the same conclusions as for females.

ATD ANGLE

The ATD angle is defined as that angle produced at the axial triradii, formed using the A and D subdigital triradii as end points. When only a single axial triradius exists, then this would be the obvious point at which the angle is formed, but when there is more than a single triradius, resulting in general from either a peripheral hypothenar loop or a hypothenar whorl, more than a single angular measurement is possible. This gives the concept of a minimum and maximum ATD angle. The maximum angle naturally occurs at the most distal axial triradius as measured from the wrist, while the most proximal triradius forms the minimum ATD angle. When only a single triradius exists it becomes necessary to consider whether it should be associated with a maximum or minimum angle. In the present work a single ATD angle has been classified as minimal and all the following analysis deals with the minimum ATD angle, the maximum not being

used. It follows that maximum angles only exist with a hypothenar pattern and a minimum angle. This decision was obtained by the intuitive assumption that in normal populations the single axial triradius is generally placed in the proximal position and equates much more readily with the minimum angle, when two triradii are present, than the maximum. Pupils who possessed a radial hypothenar arch had no axial triradius and hence no ATD angle. Unless otherwise stated, all the following analysis is based on data with these pupils included and not recoded out of the analysis. Removing such cases was shown to alter the means slightly, but the results obtained by the t-test or Mann-Whitney U-test were almost identical with those produced with the cases included.

FEMALES

Right Least ATD Angle : RLATD

The mean angle for the right palm was found to be 42.03° with a S.E. of 0.21. The distribution showed significant negative skewness which was removed by transformation. Kurtosis was very marked, being leptokurtic, the effect of transformation being to reduce this, but still leave it at a significant level. The range of values was from 0 to 85.5%. However, with the radial hypothenar arches recoded out, the minimum angle capable of measurement was 27.0°, the mean for the data having increased to 42.8°. The effect of this removal was to reduce kurtosis, but to give highly significant positive skew.

Left Least ATD Angle : LLATD

The mean angle for the left palm is only fractionally greater than the right, being 42.45°. Skewness was not present in significant amounts although kurtosis was. Transformation removed the slight skewness

but increased kurtosis marginally, with a leptokurtic distribution, similar to the right. The maximum angle measured was 86.0°, almost identical with the right hand, the minimum being 0°, while the minimum measured angle was 27.5°, again very similar to the right, while the mean increased to 42.7° with removal of the radial hypothenar arch.

Bimanual Comparisons

In view of the similarity between the means on each hand it is a little surprising that they were found to be significantly different by a t-test ($p = 0.038$). A strong bimanual correlation was present ($r = 0.521$, $p < 0.001$), but the lack of normality of the data may be producing spurious probabilities. The rank correlation between palms was not produced.

Geographical Variation

Partitioning the data by the various criteria was performed. The differences between subsets were investigated by treating the data parametrically, both with and without transformation and using the t-test. Additionally the non-parametric Mann-Whitney U-test was also applied to the data.

It was apparent that heterogeneity between the within-group variances was randomly distributed over the divisions, the effect of transformation being variable but, more importantly, the conclusions drawn did not change between the raw and transformed data sets.

Division by the child's birthplace showed that a significant difference existed between Powys and Salop for both palms, the greater means being associated with Powys. Removal of the radial hypothenar arches produced the same conclusions as using the U-test or the t-test on the transformed data.

Using the parent's birthplace as the partitioning criterion and examining the data parametrically showed that only the left hand maintained the significant difference between Salop and Powys, this remaining after transformation. The right hand, while having a low probability, was not significantly different between the subsets either prior or subsequent to transformation, the effect of the latter being a slight increase in the subset difference, but not to a significant level. When treated by the U-test both hands showed a statistical difference between Salop and Powys. It would seem therefore that while the left hand is consistent in its regional difference, the right hand is less clear. However, it seems likely from the pattern of probability changes that it too does show a greater mean in Powys compared with Salop on both criteria.

In changing from the former criteria to the latter the t-value increased for LLATD but no such increase was found in the rank summation. Consequently it would seem that the degree of discrimination existing between the two locations is no greater when the parent's birth location are used, compared with when the child's birth location is the partitioning criterion. The use of ancestry was noticeably unsuccessful on both hands in producing significantly different subset means. The effect of selection was to reduce the probabilities but not to significant levels. Consistency with the previous divisions was maintained, the greater means being associated with the Welsh in both hands. The dual partitions of the data were not performed.

MALES

Right Least ATD Angle : RLATD

In males the mean ATD angle of both hands is less than the corresponding measurements in females. The right hand in males has a

mean ATD angle of 41.68° with significant skewness and kurtosis in the distribution. Transformation removed the skewness while simultaneously reducing the amount of kurtosis but leaving it still significant. The maximum measured angle was 80.0°, the minimum measured angle being 27.5°, this latter angle being identical with the corresponding value in females although the maximum in males is a little lower.

Left Least ATD Angle : LLATD

The mean measurement for the left hand is almost identical with that in the right (41.65°) with significant amounts of both skewness and kurtosis, transformation eliminating the former but only slightly reducing the latter. The maximum measured angle was 74.5°, while the minimum was 25.0°.

Bimanual Comparisons

The similarity of the means noted above was reflected in the t-test between hands, there being no significant difference between them ($p = 0.832$). The bimanual correlation was highly significant ($r = 0.533$, $p < 0.001$), this latter association being almost identical to females.

Geographical Variation

Division of the data by the child's birthplace indicated that the right hand showed a significant difference between Powys and Salop when considered on the t- or U-tests. The greater means were associated with Powys. Transformation gave the same conclusions. The left hand was consistent in not having any significant differences between the two counties either prior or subsequent to transformation on either statistic.

Using the parent's birthplace did not confirm the above results. The t-test produced non-significant differences in both the raw and transformed data sets in both hands. However, the probabilities associated

with the right hand are only just above the 5% limit, the tendency being the same as for the previous criteria. The U-test was non-significant on the left hand but significant on the right. This contradiction between the two sets of analyses is similar to that shown for females previously detailed, significance produced in a non-parametrical test but not shown in the parametric t-test. In view of the lack of normality of the data it seems likely that the former test may be more accurate, if less powerful (Siegel, p. 126). Division of the data using ancestry, as in females, was unsuccessful in producing significance between subsets either prior or subsequent to selection on either statistic.

Examination of the means for all categories of division reveals that in every instance the greater mean values were associated with "Welshness" for both hands. Dual partitioning was not performed.

Sex Comparisons and Conclusions

The t-test between sexes showed that the left hand had a significantly higher mean in females while the right hand had no such difference although the mean was still larger in females.

Both sexes indicated that the child's birthplace could produce subsets that were statistically different in the mean ATD angle for the right hand regardless of the type of analysis, the left hand only showing such consistency in females. The parent's birthplace was not as successful as the child's in subsetting the data if it is considered on a t-test. However, the U-statistic gave three significant differences from the four comparisons made. As mentioned earlier, it would seem that non-normality in the raw data, particularly kurtosis, is affecting the probabilities obtained. The rank correlation methods are distribution free and thus more likely to reflect the true nature of the inter-population variability. Judging from the rank sums only, it seems that the parent's birth location is not as good a criterion for partitioning as was that of the pupils.

The conclusion reached therefore is that the minimum ATD angle as previously defined can produce significant differences between subsets for parameters based on birth locations. Ancestry seems to provide little discrimination in the present analysis. For females, both hands showed geographical variability whereas in males it is only the right hand.

Age Dependence

Although the results of the analysis for the minimum ATD angle have been given, no dual partitioning was undertaken, mainly because the variable itself has one major drawback not present in other dermatoglyphic traits and less depth of analysis was considered justified. It is known that the ATD angles are an age-dependent variable (Penrose 1968, p. 9; David 1971) and the latter author attempts to provide a correction for this. In the present work no such correction was applied due to the weakness of the assumptions on which it is based. That the results given previously may reflect nothing more than differential sampling is shown below. The data showed that greater angles were associated with Powys in both sexes, while the angle is known to increase with decreasing age. Clearly the greater number of primary school prints collected in Powys could be the reason why its mean ATD angles exceed those for Salop. The usefulness of this variable would be increased if the age dependence could be more exactly formulated, for it is a character which is capable of precise measurement.

Gross Number Collected

	Secondary School	Primary School
Powys	503	1930
Salop	529	758

PALMAR PATTERNS

FEMALES

Peripheral Thenar Loop, Right : PTR

The occurrence of peripheral thenar patterns on the right hand is in general less frequent than on the left, the present data showing that 3.9% of cases have at least a single peripheral thenar pattern (PTR). Of these, 3% contain two such elements. No case with more than two was found.

Examining the divided data by the Mann-Whitney U-statistic revealed no criteria giving a significant difference between the subsets generated. Treated categorically, similar conclusions were reached on a $x^2_{(1)}$, all the associated probabilities being non-significant. The dual breakdown of parent's birthplace with ancestry provided small cell numbers in certain cases and the probabilities must be viewed with this in mind. Although the differences between the groups were not significant, the data showed that the greater frequency of patterns was associated with "Welshness" when the criteria were used singly. The dual partitions to some extent maintained this relationship although a perfect type (1) or type (8) distribution was not obtained (see page 65) for either the child's or parent's birth location parameter, all chi^2 in the dual breakdowns being non-significant. The greatest values were related to WP, but EW and WS were both lower than ES. If the more extreme situation is examined, that is, all the grandparents being born in either Salop or Powys, then all the recorded instances of the pattern occur in Powys, although the association is non-significant ($p > 0.40$).

Peripheral Thenar Loop, Left : PTL

Peripheral thenar patterns on the left hand occurred in 8.3% of pupils of which only a single case with two patterns was found and none with more than this. A bimanual comparison of PTR/PTL was highly significant ($x^2_{(1)} = 26.4$, $p < 0.001$).

Partitioning the data showed that the use of the parent's birthplace produced significantly different subsets on both the statistics used. However, both the child's birth location and ancestry were unable to show statistical differences between their groups. The latter parameter also exhibited non-significant differences subsequent to selection for a 'local' population.

The dual partitions also showed that the Salop/Powys difference was confined to those pupils with a Welsh ancestry although low frequencies make the probabilities associated with English ancestry suspect. None of the remaining divisions gave evidence of having any notable differences between the groups produced.

Within the division by parent's birthplace, the significant difference was related to Powys having a greater frequency of patterns than Salop (9.6% as against 4.2%). The direction of this greater value is not however maintained using the child's birthplace, but is when ancestry is the dividing criterion, although the latter difference is of course not significant. This is surprising in view of the nature of the partitioning criteria. The dual partitions showed that within the Welsh the significant difference was still associated with Powys having the greater frequency, but within the English it was Salop which had the greater value. Using the child's birthplace showed some measure of agreement in that within the Welsh, Powys had a greater frequency of patterns, while within the English it was Salop. The difference lay in that this latter class had a greater frequency than the former, the reverse of the first

dual division. The former dual partition thus had a type 9 distribution, the latter a type (2/3).

Consideration of the grandparents' birthplaces showed that the Salop/Powys comparison gave a non-significant difference for pattern occurrence ($x^2_{(1)} = 0.132$, $p > 0.725$).

The conclusions therefore are that while the use of the parent's birthplace showed Powys to have significantly more patterns than Salop, the remaining criteria gave results which in general conflicted with this finding.

Radial Thenar Loop, Right : RTR

Radial patterns in the thenar area occur more commonly than peripheral, but like this latter pattern are most frequent on the left hand. The data showed that 5.8% of pupils had a single RTR, no case with more than one being found in the present sample.

Partitioning the data gave no criteria that had a significant difference between subsets on any single division for either statistic. The dual partitions gave exactly the same conclusions although low cell numbers make some of the probabilities doubtful.

There was agreement between the three dividing parameters in that the greater frequencies were always associated with "Englishness" rather than "Welshness". The distributions on the dual partitions revealed that for both series ES did have the greater frequency, but WP was not the lowest, both having type (3) relationships.

Using the grandparents' birthplaces gave a non-significant difference between Salop and Powys, the former location having fractionally more patterns than the latter although this is based on small numbers in some cells ($x^2_{(1)} = 0.127$, $p > 0.26$).

Radial Thenar Loop, Left : RTL

That the left hand exhibits more radial patterns than the right is reflected in the present data, 9.5% of pupils having at least one pattern with only 0.1% having two. The bilateral comparison is highly significant ($x^2_{(1)} = 14.74$, $p < 0.002$).

In common with the right hand, none of the divisions made gave a significant difference between the subsets for either the single or dual partitions, both statistics being in agreement. A noteworthy feature was that for both hands the radial pattern had its lowest, but non-significant, probabilities associated with the dual division by the child's birthplace and English ancestry. A larger sample may have given significance in this situation. The frequency of RTL within each subset indicated that little difference between them was apparent (as the probability values show), but additionally there was no constant association of the greater frequency with either "Englishness" or "Welshness". The dual breakdowns had a type (2) distribution using the parent's birthplace and a type (3) using the child's. The grandparents' showed a raised, but non-significant relationship with Powys ($x^2_{(1)} = 0.023$, $p > 0.90$).

The conclusions reached are similar to the right hand in that "Englishness" may produce the greater frequency of patterns although the magnitude of this tendency is slight, especially when the grandparental results are considered as well.

Peripheral Second Loop, Right : P2R

Interdigital patterns in the second region of the palm are quite rare, the right hand having 3.3% of pupils with a single peripheral pattern, no case with more than a single loop being found.

Treating the data non-parametrically by a U-test gave non-significant differences between all the subsets of the three criteria

when used alone. Selecting for a local population using the child's birthplace still gave no difference between ancestral groups. However, using the parent's birthplace was successful, the ancestral difference now being significant ($p = 0.021$), the English having the greater rank mean. Treated categorically $x^2_{(1)}$ gave non-significant differences between groups for all three parameters when used singly or in a dual partition. An exception was the comparison noted above for a selected population when the $x^2_{(1)}$ was just significant ($x^2_{(1)} = 3.989$, $p = 0.045$). This tends to confirm the above result. Taken a stage further, if we compare just the Welsh in Powys with the English in Salop (WP/ES), there is a highly significant difference ($x^2_{(1)} = 8.92$, $p = 0.003$), provided the parent's birthplace is involved. It would seem therefore that the parent's birthplace is having some effect on dividing the data when used in conjunction with ancestry, "Englishness" having the greater frequency of pattern occurrence.

Peripheral Second Loop, Left : P2L

The left hand has fewer patterns in this region than the right, the present data revealing 1.3% with a single P2L and no case with more than one of them. The bimanual comparison is highly significant ($x^2_{(1)} = 13.29$, $p < 0.002$).

The low numbers found make any comparisons speculative but with this in mind the analysis can continue. The U-statistic showed that all comparisons made produced fairly low probabilities, but only ancestry gave a statistical difference for Welsh and English ($p = 0.040$). Selection did not improve this measure. When treated categorically $x^2_{(1)}$ gave no significant differences although ancestry produced the lowest probability ($p = 0.068$). Even though the numbers are small in the various partitions made, all related the greater frequencies to "Welshness".

The dual partitions are not reported due to the low cell numbers. However, the above was confirmed in that both series had type (1) distributions. The grandparents showed the same trend, although the Salop/Powys difference was not significant. The right and left hands therefore show opposite results for while P2R showed more association with "Englishness", P2L is more frequent when related to "Welshness".

Peripheral Third Loop, Right : P3R

Over half the female pupils examined had a P3R (50.8%) but only a single case with two was found.

Partitioning the data by the three criteria gave highly significant differences on the U-statistic for both the child's birthplace ($p = 0.001$) and for ancestry (0.005), while the parent's birthplace gave a low but non-significant difference. In all cases the greater rank mean was related to "Welshness". Using $x^2_{(1)}$ gave exactly comparable results, but the dual partition revealed that the differences between Salop and Powys were confined to those pupils with Welsh ancestry, while the English/Welsh difference only existed in Powys. If all the possible comparisons are made, then it is apparent that the Welsh in Powys show significant differences from all the remaining classes when the child's birthplace is used to define location. Additionally, no differences were found between WS, ES and EP. That the birth location of the ancestors is not a prime factor for this variable is confirmed by a non-significant association between grandparents' birthplaces being shown ($p > 0.90$). The dual partitions both gave type (8) distributions even though for the parent's birthplace the differences never reached statistically significant levels.

Peripheral Third Loop, Left : P3L

The left hand showed much lower frequencies of peripheral third loops than the right, 28.7%, only a single pupil having two patterns on one hand. The bimanual comparison was highly significant ($x^2_{(1)} = 104.02$, $p < 0.001$).

The U-statistic gave only a single significant difference when applied to the partitioned data, this being between English and Welsh when a local population was selected by the child's birthplace. Using the parent's was unsuccessful in giving significance. Treated categorically beither the single or dual criteria gave any significant $x^2_{(1)}$ although low probabilities were observed for the English/Welsh difference within Powys, both the child's or parent's birthplace giving the same results. This to some extent follows the above significant result where the greater rank mean was found in the Welsh. However, the greater mean frequencies are not consistent over the three criteria while using grandparents' birthplaces gives no regional differences.

It is considered that differences between the subsets for this pattern do not reach the magnitude shown for the homologue, only a speculative difference being found between the English and Welsh within Powys.

Peripheral Third Tented Loop, Right : P3TR

Third tented loops occur due to blind terminations of the C mainline. They are less common on the right hand than the left in both sexes and can only occur singly on any named mainline. In the present sample 6.5% of pupils had a P3TR.

When partitioning the data it was found that using ancestry gave a significant difference between English and Welsh on both the U-statistic ($p = 0.01$) and $x^2_{(1)}$ ($p = 0.026$), the effect of selection

being to maintain the significance. The greater frequencies and rank means were related to "Englishness" even in those non-significant comparisons. In the dual partitions only the English/Welsh difference within Salop, based on the parent's birthplace, maintained a significant difference on a $x^1_{(1)}$ ($p = 0.050$).

The effects shown by this variable were in conflict between the single and dual partitions and undoubtedly reflected the effects of dividing the data to produce subsets with smaller sample sizes. That there exists a difference between the English and Welsh, based on ancestry, cannot be doubted, but to investigate the relationship further would require either a larger sample or a greater subset difference. It is perhaps surprising that the birth locations did not produce more significant values. However, comparing the extreme subsets WP against ES was significant on a $x^2_{(1)}$ ($p = 0.035$), when the parent's birthplace was used, but not so for the child's. This confirms the above result and suggests that admixture of the populations produced the present frequencies but that the "original" populations still maintain a distinct difference in pattern frequencies.

Peripheral Third Tented Loop, Left : P3TL

The homologue to the above pattern occurs in 10.5% of female pupils, the $x^2_{(1)}$ between hands being highly significant ($p < 0.001$).

Partitioning the data by the usual three criteria showed that in each the greater frequency was related to "Welshness" although both the U-statistic and $x^2_{(1)}$ showed that the differences were all non-significant. Selection for a local population did not increase the differentiation found between English and Welsh.

The dual divisions all gave non-significant differences between the subsets, the extreme comparison of WP with ES being exactly similar. The distribution of frequencies in the four classes showed a type (8)

pattern for the child's birthplace with ancestry, but using the parent's birth location gave a type (10) not consistent with the above criteria. Using the grandparents' birthplaces also gave non-significant differences between Powys and Salop, the former region having the greater frequency of patterns. Overall, none of the criteria used could produce subsets significantly different from each other, although a tendency for raised frequencies to be associated with "Welshness" may exist.

Peripheral Fourth Loop, Right : P4R

The overall estimate of cases exhibiting at least a single peripheral loop in the fourth interdigital region was 48.9%. The majority had only a single loop but a small number (1.0%) had two, this being the upper limit.

None of the divisions using the criteria singly gave a significant probability between subsets, the associated frequencies or rank means having no consistent relationship with "Welshness" or "Englishness". The dual partitions were all non-significant except for the comparison of Powys with Salop within the Welsh using the child's birthplace ($p = 0.013$), while the extreme comparison of WP against ES was not significantly different although there was a low probability associated with the comparison ($x^2_{(1)} = 3.134$, $p = 0.076$). It seems possible that a larger sample may have given significance in this latter case, especially in view of the significance found between WP and WS. However, any differences must be fairly weak for the parent's birthplace did not give any indication of such differences. The use of grandparents also gave a non-significant difference between counties.

Peripheral Fourth Loop, Left : P4L

The left hand had 63.5% of cases with at least a single loop in the interdigital area of the left hand of which 3.4% had the upper limit of 2. The greater number on the left hand is reflected in raised frequencies of cases with both one and two patterns compared with the right, the bilateral comparison showing a highly significant difference ($x^2_{(2)} = 87.17$, $p < 0.0001$).

Partitioning the data by the usual three parameters showed that none of the comparisons made using either single or dual criteria, in selected or unselected populations, produced a significant difference between the groups generated. The parameters were consistent in that they all had an increased frequency of patterns associated with "Welshness", slight though it was. In addition, the grandparents also showed a raised occurrence of the patterns in Powys.

Peripheral Hypothenar Loop, Right : PHR

The peripheral hypothenar loops of the right hand occur most frequently as single elements (11.6%), with a small number of pupils having two (0.3%).

Dividing the data, using the three criteria detailed, gave no significant difference between the subsets for either the single or dual partitions on either statistic, although the slightly greater frequencies were consistently related to "Welshness". The dual partitions gave type (2/12) distributions for the parent's birthplace with a type (6) using the child's. This did not maintain the relationship observed in the single divisions. The same conclusions were obtained for both statistics used. Consideration of the grandparents showed the greater frequency to be non-significantly associated with Salop, the reverse of the above situation ($p = 0.059$). This last result may well be a

reflection of random elements of sampling, especially when the numbers within each class were considered together with the analysis performed above.

Peripheral Hypothenar Loop, Left : PHL

This particular pattern occurs as a single loop in 11.0% of female pupils, only two cases with two being found. Compared with the homologue, there is no statistical difference between the two ($p > 0.85$).

Partitioning the data gave no consistent associations with "Englishness" or "Welshness", the dual partitions giving neither type (1) nor type (8) distributions. Both statistics gave non-significant differences between subsets for all the partitions made, using both single and dual criteria, in a manner exactly comparable with the right hand.

Central Hypothenar Loop, Right : CHR

Central hypothenar loops are much more frequent than either peripheral or radial loops. The present sample showed 30.0% of pupils with a single such loop (CHR) with two pupils having two.

The breakdown into subsets by the three defined parameters produced non-significant differences in every comparison made for both single and dual divisions on both statistics. When used alone, all the parameters showed "Welshness" to be associated with a raised pattern frequency, but in combination inconsistent type (9) distributions were produced. The grandparents again showed no statistical difference between their frequencies in Powys and Salop, while the latter region had the greater values, this being inconsistent with the above. There is little evidence for consistent associations on those parameters used.

Central Hypothenar Loop, Left : CHL

Significantly fewer loops occur on the left hand than on the right ($p = 0.03$), the present data showing 26.6% of pupils have a maximum of one CHL, no pupil having two or more.

The results of divisions for this hand are exactly comparable with the former. No significant or consistent differences could be detected when partitioning the data by the usual three parameters either singly or in a dual breakdown on either statistic. Using grandparents again gave a non-significant association of a raised frequency of CHL with Salop.

Radial Hypothenar Loop, Right : RHR

Of the three patterns found in the hypothenar region, the radial loops are the least frequent. The right hand revealed 4.1% of cases with a single loop, no case with two or more being found.

Using the Mann-Whitney U-test a significant difference was found between Salop and Powys using the parent's birth location as the parameter ($p = 0.034$). Ancestry and the child's birthplace both gave non-significant differences between their subsets. When treated as categorical data, the $x^2_{(1)}$ did not follow the previous statistic, giving a low, but non-significant difference for division by the parent's birthplace ($p = 0.062$). The frequency and rank means are both greater in Salop within this parameter. The remaining single and dual partitions all have non-significant differences, including the comparison of WP with ES. All the parameters, when used alone, show that the raised incidence of pattern occurrence is related to "Englishness", the use of grandparents being similar and giving a significant difference between Salop and Powys ($p < 0.05$). It suggests that birth locations are a better discriminator than ancestry and that differences between Powys and Salop

can be detected. However, the low frequencies and small samples resulting from the partitioning make any conclusions tentative. The dual divisions produced type (1) distributions for pattern frequencies for both the child's and parent's birth locations with ancestry.

Radial Hypothenar Loop, Left : RHL

On this hand only 2.0% of cases have such a loop, significant bilateral asymmetry again being present ($x^2_{(1)} = 10.67, < 0.005$). The general feature of the hypothenar region was that the right hand had patterns more frequently than the left even when the difference was not significant, as for PHR/PHL. Pupils with two patterns in the region are rare, this leaving approximately 46% of right hands and 40% of left hands with at least one pattern.

Again considering RHL, the dual partition using the parent's birthplace gave all frequencies too small to be of much use. However, all the remaining single and dual criteria were available and all gave non-significant differences on both statistics. No consistency between parameters and raised frequencies was apparent, the various criteria giving conflicting results.

Parathenar Loop, Right : PAR

Parathenar loops are a rare feature occurring in 0.9% of right hands. The low frequencies made dual breakdown statistically unwise. However, single divisions were just possible. The divisions all gave non-significant differences between subsets for all three parameters and statistics, with no consistency of raised frequencies or rank means in either "Englishness" or "Welshness".

Parathenar Loop, Left : PAL

The left hand has even fewer parathenar loops than the right with only 0.3%. the bimanual difference being just non-significant ($p = 0.065$).

None of the comparisons made produced significance or consistent association, but with such small numbers little weight can be placed on these results.

Rare Patterns

		% (N°)			% (N°)
Peripheral 2nd Tented Right	:P2TR	0	Peripheral 2nd Tented Left	:P2TL	0
Central 2nd Right	:C2R	0	Central 2nd Left	:C2L	0
Central 3rd Right	:C3R	0.1(2)	Central 3rd Left	:C3L	0.2(4)
Peripheral 4th Tented Right	:P4TR	0	Peripheral 4th Tented Left	:P4TL	0
Central 4th Right	:C4R	0.7(11)	Central 4th Left	:C4L	1.3(21)
Ulnar 4th Right	:U4R	0.1(2)	Ulnar 4th Left	:U4L	0.2(4)
Radial Hypothenar Tented Right	:RHTR	0.2(4)	Radial Hypothenar Tented Left	:RHTL	0
Ulnar Hypothenar Tented Right	:UHTR	0.1(2)	Ulnar Hypothenar Tented Left	:UHTL	0
Hypothenar Radial Arch Right	:RAHR	2.2(35)	Hypothenar Radial Arch Left	:RAHL	1.4(22)

The above patterns are recorded but are too rare to have any statistics applied to them. It is apparent that the peripheral tented loops are absent from the A, B and D mainlines and that central loops increase in frequency from the 2nd to the 4th interdigital area. The most common of the above are the hypothenar radial arches on which an initial analysis might have been performed, but this was not in fact done.

MALES

Peripheral Thenar Loop, Right : PTR

The present data contain 3.4% of male pupils with at least a single PTR. Of these, 0.3% had the limit of two loops.

Partitioning the data gave no significant differences between subsets for any of the criteria in either single or dual divisions using the U-statistic and $x^2_{(1)}$. Neither a consistent relationship between "Welshness" or "Englishness" nor an increased pattern frequency was observed. Within the dual partitions the distribution of frequencies followed a type (5) pattern using the child's birthplace and a type (7) using the parent's, neither indicating concomitance between the dividing criteria.

Peripheral Thenar Loop, Left : PTL

Peripheral thenar loops on the left hand were like females, more frequent than on the right, the collected sample having 8.1% with a single loop, only a single pupil with two being found. The bimanual comparison is highly significant ($x^2_{(1)} = 31.06$, $p < 0.001$).

Division of the data by the three parameters separately showed first, that for each, the greater number of patterns was found associated with "Welshness", using the grandparents gave complete consistency. The magnitude of the group differences within each parameter, when examined by the Mann-Whitney U-test, indicated significance only when ancestry was used ($p = 0.024$), the child's birthplace giving a low but non-significant value ($p = 0.060$) while the parent's birthplace had a much greater probability. Selection for a local population was again highly significant when English and Welsh were compared, but only when the child's birthplace was used as the selection criterion.

Treated categorically, the previous findings were confirmed. The use of the parent's birthplace never gave any significant differences between subsets when used singly or in a dual division. The child's birthplace, however, while not having a significant $x^2_{(1)}$ when used alone, showed in a dual partition that within the English a significant difference between Powys and Salop was apparent ($p = 0.043$), while within Salop a similar result was shown between English and Welsh ($p = 0.005$). The comparison of WP with ES was also highly significant ($p < 0.01$). This means that ES was found statistically to differ from the three remaining subsets, WP, WS and EP. The frequency distribution within this latter dual division was a type (6), not completely consistent with what was expected in view of the significance described above. However, ironically, when the parent's birthplace was involved a type (8) distribution was found, completely consistent with the previous findings.

It may well be that a statistical difference between the "English" and "Welsh" gene pools exists for PTL. While ancestry is seemingly partitioning the data more efficiently than any of the birth locations, the use of the latter, in conjunction with the former, still gives a meaningful distribution of frequencies within the four subsets.

Radial Thenar Loop, Right : RTR

This loop was found in 5.7% of males, only two individuals having the limit of two loops.

Partitioning the raw data gave no subsets with significant differences between them on any of the parameters when used singly or in combination on either statistic. Additionally, the distribution of frequencies gave no consistent relationships with either "Englishness" or "Welshness" over the three criteria, this being true of the dual breakdowns also. Using grandparents also gave non-significance between counties. However, this result is based on small cell numbers.

Radial Thenar Loop, Left : RTL

In common with peripheral thenar patterns, the left hand has more radial patterns than the right (10.8%), only two cases with two loops being found. The bimanual comparison is highly significant ($x^2_{(1)} = 25.04$, $p < 0.001$).

The conclusions reached as a result of partitioning the data are exactly the same for RTL as for RTR.

Peripheral Second Loop, Right : P2R

Peripheral loops in the second interdigital region occur less frequently than in either the third or fourth, 6.5% of males having a P2R, in every case there being only one.

The criteria used to partition the data all gave non-significant differences when used singly for both statistics. The dual breakdown, while also having non-significantly different subsets, did give low probabilities for one comparison, that of WP against WS ($p = 0.058$). However, WP against ES was not significant ($p = 0.175$). The frequencies within the subsets did produce a consistent relationship of higher frequencies with "Welshness", the grandparents also showing this. While WP did have the greatest value in both dual breakdowns, the lowest frequencies of patterns occurred in WS, not therefore conforming to the model for complete consistency, both distributions being a type (9).

Peripheral Second Loop, Left : P2L

The left hand had 2.2% of cases with a single peripheral loop in the second region, fewer than the homologue, the difference being statistically significant ($x^2_{(1)} = 32.95$, $p < 0.001$).

Because of the low frequency and sample size no meaningful results could be obtained from the dual breakdowns, the individual cell

numbers being too small. When the parameters were used alone they all gave non-significant differences between the subsets generated. However, the greater frequencies were always associated with "Welshness", even in the grandparents' generation.

Peripheral Third Loop, Right : P3R

The most common interdigital loop on the right hand is that in the third region, P3R, found in 55.5% of pupils, none ever having two such loops.

In common with the two previously detailed patterns, using the three described parameters, no significance could be detected between any of the subsets generated on either single or dual partitions. The same was true for the grandparents. Within these breakdowns the greatest frequencies or rank means were always associated with "Welshness". However, the dual partitions showed a type (10) distribution of frequencies for the child's birthplace and a type (9) with the parent's, neither confirming the consistency of the association.

Peripheral Third Loop, Left : P3L

Interdigital loops in the third region of the left hand are predominantly peripheral, 26.6%, significantly lower than the right ($x^2_{(1)} = 265.49$, $p < 0.0001$).

When treated non-parametrically by the U-statistic, only the parent's birthplace indicated a significant difference between Powys and Salop ($p = 0.038$), the former region having the greater rank mean. This result was confirmed by $x^2_{(1)}$ ($p = 0.050$), although significance was only just reached. None of the other criteria gave such a significant probability and while both the child's and the grandparents also related the greater frequency to Powys, using ancestry gave the English the greater

pattern frequencies. This lack of a consistent relationship was maintained in the dual partitions where the frequency distributions were both of a type (12); however, the use of the parent's birthplace with ancestry showed that the Salop/Powys difference noted earlier was only present within the English ($p = 0.020$), although a low but non-significant value was found within the Welsh ($p = 0.090$). In addition, a significant difference between English and Welsh within Powys was found ($p = 0.020$), as well as between EP and WS ($p = 0.015$). These results separate out EP as different from the remainder, but only when the parent's birthplace is used, the pattern frequency within this class being lower than in the other three in that breakdown.

Peripheral Third Tented Loop, Right : P3TR

The abortive C mainline produced 7.4% of cases with tented loops on the right hand, significantly fewer than on the left ($x^2_{(1)} = 9.135$, $p < 0.003$).

Division of the data gave no indication that subsets with statistically different mean frequencies could be generated from the three parameters used alone or in combination, on either statistic. When used alone, the larger frequency of patterns was related to "Englishness" although equal frequencies were produced for the parent's birth location. The dual breakdowns gave no significant differences or consistent relationships between the frequency of loops and the parameters being examined.

Peripheral Third Tented Loop, Left : P3TR

Apart from being more frequent in occurring on the left hand, 10.5%, the conclusions are exactly comparable with those given for the right, i.e. no significant differences being detected. It differs only in that there was no consistent association of raised frequencies with either "Englishness" or "Welshness".

Peripheral Fourth Loop, Right : P4R

Peripheral fourth loops are found on the right hands of 43.2% of all males examined, the majority having only a single such loop, while 0.8% had two. No pupil ever had more than two. The occurrence of two loops is a feature more common in this region than either the second or third and is not merely a function of the absolute frequency, for P3R had more peripheral loops, but never had two together.

Partitioning the data gave non-significant differences between the subsets generated for all the dividing criteria used singly or in combination for both statistical tests. The frequencies of loops were greater in the Welsh. However, birth locations all gave Salop the greater value. Not surprisingly, the dual partitions gave inconsistent type (11) and type (10) distributions using the child's and parent's birth locations, respectively, with ancestry.

Peripheral Fourth Loop, Left : P4L

The most frequent pattern to occur on the left hand is the peripheral loop in the fourth area, 65.4% of male pupils having at least a single loop. Of these, 5.1% had two loops, but no pupil ever had more than this number. Like the homologue, the frequency with which two loops occur together is greater than expected when the other interdigital regions are considered. The frequency of loops on the left hand is statistically greater than on the right ($x^2_{(2)} = 178.8$, $p < 0.001$). The presence or absence of a loop (recode 2 = 1) was still significant bimanually ($x^2_{(1)} = 152.2$, $p < 0.001$).

The conclusions reached from partitioning the data are exactly the same as for the right hand given above, including the association of frequencies.

Peripheral Hypothenar Loop, Right : PHR

Examination of the hypothenar region showed that peripheral patterns were found in 12.4% of males of which only 0.3% had two.

Like many patterns already examined, the effects of division by the criteria under use failed to indicate any significant differences between the subsets generated regardless of the statistics or combination of parameters used. There was no relationship between raised pattern frequencies and "Englishness" or "Welshness" as has sometimes been found, the dual partitions giving a type (12) distribution with the child's birthplace and a type (10) with the parent's.

Peripheral Hypothenar Loop, Left : PHL

The left hand has fewer peripheral hypothenar patterns than the right (11.4%), although the difference was not found to be statistically significant ($x^2_{(1)} = 0.523$, $p > 0.47$).

Using the U-statistic gave no significant differences between the subsets when the parameters were used alone, or for selected populations. Similar conclusions were reached when the data were treated categorically. However, the dual partitions revealed that variation was present. The comparison of WP with WS was statistically significant ($p = 0.046$), the former class having the greater frequency when the child's birthplace was involved, while the difference ES/WS had a low but non-significant difference ($p = 0.080$). When the parent's birthplace was used, only the difference EP/ES was statistically significant ($p = 0.050$), the latter subset having the greater frequencies. These two dual divisions are not in agreement in the subset difference and at this stage neither interpretation can be favoured. There was, in addition, no consistent relationship between the subsets and the greater frequencies of patterns.

Central Hypothenar Loop, Right : CHR

Central hypothenar loops are the most numerous pattern found in this region of the palm, the right hand having 26.1% of cases with at least one loop, two pupils having two.

Partitioning the data gave no significant differences between the subsets for any of the parameters when used either singly or in combination, on either of the statistics.

Consistency was shown by the greater frequencies always being related to "Englishness", the dual partition using the parent's birthplace with ancestry, confirming this with a type (1) distribution although substituting the child's birthplace gave a type (12), the complete opposite of the relationships.

Central Hypothenar Loop, Left : CHL

Although the left hand had fewer patterns than the right (24.6%), the bimanual comparison showed no statistical difference ($x^2_{(1)} = 0.825$, $p > 0.35$).

The conclusions reached after dividing the data were exactly the same as for the right hand, i.e. no significant differences being found between any subsets produced. The only difference was that no consistency of association for the greater pattern frequency with "Englishness" or "Welshness" was found.

Radial Hypothenar Loop, Right : RHR

Only 3.0% of pupils examined had a radial hypothenar loop on the right hand.

Like the CHL just examined, no significant difference could be detected between the subsets on any of the parameters used, no consistent relationships of raised pattern frequencies with "Englishness" or "Welshness" being apparent.

Radial Hypothenar Loop, Left : RHL

The frequency of RHL (1.1%) was significantly lower than the right hand ($x^2_{(1)} = 13.4$, $p < 0.01$).

Because of the low frequency of patterns, the dual breakdown cannot be performed. However, the divisions using single parameters gave a significant difference between Powys and Salop when the parent's birthplace was used, on both statistical tests, the latter region having the greater rank mean and frequency of loops. Selecting for a "local" population by the latter parameter gave an English/Welsh difference at a significant level on both statistics, the English having the greater number of loops. In general, raised frequencies were associated with "Englishness", even in non-significant comparisons.

Parathenar Loop, Right : PAR

Only six cases of parathenar loops were found in males (0.4%) making further analysis unrealistic.

Parathenar Loop, Left : PAL

Like the right hand, parathenar loops on the left are rare, only two being found (0.1%), while the bimanual difference was non-significant ($x^2_{(1)} = 1.127$, $p = 0.275$) allowing for the small numbers involved.

Rare Patterns

		%	N°			%	N°
Peripheral 2nd Tented, Right	P2TR	0	-	Peripheral 2nd Tented, Left	P2TL	0	-
Central 2nd, Right	C2R	<0.1	(1)	Central 2nd, Left	C2L	<0.1	(1)
Central 3rd, Right	C3R	<0.1	(1)	Central 3rd, Left	C3L	0	-
Peripheral 4th Tented, Right	P4TR	<0.1	(1)	Peripheral 4th Tented, Left	P4TL	0	-
Central 4th, Right	C4R	0.4	(6)	Central 4th, Left	C4L	0.9	(13)
Ulnar 4th, Right	U4R	<0.1	(1)	Ulnar 4th, Left	U4L	0.3	(5)
Radial Hypothenar Tented, Right	RHTR	0.1	(2)	Radial Hypothenar Tented, Left	RHTL	0	-
Ulnar Hypothenar Tented, Right	UHTR	0	-	Ulnar Hypothenar Tented, Left	UHTL	0	-
Hypothenar Radial Arch Right	RAHR	2.1	(33)	Hypothenar Radial Arch Left	RAHL	0.9	(14)

With the exception of the last pattern detailed, the above loops occur too infrequently to have any divisional analysis performed on them. General observations are similar to those for females. An abortive D mainline gave a single fourth tented loop, central loops again being a feature of the fourth interdigital region, especially on the left hand. The bimanual comparison for the RADHR/RADHL indicated a significant difference between hands ($x^2_{(1)} = 6.99$, $p < 0.01$).

Sex Comparison

The pattern frequencies were compared between sexes only for those loops which have been previously described and considered to have sufficient numbers to give a reliable statistic. In addition, central fourth loops and hypothenar radial arches were considered.

The analysis showed that the thenar area had no significant differences between the sexes for any of the patterns on either hand. The loops P2R, P3R, P4R all gave highly significant x^2 along with P2L; P4L was only just non-significant ($p = 0.0503$). For C4R/L, the only central loops with sufficient numbers gave no indication of a difference between sex. The hypothenar region was much less successful in producing variations. The loops CHR and RHL were the only ones to give significant values, all the remaining patterns producing non-significant x^2.

The above detailed patterns were the only ones to give significant inter-sex variation, attention being drawn particularly to the interdigital region. A continued refinement in methodology may give a more precise indication of the nature of the sex difference and the relative importance of pattern formulation.

FINGER PATTERN TYPES

The final class of variable not yet analysed is probably the one for which most data are available on a world-wide basis, this being finger patterns. Although they have been used extensively in detailing populations, they pose problems from an analytic point of view. They represent nominal data and thus restricted statistics may be employed in analysis, chi^2 being probably the most powerful one. I have defined eight basic pattern types which were recorded initially. However, using so many classes clearly resulted in individual cells having very low numbers when the data were partitioned, making the statistics dubious. In the present thesis the aim has been to investigate the ability of the parameter to partition the data into subsets which exhibit dermatoglyphic differences. Where there has been consistency of association between subsets, even when the differences do not reach statistical significance, they have been reported. Consequently, for finger patterns it is possible to consider which subset in any particular division contains the greater frequency of a particular pattern, for each pattern type and partitioning parameter.Every pattern is not present on each finger in sufficient quantity to give even this rather basic assessment, and the results given only include those patterns which had more than five cases in each cell compared. What is perhaps more useful is that amalgamation of the patterns into the three basic types of arch, loop and whorl when all fingers have sufficient numbers to allow individual digits to be partitional in the usual ways and $x^2_{(1)}$ probabilities given. The dual partitions in these latter classes however would only allow the child's birthplace to be included with ancestry, using the parent's birthplace in conjunction with the latter, giving too low cell frequencies. Consequently the parent's birthplace only was used as a single parameter.

The method of approach was to consider how many times a particular pattern, either original or amalgamated, occurred in a particular subset over the five digits of each hand and then over both hands. Each digit is not considered separately. The basis of this is the same as that on which intensity indices on the fingers are based. A divisive approach to report the results will be given, starting with the three amalgamated types and moving to the original eight patterns. In addition, by considering combinations of parameters, we can ask how many times two parameters have the greater mean associated with any particular subsets. The example below should make this clear.

Amalgamated Patterns Females Digit one %

Partition	Salop	Powys (child)	Salop	Powys (parent)	English	Welsh (ancestry)
Arch	3.3	4.5	4.2	4.3	4.8	3.7
Loop	64.4	61.5	60.0	61.6	61.6	64.8
Whorl	32.3	34.0	35.8	34.1	33.7	31.5
N	455	706	164	437	604	645

Greatest Subset

Arch	P	P	E
Loop	S	P	W
Whorl	P	S	E

Parameter Combination

	child B.P./Ancestry	parents B.P./Ancestry	child B.P./parents B.P.
Arch	PE	PE	PP
Loop	SW	PW	SP
Whorl	PE	SE	PS

This was done with ancestry considered in selected as well as unselected populations. For any parameter combination there are four possibilities and if the hands are taken individually, five digits, each with one possibility. This allows a 2 x 2 contingency table for each hand and for both together, with five and ten points within each. It is appreciated that the intercorrelations between digits makes such a contingency table strictly invalid, but without an alternative, they are used throughout, with little weight attached to them.

FEMALES

The amalgamated patterns partitioning by the child's birthplace gave subsets in which the highest frequencies were in agreement with similar groups produced by the parent's birth location. The relationships produced showed that arches had their greatest incidence in Powys, as did whorls,while loops were most common in Salop. Of the three patterns, arches were particularly strong in association. Consideration of ancestry showed that there was no relationship to birthplace in the groups exhibiting the greater frequencies, both English and Welsh being seemingly random in their associations. The above results were true both prior and subsequent to selection of local populations. Further evidence that ancestry and birth location occur at random to each other in their greater subset affinity as shown by the 2 x 2 tables, where applying Fisher's exact test gave non-significant associations for both the child's and parent's birthplace. Considering each hand separately was entirely consistent with the above except that in the left hand using ancestry gave agreement with the birth location for the frequency of whorls.

For the amalgamated patterns a brief investigation of individual fingers was possible for the usual breakdowns of the data except that the dual partition involving the parent's birthplace was not used due to small

cell numbers. The analysis showed ($x^2_{(2)}$ that significant differences between subsets were rare and contribute little to the understanding of variation.

By considering the individual patterns in a manner similar to that for the amalgamated classes it was found by examining all digits together that both true and tented arches were most frequent in Powys while both ulnar and radial loops related their greater frequencies most closely to Salop. Both the child's and parent's birth location gave the above, ancestry again being randomly distributed between classes. Selection did not improve the results. Considered individually, the double triradii patterns were less clear in their associations, and while Powys was favoured as having higher frequencies of all patterns than Salop, the differences were small. When each hand is examined separately, the same conclusions result, both arches and loop types being fairly strong in their respective associations, the various whorl patterns being much more variable.

MALES

Within males far less clear results were apparent. Over all digits for amalgamated classes the arch/Powys, loop/Salop and whorl/Powys relationship held for the parent's birthplace, with fairly strong agreement by ancestry in the former two patterns being found. Selection for a local population improved the agreement of ancestry with birth location marginally. Using the child's birth location, however, showed no such relationship for either this latter parameter or in combination with ancestry. Considering each hand separately revealed that using the child's birthplace gave no associations except for loops on the right hand, although this gave Powys the greater occurrence. For the child's birthplace the left hand showed results comparable with the above for all patterns, while the right hand limited the agreement to arches and loops. Ancestry tended to agree with birth location in both hands except for whorls on the right.

The individual digits gave only a single significant difference between subsets, and in this agreed with females.

Examination of the relationships for the individual pattern types showed that for true arches the parent's birthplace showed an association with Powys on both hands, but the child's birthplace gave no association in the left hand, but one with Salop on the right. Tented arches were too infrequent to allow much analysis. However, what results there were tended to relate them to Powys. The most frequent ulnar loop is predominantly associated with Salop and the parent's birthplace on both hands, although using the child's gave no relationship with either location. The whorl patterns were marked by their lack of individual relationship using the child's birthplace and it is only in the left hand for double loops and ulnar c.p. loops that Powys predominates using the parent's birthplace. True whorls had greater frequencies in Salop in this latter situation.

Comparison of Male and Female Results

The previous analysis has attempted to investigate whether there was evidence for particular patterns, either individually or in an amalgamated class having greater frequencies of occurrence in either Powys or Salop, or to the English or Welsh. Two criteria defined birth location, the child's (series 1) and the parent's (series 2), with ancestry also being used in both selected and unselected populations.

The following was concluded:-

(1) Within individual digits (not given in detail) the differences in frequency of the various patterns between the subsets generated only occasionally reached the level of statistical significance. Similarly, when the digits were combined, although the various criteria indicated a tendency for consistency.

Over all digits, in both series and sexes, the predominant relationship link raised frequencies of both types of arches and possibly two double triradii patterns with Powys (and to the Welsh to a lesser extent) while ulnar and radial loops are most frequent in Salop (and the English).

(2) The use of birth locations was more successful than using ancestry, selection not altering this conclusion. This was confirmed by examination of the probabilities found for the amalgamated classes when ancestry or birth location were examined, for although non-significant, those related to the latter parameter were lower than those in the former, this being especially so for females.

(3) The parent's birthplace was consistent in both sexes while the child's birthplace only gave similar consistency for females. In addition, within the latter, the two birth locations were in much greater agreement than in males where a lack of concomitance is the rule.

(4) The amalgamated classes gave much clearer associations, in both sexes, than the breakdowns involving the individual patterns.

The previous section must be considered in the following light. In many cases results obtained were not significant and it was the trend that was being examined between the various partitions. When comparisons over digits were performed, it is apparent that it is not strictly valid to use the binomial expansion to examine the relationships between parameters due to the intercorrelations between the digits (as already stated), the statistical test requiring independence of events before it is applicable. Exactly how the inter-relationships could be allowed for, and a statistical test akin to the binomial series applied, is not at the present time known. In addition there must be some measure of relatedness between the various patterns on any digit, in terms of which subset contains the greater frequency, as with a limited number of possibilities a greater frequency of a pattern in Powys almost always implies a raised value of another element in Salop.

Therefore, three correlation matrices are interacting; those between digits, between patterns, and between partitioning criteria. To attempt mathematically to analyse the present data set with a view to de-correlating these factors, even if possible, is not justified when the possible inaccuracies of pattern identification and the lack of knowledge of the interaction of environmental and heredity components is taken into account. Given a series of patterns which are known to be genetically independent, more sophisticated analysis into regional variability may be fruitful.

QUANTITATIVE FINGER PATTERNS

The previous section dealt with finger patterns as a qualitative trait, investigating the types of patterns present on each digit and the relative frequencies encountered between the various subsets. It is now proposed to consider the finger patterns in a quantitative manner by taking the number of times any particular pattern occurs over the ten digits. The range of values found is obviously 0 to 10, i.e. all digits showing no occurrence of a particular pattern, or all digits having the same pattern. Both sexes will be considered simultaneously, differences being noted where applicable.

True Arches

The most common situation is to have no true arches at all, the number of cases having at least one such arch being greater in females (20.1%) as compared with males (14.0%). The complete range of values was found, five females and one male having ten true arches. As the number of arches possessed by a pupil increases, so the frequency with which instances are found decreases steadily.

Tented Arches

Little difference between the sexes was observed in the disposition to possess tented arches, 4.5% of males and 4.7% of females having at least a single pattern. An inverse relationship between the number of patterns in the frequency with which such numbers are found existed, the maximum number found in any one pupil being five, a single such case occurring. What is unexplained is the jump from individuals having two tented arches to those having five, no pupils with three or four being found.

Ulnar Loops

Ulnar loops are the most common pattern occurring on any digit, there being little sex difference, only 1.5% of males and 1.7% of females not having any such loops, the average number for each pupil being 6.25 in males and 6.38 in females. The mode of the distribution is at eight in females, males having virtually two modes at seven and eight, the former class having a single case more than the latter. The complete range from 0 to 10 was found.

Radial Loops

The number of pupils having no radial loops is greater in females (64.0%) than in males (56.7%), the maximum number found being four in both sexes. The inverse relationship between number of loops and frequency is again present.

True Whorls

True whorls are the second commonest pattern encountered over all fingers with 46.6% of females and 44.3% of males not having any. The inverse relationship between number and frequency was present, 18.0% having one whorl and 0.2% having ten, both sexes being similar.

Double Loops

Females again have more cases with no double loops than males, 65.6% and 61.0% respectively, both distributions having the mode at 0. The most common number of double loops present is one, with upper limits of eight in females and nine in males occurring. That instances with ten double loops could exist seem probable, given a sufficiently large sample.

Ulnar C. P. Loops

In common with the latter two patterns, females possessed fewer ulnar C.P. loops than males, 75.6% of the former sex having no such loops and 74.1% of the latter sex. The range of values encountered is the same for both sexes, being 0 to 4, a steady decline in frequency with number of loops occurring.

Radial C. P. Loops

The conclusions reached are the same as for the latter loop except that fewer instances of occurrence are found, the maximum number being three. More than 90% of pupils had no radial C.P. loops, those that did commonly having a single one.

AMALGAMATED PATTERNS

Arches

Combining true and tented arches decreased the number of cases found with no arches at all, 76.6% in females and 82.3% in males, still being more frequent in females. The mode of distribution is at one, a decline in frequency with arch numbers being found.

Loops

The result of amalgamating ulnar and radial loops was to move the mode of the distribution to ten, females (17.5%) being marginally less frequent in this class than males (18.1%).

Whorls

With the four double digit patterns combined it was found that they occurred more frequently in males than females, 27.1% of the former having no whorls and 31.5% of the latter being similar. The commonest number of whorls to have is again one in both sexes, a gradual decline to ten being observed.

Data Partitions

FEMALES

The data were only briefly investigated by both the Mann-Whitney U-test and the parametric t-test on single parameter partitions both prior and subsequent to selection. The results obtained were in complete agreement. Using ancestry gave no significant differences between English and Welsh on any finger patterns, either individually or in an amalgamated state. Selection did not change these results. The child's birthplace showed significant differences between Powys and Salop for true arches, ulnar loops, combined arches and combined loops, both statistics being in agreement. The parent's birthplace gave no significant differences for any pattern, true and combined arches being marginal. Investigating the mean of groups within the t-test showed that true arches, double loops and ulnar C.P. loops had their greater values associated with "Welshness". The remaining patterns were more inconsistent in their relationships. In a combined state arches and whorls had greater values associated with "Welshness" with loops related to "Englishness".

MALES

Males gave less consistent results than females between statistics. On the t-test, only the parent's birthplace gave a significant Powys/Salop difference for tented arches and combined arches. However, the U-statistic only maintained the latter while just removing the former significance, but making true arches now significant between counties. The child's birthplace did not give any significance on either statistic. In an unselected population, ancestry never gave a significant probability although on the U-test several were below 10%. However, the t-test in selected populations gave significant differences for English and Welsh for radial c.p. loops. Consideration of the means of patterns showed that both true and tented arches were consistently associated with "Welshness", even in non-significant comparisons, the combined arches being exactly comparable. Both types of loops and true whorls had a tendency for greater means to be present with "Englishness", while both ulnar and radial c.p. loops are most frequently related to "Welshness". Combining loops produced an association with "Englishness", while whorls gave an unconsistent set of relationships.

Sex Comparisons

Comparing the two sexes gave the following conclusions:-

(1) In an amalgamated state, arches were most frequently associated with "Welshness", while loops had the greater mean values related to "Englishness". The corresponding whorl class, while having a possible association with "Welshness" in females showed a less clear picture in males.

(2) In neither sex could ancestry alone produce consistent differences between subsets for any pattern over the two statistics used.

(3) Within the males the use of the parent's birth location gave more significant differences than the use of the child's birthplace, the reverse being true in females.

(4) The two tests applied to the data and the various partitions failed to show any large differences in pattern frequencies between either Powys and Salop or English and Welsh, the few named variables being exceptions and, on the evidence of pattern frequencies alone, there is little evidence for a separate gene pool associated with "Englishness" or "Welshness".

MAINLINE TERMINATIONS

Producing graphs of the mainline termination frequencies shows certain consistencies between both hands and sexes. In both sexes the left hand shows a predisposition to lower terminations, i.e. the lines tend to travel in a more proximal/radial direction than on the right hand, this being shown by all the mainlines. Consideration of the C lines shows that in addition to the general tendency there are more instances of missing triradii and tented loops on the left than right hands, giving the impression on the present coding system of the continued regression to lower termination categories.

Within any one hand the lines, not unnaturally, have their most frequent point of termination gradually moving in a proximal/distal direction, round the hypothenar and into the interdigital region as we move from the A to the D line. The A mainline terminates most frequently in the 3/4 region of the hypothenar border, the B mainline at 5/7, C at 7/9 and D at 9/11 (Table 33).

The mainline indices again follow similar distributions in both sexes, the left hand having a predominance of low values, the two hands being roughly equal in frequency when the indices are at 8/9 with higher values predominating on the right hand.

Using a rank correlation statistic, tau B, the bimanual correlations were all highly significant ($p < 0.001$), the greatest values being found for the A mainline ($T = 0.48$) and the AD index ($T = 0.49$), while the lowest correlation was for the C mainline ($T = 0.22$). A sex comparison by x^2 revealed that only the B and C lines on the right hand and D on the left had statistically different frequency distributions, the respective p values being 0.025, 0.003 and 0.009.

In partitioning the data the statistics available are limited by the type of data, i.e. ordinal values. When palmar pattern types were

considered, the basic dichotomy allowed the data to be treated in a continuous manner. However, the greater number of categories present for the mainlines negates this possibility. In order to compare the groups generated by the various partitions of the data the Mann-Whitney U-statistic was used throughout. The mainlines are not considered in great detail due to the very subjective nature of the assessment of the actual point of termination.

MALES

Partitioning the mainline data for males by the normal three criteria was extremely unsuccessful in producing any significant differences for any of the comparisons made, using single parameters, on all the lines. If the indices are included, then the only significant difference was when the parent's birthplace was used on MAINCL ($p = 0.043$).

The dual breakdown for this line showed this difference to be confined to those pupils with English ancestry (ES/EP, $p = 0.013$) although the comparison EP/WP was only marginally non-significant ($p = 0.058$). The only other significant comparison in all the dual breakdowns was for WS/EP when the parent's birthplace was used to locate the pupil. The following lines and indices showed significance, MAINBR ($p = 0.039$), MAINDR ($p = 0.035$) and MAINADR ($p = 0.019$). Even though this latter comparison was implicated in the three significant variables, it is difficult to produce any conclusions concerning consistent variations except to speculate on two possible alternatives. Either there is no regional variability present, or the parameters used are not the most efficient ones to detect it. The former seems the most likely when the results of the females are considered. In addition, we would expect a small number of significant comparisons by chance from the 170 made. Remembering that the classes are not truly independent, the probability of obtaining six significant results is about 0.164, lending support to the former suggestion.

FEMALES

In view of the many more significant comparisons produced by females, the mainlines and indices will be considered separately.

Mainline A, Right : MAINAR

When using the parameters singly both the child's and parent's birthplaces gave a significant difference between Powys and Salop ($p = 0.001$ and $p = 0.010$ respectively). Ancestry was less successful, but in a selected population, based on the child's birthplace, the English/Welsh difference was marginal ($p = 0.066$); although substituting the parent's birthplace as the selection criterion gave a much greater probability. Examination of the cell frequencies within each group showed that "Englishness" was related more to low termination positions.

Performing the dual partitions with the child's birthplace and ancestry combined gave a significant difference in the comparisons WP/ES and WS/WP, although substituting the parent's birthplace identified WP/ES and ES/EP as having significant differences. Both sexes agree in indicating little differences between the English and Welsh, but they differ as to which ancestral group gives the significant Salop/Powys probabilities. This can be accounted for by remembering that if the ancestral subsets occur at random (as judged by the non-significant comparisons) then we need not expect two parameters to produce consistency between them. Alternatively, we must remember that many other variables have not shown consistent associations between using the child's and parent's birthplaces, and one parameter is more than just a refined version of the other (see page 236). It is noteworthy however that the extreme comparison of WP/ES was significant in both series, as was hoped.

Mainline A, Left : MAINAL

The probabilities obtained from the initial divisions with single parameters showed that a significant difference was only shown between Salop and Powys when the parent's birthplace was used ($p = 0.024$), although using the child's gave a marginal value ($p = 0.075$). As with the MAINAR, using ancestry gave no significant differences between English and Welsh, while all three parameters associated low termination values with "Englishness".

When the child's birthplace and ancestry were combined, the same subset as MAINAR showed statistical differences, i.e. WP/ES and WS/WP. With the parent's birthplace substituted, the only significant comparison was WS/WP, although WS/EP was at a low probability ($p = 0.066$). These results again indicated a major dichotomy between Salop and Powys, ancestry contributing much less to differentiation.

Mainline B, Right : MAINBR

Examination of the B mainline on the right hand shows a difference from the two A mainlines detailed above. The single criterion produced no significant probabilities between Salop and Powys although using the child's birthplace was marginal ($p = 0.056$). Ancestry only gave significance when a selected population was used ($p = 0.008$).

The dual breakdown of parent's birthplace with ancestry gave no significant comparisons, this reflecting the results from single parameter divisions. Combining the latter parameter with the child's birthplace did produce differences, WP/ES ($p = 0.007$) being significant, while EP/WP was marginal ($p = 0.057$). The comparison to be highlighted is again the extreme subsets although the Salop/Powys division is not as clear as that for the A line. There was again a general tendency for the lower termination number to be associated with "Englishness".

Mainline B, Left : MAINBL

Like the right hand, MAINBL gave a significant difference between Powys and Salop only when the child's birthplace was used ($p = 0.035$), ancestry and parent's birthplace giving much greater probabilities. The distribution of termination classes within the three parameters again indicates that "Englishness" is related to lower number endings.

In a manner comparable to MAINBR, using the parent's birthplace in a dual partition gave no significant differences for any of the subsets compared. With the child's birthplace involved, the only significant probability was for WS/WP ($p = 0.033$), thus agreeing with MAINAR/L. However, the limiting subsets of WP/ES did not have any such differences between them, making conclusions more speculative. It would seem that the Salop/Powys difference is present, but not particularly marked or consistent over divisions.

Mainline C, Right : MAINCR

The C mainline on the right hand is noteworthy because of the occurrence of a large number of significant comparisons. The partitions using the three parameters individually all had probabilities below 5%. These were: child's birthplace ($p = 0.001$), parent's birthplace ($p = 0.043$) and ancestry ($p = 0.001$). In selected populations the English/Welsh comparisons were also still significant.

In view of the above results it was a little surprising that the dual partitions using the parent's birthplace with ancestry only gave a statistical difference to the comparison of WP/ES ($p = 0.026$) although ES/EW was marginal ($p = 0.064$). Substituting the child's birthplace was more successful, the following being obtained: WP/ES ($p < 0.001$), ES/WS ($p = 0.040$) and EP/WP ($p = 0.047$). These results suggest that the major parameter

included in the divisions is ancestry, birth location contributing to a significant, but smaller extent. It is notable that for the first dual partition it is the extreme comparison which gives the significant result.

Examination of the individual termination classes showed that the more proximal values are consistently related to "Englishness", while the most distal classes (7, 9) are most prevalent with "Welshness".

Mainline C, Left : MAINCL

Unlike the right hand, the C mainline on the left shows no significant differences between any of the subsets compared, whether divided by single or dual parameters for any of the three criteria available. In addition, there was no consistent association of termination points with either "Englishness" or "Welshness".

Mainline D, Right : MAINDR

Consideration of the final mainline MAINDR revealed that two of the initial divisions gave a significant difference between subsets, the comparisons being for the child's birthplace ($p = 0.012$) and ancestry in a population selected by the latter parameter ($p = 0.015$).

The dual partitions using the parent's birthplace and ancestry gave no significant differences between any of the subsets compared, and reflects the result shown above for the parameters. When the child's birthplace was combined with ancestry, then at least one comparison was significant, WP/ES ($p = 0.007$) with several low probabilities, these being for EP/WP ($p = 0.070$) and WS/WP (0.101). These indicate that the subset WP is the most extreme group although statistical difference from ES only was achieved.

There is again a tendency for the most proximal terminations to be associated with "Englishness". Because all the terminations for this line are interdigital, the proximal notation refers to lower values and not the strict relationship to the palm previously used.

Mainline D, Left : MAINDL

The final mainline on the left hand revealed that none of the initial partitions of the data produced any significant subset differences on any parameter. In the dual partitions this was also true except that EP/WP with the child's birthplace was marginal ($p = 0.051$).

If the termination points are examined then there is a tendency for the exits 7/9 to predominate in Salop for both parameters, while the English only show the excess for region 7. This association is weak and differentiation is not apparent for the parameters used.

Mainline Index, Right : MAINADR

For the mainline index in the right hand the single parameters all gave significant comparisons between subsets, these being for the child's birthplace ($p < 0.001$), parent's birthplace ($p = 0.013$) and ancestry in a population selected by the former parameter ($p = 0.010$).

The dual divisions with the child's birth location and ancestry gave significant differences between WP/ES ($p = 0.001$), WS/WP ($p = 0.013$) and a marginal value of EP/EW ($p = 0.082$). The use of the parent's birthplace gave the following results: WP/ES ($p = 0.049$), ES/EP ($p = 0.029$) and WS/EP ($p = 0.044$). Both series indicated that the prime difference is between Salop and Powys but, with ancestry contributing to tuning this comparison, although a degree of random influence by the ancestral variable cannot be ruled out.

Like the individual mainlines, the lower index values are mainly associated with "Englishness", but the distinction is not clear when taken over all parameters.

Mainline Index, Left : MAINADL

Like the right hand index, the left hand exhibits a significant difference between subsets when partitioned by the child's birthplace ($p = 0.036$), the parent's birthplace ($p = 0.027$) and ancestry in a population selected by the former parameter ($p = 0.040$).

With the child's birthplace, in a dual partition, the following comparisons were found to be significant: WP/ES ($p = 0.041$), EP/EW ($p = 0.046$) WS/WP ($p = 0.046$). Unlike the right hand, the parent's birthplace and ancestry only gave the subsets WS/EP ($p = 0.038$) a significant value although WP/WS ($p = 0.098$) was low. These breakdowns, particularly the former series, again support the idea of birth location producing a greater degree of differentiation than ancestry, although this latter criterion is showing some effect, if in a less consistent manner.

Relating the index values to the parameters shows, in general, that the lower cell classes have a disposition to be most frequently associated with "Englishness".

Review

Most of the variability in the present sample was confined to females, males in general exhibiting homogeneity over all the divisions for the criteria available. The data for females were much more promising as regards the presence of differentiation between subsets. Including the indices in the following discussion it was apparent that the child's birthplace gave a greater degree of consistent differentiation into Salop and Powys than the parents' birth locations, or indeed ancestry did. The dual partitions were also most effective when the child's birthplace and ancestry were combined, the extreme comparison WP/ES however being significant in both series, this being as I would have wanted. When the remaining comparisons are made, the conclusions seem to be that the greatest dichotomy

is between counties with ancestry contributing to a much smaller extent in enhancing differentiation between subsets.

The right hand seems to produce more instances of significant differences than the left, although the general tendency for the most proximal termination points to be associated with "Englishness" is found in both hands. Perhaps, significantly in males, no such association is present, substantiating the general lack of differences in rank means between groups.

In estimating the differences between the subsets for the mainlines the Mann-Whitney test was used. This non-parametric statistic will only indicate a difference between two groups if there is a consistent directional association of high (or low) rank scores in one or other of the two subsets. However, another source of variation can be present, which will show that the groups have statistically different distributions over the individual class elements, but which produce a non-significant difference between their rank means on a U-statistic. An example is given below:-

Mainline B Left : Females

	Termination Point		
Parameter	4	5	7
English	5(5.2)	51(53.1)	40(41.7)
Welsh	3(0.8)	221(60.4)	141(38.8)

The row percentages are given in brackets. It is apparent that for the English the greater numbers occur in classes 4 and 7, while class 5 is in excess in the Welsh. The chi^2 is highly significant ($p = 0.007$), while the Mann-Whitney U-test is non-significant ($p = 0.978$). These two results are dramatically opposite but are explained by the distribution of the class frequencies. When the tables are 2 x 2 then there is usually

no conflict between U and $X^2_{(1)}$, the probabilities being almost identical. It is not always found in a 2 x N table that the two statistics agree, for when (in a 2 x 3) two adjacent classes have their excess in the same group, there is usually a consistent tendency towards one end of the rank distribution for that class. Similarly, for higher order tables (2 x N) it is not necessary for all classes to have their excess in adjacent groups, although to produce a significant U the majority must be. To conclude, therefore, it has been shown that a non-significant result on a Mann-Whitney U-test does not preclude a difference between two groups; just a consistent association of the groups with opposite ends of the rank distributions.

ONE-WAY ANALYSIS OF VARIANCE

Geographical Partitioning

In the previous univariate statistics division of the data in terms of the birth location of the child or common parents was made, an initial line between Powys and Salop being taken as the existing boundary (1977). This initial approach has shown that for some dermatoglyphic characters differences between Powys and Salop could be detected. This simple dichotomy can however be extended to the investigation of regional differentiation, beyond that of comparing two counties, and to see if variation within counties can be found. The consequence of this is the necessity to divide the sampled region up into a number of smaller units such that each may be considered to represent a multifactorial, uniform area. The theory available to geographers to attempt such a division is large and is summarised by Dennis (1977b) and will not be repeated here. There is, briefly, a conflict when performing such a task between producing subunits which are small enough to be considered homogeneous in terms of social and demographic parameters while having sufficient population numbers to make an anthropometric study statistically feasible. It is, of course, possible that no such subunits exist and that all variation within the region (demographic and dermatoglyphic) is clinal. This unfortunately makes analysis of dermatoglyphic data very difficult without recourse to sophisticated trend surface analysis, although even with this technique some subunits have to be defined.

In producing such theoretically, supposed homogeneous areas we impose to a large extent the nature of the pattern of dermatoglyphic variability which can be discovered. However, it is hoped that the regionalisation produced by such analysis subsequent to production of subunits with amalgamations would not be the end of the analysis, but a

beginning, a framework from which a refinement of areas could take place to improve within-group homogeneity.

The production of the initial units in terms of social parameters, i.e. bus routes, work movement, position of cinemas, doctors etc., marriage movement, migration etc. would in itself provide material for a doctoral thesis, but without such information a necessarily less sophisticated attempt to produce homogeneous units must be made.

In some studies the geography of the region provides natural regionalisation in terms of valleys with well-defined watersheds between, such examples being the Yorkshire dales (Dennis, 1977b) or south Wales (Smith, J. pers. comm.). Even within these natural divisions, however, some subdivision must take place, it being incorrect to assume homogeneity a priori. In some cases further divisions are made on the basis of historical evidence or by using postal districts, parishes or school catchment areas. The most promising of these is usually the historical approach, but failing this school catchments provide many of the theoretical requirements set out by geographers (Dennis 1977b) Postal districts may in many cases coincide with natural barriers or school catchments, but have the undesirable properties of frequent redefinition. Using parishes would be ideal except that in the majority of cases the sample population contained within each is too small to offer any sound statistical basis on which to proceed. This latter problem really defines the task, of giving subunits with sufficient sample numbers to make comparisons possible.

Within Powys there existed the ancient administrative units termed 'Cantrefi'. These regions (10 in all) had their basis in the geography of the area, and in terms of settlement patterns, both obviously inter-related. Using these already defined areas would have been ideal except that in a number of them the sample size was too low and amalgamation was necessary. If the secondary school catchment areas are plotted over

the cantrefi then it is immediately apparent that the boundaries of one coincide with those of the other to a large extent. There are cases where a school catchment embraces more than one cantref, as for Llanidloes and Newtown, but these are rare. In the knowledge that cantrefi have their origin or history, and that their borders coincide with the present-day secondary school catchment areas, the subunits used as the theoretically homogeneous regions from which further amalgamation took place were the catchment areas. This meant that there were six areas naturally demarcated in Powys corresponding to the catchments of the secondary schools at Llanfyllin, Welshpool, Newtown, Llanfair Caereinion, Llanidloes and Machynlleth. Each corresponded to the cantref in which it was placed or was an amalgamation of two cantrefi without dividing any between two catchments. This decision was violated for one area, namely Newtown, for here the catchment included the primary school at Carno. Consequently the parishes of Carno and Llanwynog were included in with Newtown and not Llanidloes as their cantrefi suggest. Similar reasoning placed Berriew with Welshpool, while Llandysil was also moved into Welshpool because of its proximity to Montgomery and being east of the River Severn. Finally, the parishes of Llanllugan, Llanwyddelan and Mainafon were combined with Llanfair Caereinion due to the apparent easy access to the latter secondary schools rather than the longer journey over the hill to Newtown.

Although these changes can be criticised, the number of pupils involved is small (Tables 2 & 3) and while it is hoped that these re-defined areas will prove homogeneous, it is unlikely that, given the present sample size, using the strict boundaries of the cantrefi would have changed the eventual regionalisation pattern produced, especially when it is discovered that Newtown and Llanidloes are combined as a single unit on a multivariate dermatoglyphic analysis.

While there was historical reasoning to use the secondary school catchment areas in Powys in terms of cantrefi, no such evidence was

available for Salop or the (then) north Radnorshire region. The decision to continue to use school catchments involved a consistent approach although it was hoped that factors which made the use of these so attractive in Powys would apply to the other areas. In north Radnorshire the populations were small to begin with and consequently the sample sizes were insufficient to produce detailed subdivisions of the mountain region. Only Rhayader was visited in the western side of the region, while the eastern area had no secondary schools within it, the children feeding into Knighton. The division of this southern area is therefore rather arbitrarily based. The southern limit was extended to include the unsampled region of Llandrindod Wells with a rough line drawn across the county to the south of Knighton. A division into approximately equal halves was made, considering the birth-places of pupils in the schools at Rhayader and Knighton. The two areas produced are thus only roughly delineated in terms of school catchments but are mainly included in order to give a comparison with the more northerly regions of Powys.

Within Salop complications arose since all the secondary schools were not sampled, due to a shortage of time, the most notable omissions being those in Shrewsbury and in Clun.

The schools sampled were used as a basis of a catchment but, where, as for Bishop's Castle, the region adjacent to it (Clun) was covered by an unsampled school, its catchment was extended to include this area as well. The northern edge of the Bishops Castle catchment abuts that of Pontesbury and to the east that of Church Stretton. Similarly, Pontesbury is well defined at its northern edge by the catchment of Oswestry and the combined areas of Ellesmere and Baschurch. As regards the area marked out around Shrewsbury, this is almost arbitrary and most susceptible to criticism. As the primary schools were not sampled, the sample size for this area is small and it may thus have been better not to have created the region. When the multivariate results are considered it is seen that Pontesbury

and Shrewsbury combined, so the division between the two is not as important as it initially seems. The southern limit of Baschurch is related to its catchment as are the northern parishes of Church Stretton. So even in the rather unsatisfactory sample from Salop the regions produced corresponded to the majority of the school catchments. It is worthy of note that the greatest omission of a secondary school, that in Clun, produced an area which after multivariate analysis is postulated to exhibit heterogeneity and is subsequently halved on the evidence of topography and the marriage movement matrix. Finally, the Salop parishes of Chirbury, Worthen, Brompton and Rhiston are included with Welshpool, mainly because they lie between Churchstake and Welshpool, and verbal evidence suggests that the population in these parishes look more towards Welshpool as a centre than to the surrounding towns of Bishop's Castle, Shrewsbury or Newtown. The final amalgamation of parishes and their associated group names are given in Table 3.

In total, 15 regions were defined, two parameters being used to place a pupil in any one. The first depended on the area in which the pupil was born, exactly comparable to the parameter already used. Additionally, the common parental birthplace was used, both parents needing to be born in the same area in order to place the child in it as well, again similar to the parameter already used. Because of the small numbers resulting from such a criterion the areas had to be amalgamated into larger units, 10 then remaining. Using the codes given in Table 3 the following amalgamations gave the 10 regions :

: regions 1 - 6 remained the same
: regions 7 and 8 combined
: region 9 combined with region 1
: region 10 remained the same
: regions 11, 12 and 13 combined
: regions 14 and 15 combined.

One-way Analysis of Variance

Ridge Counts

Analysis of the data by the parametric one-way analysis of variance and the non-parametric Kruskal-Wallace test were both in agreement in showing that significant differences between the 15 regions, defined as either the child's or common parents' birthplace, were comparatively rare when either the finger or palmar ridge counts were considered for either sex. The following variables gave such significance.

Table T8

Males	Parametric		Non-Parametric
	Raw	Transformed	
LT2(PPA)	0.007	0.006	0.018
FL2(PFA)	NS	0.032	0.036
Females			
RT2(CBPA)	0.023	0.034	0.039
FR2(CBPA)	0.027	0.017	0.017

Bartlett's test was used to test for heterogeneity of variances, all the above being homogeneous both prior and subsequent to transformation. It is apparent that none of the finger ridge count total or the palmar ridge counts appear in any form in the list.

Listing all other available variables where significant variation was shown gave the following:

Table T9

	Parametric		Non-Parametric
	Raw	Transformed	
Males			
RLATD(CBPA)	<0.001	-	<0.001
LLATD(CBPA)	0.015	-	0.047
CHL(CBPA)	0.002	-	0.001
PAR(CBPA)	0.036	-	0.042
TBR(CPBPA)	0.004	-	-
Females			
RD2(CBPA)	0.015	0.016	0.021
RD5(CBPA)	NS	<0.001	0.902
RD5(PFA)	NS	<0.001	0.427
RLATD(CBPA)	0.032	<0.001	0.000
LLATD(CBPA)	NS	0.017	-
P3TR(PFA)	0.026	-	0.028
MAINAL(PFA)	-	-	0.011
MAINBR(CBPA)	-	-	0.006
MAINBL(CBPA)	-	-	0.043
MAINCR(PFA)	-	-	0.048
MAINDR(CBPA)	-	-	0.050
MAINADR(CBPA)	-	-	0.008
MAINADL(PFA)	-	-	0.062

Examination of the tables shows that females produced more significant variables than males mainly due to the collection of mainlines evident for the former sex. Additionally, transformation tended to give significance where previously none was shown. Using the non-parametric test confirmed the results shown by the raw or transformed data sets.

One notable exception was RD5 in females where the raw data and Kruskal Wallace tests were non-significant while transformation was significant. This appears to be a result of heterogeneity of the within-group variances although this was not removed by transformation and probability estimates in the latter are probably spurious.

The means associated with these variables for each of the 15 defined regions (10 for parent's birthplace) were plotted on a map and will be examined below, but it must be remembered that a significant difference between regions does not mean that a consistent pattern of regional variation will be found. To have any meaning the mean occurrence of the particular variables must show some relationship over the region, consistent with geographical relationships. In addition, variables that do not produce a significant value on the analysis of variance do not necessarily lack such a criterion, they may indeed have a spatial variation which is interpretable in terms of demographic and geographical factors even though statistical significance is not reached. Without examining the distribution for all variables this cannot be confirmed or rejected and time precluded this, limiting the further investigation to those elements that did have significance attached to them.

It was striking that for only one variable (RD5 in females) was the variation attached to division by the child's or parent's birthplace, significant in both,giving further indications that the two parameters are not merely substituting for each other, and although they have a high inter-correlation, each is a distinctive measure of regional variation.

Having placed the means (or rank means) for the variables on the maps of the region, to attempt to place limits on similar geographical areas can become a very subjective factor, the greatest error being (unconsciously) to 'create' supposedly homogeneous groups where we can expect them to be. There is a great temptation to be 'elastic' about which group a particular area belongs in, especially when its mean may be just over the limit defined.

To a large extent, defining the limits creates patterns of differentiation unless the variations are very marked. We would also hope that the groupings produced would be confirmed when different variables and sex are used. If this occurs, we are justified in assuming that a defined region really exists. However, if this is not found, does this mean that there is no differentiation? It is not inconceivable that a detailed study of variation over many populations could reveal that some pattern elements are more subject to regional variation than others in a manner akin to blood group antigens. Should dermatoglyphic patterns be subject to different environmental stresses, then changes in these may result in regional differentiation for one element completely different from that formed for another. If we are speculating on different gene pools for our "English" and "Welsh" populations we would hope that sufficient genetic variability existed which would still be manifest even with heterogeneous environments in producing unpredictable G x E effects.

When the mean counts were plotted on the map it was apparent that one of the hopes just defined was not met, namely that both sexes would show the same, or at least similar variation patterns. The present data revealed that males produced no consistently interpretable regional groupings which were either similar within the sex across variables or between sexes on the same variable. Similarly, only using the child's birthplace was consistent in females, the parent's birthplace giving an almost random association of regions. The following discussion is thus limited to females on the former partitioning parameters with an attempt to discuss general similarities and indicate which regions are most inconsistent in their group placement.

Certain regions were always associated for all the mapped variables, these being as follows:-

(1) Machynlleth, Llanfair Caerinion, Meifod

(2) Llanfyllin, Welshpool, Newtown, Llanidloes, Bishop's Castle

(3) Oswestry, Shrewsbury (Ellesmere)

Looser connections are shown for the remainder:-

(4) Rhayader, Knighton

(5) Church Stretton, Pontesbury

The inter-associations of these groups vary depending on the variables, the effect of the latter change showing certain inconsistencies. Pontesbury is a region which, while generally related most closely to Church Stretton, shows certain affinities to the Oswestry group. The dichotomy however of regions (3) and (5) from (2) is clear at all times, while an association of (1) with (3) is strongly indicated. In addition, region (4) seems to have means most closely related to (1) and (3), this producing the impression of a central block of three regions with possible affinities. A comparison with the above results was made using the variable known to have the highest heritability, i.e. TFRC, to see what patterns this might reveal. In general, the agreement was good. Region (5) was placed with (3) but Llanidloes lost its affiliation with (2) and moved into (1), while (4) was now related most closely with the re-defined (2). Because this latter variable is (thought) not subject to environmental effects it is encouraging that the pattern of differentiation does follow, to a large degree, that found for other variables mapped. I cannot speculate on the causes of the environmental stress, but it is not inconceivable that some similarity between regions (1) and (4), for example, being at a higher altitude, could produce similar dermatoglyphic results even though the gene pool of (4) is most similar to (2). Those variables with low heritabilities would thus put regions (1) and (4) together, while those with higher heritabilities would favour (4) with (2).

Allowing for these inter-relationships between the new larger regions, general conclusions can be made:-

(1) There is an intrusion of Welsh influence into Salop which roughly coincides with the through route from Newtown to Bishop's Castle and upwards toward Shrewbury, while remaining west of the Long Mynd.

(2) This same region extends northward along the Severn valley and turns upward toward the valleys of the Vyrnwy and Tanat, but seems to exclude the valley around Meifod. Llanidloes is probably also included in this region, being the extension southward of the Severn valley.

(3) The western hill regions of Machynlleth and Llanidloes are separate from the valley region below them, but seem to include an extension into Meifod.

(4) Region (5) is also separate from the Severn valley lowland just detailed, even though part of the Pontesbury region lies in the valley within Salop. The Breidden hills may be producing an effect here with the greater affinities lying southeast to Church Stretton and to a lesser extent east and northeast to region (3).

(5) Oswestry shows an affiliation eastward and not down toward Welshpool or Llanfyllen.

In view of the historical connection of "Welshness" and Oswestry this is perhaps surprising. However, closer examination shows a possible connection. There is the extension of region (1) toward Oswestry, the mean values mapped showing definite similarities between the two, both for the high and low heritable traits. An explanation is difficult. Why the hill regions of west Powys should have affinities with the Salop

lowlands in terms of similar mean variable counts is not apparent. If the middle valley region was intermediate between east and west, then hybridisation and a cline would be eminently possible. That it is not just environmental is indicated by the map for TFRC (Figure 9/10) where the same dichotomy is shown. Within Powys the hill region follows the areas to the west of the linguistic divide shown by Bowen and Carter (1972) although the eastern edge bears nc relationship to the present regionalisation. That language is not the prime factor would seem to be indicated by Llanfyllin, a region with a high frequency of Welsh speaking people, being grouped with the lower frequency regions of Welshpool, Newtown etc., assuming of course that similar mean values of a dermatoglyphic trait indicates similar gene pools. Assuming the former statement is true, the groups can be amalgamated as has been done, and we must conclude similar causes in regions (1) and (3), possibly genetic. On the other hand, having similar mean counts does not necessarily mean an affinity, and to justify the initial grouping into regions one must say "similar mean counts indicate an affinity between two regions provided they are contiguous". Given time, it would have been profitable to have re-examined the region of "north Montgomeryshire" to see if a "better" regionalisation was possible which would definitely link or preclude a bridge between (1) and (3) and to establish the place of Llanfyllin in this scheme. One of the few consistent patterns shown when the parent's birthplace was used was the division between Oswestry and Welshpool, detailed above, although further investigation did not assist in the interpretation of the geographical relationships found.

Summary of Univariate Statistical Analysis

Having performed univariate analysis and given results and discussion for each series of variable classes it is necessary to ask if any general observations can be made about dermatoglyphic variation.

Consider first the statistics used and the effect of transformation. If the difference between any two subsets is small, then using the parametric or non-parametric test, with or without transformation, does not give contradictory conclusions. Where the probabilities are marginal (at the 5% level) then transformation or using the U-test usually gives a clear set of relationships, for if non-normality of the variable distribution is causing the subset difference to be significant on a t-test, then transformation tends to reduce this significance (raising the p value) while the U-test reduced it even further. In a similar manner the progression from raw to a transformed data set and then to the U-test could increase the significance of the subset difference. This latter is an instance where non-normality initially masked the subset differences. It should be stated however that the interpretation of the analysis should be made by consideration of the low, but non-significant probabilities and not by just limiting discussion to the variables which produce statistical significance.

The second problem tackled concerned the ability of the partitioning parameters to divide up the data set. Each particular set of variables has been considered individually and reference to each should be made for details. The general conclusions are that the ability of the parameter to produce differences between the subsets generated varies, depending on which set of variables is being used.

The palmar patterns, finger triradii, palmar triradii and pattern intensity indices all gave very few individual variables which had significant, or even low probabilities between subsets on any parameter for any type of

division of the data. They were extremely consistent in giving no variability.

For finger pattern types the same was true except that in females the three basic elements (arch, loop, whorl) did show differences between WS and WP on six of the ten digits. No other consistent relationship was observed. The comparable analysis on the quantitative finger pattern types was not made.

The ridge counts of fingers and palms were the most successful in terms of statistically significant differences between subsets. Females gave many more significant differences than males, the latter showing results comparable to the previously described variables, except for possibly the second digit on both hands. In females, statistical differences were much more numerous, finger counts being more in evidence than palmar counts. The unilateral maximum counts were slightly "better" than the absolute counts with digits two and five being especially noticeable for subset differences on both hands. Of the three parameters involved in division, the parent's birthplace gave fewer significantly different subsets than the child's birthplace. Ancestry was of some use when combined with the latter parameter in separating the subset ES from the remaining classes.

The palmar mainlines were, on an initial examination, significantly different in mean termination points between subsets for many of the comparisons made, for all lines and both M.L.I. Details are given in the relevant part of the text; suffice it to say that the subjective nature in determining the actual termination point for any individual mainline detracts to a large extent from their potential usefulness indicated in the reported analysis.

Section (4)

MULTIVARIATE ANALYSIS

Distance Coefficients in Multivariate analysis

All the statistics used so far in this thesis belong to the class termed "univariate". However, it is necessary to consider a more advanced series of techniques which come under the general term of "Multivariate Statistics". These allow the simultaneous examination of a group of variables, usually with the aid of the correlation matrix between them, with the ultimate aim of simplifying the structure supposed to be present with the data matrix.

The main group of multivariate statistics can be classified as follows:-

(a) Factor analysis, Principal component/co-ordinate analysis

(b) Discriminant function analysis

Other techniques available have not to date been applied to dermatoglyphics. The first series of methods (a) attempt to find a reduced number of factors or components (R) which will explain the variance contained within the correlation matrix between the original N variables (R<N). There are many different refinements and variations possible and examples of uses are numerous (see Blackith and Reyment 1971; Sokal et alia 1961; Rummal 1976; Cattel 1965(A,B); Gower 1966; Stevenson et alia 1973; Bailey 1956; Miora 1966; Holland 1968, 1969; Dennis 1977b). Since I do not intend to report any factor analysis for the dermatoglyphic data collected, I will not expand on this group of techniques any further, but will consider the second class of Discriminant Function analysis.

This latter class is best initially explained in terms of two separate groups, the object of which is to allow an individual to be placed in one or other of the groups on the basis of a set of K variables.

This amounts to finding a linear equation which will maximise some predetermined requisite taken to be indicative of between-group separation.

The linear function between two groups is defined by Blackith and Reyment (1971) as:-

$Y = (\bar{x}_1 - \bar{x}_2)' S^{-1} x$ where $\bar{x}_1$ and $\bar{x}_2$ are the mean vectors of sample size N_1, N_2, S^{-1} is the reciprocal of the pooled sample dispersion matrix (variance/co-variance matrix) and x is the vector of variables.

The coefficients of the linear discriminant functions are defined as:-

$$a = S^{-1}(\bar{x}_1 - \bar{x}_2)$$

These functions are related to the Mahalanobis generalised distance by the relationship:-

$$D^2 = (\bar{x}_1 - \bar{x}_2)' S^{-1} (\bar{x}_1 - \bar{x}_2) = d'a \qquad \text{where}$$

d is the difference between the two sample mean vectors. This formula can be extended to cover any number of intergroup relationships, a D^2_{IJ} being generated between each group I and J.

The particular programme used in this thesis is that produced by the SPSS statistical package system, and termed DISCRIMINANT (Nie et alia 1970), programmed by Klecka W.R. Readers should consult the SPSS manual for particulars concerning the implementation and use of the programme. References to the D^2 statistic can be found in Mahalanobis 1936; Rao 1952.

The linear combination of variables on the functions is given in a standardised form as:-

$$D_{IJ} = \beta_{J1} Z_1 + \beta_{J2} Z_2 \ldots\ldots\ldots\ldots \beta_{IJ} Z_J$$

where D_{IJ} is the individual score on the function, β are weighting coefficients and Z_J are the standardised form of the S discriminating variables.

D^2 is scale independent with a known distribution. Since it has this property, each D^2_{IJ} between groups can have a significance test attached to it, given by:-

$$F_{IJ} = \frac{(N-g-v+1)N_I \cdot N_J \cdot D^2_{IJ}}{V(N_I+N_J)(N-g)}$$ with (V) and (N-V-1) degrees of freedom

where N = total number of cases in the g groups

N_I = number of cases in group I

N_J = number of cases in group J

V = number of variables involved in the Discriminant function

D^2_{IJ} = Mahalanobis distance between groups I and J

One of the outputs from the programme Discriminant is an F matrix together with the associated degrees of freedom. Using the above formula the computation of a D^2_{IJ} matrix is a simple matter, a Fortran programme being written to handle the calculation by input of the complete F matrix and the associated group sizes (page 514). The interpretation of the D^2_{IJ} values can be made by considering the F matrix or the classification array, the latter showing the percentage of cases in each <u>known</u> group which would be correctly placed in that group on the basis of the discriminant functions alone. The relative importance of such function in the discriminating process can be examined by considering the eigen values or the canonical correlations (C.C), the programme deriving the functions in decreasing order of importance as judged by the amount of explained variance contained within each function. The maximum number of functions is always one less than the number of groups, but with several groups it is hoped that a few functions (2 or 3) will classify the individual cases into their correct group. There are several assumptions necessary for the discriminant analysis to be applicable, these being:-

(1) Normal distribution of the discriminating variables

(2) Homogeneity of the within-group variances and correlations (Rightmire 1969). He also comments that although these conditions may not be met by most anthropological data and that the D^2 statistic correlates closely with the simpler distance measures of Penrose's C^2H_J, the statistic is the most sound, based on those available and that its insensitivity to sample size makes its use worthwhile. This last statement is challenged by Constandse-Westerman (1972, p. 51) and is thought to be invalid by Coope (1971) and Dennis (1977b), these latter individuals having worked on dermatoglyphic data. The present thesis also supports this suggestion and considers that this is due to small samples having extreme means, thus allowing precise discrimination of the few cases into their correct group. The correction to the D^2 given by Constandse-Westerman is to subtract $\frac{V(N_J + N_J)}{N_I \cdot N_J}$ from D^2_{IJ} to give an unbiased estimator. Whenever a D^2 matrix is reported in the present work this correction has not been made. It is perhaps appropriate to state here a feature termed "Rao's paradox", considered in general terms by Kowalski (1972). It is, briefly, that when a set of variables is entered into a discriminant analysis, all of which have already been shown to exhibit a statistically significant difference between (say) two groups, the D^2 produced between these groups, on the multivariate Hoteling T^2, need not indicate significance between the same groups. This is relevant when the multivariate discriminating variables are compared with the results obtained between Powys and Salop on the univariate statistics. I have but briefly considered the theory behind discrimination, and more precise information exists in the literature. Therefore, the final comment can come from Blackith and Reyment (1971, p. 46).

" - we are fully aware of the fact that statisticians are not very happy about the biological use of the discriminant functions ....".

It is hoped that the application of this technique to the present data sets will give support to its use (given the necessary data requirements) in biological (dermatoglyphic) research.

The production of "distance coefficients" is not limited to the use of D^2, other simpler coefficients having been put forward, the earliest in 1909 by Czekanowski with others following prior to the formulation of D^2 by Mahalanobis. Constandse-Westerman (1972) considers in detail the genealogy of these coefficients and what follows draws from both, mainly chapter IV, p. 26 onward.

The early distance values and, indeed, the later ones, all depend on operating on a basic difference between the means of two groups for a particular variable. This may be limited to a summation of a raw variable mean difference, DD (Czekanowski 1909) or standardising the difference in some way DDr (Czekanowski 1932).

Karl Pearson developed his 'coefficient of racial likeness' (C.R.L.). This differed from previous measures in that it used the squared standardised difference between means, but assumes common variances for population variances. He later attempted to remove the effect of sample size from his estimates (CRLR, 1928). Czekanowski showed in 1932 that DD and CRL were highly correlated.

The next coefficient was devised by Penrose (1953-54) and was the standardised difference between the means, squared. It differs from CRL in that the standard deviation is squared along with the mean difference for each variable. The coefficient was termed C^2H after Hancke whom Penrose recognised as formulating a similar function in 1898. C^2H was later shown to decompose into two parts, a general 'shape' component C^2Z and a size component C^2Q. The relationship between them is given

$$\frac{r-1}{r} \cdot C_Z^2 + C^2Q = C^2H.$$ for r variable. The size component C^2Z has been shown to have high correlations with other distance coefficients.

The main criticism against the above coefficients has been the lack of consideration of the intercorrelations between variables, and in most cases the lack of a statistical test of significance of the intergroup distances. Penrose himself felt the former omission justified and introduced a term for the average correlation between all variables. This improvement has two faults; first, it is unrealistic to assume a general level of correlation between variables and, second, the correlation between D^2 and C_r^2 is no greater than between D^2 and C^2H although Constandse-Westerman considers the high correlation of the former two to justify the use of the average correlation.

The development of D^2 by Mahalanobis in 1936 removed the three main criticisms indicated, namely, D^2 accounts for intervariable correlations, is scale independent and has a significance test applied to it. In addition, it is supposed to be independent of sample size although the present thesis considers this unlikely unless the samples are large (>200) per group or all of comparable size between groups. In terms of relative D^2 between groups, the latter appears the most important provided the individual samples are not too small (<20). The presence of a correction for sample size would seem to justify this speculation. For all the virtues of this latter statistic, it has been shown to correlate highly with C^2H and C^2R while being much more difficult to calculate, although the use of the computer alleviates this somewhat. Penrose (1952-54) further criticises the use of D^2 by saying it is unlikely that the necessity of common within-group variances or correlations would exist in biological data. In addition he thinks it unlikely that the accuracy with which data are measured is sufficient to justify the application of such a sophisticated technique. In view of the correlation of D^2 with C^2H(C^2Q and C^2Z) this would seem a valid criticism.

A further criticism involves the computational difficulties in investigating the amalgamation of parishes into groups for D^2 analysis when each individual run may take 250-300 seconds of C.P.U. time (IBM 360/370). When the use of a "lesser" coefficient is suspect due to the intercorrelation of variables it is possible that preliminary work with C^2H may prove instructive and a final run using D^2 then undertaken. This approach is hopefully going to be investigated on the present dermatoglyphic data at a future time. However, in the present thesis, D^2 was used throughout, the particular requirement of the analysis being to maximise the smallest D^2 between groups, the option on the Discriminant programme being 'Mahal'.

Examples of the use of these distance statistics, particularly D^2, abound in the literature, the following being especially useful:-

Rudan, P. (1977), Chai (1972). Interpopulation analysis using C^2H on dermatoglyphics.

Comila, J. (1972). Interpopulation analysis using C^2H on anthropometric data.

Gower (1972). General considerations of distance coefficients.

All the previously used distance measures were based on variables which have continuous distributions. However, for discrete attributes a different approach must be used. A more complete consideration of the subject is found in Constandse-Westerman, p. 76, in which four classes of a coefficient are considered. Because none of the measures are used in the present thesis they will not be detailed any further except to refer to Dennis (1977b) who used Edward's and Cavalli Sforza's E^2 (1972) to good avail in calculating distances between populations for data based on pattern types on the fingers and on demographic characters such as religion and social class.

Non-Metric Multidimensional Scaling

After producing a matrix of distances between populations, for the present work this being a square, symmetric matrix of D^2(MxM), the intergroup relationships need to be worked out. The original discriminant programme plotted the centroids of the groups in a reduced space for the first two discriminating functions, and when the first two are the only ones which contain significant amounts of information this will prove quite adequate. However, when the number of dimensions increases to 3 or more, the ability to represent the points in a centroid plot becomes increasingly difficult. It is therefore necessary to perform some type of clustering technique on the D^2 matrix in order to investigate the group relationships most easily. Classical forms of clustering will be considered later and a technique of Non-Metric Multidimensional Scaling (M.D.S.) will be described. The technique of M.D.S. is one which tries to represent the ranked elements of a matrix of similarities (correlation coefficients) or dissimilarities (D^2, C^2H) in N-dimensional space where N is fewer than the original ^{M} dimensions of the matrix. The essential point is that the representation of the original relationships on the matrix should be truly represented by the spatial arrangement of points in a 2 or 3 dimensional M.D.S. plot. The extent to which this is achieved is measured by a parameter termed "stress". For any given configuration of points, the stress is defined by a monotone regression of the new inter-group distances against the original dissimilarities and uses the residual variance, suitably normalised as a quantitative measure. The essentials of the method are given by Kruskal, J.B. (1964a,b).

The particular programme utilised is termed Minissa and forms part of the Osiris package system programmed for the IBM(360/370) at Durham University (NUMAC). The programme allows for either a similarity or dissimilarity matrix to be entered and will give solutions for any number

of requested dimensions up to a maximum M-1. Thus a request for a four dimensional solution will also yield 2 and 3 dimensional plots. The adequacy of the plot to represent the original data is given by either Kruskal's Stress (K.S.) or the Guttmann-Lingoes Stress Coefficient (G.L.C.), the two always being very similar, the former being reported in the present work. Kruskal himself suggests the following stress percentages as guidelines to an evaluation of a plot to represent the original matrix:-

20%	poor
10%	fair
5%	good
2.5%	excellent
0.0%	perfect

However, Wagannar and Padmos (1971) have shown that the interpretation of the stress coefficient must be made in the light of the size of the original matrix, M, and that a good stress for 12 points would be poor for 3. Thus, in the present data,plots of four groups almost always gave zero stress in two dimensions, while 15 points had much greater values, but less than the maximum considered allowable by the above for two dimensions. They recommended that for any particular association coefficient (D^2) a set of random relationships be worked out to assist in evaluation. We have evidence that for the present data a plot of 54 points for Kendall's tau, a rank correlation, would give a stress of <20% although similar work in D^2 was not available. In view of the use now made of D^2 in the literature, an evaluation of its performance on M.D.S. would be of value.

Cluster Analysis

The clustering techniques mentioned at the beginning of this section, like M.D.S., seek to separate out groups or clusters within which a predetermined criterion exists. The number and type of clustering algorithm now available are extensive, witness the Clustan 1C package

system developed by Wishart (1975). During the present work, reference was made to the following: Sneath and Sockel (1973); Everit (1974); Gower (1967); Hodson et alia (1966); Jardine (1971); Rahlf and Fisher (1968); Grivaeus (1972); Cochran (1961); Johnson (1967); Dennis (1977b). In view of this extensive literature only a note on each type of clustering will be given. The methods used were all hierarchical techniques, as distinct from clumping, density or mode seeking or finally optimisation-partitioning techniques (Everitt 1974).

Single Link Clustering or Nearest Neighbour (S.L.C.)

This can be used with either similarity or distance measures and combines first the two groups with the smallest D^2 between them, and then either joins to this cluster the group with the next smallest D^2 or initiates another cluster. The distance between groups is defined as the distance between their closest members. S.L.C. was first described by Sneath (1957) and later by Johnson (1967). The technique tends to give long strings of relationships, all groups eventually falling into a single cluster (Sneath and Sockel 1973). The advantage of this method is that it is easily performed by hand.

Complete or Maximum Link Clustering (M.L.C.)

This method is the exact opposite to the above and defines the distance between groups as the distance between the most remote members of the clusters. It will in general lead to tight, hyperspherical, discrete clusters joined to each other only with difficulty with low similarity values (large D^2), (Sneath and Sockel (1973, p. 222). The programme used was part of the Osiris package and termed HICLSTR and uses the criteria given by Johnson (1967). The solution is unaffected by monotone transformations and are thus only dependent on rank order.

Average Link Clustering (A.L.C.)

The above two criteria of clustering were applied to all the D^2 matrices produced, except when indicated. For the analysis of the marriage migration matrices, however, a third method of clustering was introduced as a comparison with the other two. This latter technique was Average Link Clustering (A.L.C.) (Sneath and Sockel 1973, p. 228) and defines the distance between two groups as the distance between the average of all the distances between the two clusters. The method was extended by Lance and Williams (1966). The computer programme used was from the Osiris package, programme CLUSTER, with the option, Average.

Format of Multivariate Analysis

The following multivariate analysis attempts by means of Discriminant Function analysis, M.D.S. and cluster techniques to investigate the data set for homogeneous units and to attempt to see which of the three postulated partitioning parameters put forward is most useful in giving such divisions, or which combination can achieve the same ends.

The following must be noted:-

(1) All analysis was based on the SPSS programme Discriminant, with the option used to maximise the Mahalanobis distance between the two closest groups using a stepwise procedure (SPSS manual, p. 447). When the classification array was produced, equal prior probabilities were assigned to each group, this being done so that only the ability of the function to discriminate was being tested without sample size biasing the results. In test runs it was apparent that weighting the group probabilities raised the frequency

of correct classification from the level reported in the present work. All other parameters were left at default values for the programme.

(2) Two different matrices were used as inputs to the programme, particularly in the later analysis, these being referred to as the Reduced Matrix or the Complete Matrix.

(a) The reduced matrix consisted only of those variables with continuous distributions beyond the di- or tri-cotomous levels exhibited by pattern elements. These therefore were:-

(A1) The 20 separate ulnar and radial finger ridge counts, RFR1 to LFU5

(A2) The individual palmar ridge counts for each hand, RAB-RCD, LAB-LCD

(A3) The right and left finger intensity indices, RFPII, LFPII

(A4) The right and left palmar intensity indices, RPPII, LPPII

(A5) Right and left minimum atd angles, RLATD, LLATD

The basis for these variables was that they most closely approximate the type of variable distributions required by Pearson's correlation utilised in the Discriminant programme. 32 variables in total were input.

(b) A complete matrix included all variables measured on the fingers and palms with the exception of the finger pattern types (nominal data), the maximum atd angles and the patterns

with very low frequencies, i.e. central fourth loops. In SPSS notation they are all listed below:-

RFR1 to RCD, LAB to LCD, RFRC to LD5, PTR to P2L, P3R to P3TL, P4R, P4L, PHR to RHL, PAR, PAL, RAHR, RAHL, TR to TBL, TEFR, TEFL, TDR, TDL, MAINAR to TPPII, RLATD, LLATD (97 variables in all).

It is recognised that the inclusion of the mainline terminations is a rather generous consideration of the type of data to which they belong. They would of course be better considered as ordinal. However, if the method of Alciati (1965) is considered, the above terminations would bear a strong correlation with the interval, angular method proposed, and on this basis are thus included. The possibly more serious error may occur when data which are basically a dichotomy, as for pattern types, are not really suitable for Pearson's correlations, a rank measure being more suitable. However, the present programme makes no allowance for the use of such a statistic. Within the manual for SPSS an example given on the Discriminant programme is based on such dichotomous data and would thus seem acceptable to the writers of the programme. The use of the above list is as an explanatory technique to see if a meaningful set of discriminant relationships could be produced between any of the groups defined.

(3) The comparisons made are at the beginning of each analysis. The breakdown parameters were the child's birthplace (CBPA), common parent's birthplace (PFA), ancestry defined by surnames (DOW) and in later analysis the language ability of the pupil was considered (English only or bilingual, English/Welsh).

(4) The sexes are described separately.

(5) The Discriminant analysis gives large quantities of information for each run, of which the following are only the general conclusions and the premises on which they are based.

FEMALES

Child's Birthplace : Salop/Powys

Considering females, the discriminant function between Salop and Powys based on the child's birthplace, using the reduced data set, indicated that significant discrimination could be achieved between the two groups ($p < 0.001$). Similar conclusions were reached when all the variables were included in the analysis. In the initial function the variables which gave the greater loadings were LFU3 (-0.575), LFR5 (+0.663), RFPII (-0.553) with 11 of the original 32 input variables contributing something to the D^2. The eigen value and the canonical correlation (C.C.) both indicate however that very little of the total variance is being explained in the function, the latter indicating only 3.9% (i.e. $(0.172)^2$). The inclusion of all variables slightly changed those which were producing the greater loadings, the particular ones now being LFU3 (-0.624), RD4 (-0.501), MAINADR (-0.701). It is apparent that only the first of this list is included in both series, the division of the latter variables removing some of the discriminating power shown by the initial group. The canonical correlation was increased from that previously shown to 0.294 indicating that 8.6% of the variance is now being explained by the new function. The discrimination between the groups is still highly significant ($p < 0.001$).

In trying to decide whether inclusion of all variables improved discriminating power the C.C. is a useful guide. The actual D^2 calculated, and its associated F, cannot really be compared across series due to the different number of variables included in each. A crude indication can be obtained if the difference between the centroids in standardised space is examined. This shows that for the first analysis, the between centroid distance was 0.401 standard deviation units, while using all variables increased this to 0.601 s.d. units, confirming what was suspected above, that including more variables holds the potential for greater discrimination than does fewer, even though there is a high correlation between individual elements. Including only the three detailed above will not necessarily indicate this, due to the small but cumulative effect that the remaining variables have on discrimination, this being remembered if a reduced data set is used.

If attempts to classify individuals are made on the basis of the function, when the probabilities associated with each group are equal, then the reduced data set gives 59.85% of cases correctly classified, while using all the variables increased this to 61.09%, again indicating that the second function gives greater separation than the former.

MALES

Child's Birthplace : Salop/Powys

Like the females, males produced significant discrimination using both the reduced and complete data sets, the latter having the greater significance ($p < 0.01$ and $p < 0.001$ respectively). The former series identified four variables which could contribute to the discrimination, RFU2 (0.642), LFR5 (-0.576), LFPII (-0.950), RLATD (-0.547) which were associated with a C.C. of 0.167. This showed that the function was explaining 2.7% of the variance in the raw data set. In all, 10 variables

were contributing to the discrimination between Salop and Powys, while increasing the data set showed that 18 variables contributed significantly to the function. Strangely, only one element in this latter series achieved the 0.500 minimum for the loading, this being for RFAC (+0.677). The C.C. indicated that 5.2% of explained variance was generated using the function, this being more than the reduced data set was capable of doing. The inter-centroid distance in S.D. units is 0.347 using the reduced series and 0.477 including all variables, again showing that more variables can give greater discrimination. The classification array placed 57.3% of cases correctly in the first series and 60.95% correctly in the second, compared with the 50% expected by chance.

Using the child's birthplace as a parameter to partition the data into subsets produced groups that could be separated by a discriminant function, the D^2 between centroids being significant for both sexes. If those variables which have the greater individual coefficient are compared across series and sex then it is apparent that little continuity exists between them. No single variable is common for both sexes, while only one element (LFU3) maintains its usefulness between series. One piece of relative consistency is the magnitude of the C.C. which are higher in the complete data set than the reduced, although slightly greater in females than males. The magnitude of the amount of explained variance illustrates the enormous variability which exists for dermatoglyphic variables even when two groups are statistically separable. Approximately 60% of cases could be correctly classified, this only being a slight, but significant improvement on the 50% expected by chance. It would have been possible to improve this figure if the probability of being in a particular subset was weighted in proportion to the sample size. However, it was felt that the ability to discriminate would be a more severe test if the sole requisite for classification were the function itself, the result of such a procedure being given above.

FEMALES

Parent's Birthplace : Salop/Powys

Selecting the alternative criteria to define geographical location by the common birthplace of both parents showed for females that for a reduced data set a discriminant function could be produced which would significantly differentiate between the two groups ($p < 0.01$). The main contributors to the separation were LFU2 (0.689) and LLATD (-0.534), the function as a whole accounting for 5.7% of the contained variance. In all, 9 variables were involved in the construction of the function, all coefficients being $> |0.24|$.

Using the complete series of variables also allowed significant discrimination between the groups ($p < 0.01$), the amount of explained variance increasing from the former series, the values being 15.7% (C.C. = 0.397). Examination of the standardised coefficient revealed that although the ability to separate the two groups had increased, no particular variable has an excess weight. The two variables noted above were greater than the other coefficients >0.47 although <0.5 and illustrate that to achieve a statistical difference it is not necessary to have a few highly weighted variables, separation being possible on the basis of many elements, each contributing equally small but significant amounts to the final D^2.

The distance between the centroids is again greater when more variables are used, than with fewer, 0.868 as against 0.533 S.D. units, this allowing greater precision in classification, the former series having 70.9% of cases correctly placed in a group while the latter had fewer, 63.04%.

MALES

Parent's Birthplace : Salop/Powys

Producing a discriminant function between the groups for males achieved a D^2 that was statistically significant for both the reduced and complete data set ($p < 0.01$). The smaller set gave 12 variables which contributed to the discriminant, but only four of which had weight over 0.5, those being RFR1 (-0.502), RFRH (+0.615), LFR1 (+0.686), LFR5 (-0.714). These are all finger ridge counts, digit 2 being represented on both hands. In total, 4.7% of the variance was accounted for by the function, less than the corresponding comparison in females.

Consideration of all the variables produced a complete contrast with females, for while the latter had no outstanding variables, as judged by the coefficient, the present series now gave six, 28 in total contributing something. The outstanding elements were LFR5 (-0.738), TFRC (-1.686), RD1 (-0.516), CHL (+0.771), RHL (+0.520), TBL (-0.601). This is the first occasion that a highly genetic character has been involved in discrimination, namely TFRC. The associated C.C. showed 11.3% of the variance to have been accounted for by the linear function.

The two series showed that, as with the previous analyses, increasing the number of variables offers a greater opportunity to effect discrimination between two groups. Only one element was present with a high loading in both series, LFRC, the remainder being unique to each analysis. Consideration of the distance apart of the centroids gives the reduced data set a value of 0.508 S.D. unit, while the complete series gave 0.896, the corresponding percentages of correctly classified cases on the basis of the function alone being 58.71% and 68.94% respectively. Both these indicate that the complete series of data is of more use than the reduced set.

Comparing the results from males and females again showed that the latter were giving a greater difference between the two locations than the former. This was seen, not in the significance of D^2, but in the magnitude of the between-centroid distance in S.D. units, the C.C. and the percentage of correctly classified cases. For both sexes increasing the number of variables available for analysis improved the ability to discriminate between the groups produced. There is little consistency between sexes in which variables have the greatest loadings on the functions, a result previously indicated. Considering all the variables which did contribute to the discrimination gave only 9 in common between sexes for series 2.

Comparison of Parent's Birthplace and Child's Birthplace

In many ways the purpose of the present thesis is to attempt to produce a parameter or series of parameters which will partition the data into groups which are both statistically and logically different. Throughout the work to date the two criteria for allotting a pupil to one county or the other has been either that they were born in the location or both parents had the same birthplace in either county. Both possibilities were examined by univariate and multivariate methods and we must now ask whether one criterion is better than the other. Better in this case would mean either explaining more of the variance contained within the data matrix or correctly classifying more of the cases on the basis of the function. With these in mind it is apparent that using the common parental birthplace allows greater discrimination between the groups than using the child's birth location. This is true for both sexes regardless of the size of the input matrix although the complete data set seems to give a greater difference when the criteria are compared than does the reduced set. The groups generated can be labelled Salop and Powys. One parameter is

not merely a selected version of the other. The discriminant functions appear to be acting on different characteristics in the population. This is supported if the variables which are involved in discrimination are compared between parameters when, for example, in females only 10 of 28 elements are common to both the child and parent's discriminating functions, those with the major coefficient loadings being unique to each analysis and not being maintained over a change of partitioning parameters. There appears to be as great a change in the choice of discriminating variables between sexes as between parameters. That this is shown for sex is not too surprising, but a change of the magnitude shown above between parameters is more unpredictable. The explanation must be in the forces acting on dermatoglyphics when we use the child's birthplace compared with using the common parent. The former is perhaps simpler. The genotype of the pupil is an obvious component in variation, the environment playing a considerable role. This latter component will be a uterine environment affected by the direct influence of stimulus on the mother, possibly changing as a result of interaction with the genotype of the mother and the additional unique effect created by the mother's genotype. At the present time little more can be said due to a lack of biometrical analysis into components of variation.

Trying to determine which contribution the parent's common birth location has on the child is more difficult. In using the same location common to both parents, we are assuming that there is a greater degree of similarity between the genotypes of the parents because of the common birthplace than there would otherwise be, and that this is reflected in the child. We are discounting the environmental effects in which the mother finds herself during pregnancy, although in many cases the child will be born in the same locality as the parents. We can speculate upon the effects that the environment of the mother's birthplace would have on

the child during foetal life although this can all be combined into a single material effect. It would seem therefore that we are assuming that we have randomised the environmental component and are dealing with the genetic. This is a very tentative conclusion and will not be emphasised. However, it seems likely that this is so when we are in fact comparing the effects of the two parameters.

FEMALES

Degree of Welshness, Ancestry : English/Welsh

The third parameter used to partition the data set was termed ancestry, related to surnames of the members of the family (page 55). The comparison was made using both the reduced and complete data sets. It was possible to produce a significant discriminating function with the reduced set between English and Welsh, but only just $p < 5\%$, while the amount of explained variance is small, 1.53%. The variables which weighted most on the functions were RFR2 (+0.514), RFU (0.5581), RAB (+0.5124), LFPII (-0.7817). It can be seen that the right hand digit two is represented by both its radial and ulnar ridge counts, an association not shown by the previous partitions. Two further measures of discrimination were the distance apart of the group centroids, 0.248 S.D. units, and the final probability of the correct classification of cases which was only 53.73%, just marginally above that expected by chance.

Using the complete data set, more discrimination was possible ($p < 0.01$). The CC showed 3.8% of explained variance with a corresponding increase in the between-centroid distance and the frequency of correct classification (57.4%). The finger ridge count variables were all replaced by palmar variables as ones which had the greatest weight on the function.

The conclusion is that little differentiation is possible between the two groups even though there were statistically significant differences between them. Compared with the other two parameters (CBPA, PFA), all the statistics show that less discrimination is possible than using birth location, as observed previously in the univariate statistics.

MALES

Degree of Welshness, Ancestry : English/Welsh

Unlike the previous parameters, males show more discrimination than females between the groups, but only marginally. There was a significant discriminant function $p < 0.05$ with 1.79% of explained variance within it, for the reduced data set. Those variables with the greater coefficients were RFR3 (+0.6668), LFR3 (-0.5732) although two more, RFU4 and LFR2 had weight greater than 0.49. No digit was particularly represented. Both the distance between centroids, 0.266 S.D. units, and the probability of correct classification, 56.27%, are greater than in females. The complete data set improved discrimination between the groups, the D^2 being significant ($p < 0.01$). The amount of explained variance was substantially increased to (4.66%) as well as the inter-centroid distance (0.432 S.D. units). However, the ability to predict the group in a classification array was only marginally improved from the reduced set, this being a little unexpected in view of the detailed statistics. Compared with the previous parameters, ancestry is comparable in its ability to discriminate, especially on the reduced data set. The explained variance, classification arrayed, and distance apart of the centroid, are similar to those found for males previously, although closer to those using the child's birthplace than to the groups generated using the parent's. It is noticeable that only finger ridge

counts have the greater weight in the first set, similar to that shown when the parents' birth locations were analysed above, although different variations are represented in each.

Language : English and Welsh, Reduced Matrices

The possibility that a division of the population, in terms of ability to speak Welsh, was not investigated by univariate statistical method. However, it will be examined by multivariate means in combination with the three primary parameters used. First, an attempt to give a general discriminant function between the two language groups will be made.

Females

It was possible to produce a discriminant function between the two language groups, the magnitude of the between-centroid distances being statistically significant ($p < 0.1\%$). Very little of the contained variance was explained by the function however (1.48%), although a high frequency of correct classifications was achieved, namely 57.58%. In all, nine variables contributed to the function, the greatest coefficient being associated with RFU4 (+0.595), LFR5 (-0.616), RFPII (-0.768). The distance between the centroids in S.D. units was 0.330.

Males

Males were less successfully discriminated than females. No significant function could be generated to separate the group centroids ($p > 10\%$). The amount of explained variance was very small, 0.60% with correspondingly low probability of correctly classifying the cases, 54.52%, not statistically different from chance.

The analysis indicates that, on its own, language is not a useful parameter on which to base data interpretation. There appears to be little difference between the groups in either males or females although for females a degree of discrimination between the groups was possible.

Ancestry : All categories (DOW/0,4))

Throughout the previous analysis, and indeed all subsequent analysis, the parameter termed 'ancestry' has taken two divisions, English and Welsh, these classes corresponding to those individuals with zero or one Welsh grandparental surname and three or four Welsh grandparental surnames respectively (page 55). The amalgamation of the original five groups into two, with the elimination of one, was due to the necessity to raise the sample size within each class on the assumption that those groups combined were the most appropriate. The two groups have been examined by both univariate and multivariate methods for possible variability. However, we are now at a stage to ask if a multivariate discriminant analysis will support the initial assumption on which amalgamation was based. The discriminant functions were between the five classes using the complete data matrix for each sex.

Females

Between the five groups four discriminant functions could be established. The C.C. shows that in total they accounted for 10.59% of the contained variance, this being much greater than the amount explained when the amalgamated sets were compared. The contribution of each function is shown in Table 68. No particular label can be attached to the functions, except possibly that it alternates for the greater loading on the left and right hand, the axial triradii being represented on function (1) and (3). The classification array based on the functions showed that 27.18% of cases were correctly classified as against 20% expected by chance. Further examination revealed that each group differed in the ability of its members to be correctly placed, the middle group (DOW = 2) having the lowest value (20.3%), while the two extreme classes were much higher, DOW(0) = 29.1%. DOW(3) = 31.5%, DOW(4) = 33.0%. This is what was hoped for, the class with

equal inputs of English and Welsh being intermediate between the others, containing elements of both. However, with such a small number placed correctly, the differences between the groups is only slight. Even so, the F matrix for the significance of the D^2 between groups indicates that many of the differences are statistically significant. In order to obtain a pictorial representation of the relationship between the groups a non-metric multidimensional scaling test was performed using the programme Minissa. An alternative would have been to plot the centroid coordinates in all dimensions. However, Minissa attempts to relate actual N dimensional relationships to a rank order matrix in fewer dimensions. In the present matrix the four dimensions were reduced to two with zero stress on Kruskal's stress estimator. The plot is given on page 432. Implicit in the use of the parameter is the assumption that when moving from the class with no Welsh grandparents to that with four, the intervening groups will show monotonicity. We do not expect that the intervals in terms of D^2 between classes will be equal, although we do attempt to place points in linear N dimensional space. If the relationship was perfect, the five classes would fall on a straight line. In practice, of course, they do not, as Figure 11 shows.

Examining the input matrix reveals that in general monotocity is achieved between the five classes, the main error being for class two (DOW(2)) which is too close to DOW(0), and the distance between DOW(3) and DOW(4) which is too great compared with the remaining lengths. It can be seen that class DOW(2) falls somewhat between the remaining points, while the addition or removal of a Welsh grandparent causes as great an increase in the respective D^2 relative to a second inclusion or removal. (The DOW (4)/(3) and DOW(0)/(1) distances are greater than the DOW(3)/(2) and DOW(1)/(2) respectively.) The greatest distance is, as hoped, between the 'pure' classes of DOW(0) and DOW(4). It must now be asked how this affects the

initial assumption to amalgamate. In judging this we must remember that an additional analysis between the classes with DOW(2) removed may, or may not, alter the relationships generated. Actual analysis showed that another set of functions generated without DOW(2) did not change the relationship between the remaining points. The amount of explained variance was in fact increased with all inter-class D^2 being statistically significant ($p > 0.05$). It seems that while we are justified in assuming that classes DOW(0) and DOW(4) are at opposite poles, the inclusion of the other classes with them may seriously affect partitioning. On the evidence to hand, better amalgamation would have been DOW(1) with DOW(3), even though the F matrix indicates that they are statistically differentiated. Since they have the smallest D^2, class DOW(2) would be eliminated from further analysis as it is now.

Males

The corresponding discriminants between the ancestral classes for males explained a greater proportion of the variance than for females, viz. 11.79%. The variables with the greater loadings do not bear any relationship to those shown in females, a feature found for other functions, only six variables being common to each analysis. A noteworthy feature however is that the variable TBL is present with a large loading in each of the first three functions. Indeed, it alone has a weight greater than 0.5 on function one. Classification on the basis of the functions gave 28.69% correctly placed, slightly higher than in females, but like them in that the greater frequencies of correct placement occur in the outer groups with DOW(2) again having an almost random distribution of the functions. The F matrix shows that not all the distances between centroids are statistically significant, examination of the Minissa plot of D^2 showing the relationship of the points. A two-dimensional plot gave zero stress by Kruskal.

Examination of the plots shows that classes DOW(2) and DOW(3) lie very close together, with a non-significant D^2 between them. When the D^2 associated with the remaining points are examined, however, in conjunction with the plot there is no monotonicity indicated. A ranking of the distance factors for the five classes would essentially be DOW(0), DOW(3), DOW(2), DOW(4), DOW(1). While DOW(0) and DOW(4) are at opposite poles, the extreme position of DOW(1) compared with DOW(0) precludes the ranked order which was evident in females. Compared to females, it seems tht class DOW(1) and DOW(3) have interchanged, altering the relationships. It shares a common feature in that the distances DOW(0)/(1) and DOW(3)/(4) are large, the result of a substitution producing a dramatic effect. However, the lack of monotonicity does not correspond to the hypothesised relationships.

In relationship to my original amalgamation it would seem that heterogeneity has been introduced into the dichotomous model. However, as the intergroup relationships are not aligned, as hoped, the usefulness of the parameter is doubtful. An improvement may have been the amalgamation of classes DOW(2) and DOW(3) or even their removal from the analysis, although it is doubtful if a trimodal parameter with no linearity, resulting from a name substitute, would be any better than the amalgamated groups or a dichotomy based on the polar classes. In a manner comparable with the analysis for females, discriminant function between the classes with DOW(2) removed increased the amount of explained variance, but left the relationships between the remaining classes essentially identical in absolute magnitude and rankings.

Child's Birthplace and Ancestry: Salop/Powys x English/Welsh

The ability of the parameters to produce discrimination when used individually has been considered by multivariate discriminant functions. Attention must now turn to combinations of these criteria to see if a more strict definition of the subset can improve both the predictability of correct classification of the cases and the amount of explained variance, as well as the investigation of the spatial relationships between the groups. In essence I wish to reduce the within-group heterogeneity while increasing between-group heterogeneity. The first combination will be ancestry by the child's birthplace, both parameters taken as dichotomous, i.e. English and Welsh with Salop and Powys.

Females (F.C.)

Table 71 gives the description statistics for the four groups generated. Three functions can be produced between these, the total amount of explained variance being 7.44%. Most of this is taken out by the first two functions, only 0.53% being attributable to the third. The analysis was based only on a reduced data matrix. In all, 10 variables contributed to the function from the 32 input. Plotting the first two principal functions indicated that the first is producing a split between Salop and Powys, while the second axis has no easily discernible relationship combining WS and EP against WP and ES. The third function, although not plotted, clearly relates to dividing English from Welsh, the small C.C. reflecting the initial multivariate analysis on this parameter alone. If the first function is compared with that produced earlier between counties based on the child's birthplace, it is apparent that the variables with the largest weight occur in both, these being LFU3 and LFR5, although a third variable in the latter is not shown in the former. Function two has no counterpart on an earlier analysis, but the final function does. Like the first, variables detailed

with major weights in the initial discriminant analysis were represented in the present, those in common being RAB and LFPII, although this latter function contained an extra discriminating variable RFR4 at the expense of another. It is tentatively concluded therefore that the two parameters are sufficiently distinct to have different variables discriminating between their centroids and, when in combination, they act almost independently, producing functions with many of the characteristics of those initially generated. The classification array revealed that 31.20% of cases could be correctly placed. However, this would have been greater were it not for the low frequency found for the subset WP which had a much lower success rate, the remaining three subsets all having more than 35% correctly classified cases.

The F matrix between groups showed that only EP and WP did not have a significant D^2 between them. Plotting the centroid on the first two functions (Figure 12) reveals this clearly, these two groups differing from both WS and ES which are, in their own turn. statistically different. It seems therefore that within Salop ancestry is playing a part in discrimination, but not in Powys, while a major dichotomy between regions is present.

In comparing these results with the univariate statistics any relationships tend to be tentative due to the high intercorrelation between variables. Allowing for this it seems that:-

(1) Finger ridge count tends to differentiate Salop from Powys

(2) Ancestry shows no such association with variable groups

(3) The relationships speculated to be occurring by univariate results are in general upheld by multivariate. The Salop/Powys division is maintained but the significance of ancestry was more confused, the univariate result highlighting the comparison of ES/EP as a major dichotomy, as did the multivariate, but the latter also indicating a difference between WS/ES, a feature not clearly seen from the former analysis.

Males (M.C.)

Using the sama parameters as for the females, just described, on a reduced data set the three functions produced explained 7.51% of the contained variance, slightly more than in females. The distribution of this between the functions differs however in that the third function has a greater share of the total, even though the main part is taken out by the first two.

The first function again separated Salop from Powys, while the second partitioned English from Welsh. The final one compared WP and ES against WS and EP, giving similar results to females except that the second and third functions are reversed. The 11 variables which are used in discrimination are nearly all concerned with some aspect of the fingers, the two palmar elements never having a major loading on any function. Comparing those variables with the greater loadings between the present analysis and the initial multivariate comparison for each parameter separately gave only slight agreement between the two. Function one had two common variables with large weight, while the second had none, a different situation from females. One variable LFPII was represented with high loadings on all three functions, also being one of the common two noted above. This suggests that it is a major discriminator between the four subsets. This is however unexpected because the univariate results gave no indication of this variable having any significant differences between any groups, regardless of the partitioning parameters or combination, and serves to illustrate how inter-correlation can alter the interpretation of the variability of a character between groups.

The ability of the functions to discriminate, as judged by the classification array, revealed that 32.40% of cases were correctly placed but, like females, the subset WP had the lowest value, reducing the overall frequency although this is not as marked as in females.

Mapping the centroids for the first two functions gave the conclusions noted above. The F matrix gave non-significant differences to the D^2 between ES/WS and EP/WP. However, the remainder show marginal values, the exception being for the D^2 for WP/ES which is highly significant ($p < 0.01$) and WS/WP ($p < 0.05$). It may be considered that ancestry is contributing little to discrimination for males, while birthplace again becomes the major component; the Salop/Powys division being most prominent. The univariate statistic gave no firm conclusion as to intergroup relationships, mainly due to the lack of significant results available. One constant feature is that the variable RT2,which was one of the few to have statistical significance between some of the groups, was represented by both ulnar and radial count in the present discriminant analysis; the third digits also had some constant use between statistics.

Comparing the distribution of subsets between sexes showed some similar patterns. Both sexes give a major division between Powys and Salop even though the variables on which this is based differ. They depart from total consistency in that while females give a significant WS/ES split, males do not, both sexes however agreeing in combining WP/EP.

Common County of Parent and Ancestry: Salop/Powys x English/Welsh

A direct continuation from the previous dual division is to use the common place of origin of the parents to define birth location (Salop/Powys) and to combine this with ancestry, analysis again being based on a reduced data set.

Females (F.P.)

Examining Table 72 revealed that the three functions were explaining 10.48% of the contained variance, of which 63.7% was taken out by the first function and another 32.06% by the second. The final function

had very little discriminating power. Interpretating the functions was more difficult than in the previous comparisons. It appeared that the first again separated Salop and Powys while the second was mainly involved with discrimination between WS and ES, the remaining two having much lower loadings than these on the function. Those variables which loaded heavily on the first function could thus be compared with the former analysis between Salop and Powys, based on ancestry. This revealed that only one variable was common to both, LFR2, although the other element identified earlier was also present, but with a low loading (LLATD - 0.35507). The second function showed no common variables with the function between English and Welsh presented earlier.

The number of cases correctly classified by the functions alone was 23.75%, only just above the random level. However, the table showed that the group WP was an aberrant set with very few correct placements, most of the pupils from this set being placed in EP. The remaining three subsets all had greater than 33% correct classification, the overall mean with the aberrant group removed being 39.86%, comparable with 39.39% given for the child's birthplace with ancestry if WP is not considered.

The plot of the centroid against the first two functions is seen in Figure 12 Consideration of the F matrix revealed that the D^2 between EP and WP was not significant, while all the other comparisons were. This therefore gives a major dichotomy between Powys and Salop, but with ancestry separating out English and Welsh within Salop, but not Powys. These conclusions exactly parallel those found when the child's birthplace and ancestry were analysed (page 245). In view of the lack of significance shown by the univariate statistics on the dual partitions, these similarities could not have been predicted.

Males (M.P.)

The same analysis performed on males showed the generated functions were capable of accounting for 10.46% of the variance contained within the discriminating variables. Like the previous analysis on males, the third function accounted for a greater proportion of this than it did in females where two functions clearly held > 90% of the original information. Three variables had large weight on the first function, RFR3 (-0.851), LFR5 (+0.745), LFU5 (-0.509) from 8 selected, the first two of which were the only ones common to the earlier discriminant between males DOW(0,1) and PFA (0,1) respectively. Clearly there is little equivalence between the present and previous functions. The classification array gave 30.47% correct classification although two groups, ES, EP, had much greater values, 50.0%.

As usual, we can plot on the first two principal functions the centroids for the groups. Figure 14 shows that the first function is separating out ES differentially, while the second pulls EP away. Both WP and WS are close to the origin on both functions. However, the third function does separate WS from the remainder, this being a possible alternate to the distribution, considering the similarity of the C.C. for functions 2 and 3.

WP is at the origin of all three axes. The F matrix showed that the D^2 between WS and WP was non-significant ($p > 0.05$) as were the distances WP/EP and WS/EP. This result in the subset ES is the only one statistically to differ from the remaining three, all of which could be combined into a single group. The comparison with females shows agreement in that ES is separated, but the set WS has become combined with WP/EP (and not remained separate). Again, in comparison with the figure for CBPA (0,1) and DOW(0,1), WS is not combined with ES but with EP-WP.

Examination of the univariate statistics gave no indication of the relationships expressed in Figure 14.

We can now ask if the four sets of analysis just reported have produced any consistent conclusions concerning the relationships between the four subsets. We have already reported the possible differences between using the child's birthplace or the parent's birth location to define geographic placement (page 236). However, for this section no difference will be made between either parameter, e.g. EP being the same for each analysis. Figure T2 shows the relationship graphically, the following being noted:-

(1) Within Powys no significant difference was found between the English and Welsh regardless of sex or geographic placement parameter.

(2) The English in Salop (ES) were always statistically separable from both EP and WP.

(3) For the Welsh in Salop (WS) the relationship with the remaining subsets was variable. In females it was always a separate entity, statistically differentiated from both ES and EP/WP for both the analysis FC and FP.

Figure T2

In males, WS was combined with ES for analysis MC, but amalgamated with WP-EP in MP.

(4) Females always showed a major division between Salop and Powys, regardless of ancestry, while this was true only for analysis MC in males. This was reflected in the first principal discriminant function separating counties in all but this latter analysis.

(5) The variable with the greatest loadings on the functions were not in general the same between the four sets FC, MC, FP and MP.

(6) The amount of explained variance was greater when the parent's birthplace was used, than when the child's birth location was substituted for both sexes. However, within this females had on both occasions > 93% of the explained variance contained within the first two functions, while in males it was never greater than 80%.

(7) Considering the univariate results it seems unlikely that the consistent relationships detailed above would have been noted. With the unilateral maximum finger ridge count, an indication was given (page 97) but it was not until the present analysis that other variables could be included in defining the associations, and the constancy over both sex and parameter combinations revealed.

Child's birth location (Salop/Powys) x Ancestry (English/Welsh) x Language of the child (English/English-Welsh)

The general conclusion concerning the interaction of two parameters has been given above for a reduced data set, it being considered that the complete set of data would not have changed the above conclusions and relationships. The third parameter to be examined initially was language.

Little discriminating power existed within this latter parameter although the D^2 between centroids for females was statistically significant. It was possible however that when used in conjunction with the above parameters

it may increase the amount of discrimination. There would of course be 8 possible combinations of three parameters, each with two alternatives, but it was apparent that sample size was too low in some to give useful comparisons. For instance, the low frequency of Welsh speaking children in Salop makes their inclusion in a separate category unrealistic, and for Salop language was not therefore considered, division producing just an English and Welsh by ancestry, comparable with the above. Within Wales, however, it was possible to have four separate classes initially, the discriminant function analysis on a reduced data set being based on six classes (Tables 73/4 & 78/9). Subsequent to the analysis, however, it was found that one class, the Welsh speaking English in Powys, contained fewer cases than was desirable compared with the other classes (15), and although the analysis was not repeated, this class was not reported in the plots of centroids, being abnormally distant from the remainder. The six classes compared are thus:-

	County	Ancestry	Language	Code
Salop	Salop	English		ES
	Salop	Welsh		WS
	Powys	English	English	EPE
	Powys	English	Welsh	EPW
	Powys	Welsh	English	WPE
	Powys	Welsh	Welsh	WPW

Females (F.C.P.)

Using the reduced data set, the discriminant function analysis produced five functions which accounted for 12.65% of the contained variance, more than the functions based on only two parameters. The distribution of the variance was such that 63.32% of it was accounted for

by the first two functions. In all, 10 variables were involved in the discrimination, of which two were palmar ridge counts and the two ATD angles, the remainder being finger parameters, this being about the expected proportion of finger and palmar variables from the initial input.

A conflict arises because we have five group centroids to plot into four dimensional space. With three groups a two-dimensional plot is available; with four, the majority of the variance is within the first two functions, consequently a two-dimensional plot will give a good indication of the relationships. However, as the number of groups rises to 5 and above, the variance tends (in the present data) to be spread on almost a steady downward gradient between the functions, the consequence being that plotting only the first two dimensions will distort the relationships. The approach used for this and all subsequent analysis, unless otherwise stated, is to use a non-metric multi-dimensional scaling plot utilising the programme Minissa (see page 225). This has the advantage of utilising the D^2 and attempting to reproduce N dimensional relationships in fewer (hopefully two) dimensions. The disadvantage is that it utilises the rank of the input matrix elements, this becoming less serious as the number of input groups increases. With only five groups the ordered relationships are sound, but the absolute magnitude of the interpoint distances are not. Plotting five of the original six groups (Figure 13) and considering the associated F matrix shows that two main groups are produced, these corresponding to Powys and Salop, this latter region having its English and Welsh fractions statistically separated ($p < 0.01$). Both these latter classes are at a statistically significant distance from all the groups within Powys, which in themselves have certain similarities. Reference to the previous analysis (Figure 12) shows that for all cases the English and Welsh in Powys do not differ statistically, the present analysis supporting this to some extent. The previous class EP has been shown to be almost exclusively EPE and

is therefore comparable. The group WP has been split into two parts depending on linguistic ability. The conclusions are thus:-

(1) The group EPE does not differ statistically from either WPE or WPW

(2) The two groups WPE and WPW are statistically different ($p < 0.05\%$), although only just.

The use of language has pulled the two factors within WP apart, neither however being statistically different from EP. It is useful that the most Welsh section WPW is, in rank terms, further away from ES and WS than the other two (WPE/EPE), although WPE is unfortunately nearer than EPE to these latter classes (ES/WS). Although there are two non-significant differences in Powys, the set WPW is further from EPE, both in terms of the D^2 and the significance of this distance than is WPE, suggesting that EP and WPE have more similarities, than either, to WPW. This is an extension of the earlier result. Within Powys two groups now tentatively exist, namely WPW and EP + WPE, the latter lying between the former group and the two sets within Salop.

Males (M.C.P.)

Combining language with the child's birthplace and ancestry in males, again using the six classes defined for females, gave discriminant functions which explain 7.49% of the contained variance in the reduced data set. The first function accounted for nearly half of this, 5 of the 8 variables involved having high loadings. Using a Minissa plot of D^2, not including class 3, gave Figure 15. It is interpreted in conjunction with both the F matrix and the previous 'two parameter' analysis (Figure 14).

The constant features are, first, that ES and WS remain associated, with a non-significant D^2 between them, with this group opposing those having Powys as the birthplace. As with the previous analysis, WS is very close to being statistically different from the Powys classes, but not exactly so. However, its position clearly combines it with ES most strongly. The essential difference from Figure 14 is that the class WP, now divided by language, produced a class WPW, the most Welsh element that was positioned at a non-significant distance from both ES and WS, the former being marginally closer than the latter. WPE was in a position comparable with WP in Figure 14. It is clear that this arrangement makes no sense in terms of the proposed hypothesis. The most Welsh set should be furthest away from the influence of Salop, not closest to it. It appears that in subsetting WP into WPE and WPW an aberrant latter set has resulted. To describe a subset as aberrant requires evidence beyond a relationship not comparable with our hypothesis. Two pieces of evidence point to this being correct. First, the amount of information extracted in terms of explained variance falls between the initial analysis (page 247) and the inclusion of language in the present functions. The incorporation of language has not contributed to the discriminating ability of the variables, this being in direct contrast with the results for females where there was almost a doubling of the canonical correlates and a meaningful distribution of centroids on the plot. It can be added that the plot itself was a sufficient representation of the original D^2 distance, the Kruskal Stress being zero in three dimension.

The second line of evidence is that even though the class WPW is statistically differentiated from other classes, the number of correctly classified cases within, based on the functions, is only 14%, a greater number in fact being placed in class WPE (18.9%) although we would expect 16.67% by chance alone. It is probably a direct result of WPW moving

toward ES/WS which maintained WPE in a position comparable with WP rather than the inherent separability of the subset.

It appears that language is not adding to discrimination for males when combined with ancestry and the child's birthplace, at least in a reduced data set. The subset WPW occupies an aberrant position on a Minissa plot, close to the "English" element, while chance probably placed WPE in a favourable position relative to the remaining classes.

Parent's Birthplace (Salop / Powys) x Ancestry (English/Welsh) x Language (English/English-Welsh)

As with the previous analyses, the location of the child in geographical space can also be defined by the common location of the parents' birthplaces. Discriminant functions exactly comparable with those just detailed for males and females can thus be generated. However, a new aspect is now introduced. In all previous analyses the amalgamation of classes was based on the non-significance of the D^2 between centroids. In much of the following analysis two forces conflict. It is a well known statistical axiom that given a sufficiently large sample size almost any comparison can become significant, yet in discriminant analysis small sample sizes tend to bias the estimated D^2 upwards, exaggerating the distances. The first facet of large sampling probably resulted in the significances found earlier between the two subsets based on ancestry alone, while small size undoubtedly made group (3) on page 253 extreme. When the substitution of the common parental birthplace for the child's occurs, there is a corresponding reduction in the sample size within each class. If the number of cases within each is roughly equivalent, then this bias is unlikely to alter the ranked relationships between classes, but the significance of these distances could be biased. If the actual distance is an accurate reflection of the "correct" distance, then a small sample will reduce the degree of freedom and raise the probability.

Alternatively the small sample may give an abnormally high D^2 with the associated high significance. In many ways the argument is circular but if we allow for sample size, then this would at least reduce the bias. The present SPSS programme does not do so, the associated F matrix being for the raw D^2. Hence in interpreting results from such analysis the Minissa plots are valuable in using rank and giving spatial representations which can, to a limited extent, reduce extreme distances. References will therefore be made partly to the F matrix and also to the relative distribution of points in reduced space and compared with plots made using the larger sample sizes based on the child's birthplace.

Females (F.P.P.)

When the child's birthplace was replaced by the common parent's the sample size was reduced from 874 to 459, of which 216 fell in one group, the inequality in group samples thus being large. The functions generated however accounted for 18.15% of the contained variance, more than the comparable analysis with the child's birthplace (page 437), the inclusion of language to the dual comparison almost doubling the percentage (page 436). More than 90% of this information is contained within the first three functions, the first two of which have their greatest loadings on finger ridge counts while the palmar ridge counts contributed mostly to the third one. The palmar pattern intensity index only appears in the fourth and fifth functions while the left ATD angle (LLATD), although present in the list, never loads high on any function.

A Minissa plot of the D^2 gave a two-dimensional representation with zero stress (Kruskal). The distribution of points again shows a division between Salop and Powys, yet within the former the English and Welsh are not statistically separate ($p > 0.10$), this being the first occasion for females when this comparison has not given a significant D^2.

The actual significance of the numerous D^2 varies, but in general Salop remains apart from Powys although all comparisons with ES are marginal. Within Powys WPW is again statistically significant from WPE although not so from EPE. These probabilities are at odds with previous results in part. If the position of the plots is examined they are extremely comparable with both Figure 13 using the child's birthplace and Figure 12 without language inclusion. The main locational difference is the position of WPW relative to the remaining groups. Whereas in Figure 13(a) it was most distant from the Salop group and on the opposite side of EPE from WPE, the present analysis found it rotated away from EPE with WPE now in a more medial position. Compared with Figure 12 the division of WP into its two parts results in WPW moving in some direction to the right of the plot and WPE moving close to EPE. Hence the distribution of plots is comparable with the relative locations prior to the inclusion of language. In general, the analysis gives three groups:-

(1) Salop as a unit, with English and Welsh combined

(2) WPW as a separate group, although with its closest relationship with the third group rather than the first.

(3) An amalgamation of EPE and WPE, most closely associated with WPW and distal from ES and WS

Compared with Figure 12 the main differences are the amalgamation of ES with WS and the relative position of WPW to the remaining groups.

Males (M.P.P.)

An analysis for males comparable with that just given for females showed that the discriminant functions produced could explain 14.4% of the contained variance, again an increase from the 7.49% found with the child's birthplace being used and from the 10.46% for analysis MP. Almost 79%

of this information is contained within the first two functions approximately equally and of the 8 variables contributing to this discriminator only one (RLATD) is not a finger ridge count, this latter element not loading highly until the third function is derived.

The Minissa plot of the D^2 gave zero stress (Kruskal) for a two dimensional representation of the rank order distances (Figure 15) The F matrix revealed that only one clas, ES, was statistically different from the remainder, confirming previous analysis (Figure 14) The remaining groups lie in a line but consideration of the actual D^2 and the F matrix, apart from showing all the distances to be non-significant suggests that the groups WPW and WPE are much more closely related to each other than to the remaining two. The closest group to this is EPE, again with a birthplace in Powys, while WS is most dissociated from the remainder. These relationships bear little resemblance to those in Figure 14 with the child's birthplace used. However, the wayward nature of this distribution has already been noted (page 256) and yet compared with analysis MP (page 250) there is a reasonable agreement. ES is still the only significant group but the relationship of WPW and WPE to the remainder is different from that shown by MP, the main difference being that EPE is now between WPW + WPE and WS, and not most distant from it.

It seems therefore that within males only two groups can be detected; ES is one, the remainder being combined within the second. The relationships within this second group are vague, in one case EP being combined most closely with WPW + WPE (WP), while in another analysis WS is most closely associated with WP, EP being distant from them. The lack of statistical difference between the groups and of consistent relationships in terms of D^2 suggests random forces acting within the second major class to influence and remove more precise relationships.

Having detailed for the eight previous sets of analysis the effect that successive partitioning of the reduced data set had produced, we may now ask whether any consistent association or conclusions can be deduced. For the dual partitions this has been dealt with earlier (page 251).

The inclusion of language was most productive in females allowing the division of WP into WPE and WPW, the latter being placed at a statistically significant distance from the amalgamated classes WPE and EPE (Figures 13 & 15). The relative position of WPW to the other classes differed depending on whether the child's or parent's birthplace was used in the analysis. In the former cases WPW was furthest away from ES and WS, while with the latter parameters it was approximately equidistant from WPE + EPE. A statistical difference between ES and WS was evident for three of the four sets of analysis, and only in the final one was this difference reduced (Figure 15). If, however, the magnitude of the D^2 between those groups is compared as a simple fraction to the maximum D^2 produced by the analysis, then the corresponding values for Figures 13(a) and 13(b) are 0.595 and 0.609, clearly very similar although the latter analysis gave non-significant probability in the F matrix. This therefore is possibly a result of a small sample affecting the significance although all that has previously been stated about the sample size, D^2 and significance must be borne in mind. The previous sets of analysis have given significance to the ES/WS D^2 and it seems that they may indeed form separate classes within Salop, giving four possible groups on the basis of the three parameters available.

Compared with the females, males gave a much more confused result. It was evident that increasing the number of classes within the discriminant analysis does not automatically lead to an increase in the amount of explained variance, as was evident when the analysis MC was compared with

analysis MCP. The most deviant result in males is indeed that for MCP, the remaining three having some consistency. It seems that the subset ES forms a separate group in males when the parent's birthplace is one of the partitioning criteria, but not when the child's birthplace is used in its place. Within Powys no difference between English and Welsh is evident except for the aberrant plot in Figure 15(a). The interrelationships of the subsets within Powys are variable but with the parent's birthplace, used WS is also shown to belong to this set regardless of language considerations, giving two basic classes for the analysis. When the child's birthplace is used, the basic division is between Salop and Powys. If analysis MCP is not included, then the main divisions of the male data are between Salop and Powys. Language is having little discriminating effect, while substituting the parent's birthplace for the child's results in the movement of WS from being with ES to an association with Powys.

The Salop-Powys split is common to both sexes as well as the separate ES group with the parent's birthplace. The three areas of difference are:-

(1) ES always being separate from WS in females but only when the parent's birthplace is used in males

(2) The class WPW exists as a separate unit in females but not in males.

(3) WS is never associated with Powys in females but is in males when the parent's birthplace is involved.

Additional general conclusions can be summarised as follows:-

(1) Increasing the number of classes in the analysis allowed a greater percentage of explained variance.

(2) Using the parent's birthplace gave a greater amount of explained variance than using the child's birth location.

(3) Finger ridge counts tended to weight most heavily on the first few discriminant functions while palmar variables were either not involved in the production of the functions or only had significant loadings on the lower functions.

Regional Multivariate Analysis

The use of multivariate analysis was now extended to the fifteen regions defined previously (page 204).

Child's Birthplace

Female

Discriminant function analysis was carried out on both the reduced and total data set. Examination showed that the latter matrix was much more capable of producing discrimination both in terms of the amount of explained variance and the ability to correctly classify cases. The reduced data set gave 18.85% explained variance with 12.39% of cases correctly classified, while the complete matrix accounted for 54.74% of the variance and had 17.17% of cases correctly placed. When these figures were compared with the 6.67% of correctly classified cases expected by chance, it was apparent that in moving from the former to the latter data set, in every group except one, the number of cases correctly placed had increased, the magnitude of this varying over groups but the differences being reflected in the weighted means given above.

Comparing the variables which contributed to the functions showed that of those that were potentially common to each data set, the ones which had the highest loading on the first function, for the reduced matrix, were maintained in the analysis when using the complete matrixa, although these variables which loaded most highly on the lower order functions did not transfer across. In addition it seemed that those variables which gave

significance on the one-way analysis of variance described earlier, were not preferentially contributing to these functions, while many variables that did not give such significance were capable of contributing to the first few discriminant functions when entered into the analysis. It seems from the analysis that even when many variables are correlated, entering as many as possible into the analysis affords a greater chance of finding some which will give significant discrimination between the groups, even though the univariate statistics gave no indication as to their usefulness.

The D^2 produced from the F matrices were subjected to single link clustering (SLC), maximal linkage clustering (MLC) and multidimensional scaling using Minissa (MDS). Each data set had its own matrix and each will be described separately and a comparison made at the end. As there is much detail to be obtained from each analysis, the main association will be given somewhat briefly, with relevant arguments where necessary. All material on which the discussion is based is given in the Appendix.

Reduced Matrix

Females

The two clustering methods and the MDS all agree in the primary level of amalgamation, these being:-

(1)	Welshpool Newtown Llanfyllin	(2)	Oswestry Ellesmere	(3)	Llanfair Caereinion Llanidloes	(4)	Machynlleth Knighton

Those in group (1) form a natural unit as do those in (2). The third group is a little unusual in that the regions are not directly connected. However, it seems possible that a redefinition of the Newtown catchment might give continuity between them. The fourth group is peculiar in that the two locations are separated by a large distance, yet they are at least both mountainous regions, this possibly providing the connection between them.

The remaining groups all have their relationships to the above clusters at a much lower level than exists within the above, the exception possibly being Shrewsbury. This region is on MLC combined into (3) due to its small D^2 with Llanfair Caereinion. However, SLC does not amalgamate it with the latter until the groups (1), (2) and (3) have themselves been combined. MDS favours the result from MLC, although this is a subjective conclusion. The relationships of the above groups are also clear, groups (1) and (2) being most similar, group (3) combining with them next. Depending on which manner of clustering is employed Shrewsbury will next combine with the three sets if it has not already done so. Having reached the point where the level of similarity has been reduced to include those regions in the three groups, the areas remaining all have more vague relationships to the above and to each other. It is at this level that SLC and MLC start to disagree. SLC combines Bishop's Castle into the main group because of its relationship with Ellesmere, while MLC puts it with Rhayader, This latter combination seems much better due to the close proximity of Bishop's Castle with the latter. In addition, these two are most similar to group (4) on MLC, this again being geographically meaningful, although the level at which these regions associate is among the lowest for the matrix. Pontesbury has its closest association with Oswestry, while Church Stretton relates mostly to Llanfair Caereinion. It is apparent that as we widen the degree of association between groups, then ultimately we end up with a single class. The decision as to what point we judge the clusters to be heterogeneous is arbitrary. In the present analysis where sampling may be critical in producing aberrant D^2, it seems that anything not included in the initial groups are suspect in its final association. The chart which follows summarises the relationships found:-

Figure T3

It seems that the southern areas of Rhayader, Knighton and Bishop's Castle, with Machynlleth joining it, although having variable association, tend to have more in common than they do with any of the remaining areas. The interrelationships between these other regions are clear, although two areas are suspect in this class, while the relationship to the southern region is not convincing. Small sampling makes the position of Meifod extremely tentative.

Complete Matrix

Females

Using MLC, the relationships set out in Figure T4 are considered to be the most probable. Three initial groups are formed. However, SLC shows that within this first level two regions are in conflict. First, Shrewsbury has its smallest D^2 with Oswestry, while Newtown has its closest association with Welshpool. MDS revealed that after fitting the fifteen regions into three dimensional space (Kruskal stress = 0.090), Shrewsbury remainder closer to Oswestry than Llanidloes. In fact this was its

closest association with any region. Newtown differed however in that MDS placed it nearer to Llanfair Caereinion than to Welshpool, confirming the MLC relationship above. Ellesmere amalgamates readily with group (1) due to its close association with Llanfyllin, Welshpool and Oswestry, while groups (2) and (3) also fairly naturally merge together.

Figure T4

The conciseness of the clusters is now decreasing, Figure showing the order in which the different regions are merged with the major groups initially defined. When examined by MDS they form two units, the most outlying regions entering the cluster last. As identified earlier, it is Newtown which is 'pushing' into the alternative group most strongly with Shrewsbury to a lesser extent. If the two divisions set out above are displayed geographically, then the relationships shown fit well into

what we would want, i.e. those regions which adjoin each other are present in the same group. The final two regions to enter the above groups, Rhayader and Knighton, are those which show an aberrant relationship. It would have been a clearer picture had one or both of them been placed in the alternative group, there then being no disjointed boundaries for these. Of the two, it is Rhayader that is most suspect, being the last to enter the analysis on both SLC and MLC, as well as having a peripheral position on a MDS plot. Even so, both these regions must be suspect in their relationships at the present stage of the analysis, especially when their sample sizes are considered.

The other disjointed association is between Machynlleth and its neighbours for it is most strongly combined with Llanfyllin and Welshpool and not with the adjoining areas. In view of the strength of this relationship, being the second strongest on SLC and MLC, it cannot be dismissed as sampling and must for the present time be considered a real relationship.

It can now be questioned whether the two data sets give comparable results, and the answer is seemingly 'Yes', although the fact that one set was contained within the other must influence the results. Several 'basic' groups appear although the relationships within these groups vary, as do those between groups.

The strongest associations are:-

(1) Llanfyllin, Welshpool, Oswestry, Ellesmere

(2) Llanfair Caereinion, Newtown, Llanidloes, Shrewsbury

(3) Pontesbury, Church Stretton

(4) Rhayader, Bishop's Castle

It seems that (3) is related to (2) while (4) is never combined with (2) or (3) although it can be with (1). This latter group changes

its association with (2) + (3) and (4) between the two sets of analysis. Machynlleth is never strongly associated with (4) but on both occasions belongs to the same super group as does Meifod. Finally, Knighton gave no consistent association with any other area.

Parent's Birthplace

Females

As with the previous series of analyses put forward, the next stage was to consider using the common parental birthplace to allocate a pupil to a particular location. When this was done it was apparent that the size of sampling within some groups was lower than desirable, even after amalgamation. With this in mind two sets of discriminant function analyses were carried out to see if, even under these undesirable conditions, any variation akin to that shown for the child's birthplace was present. It was seen that few constructive relationships were going to emerge. Although the amount of explained variance was large for both data sets, the F matrix elements and the D^2 were large, subsequent clustering giving no structure to these matrices. With both SLC and MLC, groups were added to a single class with no differentiation into clusters appearing. The nucleus of this single group was Llanfyllin, Welshpool and Oswestry, the other regions being added to this on an apparently random basis. There are two possible explanations:-

(1) There is no variation akin to that found for the previous analysis present for this parameter. From a single 'core' region the population spread out, seemingly clinally, with the inclusion of the other regions into this group being random.

(2) Differences between regions do exist but these are masked due to the extreme D^2 produced by small samples within many of the

groups. Although we would hope that a sample, even a small one, would under multivariate conditions with a complete data set reveal its association, or lack of it, with a given region, it seems that the effect is to give an extreme population lying on the limits of its hypothetical universe of relationships, as found on a MDS plot. The sampling errors seem to outweight the finer differences possibly present over the limited geographic area studied.

The second explanation is much the more likely, especially in view of the corroborating evidence concerning sample size and D^2 by Dennis (pers. comm.) (Dennis 1977b).

Reduced Matrix

Males

Using the child's birthplace to locate the males in geographic space, and performing a discriminant function analysis on a reduced data set, revealed that fourteen functions would in total account for 29.33% of the contained variance of which the first two functions had 5.9% and 5.0% respectively. The ability of these functions to discriminate is measured by the frequency of correctly classified cases within the sample, this being 12.84% as against 6.67% expected by chance. Of the thirty two variables input, sixteen were involved in the functions, the least ATD angle being highly loaded on the first two functions and although finger ridge counts form over half the variables (9) they are less frequent as a proportion of the whole than in females.

Three methods of clustering the D^2 were again considered, the general amalgamation sequence being given in Figure T5 for MLC. Three primary groups appear, with a fourth, much weaker assemblage forming

at a later stage. The members of each group are neighbours except for group (2) although both these areas lie on the same side of the border. The strongest relationship in (1) is between Llanfyllin and Oswestry, while the remaining two regions are added only after the other two groups have been formed. As soon as these primary groups have been produced, the first two combine and remain unchanged until only the more limited areas are brought into the analysis:-

Figure T5

The third group has a progression of areas combining with it, the fourth group being produced as the strength of these relationships decreases. The merging of group (1/2) and (3) occurs only after all but two areas have been placed into one of the three classes available, these two notably being areas which had the lowest sample size. The position and order of entry of these into the formation is shown in Figure T5.

Considering SLC gave two primary classes which differentiated prior to the characteristic linkage string being formed. The first class

agreed with group (1) given above, while the second contained group (3) as its closest elements. However, it is in the relative position of the elements of group (2) that the two methods apparently differ initially, for SLC combines Shrewsbury and Bishop's Castle with group (3) prior to amalgamation with group (1) and not subsequently as MLC did. In addition, SLC forms a super group of all the elements in the primary group of Figure T5 prior to other areas being included in the cluster. Ellesmere and Llanidloes are related most closely to elements within group (3) for both MLC and SLC, while Pontesbury changes its loyalty between methods. Examination of the MDS plot gave no assistance, for the three groups form a rough equilateral triangle.

If the mean D^2 between the areas of group (2) and the other two are calculated, akin to average link clustering, then groups (2) and (3) are fractionally closer than (1) and (2) due to the proximity of group (2), with Newtown, hence the favoured SLC. The elements within the small group (4), while distal on both the MDS and MLC, form a reasonable geographical unit although the southern area of Bishop's Castle interposes into it.

The relative relationships of the groups are given in Figure T5 under the assumption that the MLC is the correct one. The primary groups remain the same although, as explained, the relative relationship of group (2) to the remainder is suspect and may, as a result of further investigation, be aligned with group (3) rather than (1) as in the presented figure.

Complete Matrix

Males

The discriminant function analysis between the male's birth locations for a complete data matrix produced fourteen functions with

54.26% explained variance between groups. As usual, most of this variance was contained within the first few functions, the initial five all taking out significant amounts of information and accounting for 63.29% of the variance. A comparison with the reduced data set showed that more information was being utilised from the complete matrix due to the ability to select better discriminators from those available. The frequency of correctly classified cases was 16.47%, again greater than the reduced set produced. Had it not been for a low success rate for one region (Welshpool), this latter frequency would have been greater still and would have then given complete consistency, for when males and females are compared, the former sex had greater discriminating success as measured by both the explained variance and the frequency of correct classification for both the complete and reduced data sets.

Utilising the same three clustering methods as previously, but considering first MLC gave the amalgamation sequence set out below:-

Figure T6

SLC shows a variation in that Newtown is combined with Llanfyllin and Welshpool before any other, while MLC waits until a looser arrangement

has been formed. SLC produced the characteristic chain of amalgamations while MLC indicated some clustering at lower levels of homogeneity. As with previous analysis, the areas with small sample sizes enter the configuration last, but the groups into which they are eventually placed make geographical sense. The exception in both the present and former analysis is Meifod which remains a distinct entity to the last. The MDS plot places groups (4) and (5) at opposite sides of the plot, the three remaining groups having a somewhat intermediate position. Whether this just reflects the smaller sampling sizes in them is uncertain but it is a possible explanation, the other of course being that this truly reflects the greatest dissimilarity being shown between them for any paired comparison. The relationships of the three remaining groups are difficult to ascertain from the MDS plots alone. There is a suggestion that group (2) is closer to group (1) than is group (3), but this is a subjective opinion at best, and it seems that the groups defined above show more similar relationships to each other than they do to the peripheral ones of the plot. The order in which the groups combine in Figure T6 seems reasonable when considered in relationship to Figure T5.

Consideration of the two matrices has produced groups which exhibited varying degrees of homogeneity within themselves. If the two sets of data are compared, then certain groupings stand out because of their consistency. These are considered to be as follows:-

(1) Llanfyllin, Welshpool, Oswestry (Machynlleth, Bishop's Castle) (Meifod)

(2) Llanfair Caereinion, Ellesmere

(3) Newtown, Llanidloes

(4) Rhayader, Knighton, Church Stretton

No conclusion as to the position of Meifod can be attained so it is included in (1) above as a supposition as to where it should go.

The most difficult areas to place are Pontesbury and Shrewsbury. It seems that they have their closest relationship with Welshpool, the reduced matrix indicating this, but the complete matrix keeping them apart. Rather than give an uncertain relationship, the question must remain open for the present.

Parental Birthplace

For reasons exactly similar to those given for females (page 269) the use of parent's birth location was precluded from further analysis due to the small sample size present in some areas even after amalgamation. The results and conclusions given for females apply equally well for males.

Comparison of Regional differentiation for each sex

In examining the structure of the populations of the mid Welsh borderland it was hoped that some measure of consistent regional differientation might be found. It is expected that consideration of variation for individual dermatoglyphic traits might indicate considerable less consistency than would the use of the multivariate techniques set out above. Whether the same sort of regional associations are expected when both series are considered is a much more problematic question. In an ideal situation it is hoped that the gene pool for each sex was under the same constraints and influences such that differentiation between two areas could be detected in either sex. I have suggested earlier that the magnitude of the sex difference for individual variables is in itself a variable worthy of investigation. This being so, if completely different patterns of regional association were found it would not negate the results for the other sex, nor indeed the whole series of analysis. What is a more likely explanation is that there may be smaller units of amalgamation of two or three areas in the present survey, and the order and manner in which these combine may vary between the sexes, but with consistency within each unit.

The basic units of consistency shown between sexes are as follows. (Meifod is included with the first group on geographical grounds.) :-

(1) Llanfyllin, Welshpool, Oswestry, Meifod

(2) Machynlleth, Bishop's Castle

(3) Newtown, Llanidloes (Llanfair Caereinion)

There is a strong indication that Llanfair Caereinion can be combined in with (3). Considering the above groups, (1) and (2) are often combined, while (3) amalgamates with them at an early stage in the procedure. For the remaining six regions consistency is lacking. Ellesmere appears to have a 'closer' relationship with Powys than with the more southerly location of Salop. In addition, Rhayader and Knighton show some relationship. Shrewsbury, Pontesbury and Church Stretton have a degree of consistency in their relationship within each sex, but not over sex. The overall conclusion from the previous series of analysis is thus:-

Figure T7

Those areas contained within (1) make good geographical sense. They lie next to each other with good communications between each. It was hoped initially that the relative position of Meifod could be

established but the small sample made this difficult and it is only geographical proximity which places it in this group. Group (3) is again a natural unit. Newtown acts as a centre of attraction for this upper region of the Severn valley and draws on the population from the northern side of the Kerry hills and below the divide at Llanbrynmaur in the upper Severn valley. The alternative movement of people from Llanidloes is either over Plynlimon to Aberystwyth or south down the Wye valley to Rhayader, both more difficult than down the Severn valley to the now expanding Newtown. It is a little surprising that Llanfair Caereinion should combine with this group rather than with Welshpool in view of the proximity of the former with the latter. In the light of the marriage matrix developed later, this is an even more conflicting association. It is possible that this reflects the historical demography of the 'English' southern Montgomery marcher lordships, extending north of the Severn into the western massif, but not extending into the Welshries of the north, or over into the western coastal regions around Machynlleth. That Bishop's Castle combines with (1) is reasonable except that this region is in the north probably much influenced by the neighbouring route into Newtown and northward towards Shrewsbury, constituting the most heterogeneous of the units initially defined on school catchment alone. Its amalgamation with Machynlleth is strange in view of the lack of proximity of the two areas.

In many cases Machynlleth is much more strongly related to (1) than the southern Shropshire region even though the Llanfair Caereinion region is interposed between them. The link (although weak) between (4) and Church Stretton seems reasonable if Bishop's Castle were heterogeneous, allowing a link through southern Salop. There will be a more detailed consideration later. However, for the time being, amalgamations set out below are made, and a reanalysis of the four sets produced, performed to see if we have made any improvement by using the available information.

New Redefined Regions

Definition of the New Regions

The multivariate analysis has thus indicated that several regions can be tentatively grouped together to form larger units. However, one such grouping makes little sense, that between Machynlleth and Bishop's Castle. Although the latter relates on many occasions to Welshpool, it was felt that a subdivision of this region would be more realistic in terms of the history and main towns in the region. Consequently the following boundary changes were made:-

(a) The southern hill region of the Bishop's Castle area, centred around Clun and extending to Lydbury North, was separated from the northern half and attached to the combined grouping at Rhayader and Knighton. In addition, the hill regions of Church Stretton were included to give a new larger grouping comprising the hill region of north Radnorshire and southern Salop. The justification for much of this is based on topography and the marriage migration matrix examined later (page 301).

(b) The northern part of Bishop's Castle had originally bordered against an extension of Welshpool over the natural border, this being based on verbal evidence and the school catchment areas. It was clear however from historical evidence that the region east of the Severn had always been considered English, or acted as a buffer zone between the Welsh and English areas. Consequently the region of Welshpool east of the Severn was re-located in a combined group comprising Pontesbury, Shrewsbury, the north of Bishop's Castle and Church Stretton, and then the land east of the Severn but still in Powys.

Of the changes made to the redefination of the region the latter (b) seems the most unsatisfactory. However, analysis proceeded on the

Redefined Regions Within The Borderland. Distribution As For Figure 4.

Group 1. Llanfyllin + Meifod + Oswestry + Ellesmere + Machynlleth + Welshpool(West of the river Severn)

Group 2. Shrewsbury + Pontesbury + Bishops Castle(North) + Welshpool(East of the river Severn) + Church Stretton(North).

Group 3. Llanfair Caereinion + Newtown + Llanidloes.

Group 4. Rhayader + Knighton + Bishops Castle(South) + Church Stretton(South).

above assumption, but it is indicated later than in the writer's opinion the larger group (2) listed below constitutes the possibly most ill-defined and heterogeneous amalgamation of the four. (Figure T8).

Female

Child's Birthplace : Reduced Data Set

Consider first the reduced data matrix for females with the criteria of locationg being the birthplace of the pupil. The discriminant function analysis showed that two significant functions could efficiently separate the groups, the total amount of explained variance being 6.47%. The first two functions accounted for 84.6% of this, the actual amount being less than for the equivalent analysis over fifteen regions. The classification array gave 31.29% correct, although this would have been greater if group (1) had been more successful; 25% is expected by chance alone. The particular variables which contribute to the functions are predominantly finger ridge counts, inspection showing that each digit is represented once (with a high loading) by either an ulnar or radial count on one of the hands. Only digit two weighs heavily on more than one element, these being RFR2, LFU2, LFR2, and reflects the usefulness of this digit as a partitioning parameter noted in both the univariate analysis and the multivariate already described.

Clustering the D^2 between regions by MLC and SLC and plotting the co-ordinates of the group centroids on Minissa gave comparable results. The four groups formed a single cluster in the order (1) + (2) + (3) + (4). The closest two were (1) and (2); (3) was equidistant from both, with (4) furthest away. The F matrix however confused the picture by putting (3) a significant distance from the remainder although the (2) / (3) distance is marginal and the (2) / (4) distance was significant.

Therefore, while (1) and (2) are most closely associated, (3) is significantly different from both, but more closely associated with (2) than (1). The north and south of Salop are separate (2/4), but the relationship between (1) and (4) remains confused, statistically non-significant, but separated by groups (3) and (2).

Complete Matrix

When the complete data matrix is available, the ability to discriminate between the groups increases as does the amount of explained variance, 13.75%, and the frequency of classified cases, 35.21%. The reasoning behind this has been considered earlier. Consideration of the F matrix shows that all the D^2 values between groups are now significant, while MLC, SLC and the plot of the centroid on a MDS show that clusters form in the order (1) + (2) + (3) + (4), exactly the same as before, the most distal group still being (4), (1) + (2) being the closest with (3) nearer to (2) than (1). Thus, in general, the same set of relationships holds for both matrices, the only difference being the significance of the D^2. It seems that given sufficient variables, region (4) attained the greatest significant differences from the remainder, compatible with its D^2. It may be concluded that (1) and (2) are closest, with (3) closer to (2) than (1), while (4) is distal from all these. As a result of amalgamation the sample sizes are larger than when fifteen regions were analysed. However, group (4) still contains the smallest numbers.

Parent's Common Birthplace

Reduced Matrix

Previously regional analysis was not carried out using the common parental birthplace due to the small samples within many of the groups. Subsequent to amalgamation into four regions this objection was lessened, although two groups still contained samples smaller than desirable.

The analysis based on the reduced matrix produced three functions, all of which removed significant amounts of variance from the initial set, the total amount being 12.6%. The ability to classify on the basis of these functions was improved to 36.21% correctly placed, comparable with the complete matrix given above. Whereas finger ridge counts predominated in the initial analysis using the child's birthplace, palmar variables and finger intensity indices were more in evidence, constituting four of the ten discriminating elements.

Performing, MLC and SLC gave the same result, the sequence of amalgamation being (1) + (3) + (2) + (4), the smallest D^2 being between (1) and (3) with (2) nearer to both than (4). In terms of significance the comparisons (1) / (3) and (2)/(3) produced non-significant D^2 values, all the remainder being so ($p < 0.05$). The distribution of centroids means that groups (1) and (2) are significantly different, with (3) lying between them, although much closer to (1) than (2), while (4) again occupies a peripheral position close to (1) only by a slight reduction of the D^2 compared with the others.

Complete Data Matrix

For the complete data matrix both the amount of explained variance, 26.42%, and the ability to correctly classify cases, 42.74%, was increased by using the complete matrix, the child's birthplace being used as a parameter. Three functions all remove significant amounts of variance in roughly equal amounts, allowing for the method of derivation of the function.

The F matrix showed that all the D^2 values between groups were significant ($p < 0.05$), a MDS plot giving a two dimensional map with zero stress (Figure 18). SLC and MLC again agreed in producing one cluster in the order (1) + (3) + (2) + (4), the (1)/(3) distance being less than (1)/(2), while (2)/(3) is greater than both. Group (4) again occupies a

distal position in relation to those three. The contrast with the reduced matrix lies in (2) being closer to (3) in the former analysis but to (1) in the present. Although all the D^2 values are significant, it is apparent that the distribution of centroids is the same as for the reduced matrix, (1) and (3) being closer to each other. (2) is also near, but (4) is distal from them all. It is not too difficult to transform Figure 18(a) into Figure 18(b) for if the (1) - (3) distance is not significant, it could presumably reverse their relative locations to give Figure 18(b) Certainly MLC is the same for both. Whether in fact (2) is closer to (1) or to (3) is secondary to having a basic amalgamation of Powys before Shropshire joins in, the southern region remaining separate.

We have similar conclusions to previous analysis for the results of substituting a complete matrix for a reduced one. Briefly, this provides the opportunity to select from a greater sample of variables those which will maximise discrimination in terms of the criteria set out initially. This means that a greater proportion of the variance contained within these variables can be removed by the functions and the ability to correctly place cases into their group increases. In general, the inter-group relationships in terms of the D^2 remains roughly similar between matrices, the main difference being that the increased degrees of freedom give significance where previously there may not have been any. This is a constant problem for it is known that a simple increase in variable input will keep the same spatial relationships but alter the significant levels associated with the distance, generally making them more significant. With many groups in the analysis the relative change in centroid positions can be greater than for fewer groups, making consistent interpretations, in terms of significance, difficult. The effect of sample size cannot be omitted, much evidence for this being present both in this thesis and in other works. It is difficult to compare a series of relationships where the group sample size alters

drastically between parameters. It has been shown above that the F matrix alone can give significance fairly easily, which all leads to a tendency to consider the order of the points in space rather than their absolute magnitude on significant values.

Considering the four series of analysis just presented for females, particular consistency emerges:-

(1) Group (4) is always distal from the remaining (3) but also has the smallest sample size.

(2) For the remaining groups the (2)/(3) distance tends to be the greatest.

The main difference between changing parameters to define locations is that when the child is used group (1) combined first with (2) with (3) closest to (1), while using the common parent's birthplace (1) combines first with (3) and (2) being closest to (1). The extreme position of (4) could be either:-

(1) Low sampling producing an aberrant D^2

(2) The group is mainly under the influence of migration from other regions and is 'cut off' from the more northerly gene pool, having closer relationships with a region to the south of the investigated area, its extreme position reflecting a true difference in the region from the adjacent more northern area.

Males

Child's Birthplace : Reduced Matrix

Males were considered in a manner exactly comparable with females, the discriminant analysis between the same four redefined regions being performed. The initial analysis used a reduced data matrix, the

child's birthplace being used to define geographical location. Three functions, all contributing significantly to discrimination, were obtained, the total amount of explained variance being 8.45% giving 35.7% of correctly placed cases on a classification array. The F matrix indicated that all the D^2 values between groups were significant ($p < 0.01$) with a Minissa giving the spatial plot in Figure 20. Both SLC and MLC combine the groups into a single cluster in the order (1) + (2) + (3) + (4), the plot showing that (4) is set aside from the rest with (1) and (2) closest together and the (2)/(3) distance being greater than the (1)/(3). In previous analysis of females, finger ridge counts were the dominant element within those variables which were involved in discriminance, at least in the reduced matrix. However, this first set of functions for males had more palmar variables included, only four of the eleven being finger ridge counts.

Complete Matrix

Using the complete matrix set gave what is now a familiar relationship, both the amount of explained variance, 19.96%, and the frequency of correct classification, 38.44%, being greater than those obtained from the reduced matrix above. All three derived functions are highly significant ($p < 0.001$) in their discriminating ability, and although most of the variables used in the functions from the reduced matrix are represented in the present set, they do not have, with two exceptions, high loadings on any functions reflecting the high inter-correlation found between variables.

The F matrix showed that all the D^2 variables between the four groups were significant ($p < 0.001$), SLC and MLC combining them in the order (1) + (3) + (2) + (4). As usual, the two dimensional Minissa plot gave no Kruskal stress and placed group (4) apart from the remainder.

In common with the reduced matrix the (2)/(3) distance is greater than either the (1)/(3) or (2)/(1), the former being shorter than the latter. Compared with the plots for the reduced matrix, the main change is that (3) is nearer to (1) rather than (2) being closer.

Parent's Birthplace

Reduced Matrix

With location defined by the common birthplace of the parents, the sample sizes in the groups are reduced. Eight variables were used in the functions, but only the first function removed a significant amount of variance. Although all three accounted for 10.73% of the contained variance with 36.7% correctly classified cases, both parameters were slightly higher than the corresponding analysis using the child's birthplace. The F matrix revealed that only two of the distances were statistically significant, those for (1)/(3) and (1)/(4), although the order of amalgamation on both the SLC and MLC of (1) + (2) + (3) + (4) and the rank order relationships on a two dimensional Minissa plot were similar to those found for the child's birthplace on a reduced matrix shown above. It is interesting that this former analysis had significant D^2 values, but the relationships of the groups are the same as in the present analysis and illustrate that the significance levels must not be taken as an absolute criterion for amalgamation unless there is corroborating evidence from different sets of analysis.

Complete Matrix

Changing to the complete matrix again increased the amount of explained variance used by the functions, 38.37%, the third function being marginally non-significant, while the ability to discriminate placed 49.57% of cases correctly. The F matrix showed that all but the (2)/(4)

D^2 value was statistically significant ($p < 0.05$). Using the MDS plot produced similar relationships to those found previously with the child's birthplace used as a parameter. Both SLC and MLC amalgamated the groups in the order (1) + (3) + (2) + (4). Group (4) is again separate from the remainder, with (1)/(3) being the shortest distance, and (2)/(3) being greater than (1)/(2).

Having briefly examined the four plots for males it is necessary to see if any consistent relationships have appeared. In many ways it is not too surprising that the Minissa plots are similar due to their using rank order relationships, but more confidence can be placed on them since both the SLC and MLC give a comparable sequence of amalgamations. In essence, changing from using the child's birthplace to that of the common parent's did little to alter the between-group relationships in terms of their rank order on clustering sequence. What did change was the absolute magnitude of the D^2 and the associated F value, no doubt a direct result of a change in the sample sizes as much as an alteration of the variable means. All the sets of analysis place group (4) apart from the remainder with, in general, the (2)/(3) distance being greater than either (1)/(2) or (1)/(3). The greatest dichotomy is that the reduced matrix places (1) and (2) closest together, while the complete matrix places (1) and (3) in closest proximity. These results suggest that while the main differences remain over parameters and data sets, a degree of tuning occurs as regards the relationship of (1) to (2) and (3). Much of the description concerning group (4) in females applies here alone.

Sex Comparison

Comparing the group relationships over sex produced the following consistencies:-

(1) Using the parent's common birthplace gave a better frequency of correctly classified cases and had more explained variance than when the child's birthplace was used.

(2) The complete data matrix allowed a greater degree of discrimination as measured by the amount of explained variance and the classification array than did the reduced matrix.

(3) Group (4) was always the most separate of the groups.

(4) Groups (2) or (3) tended to have a greater D^2 with each other than either did with (1).

The main difference between the sexes is the relationship of group (1) to groups (2) and (3). While females have their dichotomy between parameters, males show it between the two matrix sets, there being no way at the present time of deciding which alternative is 'correct'. If greater confidence is placed on the results of the analysis based on a complete matrix, then in three out of four sets of analysis the (1)/(3) distance is smaller than the (1)/(2). It is notable however that the D^2 for (1)/(2) in the single case where the above did not hold when compared with the (1)/(3), D^2 shows a much smaller difference than a similar comparison on the other three series of functions, this reducing the weight placed on this discordant relationship although it must be added that in this analysis (CBPA for females) the D^2 between (1) and (2) is still statistically significant.

Four Redefined Regions x Ancestry

The use of ancestry together with the basic Salop/Powys division was considered earlier. Subsequently an extension of the present four regions' analysis was performed partitioning by ancestry as an additional parameter. This gave 8 groups, but due to small sample size the parent's birthplace was not used, only the child's birth location being involved as a parameter.

Females

Little need be said concerning the results for females due to ancestry having little effect in the group relationships. Within each region the D^2 values between 'English' and 'Welsh' were always non-significant and a two-dimensional Minissa plot placed the points close together such that the middle of each group roughly maintained the relationships shown for analysis without ancestry.

Males

Males gave slightly more positive results, the Welsh element in (2) and (4) pulling to opposite poles on MDS and MLC, to the English population in (3) and (4). No difference between 'English' and 'Welsh' in (1) was detected while the Welsh in (3) were closest to them. The Minissa plot is given in Figure 22 (Kruskal's Stress = 0.076), the interpretation combined with the MLC being as follows. Ancestry is contributing to partition the data set. In region (1) no difference between English and Welsh was found, while the Welsh in (3) are closely related to them. This gave a basic "Powys" locational block. The English in regions (3) and (4) have much in common, as do the Welsh in (2) and (4). The position of the English group (2) is peculiar for it combines with the Powys location rather than having any English affinity.

Figure T9

(MALES)

This diagram is given brief mention due mainly to the imbalance of sample sizes between groups. It also seems that to obtain a consistent interpretation would be difficult. In addition, it was based only on a reduced data set.

New Location x Language x Ancestry

In the light of the disappointing results obtained when ancestry was combined with the redefined birth locations in the last section (page 288) it was decided to adopt a slightly new approach to appraise both ancestry, birth location and language as parameters for discrimination. The original fifteen regions were retained but amalgamated in a slightly different way, as follows:-

(A) Llanfyllin, Llanfair Caereinion, Machynlleth

These three cut across the groups previously defined, Llanfair Caereinion being the odd region. However, they have a common factor in that they represent the regions where Welsh is still the predominant language with over 67% of the present sample speaking the language in the combined hill regions. Their demarcation approximately follows the limits set out by Bowen and Carter (1974) for their linguistic divide in Powys. Within the region over 85% of people have Welsh ancestry, as defined by surnames, consequently two classes were produced using only those pupils with Welsh ancestry and dividing them by linguistic ability.

(B) Staying within the confines of Powys but only within what used to be Montgomeryshire there is the lowland region of the Severn valley constituting the regions of:-

Welshpool, Meifod, Newtown, Llanidloes. This combined region is mainly English speaking (> 90%) among the pupils but a split into English and Welsh by ancestry is possible.

(C) Due to the relatively small sample sizes and locations outside the Severn valley the regions of Rhayader and Knighton were combined regardless of ancestry or linguistic ability. As Welsh-speaking was very rare in the pupils from the region this was a reasonable decision, for while the English/Welsh division would have given groups with a sample size of 1.36:1, the absolute numbers were too small to allow this and the parameter was thus not used.

(D) Oswestry has a tradition of Welsh association even though it is in Salop, as the present analysis also suggests. However, in the present sample the number of pupils was such that two groups based on ancestry could be formed to compare with the above. As regards language, Welsh speaking is rare among the pupils with > 95% speaking only English, and was not therefore used as a parameter.

(E) The remaining regions of Salop, Ellesmere, Pontesbury, Shrewsbury, Bishop's Castle and Church Stretton were combined to give a single class. This group was then divided by ancestry.

The above divisions gave nine groups in all involving over 50% of all pupils within each sex. Experience had shown that in general the results generated in a complete data matrix are possibly more reliable than those on a reduced matrix, while using the child's birthplace to define location gives larger sample sizes than using the common parent's birthplace, but with essentially similar conclusions at the end. Hence this final set of discriminant analysis was performed on each sex using only the child's birthplace as a parameter to place the pupils and the complete data matrix on which to extract the discriminant functions. Analysis was again performed using MDS, SLC and MLC.

Child's Birthplace : Complete Matrix

Females

The discriminant analysis between the nine groups gave a series of functions which accounted for 38.07% of the contained variance and correctly classified 22.06% of cases as against 11% expected by chance. The first three functions all contributed significantly to the discrimination with 26 variables being involved. All three of these functions had their greatest weights associated with some aspects of the finger ridge counts or intensity indices, the ridge count total being very much in evidence.

Using Minissa, a two-dimensional plot was obtained (Kruskal's Stress = 0.042). Another dimension gave much lower stress, but all the salient features are considered to be present in the two-dimensional interpreations. Neglecting for a time the Welsh in Salop (2) and the English-speaking Welsh in the Western Hills, the seven groups fell roughly on a straight line. Examination of the F matrix shows in essence a cline, non-significance being attached to the adjacent groups and with significance being found between the more distant. There is a rough divide along the line, however, as indicated in Figure T10. It divides those regions with a Powys birth location from those born in Salop. Within this latter group there exist no significant differences, while in the former, Rhayader is similar only to the Welsh-speaking people in the western hills.

The relationship along this line makes sense in that Rhayader occupies an extreme position similar only to the most Welsh region of western Montgomeryshire. The western Welsh hills lie closer along the line, while those pupils born in Salop occupy the other extreme while sandwiched between the two, as we would hope, are those pupils born in the valley region. No significant difference was found between English and Welsh within Oswestry or the Severn valley, although within Shropshire the parameter did give a significant separation into two classes.

The two remaining groups omitted above must now be considered. The Welsh in Salop are separate from all classes except the Welsh in Oswestry, indicating some common features although even here the D^2 is large. The English speaking Welsh in the western hills associate most closely with the valley region and to the Welsh speaking people of their own group.

Figure T10

It seems that these two classes may occupy positions which are extreme, due mainly to their small sample size, and larger samples would produce smaller D^2 values. It is interesting that the English speaking Welsh in the western hills seem to be partway between their Welsh counterpart and the valley population, indicating a possible demarcation between the language groups such that the pure Welsh of group (6) are even more extreme than their English speaking counterparts in (7). This is a difficult hypothesis to test due to the small numbers involved in the samples and the lack of other comparison, but it does give one of the few indications that language is of some use as a demographic parameter in partitioning a data set. Even in this analysis the significance of the D^2 between the two linguistic groups was marginal at the 5% level. This confirms the previous analysis where non-significance of a language comparison was found when birth location over all Powys was considered together with ancestry (Figure 13). The MLC gives

essentially the same results except that the two aberrant regions of (2) and (7) show different associations (7) combining with the groups in Salop and (2) with Powys. Taken together and considering the F matrix the initial association seems most probable and would, it is hoped, be supported by larger dermatoglyphic samples or other anthropometric data.

Child's Birthplace : Complete Matrix

Males

A similar analysis for males gave six functions which contributed significantly to discrimination with 54.47% of explained variance between them. The classification array correctly placed 27.92% of cases as against 11% expected by chance alone. In all, 35 variables were involved in producing the functions but the weights attached to them indicated that elements connected with the fingers were much more useful than those associated with the palms in contributing to discriminating ability.

The MDS Minissa plot of the D^2 gave 0.042 Kruskal Stress in 3D, an acceptable amount, but it revealed that the majority of the points lay in a plane with two groups set apart at opposite poles. Consequently a 2-dimensional plot with 0.110 Kruskal Stress was used with the knowledge of which groups were most deviant. When examined in conjunction with the F matrix and SLC it was soon apparent that a picture interpretable in a manner comparable to that for females was not found. The schematic diagram is intended as a résumé of the main associations, Figure T11.

Figure T11

1: English in Salop
2: Welsh in Salop
3: Rhayader and Knighton
4: Valley English
5: Valley Welsh
6: West Hills Welsh, Welsh SP
7: West Hills Welsh, English SP
8: Oswestry Welsh
9: Oswestry English

First, language was having little effect in the Welsh hills even though there was a moderate D^2 between groups (6) and (7). The Welsh in the valley region appeared as a separate unit from both the west and eastern sides, while the English in the valley were amalgamated with the English of Salop. However, the F matrix linked this latter amalgamation to the western hills, while separating it from the Welsh in the valley, clearly an illogical association in terms of migration. The association of the marginal groups was confused but considered to be as follows. The Welsh in Salop relate mostly to the Welsh in the western hills, an indication of consistency with their English counterparts. Rhayader is only statistically different from the two Oswestry groups while these latter two have, unfortunately, an association which would be better if reversed, for the Welsh in Oswestry associate mostly with the English element in Salop and the valley, while the English in Oswestry (9) are most similar to the western hills, a confused relationship.

Considering MLC, like MDS, gave a confused picture, there being a tendency to combine all the groups into a single group, no clusters being formed at intermediate levels. Although recognised as a loose set of relationships, those formed from MDS appear more reasonable in terms of geography and intra parameter associations than the MLC produced.

Sex Comparison

If the set of relationships is examined it is possible to obtain some similar associations common to each sex although some marked differences occur. The division into the three locations seems to be present in both sexes but much stronger in females than males. Language was seen to contribute to a non-significant D^2 in the western hills, also for both sexes with the Welsh in the valley remaining separate from its neighbouring regions. The association of Salop and the western hills is much stronger in males than females. In fact, only the Welsh in Oswestry seem to have a non-significant difference with the English of the valley rather than the hill population. Rhayader remained related mainly to the western hills in both sexes but separate from Oswestry. The overall difference therefore between the sexes is the strength of the association between the hills of western Powys, and the Salop population, the link being stronger in males than females, the males almost jumping over the intermediate valley to reach the hill population. The significant difference between the English and Welsh of Oswestry found only in males is difficult to interpret when the ensuing relationships are examined. In females Oswestry is related to Salop and the English, whereas this is true for neither of the classes in males, both tending to have their association moved westward with, unfortunately, a nonsensical set of associations. All that can be said is that in Oswestry males seem more Welsh than do females.

Comparison with Univariate Distribution

It is now possible to examine whether the regions defined by multivariate analysis could have been predicted from the univariate regions produced earlier (page 211) and the answer would seem to be negative. Certain associations were evident in both types of analysis, namely the amalgamation of (a) Llanfyllin and Welshpool, (b) Newtown and Llanidloes, (c) Rhayader and Knighton. However, the remaining areas show different associations from those given on a multivariate analysis. (page 245 onward). It seems therefore that to attempt to predict regional patterning from single variable observations is unlikely to be reflected in consistency with multivariate techniques, the latter allowing the effect of many variables to be considered simultaneously.

General Multivariate Conclusions

Having completed the multivariate analysis using several combinations of parameters and data sets it must be asked, if any general conclusions can be drawn concerning regional variability within the borderland and the usefulness of the partitioning parameters when investigated by means of dermatoglyphic variations. The individual sets of analysis have been considered in detail as well as the relationship of sex to consistent interpretations, and readers are urged to consult the individual part of the analysis for detail. I am now concerned with more general comparisons.

Consider first this last series of breakdowns (pages 490 - 497) concerning language, birth locations and ancestry for the broad regional divisions. In females the results are faily easily interpreted. The Welsh speaking Welsh have been shown to be limited to the western hills and are separated out as a unit from the remainder. Whereas previously

all the remaining people in Powys were combined (WPE + EPE) in a single group, we now see that those Welsh born in the western hills have much in common with their Welsh speaking counterparts, as well as with the valley. It is possible that given a large sample this subset would be more precisely located. However, for the time being it is most closely related to its Welsh speaking counterparts and suggests that a major division between the valley and western hills may exist. The English and Welsh in Salop generally separate out on both series of analysis, yet it is shown that the Oswestry region is probably mostly related to Salop, while the Welsh in Salop are much less associated with these latter regions, although they do not show any tendency to be "closer" to Powys than to the English in Salop. Rhayader and Knighton both separate out from the other regions, being more like the Powys population than those of Salop, although the placement of this combined area is not strongly associated with either region when only the four main ones are examined (page 287). What has emerged would seem to be a main Salop/Powys division, language having a small effect, although along with ancestry it does not seem a 'good' parameter. Within Powys a split between the valley region and the west is indicated, the areas of the south (Rhayader) being separable from the remainder. This is indicated both on the above analysis and on that of the four large regions (page 287). The position of Oswestry in the above analysis places it closer to Salop than to Powys.

Consider now how the above relates to the regional analysis of the fifteen areas without reference to ancestry or language. The regions thought to be homogeneous have been previously given (page 275), but it is apparent that the divisions given above do not hold, except perhaps for Rhayader and Knighton being only weakly related to the remainder. Take first the position of the Bishop's Castle region. I have suggested that it is perhaps better to have it divided into two areas, the southern

part combined with Knighton, the more northern region showing association with Welshpool. When the new regions were defined, then after amalgamation the historical evidence was considered whereby the parishes east of the Severn, but within Powys, i.e. from Montgomeryshire northward to Crew Green were combined with Salop and the southern half of Bishop's Castle and Church Stretton placed in with Rhayader and Knighton. It is possible that its association with Welshpool resulted in its intermediate position between the extreme Rhayader and Knighton areas and the English regions of Salop, the result being a compromise, Welshpool being its (then) closest neighbour. Due to the consistency with which Bishop's Castle has combined with Welshpool and the close proximity of the two on the marriage matrix (Figure 35) the former suggestion of a north and south, with the former related to Welshpool, seems reasonable, but further evidence by way of larger samples would need to be collected in order that a re-analysis would give more reliable results. Similarly Welshpool does not form part of the valley but combines with Bishop's Castle and Llanfyllin, directly across the regions proposed earlier, while Llanfair Caereinion also is in its 'wrong' region, having a close relationship with the valley and not the hills. What appears to have happened is that in producing the larger regions of a valley, the Welsh hills and Salop, variation within these areas has been swamped, giving slightly false impressions. For example, the inclusion of Welshpool with Newtown and Llanidloes was not enough to remove the difference of these latter two from the western hills, with which Llanfair Caereinion is misplaced. It seems, as has been stated several times earlier, that birth location as defined by the child's birth-place, or sometimes the common parent, is the major parameter in giving differentiation within the female data set. With sufficiently large samples resulting from amalgamation of subunits, ancestry may give additional differentiation, but when combined with smaller units, or the four

regional areas defined (page 288) they gave no real differentiation which cannot equivocally be attributed to sample size. For females I therefore propose that regional dermatoglyphic variability exists (as set out on pages 268 to 269) and that the other parameters relate to being concentrated in particular classes in regions which have already been combined, for example, Welsh speaking is only really found in the western hills, but within the region is not acting as a divisor although it will separate out these areas from the rest by virtue of birthplace and language being highly correlated in the west. The position of Oswestry is the most precarious, for regional analysis places it in with north Powys (page 276) while the last series showed it definitely placed with Salop. In view of the above remarks I place it in with north Powys and assume that the last analysis gave an association based on an average produced by combining heterogeneous areas.

The various sets of analysis produced for males do not give as clear a picture as did the female data set described above. Language was shown not to be differentiating within the western hills, while there was clear indication that this latter region relates to Salop rather than the valley. This is brought out on the initial analysis (page 274) and the last breakdown (page 294). The MLC on this latter series tended to combine the regions into one single cluster in a regular manner, no discernible structure of clustering being found. Like females, the results produced when broad regional analysis is combined with ancestry and language tended to give conflicting results when the geographical analysis of fifteen regions was made. The reasons for this are thought to be similar to those for females, that is, small samples produced by excessive subdivisions. For the latter, however, there is less evidence of a central valley region or for the association of Oswestry with Salop, ancestry having an apparent effect within this area. Although the regions defined upon amalgamation differ slightly from those for females, the similarity present between the

two strongly suggests that they are acceptable amalgamations of homogeneous regions, at least at the initial stages of dermatoglyphic investigation. A redefining of the region may no doubt produce small changes but I consider that, as for females, the regions given earlier (page 276) represent a consistent pattern of differentiation discernible in both the child's and common parent's birthplaces, and that ancestry and language contribute much less to improving discrimination with the data set for the borderlands.

Marriage Distance

In order to obtain some idea of movement between the fifteen regions defined an index of marriage movement was devised. Analysis of migration has been made by several authors using fairly sophisticated techniques and indices, as well as allowing for common migrants to two areas (Dennis 1977b).

However, since the present data were not collected with the specific aim of investigating movement within the borders by such methods, the use of a simpler statistic was felt to be justified.

The index (I) developed was simply the proportion of marriages between two areas that occurred as a fraction of all marriages within both regions, weighted by the number of marriages occurring within both regions as a fraction of the whole population.

Figure T12

FEMALES

	PARISH OF BIRTH	1	2	3	15	
MALES	1	$x_{1,1}$	$x_{1,2}$	$x_{1,3}$	$x_{1,15}$	$T_{1.}$
	2	$x_{2,1}$	$x_{2,2}$	$x_{2,3}$	$x_{2,15}$	$T_{2.}$
	3	$x_{3,1}$	$x_{3,2}$	$x_{3,3}$	$x_{3,15}$	$T_{3.}$
	15	$x_{15,1}$	$x_{15,2}$	$x_{15,3}$	$x_{15,15}$	$T_{15.}$
		T.1	T.2	T.3	T.15	T..

$$I_{13} = \frac{X_{13} + X_{31}}{(T_{1.}+T_{2.}+T_{.1}+T_{.2}) - (x_{11}+x_{13}+x_{31}+x_{33})} \cdot \frac{(T_{1.}+T_{2.}+T_{.1}+T_{.2}) - (x_{11}+x_{13}+x_{31}+x_{33})}{T..}$$

which reduces to $I_{1,3} = \frac{X_{1,3} + X_{3,1}}{T..}$ or $I_{1,3} = K \frac{(I_{1,3} + X_{3,1})}{T..}$

It is recognised that this index can be faulted on many criteria, yet it is felt to be adequate for the present work as an initial parameter from which to progress. The main fault of the index is its dependence on sample size, but for all that the MDS plot of the matrix gave an exceedingly good representation of geographical locations of the regions involved, the correlation of (I) with distance in miles between any two regions being $\simeq .6$ (page 498).

The actual index used was multiplied by a constant (K) to give larger figures from which to work; in this analysis the value of K was (2), this making no difference to the MDS or clustering algorithms, but prevented possible bias due to rounding of errors at the lower decimal places. Experience suggests that K = 10 or 100 would prove slightly better as a multiplier.

Using the formula indicated (page 302) matrices were produced for the parents' marriage distances, the father's parents and the mother's parents separately. There was no prior expectation that the parents or grandparents of male pupils should show any different patterns of movement from females, the two therefore being combined in the present analysis. Four methods of clustering the similarity matrices were used, these being SLC, MLC and MDS as previously used on the D^2 matrices and, in addition, the method of average link clustering was used to give a comparison with the others.

It was apparent that the three matrices produced very similar results on all the clustering methods, especially MLC, ALC and MDS. Consequently a new matrix from all the marriage pairs over two generations was produced and re-analysed and it is this matrix which will be reported upon. Average link clustering using a 5% limit to enter a cluster gave the following groups:-

(1) Newtown + Llanidloes + Machynlleth

(2) Llanfyllin + Llanfair Caereinion + Welshpool

(3) Pontesbury + Shrewsbury

(4) Knighton + Bishop's Castle

(5) Oswestry + Ellesmere

(6) Rhayader + Church Stretton

(7) Meifod

It is apparent that Meifod is an aberrant region in the above, as was group (6). However, MLC reduced these groups by two, moving Meifod into group (1), Rhayader into (4) and Church Stretton into (3), the members of these other groups remaining consistent between the methods. The groups so defined now make more intuitive sense than for ALC due to the neighbouring regions being combined with no jumps as for group (6) above. What was

particularly revealing however was the Minissa plot (Figure 35). The MDS had an extra group defined, this being a general birth location of a partner outside the region, giving an indication as to which area was receiving most migrants from outside the sampled area, no differientation within the class being formed. The map given is a two-dimensional representation with significant stress (Kruskal Stress = 0.122). Although a three-dimensional, or higher, plot would reduce this stress, it was felt that the two-dimensional representation of the points gave sufficient indication of the salient relationships extracted from the matrix. If the distribution of the points is examined, it is seen that the inter-relationships give a structure which is remarkably similar to a geographic map of the mid borderlands. It must be remembered that this is a two-dimensional Minissa plot and higher dimensions can only improve the stress. The lines joining the points indicate the SLC. Several points are worthy of note:-

(a) The general group of marriage partners born outside the region (group 16) is placed in the middle of the plot indicating that all areas have, to a greater or lesser degree, some inward migration. However, in terms of SLC and its particular placement on Figure 35 Oswestry has the majority of this new material, Llanfyllin, Welshpool and Newtown being the next most favoured locations, but the number of marriages in these latter three is less than half the number in Oswestry.

(b) While the link between Welshpool and Oswestry is strong, the most favoured local region to provide a matrix is Ellesmere, with Llanfyllin next. Meifod clearly relates to Llanfyllin.

(c) The route down the valley is clearly marked, but, surprisingly, Machynlleth is linked with Llanidloes rather than with Newtown, this latter being on the route over the massif via Caersws.

(d) The degree of intermarriage between the regions is clearly related to geographic proximity, indicated by the relative positions of the MDS points.

(e) The most unusual feature concerns the SLC route from Church Stretton to Bishop's Castle, then into Wales via Knighton, Rhayader and to Llanidloes. Considering the proximity of Bishop's Castle to the through route into Wales to Newtown it is surprising that the SLC gives a firm relationship to Knighton. However, the relative geographic interpretation of the points shows that the degree of intermarriage may indeed be closely related to distance.

(f) SLC and MLC give comparable groupings except for Church Stretton (15), for while MLC gives the region associations with the more northerly region of Salop, its strongest connection is with Bishop's Castle (14). This latter group however is associated with Knighton and Rhayader on both clustering methods. The difference in the relationships produced by SLC and MLC gives further evidence that the regionalisation areas defined in this southern part of Salop could be improved with closer examination of the geography of the region and with more detailed/extensive data from which to work.

If we were to consider which method of clustering is giving the most logical interpretation of the marriage matrix in terms of associations of neighbours, then MDS appears supreme, although MLC gives a very similar picture. MDS allowed, albeit with a degree of stress, the whole matrix

of relationships to be perceived, and not just an amalgamation. Probably the best conclusion would be to emphasise the usefulness of an MDS plot when used in conjunction with both MLC and SLC, ALC providing little further information that these do not.

Having shown that a good plot was obtained on MDS it can be asked to what extent do the intergroup indices relate to actual distances between groups. The problem here is in deciding where to take the measurements from within each area. In general this was taken arbitrarily as the town with the largest population, or, in the case of the Ellesmere region, halfway between it and Baschurch. Similarly for Church Stretton, the point of reference was between it and Stokesey. In order to obtain a slightly more realistic picture, distances taken from the AA map (AA, 1972) of miles along the roads of the shortest route between two areas were utilised, and not a direct "as the crow flies" line.

The initial plot of the index against miles gave a negative correlation of -0.621 ($p < 0.00001$). This straight line plot gave a very good representation of the data, yet it was clear that the points were better estimated by a polynomial, possibly a hyperbolic function. These suggestions were only briefly tested with plots of the index (I) against the reciprocal of the distances.

$$I \propto {}^{1}/_{D}, \quad I = \frac{K}{D} \text{ for } K = 1 \quad (r = 0.639),\ p < 0.00001$$

and (I) against the reciprocal of the squared distances.

$$F \propto {}^{1}/_{D^2}, \quad I = {}^{K}/_{D^2} \text{ for } K = 1 \ (r = 0.485),\ p < 0.00001.$$

Clearly the first measure is the more successful, with a small improvement on the initial relationship ($I \propto D$). In view of the nature of the simplicity of the marriage index (I) and of the distance measured, it is felt that the correlation obtained is remarkably successful, the relationship between two areas in terms of inter-marriage being proportioned to the inverse of the distance between them.

It is obvious from the nature of the index that this is a non-directional measure and gives no indication of the direction of movement of the marriage partner(s) subsequently, or indeed prior to marriage. Two further comments can be made. First, it is recognised that the movement patterns differ between the various social classes but that no account of this has been made in the above calculations, and second, that while the absolute value of the index may vary, depending on the populations used, the constant divisor will not alter the relative or rank relationships between the distance measures. Consequently the index tends to reduce merely to the number of cross marriages that occur between two areas without taking population size into account. Even with these errors included, the MDS fit is very good, as is the relationship of the index to the universe of the distance in miles.

The complete matrix of correlations for the individual indices and the two distance measures are given in Table 105 for both the Pearson and two rank order correlation coefficients of Kendall and Spearman. They all show first that the correlations between the indices are high, justifying the use of the combined data above while the rank order measures give the relation with distance as -0.580 for Kendal Tau and -0.765 for Spearman. Both are similar to the Pearson. The use of $^1/D$ only alters the sign, of course, the rank order of distances remaining identical under transformation.

Relationship of D^2 with geographical distance and marriage index (I)

In the earlier multivariate analysis of the fifteen regions defined by the child's birthplace there were sets of D^2 distances generated for both sexes using a reduced and then complete data matrix. On the basis of these distances the larger (homogeneous) groups were then produced. We can now ask what is the relationship of the D^2 between similar regions generated for the two sexes and matrices, and of these D^2 to the marriage

index (I) and to geographical distance. Considering first the inter-relationship between the D^2, using Table 101 , we see that the greatest Pearson correlation occurs between the D^2 within the same sex, but over matrices, although even the lowest value of r = 0.575 is a reasonably good fit between the two measures, this being over sex. The rank correlation measures give similar results, although the magnitudes of the correlations tend to be smaller.

Considering the D^2 against geographical distance showed that on a Pearson correlation the reduced matrix within each sex gave a significant relationship (positive) with distance, viz. 0.209 for females, 0.232 for males. The complete matrix for females was also significant against distance (r = 0.201). The inverse distance measure never gave a significant correlation with any measure of D^2. It is obvious that even when the association is significant the level is not any higher, with only slightly more than 4% explained variance between the measures. If considered in rank terms, then only the reduced matrix in males is significantly related to distance, 0.158 on Kendal's Tau and 0.224 on Spearman, although even here the positive associations are small.

The relationship of the D^2 to the marriage indices revealed that the magnitude of those associations that were significant had a similar range to those found for D^2 and geographical distances, i.e. between 0.2 and 0.25 for Pearson's r. The correlations gave significant values for both the indices, using just the pupil's parents and for all the marriages combined, for each sex on both matrices, with only a single exception. The magnitude of the correlation was similar in each association while using the grandparents' marriage distances tended to give non-significant correlations with any of the D^2. The rank correlations gave comparable conclusions except that Spearman's (ρ) was generally higher than Pearson's (r) with, in addition, the grandparental marriage indices being significant against distance, although at a lower level than either parent's indices or the index of all marriages. Four conclusions resulted:-

(1) The index for marriages of the parents' birthplaces and that of all marriages are significantly related to the D^2 for both sexes and matrices.

(2) The choice of a matrix does not alter the above conclusion.

(3) The former index gives a higher set of correlations than the latter.

(4) The rank order correlations all seem higher (and significant) than Pearson's (r).

It seems therefore that the D^2 produced related more closely with the marriage indices, particularly that of the parent, than with the geographical distance between two areas and that the relationship is better considered in a rank order manner than in absolute terms.

Interpretation of Geographical variation

All the previous analyses, particularly the multivariate, have attempted to detect geographical variation within the mid Wales borderland for dermatoglyphic traits. The usefulness of ancestry and language in interpretation has also been extensively considered, the outcome being the production of four regions exhibiting comparative homogeneity within an area, but heterogeneity between areas. The object of the research was to investigate the possibility that areas of homogeneity could be produced, as for the blood group alleles (A.B.O.),with less emphasis on which particular dermatoglyphic traits were involved, this latter question requiring more extensive regional investigation. The actual boundaries of the initial fifteen regions were taken as school catchment areas, which have good concordance with the ancient cantrefi of Powys but which, as such, necessarily limit the boundaries of the amalgamated groups. Having produced four groups, only the Bishop's Castle and Church Stretton areas were redefined.

Evidence supporting the latter comes from Sylvester who shows that the upland district of south Salop, particularly the Clun forest, can be considered as an extension of the Welsh county, extensive numbers of places having Celtic connections, the Oswestry region also having many such names. In the north however these names did not extend as far as Ellesmere, suggesting that this area may in itself exhibit heterogeneity although the marriage matrix shows large amounts of movement between Ellesmere and Oswestry possibly nullifying any earlier differentiation. Certainly in terms of place names the central region of the Salop/Powys border surrounding the Long mountain and Breiddon Hill lacks Celtic representation, and along with Roman evidence of the English regions to the east of the Severn (Sylvester 1969) support the inclusion of these parishes with Salop rather than with Welshpool.

Considered in terms of geography many of the amalgamations which make up the four larger groups make sense. The marriage matrix showed that Meifod belongs to Llanfyllin although the small numbers available for dermatoglyphic investigation produced inconsistencies.

The historical connection of Welshpool and Oswestry is well documented in the literature as well as the Oswestry/Llanfyllin link and together with the marriage matrix gives a good basis for amalgamation into a single group. Whether Ellesmere is to be included in this group remains slightly speculative but it is proposed on the dermatoglyphic evidence that the connection with at least the western part of this latter area is correct even though the eastern edge may be more connected with Salop and the English. The uniting of Newtown with Llanidloes consistently occurs and is reasonable in terms of geographical proximity. This is surprising when the migration into Newtown in the last decade is considered; however additional evidence confirms the link. It is known that this southern part of Powys (Montgomeryshire) was the most civil of all the

Roman regions within the county. Although captured periodically by the Welsh, it remained the most occupied, and under the greater migrational influence. Similarly, in Norman times, the marcher lordships extended their territory to a greater extent in this southern region, maintaining an association with Salop or at least less so with the more northern areas.

The amalgamation of Llanfair Caereinion with Newtown and Llanidloes is difficult to explain purely geographically. The area delimited is the catchment area of the secondary school but is bound on its northern and southern side by watersheds and has running through its middle the east/west route from the lower Severn valley, up the valley of the Banwy to Mallwyd, and then either north to Dolgellau or south to Machynlleth. In terms of proximity it should combine with the more northern regions. It did in two sets of analysis combine with Shrewsbury or Ellesmere preferentially in SLC and MLC, but on two further occasions it relates to Newtown or Llanidloes, and because of this, and also that its SLC link with these latter two was always fairly strong, it is placed with them. It is difficult to envisage how a new subdivision could be justified after consideration of the geography of the area. A more detailed study of regional movement and social factors may provide the answers. What makes this intermediate position of Llanfyllin more difficult to envisage is Machynlleth being placed consistently with the north Powys area. The placement of groups on the marriage matrix does not suggest preferential movement to Welshpool or Llanfyllin and there seems to be little geographical connection, having the Banwy valley interposed. A purely intuitive suggestion is that Machynlleth was always considered a Welsh region, relatively uninfluenced by the Roman/Norman influx, an area where Welsh language and culture remain, hence the link with the north of the county. If it were possible to sample the Llanfair Caereinion area more thoroughly, then we could hope for heterogeneity, the western hill region providing the connecting link around the 'English' region of Newtown

and Llanidloes.An alternative explanation is that Machynlleth represents a separate region and only chance sampling has combined it with the more northerly areas.

To the south of north Powys (Montgomeryshire) the Kerry hills, Black Mountains and the eastern extension of Plynlimon separate Rhayader and Knighton from the above and they have been combined into a single (loose) unit on the basis of dermatoglyphics. The marriage matrix, together with place name evidence, puts the lower half of Bishop's Castle and Church Stretton in with this region, and the discriminant analysis (page 288) shows that this combined area separates out from the remaining areas on all the series, giving strong evidence for its dermatoglyphic individuality and also (by extension) degree of homogeneity.

The remaining combined regions form the central region of Salop, including those parishes in Powys east of the Severn. This region constitutes possibly the most heterogeneous group of the four produced. Its individual areas (Shrewsbury and Pontesbury mainly) have at times shown affiliation with nearly all the surrounding areas of Wales and Salop. The split of the south Salop region hopefully would, if investigated further, show that there is less connection between Shrewsbury and Pontesbury than previously indicated, while increasing homogeneity. It is the least defined of all the combined areas but makes geographical sense in terms of being essentially the lowland extension of the Severn valley into Salop. Whether or not it should include the Long Mynd and its westward extension is a matter of conjecture which the sample size in the present survey could not answer. In terms of marriage, Bishop's Castle certainly relates to Church Stretton and Knighton as a northern extension. To include all of the original Bishop's Castle area within a southern hill group may be realistic, although the original analysis placed this region with Welshpool on dermatoglyphics alone, hence the suggestion of a divide. Perhaps the best that

can be said for Salop on available evidence, on the level of analysis performed, is that there exists a northern region with Welsh affinities, centred around Oswestry, while its southern hills show evidence of a relationship with the hills of what was North Radnorshire, and between is an area of "Englishness". The precise lines which demarcate the three can only roughly be indicated on the available evidence.

Consideration of the demarcated areas in relationship to language initially produced no particularly consistent relationship. Papers by Williams, 1936, 1937), Thomas (1956), Bowen and Carter (1974), Jones and Griffiths (1961) all reveal a gradual westward retreat of the Welsh language into the western hills of Powys. Language alone has already been shown to contribute little to differentiation within the data set. A publication by Thomas (1973) gives dialect distribution maps for Wales as a whole. Necessarily crude in scale, and with errors concerning the placement of towns in relation to rivers (uncorrected Dec. 1977) in the mid borderlands, the distribution of minor speech areas west of the Severn show three broad divisions (Figure 6, 1973) termed Tanat-Fyrnwy (6), Dyfi (5) and south east midlands (7). Allowing for the different definitions of regions defined in the present survey, these three areas show remarkable consistency with the North Powys (6), Machynlleth (5) and Newtown/Llanidloes/ Llanfair Caereinion (7) regions defined by dermatoglyphics. Noteworthy is the extension of the south east midlands region northward into the upper Banwy valley, comparable with the dermatoglyphic findings above. Obviously no dialect distribution for the Welsh language is available for any region east of the river Severn or for north Radnorshire, so no comparison with these areas can be made, but for the Welsh speaking areas of Montgomeryshire the agreement between dialect and dermatoglyphics is good. Thomas' book shows that dialect distribution in Wales has close ties with medieval administrative boundaries, 'The Gwledyyd', but also in many cases

with particular cantrefi. In order to relate dialect distribution to ancient boundaries for example,

"It would thus seem reasonable to postulate the medieval gwledydd as being co-terminus with significant dialect areas in the same period. The further significant point then emerges that, although considerable re-orientation of the dialect areas has been brought about by successive extension of the distribution areas of particular words, the new boundaries of such distribution areas tend still to correspond closely with the medieval administrative boundaries. Thus, although the territories of the Gwledydd when they cease to be administrative units cannot be said to have positively influenced the historical development of the dialects, their peripheries are found to be relevant still in the classification of Welsh word geography. But this is not to suggest a causal connection between administrative boundary and word-geographical movement and distribution because of the coincidence of medieval administrative boundaries and of present-day word-geographical boundaries with the physical geography of the country. Whereas the physical geography of the country undoubtedly influenced the establishment of medieval administrative boundaries and controlled the dialect movement which resulted in present-day geography, the interrelation of the latter two must be left to detailed study elsewhere".

The present thesis provides further evidence of the ancient borders and physical boundaries producing detectable variations, in this case dermatoglyphic. At the time of writing, detailed dialect studies comparable with that in Wales are not available for Salop (see Orton and Barry 1969).

While this thesis is the first dermatoglyphic investigation of the mid Wales borderland, a comparable study using the ABO blood groups has been made and reported on several occasion by Watkin (1952, 1956, 1963, 1965) and Mourant and Watkin (1952). These works have dealt with the

whole of Wales, giving general observations, with detailed gene frequency variation, in localised areas not given, except for a single paper on western Salop and later for Salop as a whole.

The distribution of frequencies indicated that no significant differences existed between the eastern and western halves of Salop while in the west no difference about a north-south line was found. However, significant differences between subsets based on English or Welsh surnames were shown. They indicate that the Elizabethan linguistic boundary was not an important anthropological divide. While the context was slightly different, similar conclusions were reached in the present work for a language divide (but not the dialect distribution as above). The use of surnames was shown to be important as a parameter, again verified by the present dermatoglyphic evidence, but only when gross regionalisation was involved. Partitioning the four amalgamated regions by ancestry, while giving significant differences between groups, gave a confusing set of relationships, which it was felt contributed little to the understanding of the data. It could be added that this conclusion may have been different had region (2) been consistent in its subset relationships, hence the possibility that with more detailed permutation and regional amalgamations, ancestry (surnames) may turn out to contribute more to revealing variability within the data set. Watkin (ibid.) could detect no geographical variation in Salop akin to that presented by dermatoglyphics although he limited his investigations to a north/south divide. He indicated on his maps, particularly on the 1952 paper, that there may be an out-pushing of Welsh influence, by way of high 'O' gene frequencies, into Salop and south of Shrewsbury, while a corresponding low (O) level moves into Powys from Salop around Newtown. Some regional variations within the borderland beyond that shown for surnames may exist. However, regions such as those given on the basis of dermatoglyphics were not evident.

No additional genetic or anthropometric evidence is available to confirm the regional patterns given above. Fleure in his collection of data did not sample the borderland in sufficient detail to give any evidence of regional variations, and additional serology is still awaiting investigation. In terms of historical evidence, the four regions delimited seem reasonable on the evidence given, and although further investigations may move the boundaries between areas slightly, it is unlikely that the broad outline presented will be drastically altered, although it is hoped they will be improved. Indeed, the writer feels that ongoing analysis subsequent to this presentation with additional multivariate techniques will be able to improve regional distributions, especially with regard to the mid-Salop area (2) and the role of ancestry.

Much of the interpretation of genetic variability is made in terms of migration or invasion, the ABO blood group distributions constituting the classis example in the British Isles. The present data confirm that the south of the region, comprising Newtown, Llanidloes and Llanfair Caereinion, is distinct from the north of the county, and also indicate that the hill region of area (4) is again distinct from the remaining regions. The relative relationships were given earlier (page 287) and need not be restated. As regards regional movement, there is only evidence that Oswestry and Ellesmere are closer to north Powys than to the remaining regions, while there is a greater similarity within Powys between the north and south than for either with the central or southern parts of western Salop. No conclusion as to where the Welsh in Salop originated from, or relate to, is given due to the lack of consistency shown for ancestry as a parameter. It seems that regional variation based on the child's or parent's birthplace is the most useful criterion for partitioning the data. While using the common parental birthplace improves the ability to discriminate and classify, it also reduces the sample sizes, so making the relationship more speculative.

It was not possible to investigate the formation of amalgamated groups from the original fifteen areas defined when the common parent's birthplace was used in a manner comparable with that using the child, due to the small sample sizes which result.

However, the results of the analysis for the four areas based on the former parameters were not inconsistent with the result given for the child's birthplaces. The relationship of the two parameters was given earlier (page 236) and while there seems reasonable agreement in the conclusions reached using either parameter, the possibility that a different pattern of variability may be produced when the common parental birthplace is employed with larger samples must not be overlooked.

Multiple Regression Analysis

The technique of multiple regression attempts to predict the value of a dependent variable for the values of a series of independent variables. In a sample bivariate case the standard regression equation

$$Y^1 = A + BX$$

would result, where Y^1 is being computed from an independent variate X, with constants A and B chosen to minimise the residual sum of squares. The extention to more than one predictor variate takes the form,

$$Y^1 = A + B_1X_1 + B_2X_2 \ldots\ldots + B_NX_N$$ where the Bs are termed regression coefficients. Further explanations will not be given but reference to the SPSS manual (page 320 onward) gives extensive details about the subprogramme Regression utilised for this analysis and general theory behind multiple regression.

In the discriminant analysis performed it was shown that regions could be produced which exhibited a degree of homogeneity within themselves and heterogeneity between. Comparing the original D^2 values between the 15 regions defined, with certain demographic characters, showed that of those described, the marriage movement index (I) gave the highest correlation with D^2, particularly the (I) for the parent's movement. This idea of attempting to predict the D^2 values from demographic variants can be extended to include population sizes of each region, frequency of Welsh ancestry or nonconformity in each area and sample size variance between areas. The advantage of using multiple regression compared to bivariate regression stems from the ability of the former technique to allow for intercorrelations between the predictor variates, although care must be exercised if the intercorrelations between these variates is high (> .8).

In attempting to predict the D^2 the following variables were input as potential predictors.

(1) Distance between regions (miles)

(2) $^1/$miles - reciprocal of intergroup distance

(3) The three marriage indices and that produced from the combined generations.

(4) The sample size of each pair of groups compared

(5) The frequency of pupils with Welsh ancestry in each pair of regions

(6) The frequency of nonconformity in each pair of regions

(7) An estimate of sample variance between any two groups calculated as the reciprocal of the standard deviation of the binomial expansion

$$\text{Var} = \frac{1}{\left(P_{IJ} \cdot Q_{IJ} \cdot (N_I + N_J)\right)^{1/2}} = \left(\frac{N_I + N_J}{N_I \cdot N_J}\right)^{1/2}$$

Only the conclusions obtained will be described and the summary of the regression weights given (Table 106) on a multiple stepwise regression.

It is apparent from Table 106 that the total amount of explained variance in the D^2 predicted by the variates differs slightly between sexes and matrices, the smallest value being for females with a reduced matrix (.499), while the reduced matrix in males gave the highest value (.686). The consistent feature in all four regression analyses was that the variate which accounted for the vast majority of the explained variance was the same, being the estimate of sample variance (var).

These results confirm a suggestion made throughout this thesis, that sample size can markedly affect the magnitude of the D^2 values produced from dermatoglyphic variables. Similar conclusions were reached by Dennis (1977b).

It has previously been discussed how the 15 regions could combine to produce larger units which were relatively homogeneous and which related to dialect distributions and historical events. If a measure of sample variance can predict over 50% of the absolute D^2 value it should be asked if the inter-relationships represent nothing more than sampling methodology. Several points indicate that this may not be so.

The values given by Dennis for the correlation between his D^2 and E^2 values and sample variance (var) were, in general, greater than those obtained in the present thesis, the former writer having many correlations > .90. This is reflected in a multiple r^2 for his regressions which had a minimum value of .876 ($E^2_{(32)}$) and a maximum of .950 ($D^2_{(62)}$), the minimum being much greater than in the present work. Care must be taken with such a comparison for the former worker entered more variables as potential predictors than the present writer, the effect being obvious, although Dennis indicates that only the first variate (generally var) contributed an r^2 of more than .01 to the total.

In the present work the absolute magnitude of the D^2 was not the only criterion available for analysis, for the MDS plots used the rank order relationships. Groups were formed, not on an absolute hierarchical scale, but by consideration of MDS, SLC and MLC relationships, as well as for subsets based on large group numbers (pages 231 to 279). The multiple regression shows that there is over 50% of the variance in some of the D^2 not explained by sampling variance. The writer feels that it is this 50% which resulted in the amalgamation of groups so formed, resulting from genetic (dermatoglyphic) similarity. Because both sexes gave fairly similar amalgamation patterns this seems a justified conclusion although sample sizes for each region correlate highly over sex. The result of sampling would have altered the absolute magnitude of the D^2, but, it is felt, not the relative relationships, apart from when very small

samples or dichotomy of samples is involved. No attempt has been made to place too much emphasis on the fine interrelationships within each amalgamated group, with only general observations as to the relative ease with which regions combined. This was directly due to prior evidence of the effect of sampling. The writer feels that this thesis suggests that there may indeed be regional variation in dermatoglyphics over the mid Wales borderlands, particularly between Salop and Powys, between north and south Powys (Montgomeryshire) and possibly between the southern Powys areas of Rhayader and Knighton and the more northerly regions just listed. Various changes to this broad regionalisation have been considered also. However, the results of the multiple regression analysis suggest that studies of regional variation by multivariate methods (D^2, E^2) should be made with extreme caution if the sample size within each defined region falls below 200 per sex, with additional care should the dichotomy of sample size between regions be great.

Analysis of dermatoglyphic variation, with the county as the O.T.U. (Operational Taxonomic Unit) is probably valid, possibly with a single or double subdivision of this O.T.U., but when O.T.U.s are formed from a small number of parishes (e.g. < 10) (see page 342), then the writer feels that sampling effects may predominate, obscuring any underlying dermatoglyphic variation.

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Dear Sir,

Biological Study of the North Wales borderlands and the adjoining West Midlands region

I am currently engaged on a research project in the Department of Anthropology, University of Durham, into the genetical variation of the peoples of the Welsh/English borderland of North Wales and the adjoining West Midlands region. The aim of this investigation is to determine the nature of this variation and to pursue the historical and geographical reasons for it.

The material for this study has been, in other United Kingdom schools, satisfactorily collected by using simple and rapid tests on large numbers of school children, and I have the permission of the Director of Education for the County to contact you and in turn to seek your approval for a part of this survey which I hope you will allow me to carry out at your school,

The subject matter carefully chosen for use is palm prints which are very easily and rapidly collected. The prints are made directly on to sensitized paper. This factor was chosen to cause the least inconvenience possible in schools and is in no way harmful. Each individual is required for no more than a few minutes, such data being obtained from 250 persons in five hours.

The dermal prints values have been widely used in the British Isles in similar studies supported by the Medical Research Council. Many hundreds of school children have helped us in such research projects initiated by this department over the last few years. The palm prints contain a vast amount of information on inherited characters. Past results show there is a great deal of normal variation in palmar patterns over the country, and as in Oxfordshire this has greatly assisted in the reconstruction of the history of the people. However, the distribution of variation is unknown in Wales, and from the unique history of the region the results are certain to be of especial interest.

I would be most grateful to receive your approval for a survey as outlined above to be carried out in your school at some convenient date. In other areas we have circulated forms from the schools to the pupils' parents, firstly to give their consent and also to take the opportunity of asking them some simple geographical details. I enclose two specimen forms of this type. If you would wish to alter these in any way this can be arranged. The survey does not normally involve more than 30 per cent of all the children. For the schools taking part in the survey, it is intended to compile a report of the findings and conclusions of the research.

Finally, I would be pleased to visit you at a time convenient to yourself, to detail any points you would wish to discuss.

Yours truly,

W.R. Williams. M.Sc.

Enc.

University of Durham Department of Anthropology

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Dear Parent,

Biological Study of Mid Wales and the English/Welsh Borderlands

I would like to ask permission for your son(s) and/or daughter(s) to take part in the survey outlined below which I am at present carrying out in many schools in Salop.

I am currently carrying out a research project into the variation of inherited features in the people of the Welsh/English borderlands and the adjoining mid Wales areas. I have the consent of the Headmaster and the Director of Education to approach you with respect to the survey. Its aim is to discover whether the people of the Welsh valleys and Welsh borderlands differ from area to area and from the English people now living in the area, as is suggested from a study of the History and Geography of Wales and the Marches.

The features used in the study are palm and finger patterns. On different areas of the palms and the fingers there are various patterns created by the very intricate lines present and these patterns are known to be inherited to a very large extent.

Because of the shorter distances travelled before the present century and the incidence of local marriages in towns, villages and valleys the populations of small areas become distinct, with local characteristics, and it is to see if such differences exist in finger and palm prints that my research has been initiated. It is important to obtain as many sets of prints as possible from people of local ancestry as well as from people who have grandparents who were born outside the areas not being examined.

With such a large region to study enough information can only be gathered by carrying out observations on extensive numbers of school children and I very much hope that you will allow your son(s) and/or daughter(s) to take part in the survey. Only school children will be used and no approach to any any parents to take part will be made except for consent to allow their children to participate and to complete the questionnaire if they so agree.

Taking prints is quick, clean and simple and the method has already been used in a large number of schools in South Wales and Yorkshire.

I hope you will fill in the questionnaire as fully as you can, thus providing information which is invaluable in effecting an analysis of the results. Any information given will be treated in complete confidence and neither the questionnaire nor the prints taken will be available to any person outside the Department of Anthropology, University of Durham.

It is intended to provide each school taking part in the survey with a report and conclusions of the work undertaken.

Yours sincerely,

W.R. Williams. M.Sc.

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Annwyl Rieni,

Astudiaeth fywydegol yng Nghanolbarthau Cymru a'r Gororau

Hoffwn ofyn am eich caniatâd i'ch mab (meibion) a'ch merch (merched) i gymeryd rhan yn yr arolwg yr wyf ar hyn o bryd yn ei gweithredu mewn llawer o ysgolion ym Mhowys.

Yr wyf yn astudio rhai nodweddion corfforol a etifeddir yn enedegol, ymysg poblogaethau'r Gororau ac ardaloedd cyfagos yng nghanolbarthau Cymru. Eisoes derbyniais ganiatâd y Prifathro a'r Cyfarwyddwr Addysg i ofyn am eich cydweithrediad. Amcenir darganfod a ydyw pobl y dyffrynnoedd Cymreig a'r Gororgu yn wahanol o ardal i ardal ao os ydyw'r Cymru yn wahanol i'r Saeson sydd yn awr yn byw yn yr ardaloedd, fel y tybid y dylent fod, o astudio hanes a daearyddiaeth Cymru a'r Gororau.

Y nodweddion a ddefnyddir yn yr arolwg fydd y printiau ar y dwylaw ac ar flaenau'r bysedd. Y mae patrymau yn y printiau ar wahanol rannau o'r dwylaw a'r bysedd a gwyddom fod y rhain, i raddau helaeth, yn uniongyrchol dan ddylanwadau genedegol.

Cyn y ganrif hon, ychydig o bellter oddicartref y teithiau mwyafrif y boblogaeth, ac fel rheol priodau'r rhan fwyaf ac ereill o'r cylch. Felly datblygodd poblogaethau'r ardaloedd yn wahanol i'w gilydd mewn llawer modd a bwriedir gweld a yw'r poblogaethau yma yn wahanol yn y patrymau y soniwyd amdanynt. Pwysig iawn fydd casglu cymaint o brintiau ag sy'n bosibl oddiwrth y rhai sydd a chyndeidiau lleol, yn ogystal ag oddiwrth y rhai sydd a chyndeidiau o ardaloedd tu allan i'r rhai y cynhelir yr astudiaeth bresennol ynddynt.

Gan fod ardal mor eang i'w hastudio, dim ond drwy gydweithrediad llawer o blant y gellir casglu digonedd o wybodaeth. Felly mawr obeithiaf y caniatewch i'ch plant gymeryd rhan yn yr arolwg. Dim ond plant ysgol a ddefnyddir yn yr arolwg ac ni ofynir i'r rhieni gymeryd rhan ond gofynir am eu caniatâd i'w plant gymeryd rhan ac iddynt ateb y cwestiynau ynglyn â'u plant, os cytunant gydweithredu.

Gellir cymeryd y printiau yn gyflym, yn syml ac yn lan ac yr ydym, o Brifysgol Durham, eisoes wedi gwneud gwaith cyffelyb mewn nifer o ysgolion yn Neheudir Cymru, yng Ngwynedd ac yn Swydd Efrog.

Gobeithiaf yr atebir y gofyniadau mor gyflawn ag sy'n bosibl er mwyn i mi gael y wybodaeth sy'n amhrisiadwy bwysig i ddeall y mesurebau a gesglir. Ni roddir naill ai'r printiau na'r wybodaeth a gesglir i unrhyw un tu allan i'r Adran Anthropolegol ym Mhrifysgol Durham.

Bwriedir rhoddi adroddiad o'r gwaith a'r casgliadau i bob ysgol a gydweithreda yn yr arolwg.

Yn gywir iawn,

W.R. Williams. M.Sc.

This questionnaire is designed to provide information on the patterns of movement within the entire region and to assess differences that may occur regarding the inherited characters within one region as to occupational and religious groups. I would be very grateful if you and your husband would complete it as accurately as possible. If you do not know the answer to a particular item please indicate 'NOT KNOWN'.

I give/do not give permission for my son/daughter to take part in the survey outlined above.

Signed . . . . . .
(Parent/Guardian)

Name of son/daughter . . . . . .
Name of any brothers and/or sisters in school(s).
Please give school(s) as well. . . . . .

Name of any first cousins at school. . . . . .

Maiden name of mother . . . . . .

Maiden name of mother's mother . . . . . .

Maiden name of father's mother . . . . . .

*Place of birth of pupil . . . . . .

*Place of birth of father . . . . . .

* " " " " mother . . . . . .

* " " " " father's father . . . . . .

* " " " " father's mother . . . . . .

* " " " " mother's father . . . . . .

* " " " " mother's mother . . . . . .

*actual residence at the time of birth; not hospital.

Religion of the family . . . . . .

*Occupation of the family (father). . . . . .

* " " " father's father. . . . . .

* " " " mother's father. . . . . .

*if deceased state prior occupation.

Answer yes or no in the appropriate rows for each of the questions at the head of each column space.

	Can any of the family listed below speak:-		
	Welsh only	Welsh and English	English only
Pupil	. . . . .	. . . . .	. . . . .
Father.	. . . . .	. . . . .	. . . . .
Mother.	. . . . .	. . . . .	. . . . .
Mother's father .	. . . . .	. . . . .	. . . . .
Mother's mother .	. . . . .	. . . . .	. . . . .
Father's father .	. . . . .	. . . . .	. . . . .
Father's mother .	. . . . .	. . . . .	. . . . .

Please leave blank any questions you do not wish to answer. All information will be treated in strict confidence.

Cynlluniwyd y gofyniadau isod er mwyn ceisio darganfod patrymau'r symudiadau o le i le a fu ymysg y poblogaethau yn yr ardaloedd yma ac i ddarganfod a oes gwahaniaethau mewn nodweddion etifeddegol yn yr ardaloedd, ymysg yr enwadau crefyddol ac ymysg y galwedigaethau hefyd. Mawr werthfawrogwn pe baech chwi a'ch gŵr (gwraig) yn ateb y gofyniadau mor llwyr ag sy'n bosibl. Os nad ellwch ateb rai gofyniadau, rhowch 'Nis gwn' gyferbyn a hwg.

Rhoddaf/Ni rhoddaf ganiatâd i'm mab/merch gymeryd rhan yn yr arolwg.

Arwyddir . . . . . .
(Mam/Tad/Geidwad)

Enw'r Plentyn . . . . . .
Enwau unrhyw frodyr neu chwiorydd mewn ysgolion ar hyn o bryd. Rhowch enwau'r ysgolion . . . . . .

Enwau unrhyw gefnder/cyfnither yn yr ysgol. . . . . .

Enw morwynol mam . . . . . .
" mam mam . . . . . .
" mam nhad. . . . . .

*Lle ganwyd: y plentyn . . . . . .
* " ei dad . . . . . .
* " ei fam . . . . . .
* " tad ei dad. . . . . .
* " mam ei dad. . . . . .
* " tad ei fam. . . . . .
* " mam ei fam. . . . . .

*Lle'r cartreg adeg y geni; nid yr ysbytty.
Enwad crefyddol y teulu. . . . . .

*Galwedigaeth y teulu (tad) . . . . . .
* " tad y tad . . . . . .
* " tad y fam . . . . . .

*Os yw'n farw, rhowch ei alwedigaeth cyn iddo fraw.

Atebwch 'Gall' neu 'Nis gall' i'r gofyniadau ar ben y colofnau, gan roddi'r atebion yn y rych a'r golofn briodol.

A all aelodau'r teulu a restrir siarad y canlynol?

	Cymraeg yn unig	Cymraeg a Saesneg	Saesneg yn unig
Y plentyn	. . . . .	. . . . .	. . . . .
Ei dad	. . . . .	. . . . .	. . . . .
Ei fam	. . . . .	. . . . .	. . . . .
Tad ei dad. . . .	. . . . .	. . . . .	. . . . .
Mam ei dad. . . .	. . . . .	. . . . .	. . . . .
Tad ei fam. . . .	. . . . .	. . . . .	. . . . .
Mam ei fam. . . .	. . . . .	. . . . .	. . . . .

Gadewch rhai gofyniadau heb eu hateb os gwell genych beidio rhoi'r manylion. Cedwir y ffeithiau a roddir yn hollol gyfrinachol.

Figure 1

Salop - Powys Border
County Border
Path of Offas Dyke
152.4 mt. (500 ft) Contour
Land Over 304.8 mt
Scale · Km.
0 5 10 15
Weston Rhyn
Ellesmere
Oswestry
Cader Berwyn
r. tanat
Baschurch
GWYNEDD
Llanfyllin
POWYS
SALOP
r. vyrnwy
Shrewsbury
r. banwy
Welshpool
Long Mountain
Llanfair Caereinion
Pontesbury
r. severn
r. dovey
Machynlleth
Long Mynd
Wenlock Edge
Church Stretton
Newtown
Bishops Castle
Plynlimon
Kerry Hills
r. severn
Llanidloes
Clun
DYFED
Knighton
Rhayader

Table 1

Head Teacher.	
Mrs. M.D. Shuker,	C. in W. School, Bettws, Newtown, Powys.
Mr. W.M.R. Astley,	C. in W. School, Castle Caereinion, Welshpool, Powys.
Mr. W. Jones,	C. in W. School, Forden, Welshpool, Powys.
Mrs. C. Darlington,	C. in W. (Cortrolled)Infants School, Gungrog, Welshpool, Powys.
Mr. D.O. Evans,	C. in W. (Aided) School, Kerry, Newtown, Powys.
Mr. J.B. Goldsmith,	C. in W. School, Llandysilio, Llanymynech, Powys.
Mr. J.H. Pritchard,	C. in W. School, Llanfechain, Powys.
Mr. E.W. Roberts,	C. in W. School, Llanfihangel, Llanfyllin, Powys.
Mr. A.R. Roberts,	C. in W. (Aided) School, Llansantffraid, Powys.
Mrs. E. Williams,	C. in W. School, Maesmawr, Welshpool, Powys.
Mr. W.E. Blair,	C. in W. School, Montgomery, Powys.
Mr. D.J. Dee,	C. in W. (Aided) School, Sarn, Newtown, Powys.
Mr. J.E. Hughes,	C.P. School, Aberhafesp, Newtown, Powys.
Mr. G. Lewis,B.A.,	C.P. School, Abermule, Powys.
Mr. T. Pierce,B.A.,	C.P. School, Ardleen, Llanymynech, Powys.
Mr. E. Roberts.	C.P. School, Banw, Llangadfan, Welshpool, Powys.
Mr. D.A. Evans,	C.P. School, Brynhafren, Bausley, Crew Green, Salop.
Mr. H. Sheran,	C.P. School, Buttington/Trewern, Buttington, Welshpool, Powys.
Mr. L. Taylor,	C.P. School, Caersws, Powys.
Mr. A. Phillips,	C.P. School, Carno, Newtown, Powys.
Mr. T.L. Williams,	C.P. School, Carreghofa, Llanymynech, Powys.
Mr. W. Hopkins,	C.P. School, Churchstoke, Powys.
Mr. W.A.E. Hughes,	C.P. School, Guilsfield, Nr.Welshpool, Powys.

Table 1 cont.

Mr. P. Thomas,	C.P. School, Leighton, Welshpool, Powys.
Mr. J.M. Jones,	C.P. School, Llanbrynmair, Powys.
Mr. W.J. Stephens,	C.P. School, Llandinam, Powys.
Mr. E. Thomas,	C.P. School, Llanfair Caereinion, Welshpool, Powys.
Mr. E.T. Edwards,	C.P. School, Llanfyllin, Powys.
Mr. G.R. Roberts,	C.P. School, Llangurig, Llaniloes, Powys.
Mr. H.L. James,	C.P. School, Llanidloes, Powys.
Mr. D.G. Williams,	C.P. School, Llanwddyn, Oswestry, Salop.
Miss A.M. Williams,	County Infants School, Machynlleth, Powys.
Mr. D.G. Jenkins,	C.P. School, Meifod, Powys.
Mrs. E.M. Hughes,	C.P. School, Mellington, Churchstoke, Powys.
Mr. J.E.J. Davies,	Hafren County Junior School, Park Lane, Newtown, Powys.
Miss W.H. Morris,	County Nursery and Infants School, Newtown, Powys.
Miss M.E. Evans,	Penygloddfa Nursery and Infants School, Newtown, Powys.
Mr. S. Jenkins,	C.P. School, Tregynon, Newtown, Powys.
Mr. T.J. Rees,	Ysgol Glantwymyn, Cemmaes Road, Machynlleth, Powys.
Mr. E. Griffiths,	Ysgol Pennant, Pentbontfawr, Oswestry, Salop.
Mrs. G. Smith,	C. in W. School, Llangunllo, Knighton, Powys.
Mr. J. Cooper,	C. in W. School, Rhayader, Powys.
Mr. A.P. Jones,B.A.,	Caereinion High School, Llanfair Caereinion, Welshpool, Powys.
Mr. A. Griffiths,M.A.,	High School, Llanfyllin, Powys.
Mr. W.G. Harries,B.A.,	High School, Llanidloes, Powys.
Mr. I.R. Parry,B.A.,	High School, Machynlleth, Powys.

Table 1 cont.

Mr. M.E. Thorne, M.Sc.,	Bishop's Castle C.P. School, Church Street, Bishop's Castle, Salop.
Mr. L. Cunnick, B.A.,	Church Stretton C.E. (Controlled)School, Shrewsbury Road, Church Stretton, Salop.
Mr. K.M. Allan,	Ellesmere C.P. School, Elson Road, Ellesmere. Salop.
Mr. E. Jones,	Gobowen C.P. School, Oswestry, Salop.
Mr. R.F. Harrison,	Kinnerley C.E. (Controlled)School, Oswestry, Salop.
Mr. P. Leech,	Minsterley C.P. School, Shrewsbury, Salop.
Mr. J.R. Moore,	Pontesbury C.E. (Controlled)School, Bogey Lane, Pontesbury, Salop.
Mr. C.S. Page,	Stokesay C.P. School, Craven Arms, Salop.
Mr. C.R. Fowler,	Weston Rhyn C.P. School, Oswestry, Salop.
Mr. P.W. Mann,	Wistanstow C.E. (Controlled)School, Craven Arms, Salop.
Mr. R.H. Jackson,	Baschurch Modern School, Baschurch, Salop.
Mr. S.E. McLoughlin, M.Sc.,	Oswestry Boys' High School, Holbache Road, Oswestry, Salop.
Miss P.E. Gilbert, Ph.C.,	Oswestry Girls' High School, Upper Brook Street, Oswestry, Salop.
Miss D.L. Tharby,	Oswestry Girls' Modern School, Pen-y-lan Lane, Oswestry, Salop.
Mr. J.D.M. Preshous, M.A.,	Bishop's Castle County High School, Bishop's Castle, Salop.

Table 2

REGIONAL SAMPLES

POWYS

	School	No. of Pupils on Roll	No. of Pupils Printed	% Accepting
	Church in Wales Primary Schools			
1	Bettws, Newtown	31	23	74.2
2	Castle Caereinion, Welshpool	34	14	41.1
3	Forden, Welshpool	70	34	48.6
4	Gungrog, Welshpool	80	31	38.7
5	Kerry, Newtown	80	42	52.5
6	Llandysilio, Llanymynech	61	27	44.3
7	Llanfechain, Powys	42	18	42.8
8	Llanfihangel, Llanfyllin	33	11	33.3
9	Llansantffraid, Powys	89	53	59.5
10	Maesmawr, Welshpool	21	6	28.6
11	Montgomery, Powys	120	26	21.6
12	Sarn, Newtown	40	21	52.5
	County Primary Schools			
13	Aberhafsp, Newtown	40	27	67.5
14	Abermule, Powys	84	62	73.8
15	Ardleen, Llanymynech	82	48	58.5
16	Banw, Llangadfan	43	19	44.2
17	Brynhafren, Crew Green Salop	38	17	44.7
18	Buttington/Trewern, Buttington	100	42	42.0
19	Caersws, Powys	100	66	66.0
20	Carno, Newtown	57	49	85.9
21	Carreghofa, Llanymynech,	59	43	72.9
22	Churchstoke, Powys	51	30	58.8
23	Guilsfield, Nr. Welshpool	146	83	56.8
24	Leighton, Welshpool	50	11	22.0
25	Llanbrynmair, Powys	60	22	36.7
26	Llandinam, Powys	35	29	82.8
27	Llanfair caereinion, Welshpool	180	70	38.8
28	Llanfyllin, Powys	162	79	48.8
29	Llangurig, Llanidloes	23	13	56.5
30	Llanidloes, Powys	230	177	76.9
31	Llanwddyn, Oswestry, Salop	43	29	67.4
32	Machynlleth (infant) Powys	96	49	51.0
33	Meifod, Powys	46	33	71.7
34	Mellington, Churchstoke	42	22	52.4
35	Hafren County, Newtown	360	173	48.0

Table 2 cont.

School	No. of Pupils on Roll	No. of Pupils Printed	% Accepting
36 County Infants, Newtown	120	68	56.6
37 Penygloddfa Nursery, Newtown	100	48	48.0
38 Tregynon, Newtown	32	18	56.2
39 Ysgol Glantwymyn, Cemmaes Road.	60	40	66.7
40 Ysgol Pennant, Pentbontfawr. Salop.	54	43	79.6
41 Knighton, Powys.	314	145	46.2
42 Llangunllo, Knighton.	21	6	28.6
43 Rhayader, Powys.	100	63	63.0
Sub-total	3629	1930	53.18
Secondary Schools			
44 Caereinion High School, Llanfair caereinion.	300	113	37.66
45 Llanfyllin High School, Powys.	500	170	34.00
46 Llanidloes High School, Powys.	380	121	31.8
47 Machynlleth High School, Powys.	372	125	33.6
Sub-total	1,552	503	32.41
SALOP			
Primary Schools			
48 Bishop's Castle County, Salop.	173	75	43.35
49 Church Stretton, Salop.	312	131	41.98
50 Ellesmere County, Salop.	368	96	26.08
51 Gobowen County, Oswestry.	254	142	55.90
52 Kinnerley, Oswestry.	119	40	33.61
53 Minsterly County, Shrewsbury.	102	36	35.29
54 Pontesbury, Shrewsbury.	253	132	52.17
55 Stokesay, Craven Arms.	170	46	27.05
56 Weston Rhyn, Oswestry.	176	36	20.45
57 Winstanstow, Craven Arms.	79	24	30.38
Sub-total	2006	758	37.78
Secondary Schools			
58 Baschurch Modern, Shrewsbury.	352	77	21.87
59 Oswestry Boy's High, Oswestry.	402	181	45.02
60 Oswestry Girl's " "	450	135	30.00
61 Oswestry Girl's Modern, "	400	50	12.50

Table 2 cont.

	No. of Pupils on Roll	No. of Pupils Printed	% Accepting
62 Bishop's Castle High, Salop.	500	86	17.20
Sub-total	2104	529	25.14
Grand Total	9291	3720	40.03

Distribution of Schools in the Powys-Salop Borderland

Figure 2

Table 3

REGIONAL CODE AND NAME	CONTAINED PARISHES AND CODE		POP. IN PRIVATE HOUSES IN '71 TOTAL	M.	F.	TOTAL POP. '71	'61
1. Llanfyllin	1	Llanwddyn	315	160	150	324	369
	2	Llangynog	265	135	140	265	292
	3	Pennant	235	120	115	234	237
	4	Hirnant	65	35	30	63	120
	5	Llanrhaeadr-ym-Mochnant	405	205	200	403	465
	8	Llanfihangel	395	215	180	394	458
	10	Llanfechain	440	215	225	483	439
	11	Llansantffraid Pool	666	320	335	671	647
	9	Llanfyllin	1030	505	525	1118	1252
2. Welshpool	39	Berriew	1120	570	550	1125	1190
	12	Carreghofa	420	205	215	419	402
	17	Llandysilio	495	245	250	501	520
	14	Llandrinio	490	245	246	488	588
	15	Bausley	345	175	170	344	438
	18	Guilsfield (without)	810	410	400	811	892
	19	Middletown	315	155	155	313	294
	21	Castle Caereinion	210	110	100	210	299
	41	Trelystan	305	140	160	303	302
	40	Forden	645	325	320	821	791
	42	Montgomery	970	455	510	968	972
	44	Llandyssil	465	230	235	520	465
	43	Church Stoke	1075	555	525	1092	1213
	133	Brompton & Rhiston	95	55	40	93	104
	134	Shelve	85	50	35	86	102
	131	Worthen	1650	825	820	1658	1844
	20	Welshpool	6935	3358	3550	7030	6330
	13	Llansanffraid Deytheur	250	130	120	258	288
	132	Chirbury	730	370	360	729	818
3. Llanfair Caereinion	6	Garthbeibio	75	40	35	75	111
	7	Llangadfan	375	190	185	392	432
	24	Llanerfyl	285	145	140	287	338
	35	Llanllugan	170	95	75	168	192
	36	Llanwyddelan	170	90	85	172	205
	37	Manafon	260	140	120	262	289
	23	Llangyniew	295	150	145	293	295
	22	Llanfair caereinion	1175	595	580	1187	1428
4. Machynlleth	27	Llanwrin	365	185	180	389	474
	30	Uwchygarreg	125	65	60	126	130
	31	Darowen	395	205	185	393	434
	32	Penegoes	270	145	125	272	285
	33	Llanbrynmair	665	340	325	727	666
	28	Machynlleth	1685	810	875	1768	1904
	25	Cemmaes	420	205	215	434	520
	26	Caereinion Fechan	45	25	20	43	42
	29	Isygarreg	180	100	80	179	216
5. Newtown	34	Carno	450	250	200	455	481
	52	Llanwnog	1205	600	605	1352	1304
	49	Penstrowed	80	40	40	83	100
	51	Aberhafesp	295	150	145	292	299
	38	Tregynon	365	190	180	425	406

Table 3 cont.

	46	Bettws	420	215	205	422	440
	45	Llanmerewig	90	45	45	91	99
	48	Mochdre	285	145	140	289	228
	47	Kerry	1445	740	705	1451	1397
	50	Newtown & Llanllwchaiarn	5970	2875	3095	5517	6115
6. Llanidloes	53	Llandinam	895	440	450	911	996
	54	Llangurig	585	310	275	598	666
	55	Llanidloes Without					
	56	Trefeglwys	670	340	330	777	669
7. Rhayader	62	Llansantffraed-Cwmdeuddwr+Rhayader	1585	765	820	1614	1434
	61	St. Harmon	420	225	195	419	427
	60	Abbey cwmhir	220	105	115	221	271
	59	Llananno	75	45	35	73	110
	64	Llanddewl Ystradenny	305	170	135	305	293
	79	Llanbadarnfraw	500	255	240	502	459
	80	Llandrindod Wells	3085	1385	1700	3381	3251
	77	Llanfihangel Heygen	40	20	25	49	45
	78	Llanyre	620	310	315	626	679
	63	Nantmel	620	330	290	630	687
8. Knighton	58	Llanbadarn Fynydd	170	100	70	175	182
	57	Beguiley	415	225	185	416	436
	65	Llanbister	340	185	155	339	439
	66	Llanahangel Rhydithou	185	95	85	183	227
	76	Cascob	50	30	25	51	50
	69	Bleddfa	115	60	55	119	120
	67	Llangunllo	245	140	105	246	318
	68	Heyope	120	55	65	123	113
	75	Litton & Cascob	30	15	15	29	30
	70	Pilleth	50	25	25	50	65
	74	Norton	250	125	125	250	189
	71	Knighton	1945	965	975	2008	1824
	72	Stanage	80	40	40	79	75
	73	Whitton	110	55	55	110	99
9. Meifod	16	Meifod	790	400	385	901	788
10. Oswestry	81	Weston Rhyn	2120	1025	1095	1934	2438
	82	St. Martin's	2200	1105	1095	1970	2202
	88	Selattyn & Gobowen	2920	1385	1535	3610	3528
	89	Oswestry	11830	5560	6270	11215	12018
	87	Whittington	2050	985	1060	2651	2060
	90	Oswestry Rural	2925	1440	1485	3529	3110
	93	West Felton	700	360	340	787	702
	91	Llanyblodwell	805	405	400	768	804
	92	Llanymynech & Pant	1155	550	650	1081	1173
	96	Kinnerley	955	475	480	990	958
	95	Knockin	195	100	95	251	197
	104	Melverley	120	60	60	129	121

Table 3 cont.

11. Ellesmere	83	Ellesmere Rural	2420	1225	1190	2564	2438
	84	Ellesmere Urban	2545	1205	1345	2261	2630
	85	Welshampton	395	195	205	422	397
	86	Cockshutt	445	225	220	498	444
	97	Hordley	205	110	95	283	204
	101	Loppington	410	200	215	513	533
	99	Petton	90	50	40	99	88
	100	Myddle	305	160	145	745	887
	98	Baschurch	1415	705	710	1508	1536
	102	Little Ness	205	95	110	220	310
	103	Great Nesh	825	400	425	753	829
	94	Ruyton-Xl-Towns	935	490	445	826	953
12. Pontesbury	106	Montford	515	245	265	558	513
	110	Ford	685	330	350	716	686
	107	Alberbury with Cardeston	635	345	290	663	649
	108	Wollaston	210	110	95	221	208
	109	Westbury	1020	520	495	922	1036
	112	Pontesbury & Minsterley	3400	1685	1715	4054	4436
	118	Church Pulverbatch	360	185	175	322	359
	121	Smethcott	180	95	85	198	178
13. Shrewsbury	105	Pimhill	2000	1005	990	1564	2006
	111	Bicton	930	480	450	779	1038
	114	Shrewsbury	53620	25730	27895	50437	56188
	113	Bayston Hill	5340	2585	2755	2350	5341
	115	Berrington & Atcham	795	390	400	1292	1228
	117	Condover	1435	705	730	1304	1486
	116	Pitchford	90	45	45	130	90
	124	Acton Burnell	170	85	85	300	202
	123	Cound	455	225	230	408	458
14. Bishop's Castle	135	Ratlinghope	90	55	40	129	95
	137	Wentnor	210	105	105	206	209
	140	Myndtown	85	50	35	94	85
	139	Norbury	105	55	50	117	103
	136	More	105	55	50	125	107
	146	Lydham	220	115	105	239	221
	148	Bishop's Castle	1110	530	585	1228	1199
	147	Lydbury North	530	280	250	568	528
	159	Edgton	50	25	25	86	51
	165	Colebatch	70	45	30	90	72
	166	Mainstone	95	45	50	110	97
	167	Bettws-y-crwyn	200	110	90	250	200
	168	Llanfair Waterdine	190	110	80	228	190
	169	Stowe	140	75	65	167	142
	170	Clun	1250	665	600	1388	1261
	163	Bucknell	445	220	225	455	447
	171	Bedstone	65	35	25	75	176
	162	Hopton Castle	65	30	35	96	65
	160	Clungunford	230	115	115	297	228
	164	Clunbury	465	240	230	557	467

15. Church Stretton	142	Rushbury	470	240	230	575	476
	143	Eaton-under-Heywood	175	90	85	202	176
	141	Hope Bowdler	145	70	75	184	144
	138	Church Stretton	3210	1465	1705	2784	3346
	145	Winstanstow	605	315	295	662	607
	157	Sibdon Carwood	70	35	30	78	68
	144	Acton Scott	125	65	60	147	125
	156	Halford	70	30	40	167	68
	158	Hopesay	360	175	180	382	360
	155	Stokesay	1450	750	735	1207	1467
	129	All Stretton	170	85	80	190	168
	122	Woolstaston	210	110	95	221	208
	120	Longnor & Lesbotwood	400	200	200	448	401
	119	Frodesley	135	70	65	157	134
	130	Ruckley & langley	50	25	25	56	50
	127	Church Preen	120	55	60	89	118
	128	Cardington	385	205	180	412	386
	154	Onibury	295	155	140	334	297
	161	Bromfield	310	145	165	365	312
	152	Culmington	325	175	150	390	335
	153	Stanton Lacy	355	170	180	462	354
	151	Diddlebury	580	305	275	646	580
	150	Munslow	345	170	175	425	344

Figure 3

PARISH CODE NUMBERS. POWYS

Figure 3 cont.

PARISH CODE NUMBERS. SALOP

Figure 4

Regions Taken As Secondary School Catchment Areas With Associated Name And Code Number

Figure 4 cont.

SALOP

Table 4

AREAS

In Powys the Cantref (or Canton), gave way at an early stage of local history to the Commot (or Vicinity) as an administrative area. However in the case of Arwystli and Cedewain the Cantonal area is better known than its sub-divisions into commots.

AREA		PARISHES CONTAINED WITHIN
Mochnant		Llanrhaeadr (south) Hirnant Pennant Melagnell Llangynog Llanwddyn
Mechain		Llanfyllin Llanfihangel Gwynfa Llanfechain (Llanarmon-ym-Mechain) Llansantffraid-ym-Mechain Meifod
Caereinion		Llanfair Caereinion Llangadfan Llangyniew Llanerfyl Garthbeibio Rural Castle Caereinion
Cyveiliog		Machynlleth Llanwrin Penegoes Darowen Cemmaes Llanbrynmair The area of Plynlumon
Arwystli		Carno Llanwnog Llandinam Llanidloes Llangurig Trefeglwys Penstrowed Borough of Llanidloes Borough of Caersws
Cedewain	North	Bettws Cedewain Berriew (not Brithdir) Tregynon Manafon Llanllugan Llanwyddelan
	South	Aberhafesp Newtown Llanllwchaiarn Llanmerewig Llandyssil

Table 4 cont.

	Town of Dolforwyn
	Town of Aberbechan
	Town of Abermule
Kerry	Kerry
	Mochdre
Gortheur	Bausley up to Forden
	Churchstoke
	Snead
	Hyssington
	Town of Aston
	Town of Castlewright
Strata Marcella	Garthmyl
	The bottom end of Cedewin
	Welshpool
	Brithdir northward to Broniarth
	East to Golfa, Pool, to Mael y Golfa
	Two thirds within Guilsfield
	Llanercholdol
	Ystrad Marchel
	Deytheur

The above is taken from Roberts and Owen (1916).

Figure 5

CANTREFI AND CONTAINED PARISHES (Montgomeryshire)

Table 5

LIST OF WELSH SURNAMES

Adda	Francis	Kenwyn	Probyn
Anwyl	George	Kyffin	Prosser
Baynhan	Gethin	Lewis	Prothero
Bevan	Glyn	Leyshon	Prytherch
Beddoe	Gough	Llewellyn	Pugh
Bellis	Griffith	Lloyd	Rees
Beynon	Gronow	Loughor	Richards
Bithel	Gwatkin	Machen	Roberts
Blythin	Gwilt	Maddock	Rogers
Bowen	Gwilym	Mainwaring	Rosser
Breese	Gwyn	Mathias	Rowlands
Cadarn	Gwyther	Meredith	Thomas
Caddell	Harries	Meyrick	Treharne
Cadwallander	Hopkin	Morgan	Trevethan
Craddock	Howell	Morris	Trevor
Davis	Hughes	Owen	Tudor
Dilwyn	Humphreys	Parry	Vaughan
Edmonds	Idris	Phillips	Walters
Edwards	Ithell	Powell	Watkin
Elias	James	Powis	Welsh
Ellis	Jenkins	Preece	Williams
Evans	John	Price	Wynn
Eynon	Jones	Pritchard	Yorath
Foulk	Joseph	Probert	

Many names have varient spelling which may also be considered Welsh.

Table 6

SOCIAL CLASS

OCCUPATION	SOCIAL CLASS 1
Architect	
Chartered Accountant	
Chemist	
Civil Engineer	
Horticulturalist	
Surgeon	
Vet	
Vicar	
	SOCIAL CLASS 2
Artist	
Bank Manager	
Building Inspector	
Co-Director	
Farmer	
Garage Owner	
Grocer	
Inspector (railway)	
Insurance Broker	
Legal Executive	
Managing Director	
Post Officer	
Publican	
Site Manager	
Small Holder	
Stock Broker	
Sub-Post Master	
Teacher	
	SOCIAL CLASS 3
Antique Dealer	
Architect's Assistant	
Brick Layer	
Building Contractor	
Butcher	
Civil Servant	
Clerk of Works	
Coal Merchant	
Fitter Welder	
Foreman	

Table 6 cont.

OCCUPATION	SOCIAL CLASS 3
Foundary Worker	
Hairdresser	
Ironmonger	
Joiner (cabinet worker)	
Lorry Driver	
Mechanic	
Miller	
Miner	
Newsagent	
Painter & Decorater	
Pipe Layer	
Plumber	
Police Man	
Postman	
P.S.V. Driver	
Rent Collector	
Representative	
Saddler	
Sheet Metal Worker	
Shop Manager	
Tailor	
Tool Maker	
Tool Setter	
Water Board Man	
	SOCIAL CLASS 4
Agricultural Contractor	
Forestry Worker	
Maintenance Man	
Plastic Worker	
Private Investigtor	
Quarry Man	
Security Guard	
Shepherd	
Ships Steward	
Stoker	
Van Sales Man (bread etc.)	
Warehouse Man	

Table 6 cont.

OCCUPATION	SOCIAL CLASS 5
Estate Worker	
Mill Worker	
Railway Worker	
Road Man	

The above is a sample of the main occupational groups encounted in the research.

POWYS. FREQUENCY OF SPOKEN WELSH. Figure 6

MONOGLOT AND BILINGUAL COMBINED PERCENTAGES BY PARISH

SALOP. FREQUENCY OF SPOKEN WELSH. Figure 6 cont.

KEY AS FOR POWYS

Table 7

CARD/POSITION	ABBREVIATION	VARIABLE
CARD 1		
1-5	CASE	Case number
7	Sex	Sex
8-9	NoSc	Number of school
10-11	Free	
12	DoW	Degree of Welshness
13	Rlgn	Religion
14	SoCl	Social class
15-17	Cbpa	Childs birth place
18	Ngbpc	N^{o}. of grandparents born in the same parish as the child.
19-21	Pmg	Parish in which maximum number of grandparents were born.
Finger ridge counts		
22-41	RFR1-RFU5	Right finger radial/ulnar digit one to five
42-61	LFR1-LFR5	Left finger radial/ulnar digit one to five
Palmar ridge counts		
62-63	RAB	AB ridge count right hand.
64-65	RBC	BC " "
66-67	RCD	CD " "
68-69	RBD	BD " "
70-71	LAB	AB ridge count left hand
72-73	LBC	BC " "
74-75	LCD	CD " "
76-77	LBD	BD " "
78-80	RFRC	Right finger ridge count, use larger whorl/double loop count.
CARD 2		
1-5	Free	
6	CARD	Card number
7-9	LFRC	Left finger ridge count, use larger whorl/double loop count.
10-12	TFRC	Total finger ridge count, use larger whorl/double loop count.
13-15	RFAC	Right finger absolute ridge count, use all of ridge counts.
16-18	LFAC	Left finger absolute ridge count, use all of ridge count.
19-21	TFAC	Total finger absolute ridge count, use all of ridge count
22-24	RPTOT	Right palmar total ridge count
25-27	LPTOT	Left palmar total ridge count

Table 7 cont.

7	KHTR	Carpal hypothenar tented right
8	KHTL	" " " left
9	RHTR	Radial " " right
10	RHTL	" " " left
11	UHTR	Ulnar " " right
12	UHTL	" " " left
13	PAR	Parathenar right
14	PAL	Parathenar left
Triradii		
15	TR	Triradii t right
16	TL	t left
17	T1R	" t' right
18	T1L	" t' left
19	T2R	" t" right
20	T2L	" t" left
21	TBR	Border triradii right
22	TBL	" " left
23	TRR	Radial " right
24	TRL	" " left
25	TUR	Ulnar/central triradii right
26	TUL	" " " left
27	TEFR	Triradii e/f right
28	TEFL	" " left
29	TZR	Zygodactylous triradii z = AB fused right
30	TZL	Zygodactylous triradii z = AB fused left
31	TZ1R	Zygodactylous triradii z1 = BC fused right
32	TZ1L	Zygodactylous triradii z1 = BC fused left
33	TZ2R	Zygodactylous triradii z2 = CD fused right
34	TZ2L	Zygodactylous triradii z2 = CD fused left
35	TDR	Unspecified interdigital triradii group, right
36	TDL	Unspecified interdigital triradii group, left
37-38	MAINAR	Main line termination A right
39-40	MAINAL	" " " " left
41-42	MAINBR	" " " B right
43-44	MAINBL	" " " " left
45-46	MAINCR	" " " C right
47-48	MAINCL	" " " " left

Table 7 cont.

28-30	TPRC	Total palmar ridge count
Finger triradii and patterns		
31-40	RD1-LD5	N°. of triradii on each finger right & left hand.
41-50	RP1-LP5	Patterns on each finger
Palmar patterns		
51	PTR	Peripheral thenar right
52	PTL	" " left
53	RTR	Radial thenar right
54	RTL	" " left
55	P2R	Peripheral second area right
56	P2L	" " " left
57	P2TR	" " " tented right
58	P2TL	" " " " left
59	C2R	Central second area right
60	C21	" " " left
61	P3R	Peripheral third area right
62	P3L	" " " left
63	P3TR	" " " tented right
64	P3TL	" " " " left
65	C3R	Central " " right
66	C3L	" " " left
67	P4R	Peripheral fourth area right
68	P4L	" " " left
69	P4TR	" " " tented right
70	P4TL	" " " " left
71	C4R	Central " " right
72	C4L	" " " left
73	U4R	Ulnar " " right
74	U4L	" " " left
75	PHR	Peripheral hypothenar right
76	PHL	" " left
77	CHR	Central " right
78	CHL	" " left
79	RHR	Radial " right
80	RHL	" " left

CARD 3

1-5	Free	
6	CARD	Card Number

Table 7 cont.

49-50	MAINDR	Main line termination D right
51-52	MAINDL	" " " " left
53-54	MAINADR	Summational main line index A+D right
55-56	MAINADL	Summational main line index A+D left

Finger pattern intensity totals, number of triradii

57-58	RFPII	Right finger pattern intensity total
59-60	LFPII	Left " " " "
61-62	TFPII	Total " " " "

Palmar pattern intensity totals, number of triradii

63-64	RPPII	Right palmar pattern intensity total
65-66	LPPII	Left " " " "
67-68	TPPII	Total " " " "
69-71	RMATD	Right maximal atd angle
72-74	LMATD	Left " " "
75-77	RLATD	Right least " "
78-80	LLATD	Left " " "

CARD 4

1-5	Free	
6	CARD	Card number
7-22	Free	
23-25	PFa	Fathers birth place
26-28	PMo	Mothers birth place
29-31	PFaFa	Fathers fathers birth place
32-34	PFaMo	Fathers mothers birth place
35-36	RMPCT	Right maximum % function of axial triradii, t
37-38	LMPCT	Left maximum % function of axial triradii, t
39-40	RLPCT	Right minimal % function of axial triradii, t
41-42	LLPCT	Left minimal % function of axial triradii, t
43-45	ABLRH	Absolute length of right hand
46-48	ABLRT	" " to triradii t right
49-51	ABLLH	" " of left hand
52-54	ABLLT	" " to triradii t left

Welsh speaking ability

55	Pu	Pupils ability to speak Welsh
56	Mo	Mothers ability to speak Welsh
57	Fa	Fathers " " " "
58	MoMo	Mothers mothers ability to speak Welsh
59	MoFa	" fathers " " " "

Table 7 cont.

60	FaMo	Fathers mothers ability to speak Welsh
61	FaFa	" fathers " " " "
62-64	PMoFa	Mothers " birth place
65-67	PMoMo	Mothers mothers birth place

Computed Variables

RADCR	Radial count right
RADCL	Radial count left
ULNCR	Ulnar count right
ULNCL	Ulnar count left
TRC	Total radial count
TUC	Total ulnar count
RAHR	Hypothenar radial arch right
RAHL	Hypothenar radial arch left

Figure 7

Dept of Anthropology.

BOB WILLIAMS. School_____

BOB WILLIAMS

CASE					CARD	Sex	NoSc					DoW	Rign	SoCl	Cbpa			Ngbpc		Prig
1	2	3	4	5	6 1	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	RFR1		RFU1		RFR2		RFU2		RFR3		RFU3		RFR4		RFU4		RFR5		RFU5
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	LFR1		LFU1		LFR2		LFU2		LFR3		LFU3		LFR4		LFU4		LFR5		LFU5
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	RAB		RBC		RCD		RBD		LAB		LBC		LCD		LBD		RFRC		
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

CASE					CARD	LFRC				TFRC			RFAC			LFAC			TFAC	
1	2	3	4	5	6 2	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	RPTOT			LPTOT			TPRC			RD1	RD2	RD3	RD4	RD5	LD1	LD2	LD3	LD4	LD5
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
RP1	RP2	RP3	RP4	RP5	LP1	LP2	LP3	LP4	LP5	PTR	PTL	RTR	RTL	P2R	P2L	P2TR	P2TL	C2R	C2L
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
P3R	P3L	P3TR	P3TL	C3R	C3L	P4R	P4L	P4TR	P4TL	C4R	C4L	U4R	U4L	PHR	PHL	CHR	CHL	RHR	RHL
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

CASE					CARD	KHTR	KHTL	RHTR	RHTL	UHTR	UHTL	PAR	PAL	TR	TL	T1R	T1L	T2R	T2L
1	2	3	4	5	6 3	7	8	9	10	11	12	13	14	15	16	17	18	19	20
TBR	TBL	TRR	TRL	TUR	TUL	TEFR	TEFL	TZR	TZL	TZ1R	TZ1L	TZ2R	TZ2L	TDR	TDL	MAINAR		MAINAL	
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
MAINBR		MAINBL		MAINCR		MAINCL		MAINDR		MAINDL		MAINADR		MAINADL		RFPII		LFPII	
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
TFPII		RPPII		LPPII		TPPII		RMATD		LMATD		RLATD				LLATD			
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

CASE					CARD														
1	2	3	4	5	6 4	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		PFa			PMo			PFaFa			PFaMo			RMPCT		LMPCT		RLPCT	
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
LLPCT		ABLRH			ABLRT			ABLLH			ABLLT			Pu	Mo	Fa	MoMo	MoFa	FaMo
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
FaFa		PMoFa			PMoMo														
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

Figure 8

Definition of "Type" distributions.

H = Subset with highest mean value on a specified variable.
L = " " lowest " " " " " "

Birth Place Frequencies Of Family Members Within The Sample. Table 8

	Pupil	Mother	Father	Mothers Mother	Mothers Father	Fathers Mother	Fathers Father
Llanfyllin(1)	.068	.060	.065	.050	.053	.048	.061
Welshpool(2)	.092	.067	.080	.048	.051	.058	.048
Llanfair Caereinion(3)	.028	.030	.035	.034	.027	.034	.033
Machynlleth(4)	.046	.033	.034	.022	.025	.027	.032
Newtown(5)	.092	.073	.081	.064	.062	.053	.074
Llanidloes(6)	.074	.059	.062	.049	.049	.058	.056
Rhayader(7)	.015	.015	.018	.014	.014	.015	.013
Knighton(8)	.028	.018	.019	.011	.015	.015	.010
Meifod(9)	.014	.012	.013	.010	.010	.011	.012
Oswestry(10)	.113	.085	.073	.057	.060	.049	.052
Ellesmere(11)	.034	.024	.028	.018	.018	.023	.021
Pontesbury(12)	.028	.024	.020	.016	.015	.015	.019
Shrewsbury(13)	.040	.022	.019	.018	.011	.010	.010
Bishops Castle(14)	.028	.025	.021	.020	.020	.017	.013
Church Stretton(15)	.028	.016	.013	.010	.013	.009	.009
Avon	.002	.002	.004	.003	.004	.003	.002
Bedfordshire	.001	-	.001	-	-	.001	.001
Buckinghamshire	.002	.001	.003	.001	.002	-	.002
Cambridgeshire	.002	.002	.002	.003	.002	.001	.001
Cheshire	.010	.023	.022	.028	.027	.024	.017
Cleveland	-	-	-	-	-	-	-
Cornwall	.001	.001	.001	.001	.001	.001	.003
Cumbria	.001	.001	.002	.002	.003	.002	.002
Derbyshire	.003	.006	.006	.006	.007	.006	.004
Devon	.002	.003	.003	.002	.003	.005	.005
Dorset	.002	.004	.002	.004	.005	.001	.003
Durham	.003	.005	.007	.007	.007	.006	.010
Essex	.006	.009	.005	.009	.006	.004	.006
Gloucestershire	.003	.004	.003	.004	.002	.004	.005
London	.016	.030	.026	.037	.040	.031	.027
Manchester	.013	.031	.030	.041	.038	.039	.035
Hampshire	.005	.007	.004	.004	.005	.007	.005
Hereford & Worcester	.011	.015	.012	.019	.021	.018	.016
Hertfordshire	.004	.003	.002	.002	.002	.003	.002
Humberside	-	.001	-	.002	.001	-	-
Isle of White	-	-	-	-	-	-	-
Kent	.004	.006	.003	.006	.005	.002	.004
Lancashire	.004	.007	.008	.011	.010	.007	.009

Table 8 cont.

Leicestershire	.004	.004	.002	.003	.003	.003	.001
Lincolnshire	.001	.002	.001	.003	.004	.003	.001
Norfolk	.002	.004	.002	.004	.004	.003	.003
Northamptonshire	.002	.002	.001	.001	.001	.002	.001
Northumberland	.002	.002	.001	.002	.002	.002	.002
Nottinghamshire	.003	.003	.002	.002	.004	.003	.006
Oxfordshire	.002	.001	.001	.002	.003	-	.002
Salop(east)	.022	.033	.032	.036	.034	.033	.032
Somerset	.001	.001	.001	.004	.005	.002	.003
Staffordshire	.009	.014	.010	.022	.019	.014	.014
Suffolk	.005	.003	.004	.005	.003	.007	.006
Surrey	.008	.009	.007	.003	.003	.004	.003
Sussex	.002	.002	.002	.001	.002	.003	.003
Warwickshire	.004	.001	.002	.002	.001	.004	.003
Wiltshire	.001	.002	.001	.003	.003	.002	.003
Yorkshire	.006	.014	.017	.013	.017	.019	.020
Middlesex	-	-	-	-	-	-	.001
Clwyd	.023	.028	.034	.034	.036	.040	.035
Dyfed	.009	.010	.010	.013	.012	.016	.012
Gwent	.001	.003	.005	.008	.004	.007	.007
Gwynedd	.013	.022	.022	.028	.024	.025	.024
Glamorgan	.010	.021	.016	.033	.028	.028	.025
Powys(unspecified)	.001	.001	.010	.003	.001	.003	.004
Brecon & Radnor (unspecified)	.004	.005	.007	.008	.006	.006	.010
Isle of Man	.004	-	-	.001	-	-	-
Isle of Scilly	-	-	-	-	-	-	-
Scotland	.004	.007	.009	.014	.016	.015	.013
Ireland	.001	.002	.007	.008	.009	.010	.011
Wales(unspecified)	.002	.004	.002	.008	.006	.012	.008
England(unspecified)	-	.002	.001	.001	.003	.001	.001
Birmingham	.021	.040	.031	.032	.033	.029	.028
Others(foreign)	.005	.011	.019	.013	.013	.017	.018
Missing Data	(.015)	(.038)	(.041)	(.105)	(.124)	(.140)	(.144)
(Sample Size)	(2805)	(2805)	(2805)	(2805)	(2805)	(2805)	(2805)
Number of Cases of Known Location on Which The Frequencies Are Based	2763	2698	2690	2511	2457	2412	2401

Social Class Frequencies. Table 9

Class	1	2	3	4	5	N
	.0525	.3835	.4280	.1080	.0270	3102

Language Ability.

	Pupil	Mother	Father	Mothers Mother	Mothers Father	Fathers Mother	Fathers Father
English	.834	.789	.770	.733	.730	.722	.710
English/ Welsh	.166	.211	.230	.267	.270	.278	.290
N=	3145	3154	3155	3130	3112	3110	3092

Table 10

BIRTH LOCATION FREQUENCIES.

	Child	Mother	Father	Mother's Mother	Mother's Father	Father's Mother	Father's Father
Salop	.275	.203	.182	.156	.156	.145	.147
Powys	.462	.380	.424	.337	.349	.370	.394
Elsewhere	.263	.417	.394	.407	.495	.485	.459
N=	2763	2696	2690	2511	2457	2412	2401

CHILD'S BIRTH PLACE X NUMBER OF PARENTS BORN IN POWYS/SALOP.

		Parent's birth place(Powys/Salop)		
		0/2	1/1	2/0
Child's birth place	Salop	270	95	35
	Powys	13	100	792

Raw scores, sexes combined.

CHILD'S BIRTH PLACE X NUMBER OF GRANDPARENTS BORN IN POWYS/SALOP.

		Grandparent's birth place(Powys/Salop)				
		0/4	1/3	2/2	3/1	4/0
Child's birth place	Salop	57	19	41	12	13
	Powys	2	9	26	32	368

Raw scores, sexes combined.

Table 11

PARENT'S BIRTH PLACE(POWYS/SALOP) X GRANDPARENT'S BIRTH PLACE(POWYS/SALOP).

		Grandparent's birth place(Powys/Salop)					
		0/4	1/3	2/2	3/1	4/0	Raw scores, sexes combined.
Parent's birth place (Powys/Salop)	0/2	56	14	9	1	0	
	1/1	2	10	41	14	12	
	2/0	0	3	14	37	361	

LANGUAGE(ENGLISH/ENGLISH-WELSH) X SURNAME(ENGLISH/WELSH) X BIRTH PLACE(SALOP/POWYS).

		Surname													
		Child		Mother		Father		Mother's Mother		Mother's Father		Father's Mother		Father's Father	
		En	We	En	We	En	We	En	We	En	We	En	We	En	We
SALOP															
Linguistic ability.	English only	483	348	284	307	284	252	257	315	287	319	299	281	337	314
	English-Welsh	4	19	5	17	5	10	13	87	20	90	20	81	17	92
Welsh only	Welsh only	1	1	0	0	0	0	0	2	0	1	1	1	1	3
POWYS															
Linguistic ability	English only	345	773	241	495	355	575	163	340	154	350	177	361	164	382
	English-Welsh	48	307	59	336	37	414	77	343	62	377	71	348	57	451
	Welsh only	0	4	0	2	0	0	1	3	0	9	1	9	0	10

Raw scores, sexes combined.

Table 12

Table Abbreviations

Throughout the tables given in the latter half of this thesis difficulty was encounted in heading columns to indicate which particular division or parameter was used to produce the subsets on which the means or probabilities were based. As a consequence a series of abbreviations were used to indicate which division was involved.

Headings

-A-	=	Division by child's birth place; Salop or Powys.
-B-	=	" " common parent's birth place; Salop or Powys.
-C-	=	" " ancestry, ie. surnames; English or Welsh.
-D-	=	" " " " " " in a selected population by the child's birth place.
-E-	=	" " " " " " " " population by the common parent's birth place.
-G-	=	" " child's birth place; Salop or Powys within the English by ancestry.
-H-	=	" " " " " " " " " Welsh " "
-J-	=	" " ancestry; English or Welsh within Salop by child's birth place.
-K-	=	" " " " " " Powys " " " " .
-L-	=	" " common parent's birth place; Salop or Powys within English by ancestry.
-M-	=	" " " " " " " " " Welsh " " .
-N-	=	" " ancestry; English or Welsh within Salop by the common parent's birth place.
-P-	=	" " " " " " Powys " " " " " " .
-R-	=	" " child's birth place into 15 regions.
-S-	=	" " common parent's birth place into 10 regions.
WP/ES	=	Comparison of Welsh within Powys against English within Salop.
WS/EP	=	" " " " Salop " " " Powys.
ES/WS	=	" " English " " " Welsh " Salop.
EP/WP	=	" " " " Powys " " " Powys.
ES/EP	=	" " " " Salop " English " "
WS/WP	=	" " Welsh " Powys " Welsh " "

Table 12 cont.

The latter six divisions have two alternatives depending on whether the child's or common parent's birth place is used to define geographic location. Headings for these alternatives are given below , the equivalence of some of the comparisons with the divisions headed A to S being noted.

		Division Using The Child's Birth Place. Heading	Division Using The Common Parent's Birth Place. Heading
ES/WS	=	J	N
EP/WP	=	K	P
ES/EP	=	G	L
WS/WP	=	H	M
ES/WP	=	T	U
EP/WS	=	V	W

A (T) in brackets indicates the column contains transformed data; eg. A(T) , B(T) .
A (B) " " " " " " Bartlett's test probabilities on the parametric analysis of variance; eg (B) , (B) .
-R- -S-

Combining the above two would give (B) .
S(T)

So indicates a column containing the geographic subset of Salop.
Po " " " " " " " Powys.
En " " " " ancestral subset of English.
We " " " " " " " Welsh.

N= or N indicates the sample size of which the particular estimate was bases and is easily distinguished from -N- used to indicate a type of division.

Transformation Lambda.

Table 13

	Female	Male
RD1	0.85649	0.87012
RD2	1.19207	1.04119
RD3	0.75233	0.61294
RD4	0.92042	*5.06500
RD5	-0.01292	*8.41900
LD1	1.01038	0.54774
LD2	1.14547	0.90715
LD3	0.87425	0.73374
LD4	0.68820	0.40381
LD5	0.30913	-0.24118
RFPII	0.94909	0.91030
LFPII	1.04674	0.80277
TFPII	1.03959	0.90800
RPPII	-1.23125	0.26991
LPPII	-1.26658	0.27806
TPPII	-1.63580	0.47400
RLATD	1.33677	1.39603
LLATD	0.96394	0.79623
MAINAR	-0.33255	*18.16300
MAINAL	-0.16463	-0.16785
MAINBR	0.65120	0.65120
MAINBL	1.11362	1.62958
MAINCR	*6.21800	*5.31500
MAINCL	3.78960	*5.22500
MAINDR	*5.88860	*5.42100
MAINDL	2.39325	2.16621
MAINADR	2.39949	2.44550
MAINADL	1.33533	1.27129

	Female	Male
FR1	0.76762	0.80600
FR2	0.53598	0.56766
FR3	0.47677	0.47034
FR4	0.68478	0.74135
FR5	0.65765	0.72302
FL1	0.74362	0.70013
FL2	0.45269	0.48432
FL3	0.47254	0.52143
FL4	0.66667	0.64029
FL5	0.73270	0.79707
RT1	1.69338	1.70100
RT2	1.01560	1.01050
RT3	1.07797	1.04449
RT4	1.35854	1.35524
RT5	1.28626	1.44325
LT1	1.60822	1.50319
LT2	0.87942	0.92784
LT3	1.08509	1.25317
LT4	1.31299	1.34498
LT5	1.40446	1.62636

	Female	Male
RFRC	1.31867	1.28900
LFRC	1.33959	1.30461
TFRC	1.28880	1.30461
RFAC	0.29507	0.29354
LFAC	0.45491	0.31393
TFAC	0.45713	0.39621
RADCR	0.26296	0.23650
ULNCR	0.10609	0.23257
RADCL	0.46341	0.29135
ULNCL	0.15553	0.11105
TRC	0.43449	0.34082
TUC	0.21775	0.22625
RAB	0.42608	0.58944
RBC	1.91062	1.92816
RCD	2.46155	2.45097
LAB	0.12659	0.50483
LBC	1.95992	1.97038
LCD	2.49494	2.40670
RPTOT	0.94736	1.04230
LPTOT	1.04592	1.24480
TPRC	0.97039	1.26218

(*) indicates suboptimal solution, iteration stopped when lambda >5.0

FINGER PATTERNS FREQUENCIES.

Table 14

MALES	RP1	RP2	RP3	RP4	RP5	LP1	LP2	LP3	LP4	LP5	N
True Arch	.018	.061	.049	.015	.010	.032	.065	.065	.017	.010	1548
Tented Arch	.001	.021	.006	.001	.001	.000	.016	.010	.000	.000	
Ulnar Loop	.565	.323	.729	.479	.844	.679	.383	.713	.629	.901	
Radial Loop	.002	.271	.027	.008	.001	.002	.252	.037	.004	.001	
Whorl	.217	.190	.124	.357	.073	.105	.150	.103	.210	.040	
Double Loop	.176	.079	.039	.035	.025	.171	.094	.047	.056	.023	
Ulnar C.P. Loop	.018	.015	.017	.098	.046	.008	.012	.020	.080	.025	
Radial C.P. Loop	.003	.040	.008	.007	.001	.003	.027	.005	.004	.000	
Amalgamated Patterns											
Arch	.019	.083	.055	.016	.010	.032	.081	.074	.017	.010	
Loop	.567	.594	.756	.487	.845	.681	.635	.751	.632	.902	
Whorl	.414	.323	.189	.497	.145	.287	.283	.175	.351	.088	
FEMALE											N
True Arch	.041	.079	.064	.021	.015	.068	.087	.092	.029	.028	1614
Tented Arch	.000	.018	.004	.000	.000	.001	.014	.008	.004	.001	
Ulnar Loop	.623	.396	.779	.568	.859	.624	.353	.698	.621	.872	
Radial Loop	.002	.173	.016	.004	.003	.003	.235	.035	.004	.001	
Whorl	.166	.198	.087	.284	.068	.124	.177	.108	.232	.051	
Double Loop	.147	.086	.032	.013	.012	.167	.090	.042	.029	.019	
Ulnar C.P. Loop	.020	.016	.013	.105	.040	.009	.012	.013	.077	.027	
Radial C.P. Loop	.001	.035	.004	.005	.003	.004	.033	.004	.004	.001	
Amalgamated Patterns											
Arch	.041	.097	.068	.021	.015	.069	.101	.100	.032	.029	
Loop	.665	.569	.795	.572	.862	.627	.585	.734	.625	.873	
Whorl	.335	.334	.136	.407	.123	.304	.310	.167	.343	.099	

FEMALES. FINGER PATTERN FREQUENCIES.

Table 15

	RP1		RP2		RP3		RP4		RP5	
	---A---		---A---		---A---		---A---		---A---	
	So	Po	So	Po	So	Po	So	Po	So	Po
True Arch	.033	.045	.048	.095	.053	.068	.020	.021	.007	.017
Tented Arch	.000	.000	.015	.021	.004	.004	.000	.000	.000	.000
Ulnar Loop	.641	.613	.435	.378	.798	.777	.587	.545	.886	.883
Radial Loop	.002	.001	.178	.166	.020	.018	.007	.004	.004	.003
Whorl	.158	.174	.191	.195	.092	.072	.284	.297	.059	.075
Double Loop	.152	.135	.075	.092	.026	.041	.009	.016	.009	.013
Ulnar C.P. Loop	.011	.030	.018	.017	.004	.013	.088	.112	.033	.050
Radial C.P. Loop	.002	.001	.040	.036	.002	.006	.007	.006	.002	.004
Amalgamated Patterns										
Arch	.033	.045	.064	.116	.057	.072	.020	.021	.007	.017
Loop	.644	.615	.613	.544	.818	.796	.593	.548	.890	.841
Whorl	.323	.340	.323	.339	.125	.132	.387	.431	.103	.142
N=	455	706	455	704	455	705	455	706	455	706
X^2	1.657		10.564		1.220		2.312		6.295	
(P)	.436		.005		.543		.314		.043	

	LP1		LP2		LP3		LP4		LP5	
True Arch	.055	.078	.073	.101	.070	.102	.022	.031	.022	.024
Tented Arch	.000	.000	.011	.013	.009	.006	.002	.006	.000	.000
Ulnar Loop	.604	.626	.371	.347	.727	.687	.642	.596	.831	.871
Radial Loop	.007	.003	.246	.227	.044	.035	.009	.004	.000	.003
Whorl	.143	.109	.191	.167	.092	.108	.215	.258	.033	.062
Double Loop	.178	.170	.066	.099	.040	.047	.035	.023	.022	.014
Ulnar C.P. Loop	.007	.010	.015	.007	.015	.008	.070	.076	.040	.024
Radial C.P. Loop	.007	.004	.026	.040	.002	.007	.004	.006	.002	.010
Amalgamated Patterns										
Arch	.055	.078	.084	.113	.079	.108	.024	.037	.022	.024
Loop	.611	.629	.618	.574	.771	.722	.651	.601	.881	.874
Whorl	.334	.293	.299	.313	.149	.170	.325	.363	.097	.102
N=	455	706	455	706	455	706	455	706	455	706
X^2	3.753		3.500		3.951		3.612		0.149	
(P)	.153		.173		.138		.164		.929	

FEMALES. FINGER PATTERN FREQUENCIES. Table 16

	RP1		RP2		RP3		RP4		RP5	
	---B---		---B---		---B---		---B---		---B---	
	So	Po	So	Po	So	Po	So	Po	So	Po
True Arch	.042	.043	.042	.092	.036	.057	.012	.025	.012	.016
Tented Arch	.000	.000	.024	.028	.006	.005	.000	.000	.000	.000
Ulnar Loop	.600	.613	.406	.401	.824	.796	.606	.551	.897	.828
Radial Loop	.000	.002	.182	.128	.018	.023	.006	.005	.006	.002
Whorl	.164	.167	.218	.216	.091	.062	.279	.284	.055	.082
Double Loop	.188	.144	.061	.089	.018	.043	.012	.014	.000	.014
Ulnar C.P. Loop	.006	.027	.024	.014	.006	.007	.085	.114	.024	.053
Radial C.P. Loop	.000	.002	.042	.032	.000	.007	.000	.007	.006	.005
Amalgamated Patterns										
Arch	.042	.043	.067	.119	.042	.062	.012	.025	.012	.016
Loop	.600	.616	.588	.530	.842	.819	.612	.556	.903	.831
Whorl	.358	.341	.345	.351	.115	.119	.376	.419	.085	.153
N=	165	437	165	436	165	437	165	437	165	437
X^2	0.146		3.908		0.888		2.147		5.030	
(P)	.929		.141		.641		.341		.080	

	LP1		LP2		LP3		LP4		LP5	
True Arch	.061	.085	.067	.101	.055	.085	.006	.027	.018	.030
Tented Arch	.000	.000	.000	.009	.012	.005	.006	.005	.000	.000
Ulnar Loop	.606	.620	.418	.341	.727	.719	.630	.595	.897	.847
Radial Loop	.006	.000	.194	.217	.030	.032	.012	.002	.000	.005
Whorl	.121	.112	.236	.172	.091	.105	.224	.272	.030	.071
Double Loop	.206	.176	.055	.101	.061	.041	.030	.025	.006	.011
Ulnar C.P. Loop	.000	.007	.012	.009	.018	.009	.091	.073	.048	.032
Radial C.P. Loop	.000	.000	.018	.050	.006	.007	.000	.000	.000	.005
Amalgamated Patterns										
Arch	.061	.085	.067	.110	.067	.089	.012	.032	.018	.030
Loop	.612	.620	.612	.558	.758	.751	.642	.597	.897	.851
Whorl	.327	.295	.321	.332	.176	.160	.345	.371	.085	.119
N=	165	437	165	437	165	437	165	437	165	437
X^2	1.806		2.923		0.919		2.398		2.166	
(P)	.520		.319		.631		.301		.338	

FEMALES. FINGER PATTERN FREQUENCIES.

Table 17

	RP1		RP2		RP3		RP4		RP5	
	---C---		---C---		---C---		---C---		---C---	
	En	We	En	We	En	We	En	We	En	We
True Arch	.048	.037	.073	.078	.068	.053	.020	.022	.013	.017
Tented Arch	.000	.000	.012	.026	.005	.002	.000	.000	.000	.000
Ulnar Loop	.616	.643	.391	.404	.759	.800	.579	.557	.856	.865
Radial Loop	.000	.005	.175	.157	.015	.012	.003	.006	.007	.002
Whorl	.178	.158	.206	.200	.107	.076	.274	.291	.073	.065
Double Loop	.139	.129	.091	.084	.023	.042	.013	.012	.013	.008
Ulnar C.P. Loop	.018	.026	.013	.019	.018	.012	.102	.109	.035	.039
Radial C.P. Loop	.002	.002	.040	.033	.005	.003	.008	.003	.003	.005
Amalgamated Patterns										
Arch	.048	.037	.084	.104	.073	.054	.020	.022	.013	.017
Loop	.616	.648	.566	.561	.774	.812	.583	.563	.863	.866
Whorl	.337	.315	.350	.335	.153	.133	.398	.416	.124	.116
N=	604	645	606	644	606	645	606	645	605	644
X^2	1.820		1.513		3.132		0.510		0.456	
(P)	.402		.469		.208		.774		.796	

	LP1		LP2		LP3		LP4		LP5	
True Arch	.069	.064	.091	.081	.092	.095	.026	.031	.031	.025
Tented Arch	.002	.000	.023	.008	.012	.003	.002	.003	.002	.000
Ulnar Loop	.634	.634	.337	.374	.695	.698	.635	.591	.875	.873
Radial Loop	.000	.006	.239	.233	.033	.031	.002	.005	.002	.002
Whorl	.139	.104	.186	.164	.107	.112	.218	.253	.045	.061
Double Loop	.147	.183	.086	.087	.048	.047	.033	.033	.021	.016
Ulnar C.P. Loop	.007	.006	.012	.012	.012	.011	.078	.082	.025	.022
Radial C.P. Loop	.003	.003	.026	.042	.002	.005	.007	.003	.000	.003
Amalgamated Patterns										
Arch	.071	.064	.114	.088	.104	.098	.028	.034	.033	.025
Loop	.634	.640	.576	.606	.728	.729	.637	.595	.876	.874
Whorl	.295	.296	.310	.305	.168	.174	.335	.371	.091	.101
N=	606	645	606	645	606	645	606	645	606	644
X^2	0.276		2.523		0.174		2.364		1.059	
(P)	.870		.283		.916		.306		.588	

Table 18

DUAL BREAKDOWN. CHILD'S BIRTH PLACE. FEMALES. FINGER PATTERN FREQUENCIES.

	RP1				RP2				RP3				RP4				RP5			
	---G---		---H---		---G---		---H---		---G---		---H---		---G---		---H---		---G---		---H---	
	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po
Tr.A.	.041	.057	.008	.046	.041	.071	.016	.096	.046	.071	.032	.060	.015	.007	.016	.026	.000	.014	.000	.022
Te.A.	.000	.000	.000	.000	.000	.014	.040	.024	.005	.007	.008	.000	.000	.000	.000	.000	.000	.000	.000	.000
U.L.	.643	.629	.690	.613	.429	.400	.476	.386	.791	.764	.810	.803	.602	.536	.603	.534	.867	.829	.929	.841
R.L.	.000	.000	.008	.002	.173	.200	.183	.140	.026	.021	.016	.007	.005	.000	.008	.007	.005	.014	.008	.000
W.	.163	.186	.151	.171	.214	.157	.159	.214	.107	.079	.095	.067	.281	.329	.270	.298	.077	.086	.024	.075
D.L.	.138	.107	.127	.130	.077	.100	.071	.089	.020	.029	.040	.046	.015	.000	.000	.019	.010	.007	.008	.010
UCPL.	.010	.021	.016	.036	.015	.007	.024	.022	.005	.021	.000	.012	.066	.121	.103	.111	.036	.050	.032	.046
RCPL.	.005	.000	.000	.002	.051	.050	.032	.029	.000	.007	.000	.005	.015	.007	.001	.005	.005	.000	.000	.007
Amalgamated Patterns																				
Arch	.041	.057	.008	.046	.041	.086	.056	.120	.051	.079	.040	.060	.015	.007	.016	.026	.000	.014	.000	.022
Loop	.643	.629	.698	.615	.602	.600	.659	.525	.816	.786	.825	.810	.607	.536	.611	.541	.872	.843	.937	.841
Whorl	.316	.314	.294	.339	.357	.314	.286	.354	.133	.136	.135	.130	.378	.457	.373	.433	.128	.143	.063	.137
N=	196	140	126	416	196	140	126	415	196	140	126	416	196	140	126	416	196	140	126	416
X^2	0.484		5.386		3.208		8.300		1.092		0.775		2.438		2.129		-		8.099	
(P)	.784		.067		.201		.015		.579		.678		.295		.344		-		.017	

	LP1				LP2				LP3				LP4				LP5			
Tr.A.	.066	.064	.008	.082	.077	.107	.016	.106	.082	.100	.040	.103	.026	.014	.000	.041	.015	.014	.024	.026
Te.A.	.000	.000	.000	.000	.015	.036	.016	.002	.015	.007	.008	.000	.000	.000	.000	.000	.000	.000	.000	.000
U.L.	.607	.686	.627	.618	.342	.350	.414	.361	.694	.707	.786	.688	.638	.629	.643	.563	.888	.900	.873	.870
R.L.	.000	.000	.016	.005	.245	.236	.286	.219	.056	.014	.024	.034	.005	.000	.008	.005	.000	.007	.000	.002
W.	.158	.114	.127	.101	.214	.129	.159	.166	.097	.079	.079	.115	.224	.236	.222	.274	.046	.043	.024	.070
D.L.	.158	.121	.214	.183	.051	.107	.079	.091	.041	.086	.048	.046	.051	.007	.032	.034	.020	.007	.024	.012
UCPL.	.005	.007	.008	.007	.026	.000	.016	.010	.015	.000	.016	.007	.051	.100	.095	.075	.031	.029	.048	.017
RCPL.	.005	.007	.000	.005	.031	.036	.016	.046	.000	.007	.000	.007	.005	.014	.000	.005	.000	.000	.008	.002
Amalgamated Patterns																				
Arch	.066	.064	.008	.082	.092	.143	.032	.108	.097	.107	.048	.103	.026	.014	.000	.046	.015	.014	.024	.026
Loop	.607	.686	.643	.623	.587	.586	.698	.579	.750	.721	.810	.721	.643	.629	.651	.567	.888	.907	.873	.873
Whorl	.327	.250	.346	.296	.321	.271	.270	.313	.153	.171	.143	.175	.332	.357	.349	.387	.097	.079	.103	.101
N=	196	140	126	416	196	140	126	416	196	140	126	416	196	140	126	416	196	140	126	416
X^2	2.416		9.118		2.559		9.089		0.345		4.955		0.675		(7.269)		0.348		0.030	
(P)	.298		.010		.278		.010		.841		.083		.713		(.026)		.840		.984	

Table 19

DUAL PARTITION. PARENTS' BIRTH PLACE. FEMALES. FINGER PATTERN FREQUENCIES.

	RP1				RP2				RP3				RP4				RP5			
	---L---		---M---		---L---		---M---		---L---		---M---		---L---		---M---		---L---		---M---	
	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po
Tr.A.	.063	.063	.000	.041	.021	.083	.000	.096	.021	.083	.000	.057	.000	.021	.000	.029	.000	.000	.000	.022
Te.A.	.000	.000	.000	.000	.021	.021	.058	.029	.021	.021	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
U.L.	.604	.646	.673	.615	.458	.396	.404	.396	.792	.078	.885	.822	.708	.604	.596	.545	.917	.813	.942	.838
R.L.	.000	.000	.000	.003	.146	.146	.173	.128	.042	.042	.000	.010	.000	.000	.000	.006	.000	.021	.019	.000
W.	.188	.167	.135	.175	.229	.125	.231	.230	.125	.083	.077	.057	.250	.313	.269	.274	.042	.125	.038	.800
D.L.	.146	.104	.192	.134	.021	.188	.077	.077	.000	.042	.038	.041	.021	.000	.000	.016	.000	.000	.000	.010
UCPL.	.000	.021	.000	.029	.021	.000	.038	.019	.000	.000	.000	.006	.021	.063	.135	.124	.021	.042	.000	.045
RCPL.	.000	.000	.000	.003	.083	.042	.019	.026	.000	.021	.000	.006	.000	.000	.000	.006	.021	.000	.000	.006
Amalgamated Patterns																				
Arch	.063	.063	.000	.041	.042	.104	.058	.125	.042	.104	.000	.057	.000	.021	.000	.029	.000	.000	.000	.022
Loop	.604	.646	.673	.618	.604	.542	.577	.524	.833	.750	.885	.831	.708	.604	.596	.551	.917	.833	.962	.838
Whorl	.333	.292	.327	.341	.354	.354	.365	.351	.125	.146	.115	.111	.292	.375	.404	.420	.083	.167	.038	.140
N=	48	48	52	314	48	48	52	314	48	48	52	314	48	48	52	314	48	48	52	314
X^2	-		-		-		-		-		-		-		-		-		-	
(P)	-		-		-		-		-		-		-		-		-		-	

	LP1				LP2				LP3				LP4				LP5			
Tr.A.	.146	.063	.000	.086	.063	.125	.000	.111	.042	.104	.038	.089	.000	.021	.000	.035	.021	.021	.000	.035
Te.A.	.000	.000	.000	.000	.000	.042	.000	.003	.021	.021	.000	.003	.000	.000	.000	.003	.000	.000	.000	.000
U.L.	.625	.729	.692	.608	.396	.313	.442	.360	.750	.708	.750	.717	.729	.625	.558	.586	.896	.833	.904	.857
R.L.	.000	.000	.000	.000	.208	.250	.212	.201	.021	.021	.038	.029	.000	.000	.019	.003	.000	.021	.000	.003
W.	.083	.063	.115	.118	.271	.083	.212	.172	.104	.083	.077	.103	.208	.271	.231	.277	.000	.063	.058	.076
D.L.	.146	.146	.192	.182	.042	.125	.096	.089	.063	.063	.077	.045	.042	.000	.038	.032	.021	.000	.000	.006
UCPL.	.000	.000	.000	.006	.021	.000	.019	.010	.000	.000	.019	.006	.021	.083	.154	.064	.063	.063	.038	.016
RCPL.	.000	.000	.000	.000	.000	.063	.019	.054	.000	.000	.000	.006	.000	.000	.000	.000	.000	.000	.000	.006
Amalgamated Patterns																				
Arch	.146	.063	.000	.086	.063	.167	.000	.115	.063	.125	.038	.092	.000	.021	.000	.038	.021	.021	.000	.035
Loop	.625	.729	.692	.608	.602	.563	.654	.561	.771	.729	.788	.745	.729	.625	.577	.589	.896	.854	.904	.860
Whorl	.229	.208	.308	.306	.333	.271	.346	.325	.167	.146	.173	.162	.271	.354	.423	.373	.083	.125	.096	.105
N=	48	48	52	314	48	48	52	314	48	48	52	314	48	48	52	314	48	48	52	314
X^2	-		-		-		-		-		-		-		-		-		-	
(P)	-		-		-		-		-		-		-		-		-		-	

MALES. FINGER PATTERN FREQUENCIES. Table 20

	RP1		RP2		RP3		RP4		RP5	
	---A---		---A---		---A---		---A---		---A---	
	So	Po	So	Po	So	Po	So	Po	So	Po
True Arch	.027	.014	.067	.060	.060	.050	.022	.012	.010	.011
Tented Arch	.000	.001	.012	.030	.005	.005	.000	.001	.000	.001
Ulnar Loop	.556	.576	.290	.334	.707	.730	.467	.471	.866	.834
Radial Loop	.002	.003	.280	.266	.032	.023	.007	.007	.000	.001
Whorl	.238	.203	.211	.191	.139	.126	.360	.360	.055	.079
Double Loop	.159	.181	.089	.072	.037	.038	.037	.041	.020	.025
Ulnar C.P. Loop	.017	.019	.017	.008	.011	.018	.104	.097	.045	.049
Radial C.P. Loop	.000	.002	.032	.038	.002	.010	.002	.010	.005	.000
Amalgamated Patterns										
Arch	.027	.015	.079	.090	.065	.056	.022	.014	.010	.012
Loop	.558	.578	.571	.600	.739	.753	.474	.478	.866	.835
Whorl	.414	.407	.350	.310	.196	.191	.504	.508	.124	.153
N=	403	733	403	733	403	733	403	730	403	733
X^2	2.251		2.022		0.423		1.174		1.927	
(P)	.320		.363		.809		.556		.381	

	LP1		LP2		LP3		LP4		LP5	
True Arch	.037	.027	.069	.072	.067	.070	.022	.016	.017	.008
Tented Arch	.000	.000	.015	.016	.007	.012	.000	.000	.000	.000
Ulnar Loop	.672	.702	.400	.383	.722	.708	.623	.634	.898	.893
Radial Loop	.000	.003	.228	.250	.040	.025	.002	.003	.002	.000
Whorl	.107	.098	.169	.143	.107	.108	.203	.216	.040	.040
Double Loop	.166	.158	.089	.100	.045	.042	.067	.046	.020	.027
Ulnar C.P. Loop	.010	.008	.012	.010	.010	.029	.082	.076	.022	.030
Radial C.P. Loop	.007	.003	.017	.026	.002	.007	.000	.008	.000	.000
Amalgamated Patterns										
Arch	.037	.027	.084	.089	.074	.082	.022	.016	.017	.008
Loop	.672	.705	.628	.633	.762	.733	.625	.637	.901	.893
Whorl	.290	.268	.388	.279	.164	.186	.352	.347	.082	.098
N=	403	732	403	732	403	733	403	733	403	732
X^2	1.700		0.144		1.171		0.582		2.687	
(P)	.417		.930		.556		.747		.260	

MALES. FINGER PATTERN FREQUENCIES. Table 21

	RP1		RP2		RP3		RP4		RP5	
	---B---		---B---		---B---		---B---		---B---	
	So	Po	So	Po	So	Po	So	Po	So	Po
True Arch	.022	.012	.029	.061	.015	.052	.007	.014	.000	.009
Tented Arch	.000	.002	.015	.028	.000	.007	.000	.002	.00	.002
Ulnar Loop	.566	.538	.287	.307	.743	.710	.493	.461	.838	.833
Radial Loop	.007	.005	.324	.262	.029	.021	.007	.005	.000	.000
Whorl	.236	.208	.199	.210	.147	.127	.353	.384	.051	.080
Double Loop	.132	.208	.118	.068	.044	.050	.059	.040	.037	.028
Ulnar C.P. Loop	.007	.026	.015	.011	.015	.026	.081	.100	.066	.047
Radial C.P. Loop	.000	.002	.015	.050	.007	.007	.000	.014	.007	.000
Amalgamated Patterns										
Arch	.022	.016	.044	.098	.015	.059	.007	.017	.000	.012
Loop	.574	.542	.610	.568	.772	.731	.500	.445	.838	.833
Whorl	.404	.443	.346	.342	.213	.210	.493	.535	.162	.156
N=	136	424	136	424	136	424	136	422	136	424
X^2	0.942		3.080		4.421		1.670		-	
(P)	.624		.219		.109		.432		-	

	LP1		LP2		LP3		LP4		LP5	
True Arch	.029	.031	.037	.080	.029	.083	.015	.017	.013	.007
Tented Arch	.000	.000	.000	.021	.007	.014	.000	.000	.000	.000
Ulnar Loop	.669	.649	.434	.353	.699	.672	.647	.623	.897	.891
Radial Loop	.000	.002	.235	.248	.081	.024	.000	.002	.007	.000
Whorl	.125	.120	.162	.146	.140	.130	.206	.229	.044	.043
Double Loop	.147	.189	.096	.106	.037	.042	.074	.035	.015	.021
Ulnar C.P. Loop	.015	.009	.015	.012	.007	.028	.059	.090	.022	.038
Radial C.P. Loop	.015	.000	.022	.033	.000	.007	.000	.005	.000	.000
Amalgamated Patterns										
Arch	.029	.031	.037	.101	.037	.097	.015	.017	.015	.007
Loop	.669	.651	.669	.601	.779	.696	.647	.625	.904	.891
Whorl	.301	.318	.294	.297	.184	.208	.338	.358	.081	.102
N=	136	424	136	424	136	424	136	424	136	423
X^2	0.151		5.788		5.790		0.219		1.146	
(P)	.927		.055		.055		.895		.563	

Table 22

MALES. FINGER PATTERN FREQUENCIES.

	RP1		RP2		RP3		RP4		RP5	
	---C---		---C---		---C---		---C---		---C---	
	En	We	En	We	En	We	En	We	En	We
True Arch	.019	.015	.054	.075	.049	.048	.014	.015	.010	.008
Tented Arch	.000	.000	.016	.033	.004	.003	.000	.000	.000	.000
Ulnar Loop	.570	.569	.332	.326	.715	.750	.459	.490	.839	.836
Radial Loop	.000	.002	.276	.257	.026	.022	.014	.003	.002	.000
Whorl	.241	.207	.194	.187	.138	.120	.368	.346	.082	.073
Double Loop	.147	.185	.075	.065	.046	.032	.039	.033	.024	.023
Ulnar C.P. Loop	.021	.018	.017	.017	.019	.017	.102	.100	.040	.058
Radial C.P. Loop	.002	.003	.035	.040	.004	.008	.005	.012	.002	.000
Amalgamated Patterns										
Arch	.019	.015	.070	.109	.053	.052	.014	.015	.010	.008
Loop	.570	.571	.608	.583	.741	.771	.473	.493	.841	.836
Whorl	.410	.414	.322	.309	.207	.177	.513	.492	.149	.155
N=	572	599	572	599	571	599	571	598	572	599
X^2	0.310		5.336		1.708		0.543		0.235	
(P)	.846		.069		.425		.762		.889	

	LP1		LP2		LP3		LP4		LP5	
True Arch	.035	.038	.047	.090	.065	.068	.012	.022	.014	.005
Tented Arch	.000	.000	.021	.010	.007	.008	.000	.000	.000	.000
Ulnar Loop	.694	.662	.412	.359	.717	.718	.619	.633	.892	.901
Radial Loop	.002	.000	.231	.270	.042	.033	.007	.000	.002	.000
Whorl	.093	.117	.159	.139	.096	.105	.227	.210	.052	.037
Double Loop	.170	.166	.088	.085	.056	.033	.058	.043	.021	.023
Ulnar C.P.Loop	.007	.010	.011	.017	.014	.027	.077	.085	.019	.033
Radial C.P. Loop	.000	.007	.032	.030	.003	.005	.000	.007	.000	.000
Amalgamated Patterns										
Arch	.035	.038	.068	.100	.072	.077	.012	.022	.014	.005
Loop	.696	.662	.643	.629	.759	.751	.626	.633	.893	.901
Whorl	.269	.299	.289	.270	.170	.172	.362	.346	.093	.094
N=	572	598	571	599	572	599	572	599	572	598
X^2	1.514		3.948		0.134		1.776		2.525	
(P)	.490		.138		.938		.411		.282	

Table 23

DUAL BREAKDOWN. CHILD'S BIRTH PLACE. MALES. FINGER PATTERN FREQUENCIES.

	RP1				RP2				RP3				RP4				RP5			
	---G---		---H---		---G---		---H---		---G---		---H---		---G---		---H---		---G---		---H---	
	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po
Tr.A.	.022	.023	.030	.010	.079	.047	.040	.081	.073	.055	.030	.052	.028	.000	.010	.019	.011	.016	.000	.010
Te.A.	.000	.000	.000	.000	.006	.023	.030	.040	.006	.000	.000	.005	.000	.000	.000	.000	.000	.000	.000	.000
U.L.	.562	.617	.574	.562	.309	.375	.277	.326	.669	.695	.762	.738	.421	.425	.485	.475	.860	.813	.871	.829
R.L.	.000	.000	.000	.002	.264	.258	.277	.252	.028	.031	.040	.014	.011	.008	.000	.005	.000	.000	.000	.000
W.	.270	.180	.208	.226	.230	.188	.208	.195	.169	.148	.119	.129	.365	.417	.356	.353	.067	.109	.050	.081
D.L.	.129	.148	.168	.179	.067	.086	.089	.055	.039	.039	.020	.036	.039	.071	.050	.033	.022	.031	.020	.021
UCPL.	.017	.031	.020	.019	.017	.008	.040	.007	.017	.023	.020	.017	.129	.071	.099	.103	.034	.031	.059	.060
RCPL.	.000	.000	.000	.002	.028	.016	.040	.043	.000	.008	.010	.010	.006	.008	.000	.012	.006	.000	.000	.000
Amalgamated Patterns																				
Arch	.022	.023	.030	.010	.084	.070	.069	.121	.079	.055	.030	.057	.028	.000	.010	.019	.011	.016	.000	.010
Loop	.562	.617	.574	.564	.573	.633	.554	.579	.697	.727	.802	.752	.433	.433	.485	.480	.860	.813	.871	.829
Whorl	.416	.359	.396	.426	.343	.297	.376	.300	.225	.219	.168	.190	.539	.567	.505	.501	.129	.127	.129	.162
N=	178	128	101	420	178	128	101	420	178	128	101	420	178	127	101	419	178	128	101	420
X^2	0.996		2.658		1.113		3.572		0.729		1.660		-		0.404		1.227		-	
(P)	.607		.264		.573		.167		.694		.435		-		.816		.541		-	
	LP1				LP2				LP3				LP4				LP5			
Tr.A.	.028	.031	.059	.036	.051	.063	.089	.095	.096	.047	.050	.076	.022	.008	.020	.024	.022	.016	.010	.002
Te.A.	.000	.000	.000	.000	.022	.016	.000	.014	.006	.008	.010	.007	.000	.000	.000	.000	.000	.000	.000	.000
U.L.	.697	.773	.604	.661	.404	.480	.416	.352	.685	.727	.752	.714	.596	.633	.663	.624	.893	.852	.911	.897
R.L.	.000	.000	.000	.000	.208	.173	.277	.252	.039	.016	.050	.026	.006	.000	.000	.000	.006	.000	.000	.000
W.	.107	.039	.089	.131	.174	.173	.158	.136	.112	.109	.109	.107	.219	.234	.198	.231	.051	.055	.020	.043
D.L.	.163	.148	.208	.158	.096	.079	.040	.098	.039	.070	.020	.033	.051	.062	.050	.036	.011	.047	.030	.021
UCPL.	.006	.008	.020	.010	.017	.000	.010	.014	.017	.016	.010	.031	.107	.062	.069	.076	.017	.031	.030	.036
RCPL.	.000	.000	.020	.005	.028	.016	.010	.038	.006	.008	.000	.005	.000	.000	.000	.010	.000	.000	.000	.000
Amalgamated Patterns																				
Arch	.028	.031	.059	.036	.073	.079	.089	.110	.101	.055	.059	.083	.022	.008	.020	.024	.022	.016	.010	.002
Loop	.697	.773	.604	.661	.612	.654	.693	.605	.725	.742	.802	.740	.601	.633	.663	.624	.899	.852	.911	.897
Whorl	.275	.195	.337	.303	.315	.268	.218	.286	.174	.203	.139	.176	.376	.359	.317	.352	.079	.133	.079	.100
N=	178	128	101	419	178	127	101	420	178	128	101	420	178	121	101	420	178	128	101	419
X^2	2.596		1.827		0.783		2.719		2.331		1.682		1.159		0.556		2.523		1.585	
(P)	.272		.401		.675		.256		.311		.431		.560		.757		.283		.452	

Table 24

DUAL BREAKDOWN. PARENTS BIRTH PLACE. MALES. FINGER PATTERN FREQUENCIES.

	RP1				RP2				RP3				RP4				RP5			
	---L---		---M---		---L---		---M---		---L---		---M---		---L---		---M---		---L---		---M---	
	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po	So	Po
Tr.A.	.040	.000	.025	.011	.060	.067	.023	.071	.020	.022	.025	.053	.020	.000	.000	.021	.000	.000	.000	.011
Te.A.	.000	.000	.000	.000	.000	.022	.050	.035	.000	.000	.000	.007	.000	.000	.000	.000	.000	.000	.000	.000
U.L.	.600	.622	.575	.535	.320	.311	.225	.333	.760	.711	.800	.709	.420	.455	.575	.441	.800	.867	.850	.826
R.L.	.000	.000	.000	.004	.320	.289	.350	.227	.020	.022	.000	.021	.020	.000	.000	.000	.000	.000	.000	.000
W.	.320	.178	.250	.220	.240	.280	.125	.213	.160	.111	.125	.135	.340	.341	.325	.381	.100	.133	.025	.082
D.L.	.040	.178	.150	.199	.040	.044	.150	.053	.020	.067	.050	.050	.040	.091	.075	.032	.040	.000	.025	.028
UCPL.	.000	.022	.000	.028	.020	.022	.025	.014	.020	.067	.000	.018	.160	.114	.027	.107	.006	.000	.100	.053
RCPL.	.000	.000	.000	.004	.000	.044	.050	.053	.000	.000	.000	.007	.000	.000	.000	.018	.000	.000	.000	.000
Amalgamated Patterns																				
Arch	.040	.000	.025	.011	.060	.089	.075	.106	.020	.022	.025	.060	.020	.000	.000	.021	.000	.000	.000	.011
Loop	.600	.622	.575	.539	.640	.600	.575	.560	.780	.733	.800	.730	.440	.455	.575	.441	.800	.867	.850	.826
Whorl	.360	.378	.400	.450	.300	.311	.350	.333	.200	.244	.175	.209	.540	.545	.425	.537	.200	.133	.150	.163
N=	50	45	40	282	50	45	40	282	50	45	40	282	50	44	40	281	50	45	40	282
X^2	-		-		-		-		-		-		-		-		-		-	
(P)	-		-		-		-		-		-		-		-		-		-	

	LP1				LP2				LP3				LP4				LP5			
Tr.A.	.060	.022	.025	.033	.040	.067	.050	.103	.060	.044	.025	.082	.020	.000	.025	.021	.040	.000	.000	.007
Te.A.	.000	.000	.000	.000	.000	.044	.000	.018	.000	.022	.025	.011	.000	.000	.000	.000	.000	.000	.000	.000
U.L.	.660	.800	.725	.628	.446	.400	.456	.344	.700	.756	.725	.681	.620	.711	.750	.603	.840	.889	1.0	.890
R.L.	.000	.000	.000	.000	.240	.244	.275	.230	.100	.022	.100	.025	.000	.000	.000	.000	.020	.000	.000	.000
W.	.140	.022	.075	.138	.120	.178	.175	.131	.080	.111	.125	.121	.220	.200	.175	.248	.060	.089	.000	.036
D.L.	.140	.159	.125	.184	.100	.067	.050	.106	.040	.020	.000	.043	.060	.022	.025	.039	.020	.022	.000	.018
UCPL.	.000	.000	.025	.011	.020	.000	.000	.018	.020	.022	.000	.035	.080	.067	.025	.083	.020	.000	.000	.050
RCPL.	.000	.000	.025	.000	.040	.000	.000	.050	.000	.000	.000	.004	.000	.000	.000	.004	.000	.000	.000	.000
Amalgamated Patterns																				
Arch	.060	.022	.025	.039	.040	.111	.050	.121	.060	.067	.050	.092	.020	.000	.025	.021	.040	.000	.000	.007
Loop	.660	.800	.725	.628	.680	.644	.725	.574	.800	.778	.825	.706	.620	.711	.750	.603	.860	.889	1.0	.890
Whorl	.280	.178	.250	.333	.280	.245	.225	.305	.140	.156	.125	.202	.360	.289	.225	.376	.100	.111	.000	.103
N=	50	45	40	282	50	45	40	282	50	45	40	282	50	45	40	282	50	45	40	281
X^2	-		-		-		-		-		-		-		-		-		-	
(P)	-		-		-		-		-		-		-		-		-		-	

QUANTITATIVE FINGER PATTERNS.
SUMMATION OVER ALL FINGERS.

Table 25

	N°. OF PATTERNS.											
MALES.	0	1	2	3	4	5	6	7	8	9	10	N
True Arch	.864	.059	.030	.015	.010	.005	.006	.005	.003	.001	.001	1548
Tented Arch	.954	.039	.006	.001	-	-	-	-	-	-	-	"
Ulnar Loop	.015	.023	.058	.057	.084	.103	.137	.167	.166	.129	.061	"
Radial Loop	.567	.281	.134	.016	.003	-	-	-	-	-	-	"
Whorl	.443	.182	.127	.085	.065	.033	.029	.018	.012	.004	.002	"
Double Loop	.610	.200	.106	.048	.018	.006	.005	.004	.002	.001	-	"
Ulnar C.P. Loop	.741	.194	.053	.010	.002	-	-	-	-	-	-	"
Radial C.P. Loop	.914	.075	.010	.009	-	-	-	-	-	-	-	"
FEMALES.												
True Arch	.801	.080	.047	.024	.017	.011	.005	.006	.004	.002	.003	1614
Tented Arch	.956	.041	.002	.001	-	-	-	-	-	-	-	"
Ulnar Loop	.017	.023	.047	.057	.078	.104	.134	.150	.180	.125	.085	"
Radial Loop	.640	.252	.098	.009	.001	-	-	-	-	-	-	"
Whorl	.466	.189	.114	.076	.058	.038	.022	.013	.012	.007	.004	"
Double Loop	.656	.176	.098	.040	.017	.007	.004	.001	.001	-	-	"
Ulnar C.P. Loop	.756	.174	.055	.013	.002	-	-	-	-	-	-	"
Radial C.P. Loop	.917	.073	.009	.001	-	-	-	-	-	-	-	"

QUANTITATIVE FINGER PATTERNS.
SUMMATION OVER ALL FINGERS.
SUBSET MEANS.

Table 26

	---A---		---B---		---C---		---D---		---E---	
FEMALES.	So	Po	So	Po	En	We	En	We	En	We
True Arch	0.40	0.58	0.35	0.56	0.53	0.50	0.45	0.50	0.47	0.52
Tented Arch	0.04	0.04	0.04	0.05	0.05	0.04	0.04	0.04	0.08	0.04
Ulnar Loop	6.57	6.26	6.61	6.31	6.37	6.43	6.47	6.40	6.62	6.41
Radial Loop	0.51	0.46	0.45	0.41	0.47	0.45	0.50	0.45	0.45	0.39
Whorl	1.45	1.52	1.50	1.53	1.53	1.48	1.52	1.49	1.43	1.54
Double Loop	0.60	0.65	0.63	0.65	0.61	0.63	0.57	0.65	0.58	0.64
Ulnar C.P. Loop	0.29	0.34	0.31	0.34	0.31	0.33	0.30	0.34	0.21	0.33
Radial C.P. Loop	0.09	0.11	0.07	0.11	0.09	0.10	0.12	0.09	0.11	0.10
Amalgamated Patterns										
Arch	0.44	0.63	0.40	0.61	0.58	0.54	0.50	0.54	0.56	0.56
Loop	7.09	6.73	7.06	6.73	6.84	6.89	6.97	6.85	7.08	6.81
Whorl	2.46	2.63	2.53	2.65	2.56	2.55	2.52	2.59	2.35	2.62
MALES										
True Arch	0.39	0.34	0.19	0.36	0.32	0.38	0.38	0.39	0.29	0.39
Tented Arch	0.04	0.06	0.02	0.07	0.04	0.05	0.04	0.06	0.04	0.07
Ulnar Loop	6.20	6.27	6.27	6.02	6.07	6.23	6.25	6.19	6.37	6.07
Radial Loop	0.59	0.58	0.69	0.56	0.60	0.58	0.53	0.56	0.65	0.53
Whorl	1.62	1.55	1.69	1.67	1.64	1.54	1.70	1.61	1.64	1.66
Double Loop	0.72	0.72	0.75	0.79	0.74	0.69	0.69	0.67	0.60	0.74
Ulnar C.P. Loop	0.33	0.34	0.30	0.38	0.32	0.38	0.32	0.37	0.32	0.39
Radial C.P. Loop	0.69	0.10	0.06	0.11	0.08	0.11	0.06	0.11	0.04	0.13
Amalgamated Patterns										
Arch	0.43	0.41	0.22	0.48	0.36	0.44	0.42	0.45	0.34	0.46
Loop	6.79	6.84	6.96	6.58	6.87	6.82	6.78	6.76	7.03	6.60
Whorl	2.76	2.77	2.81	2.96	2.75	2.73	2.79	2.77	2.62	2.93

Table 27

RANKING OF UNILATERAL MAXIMUM FINGER RIDGE COUNTS OVER DIGITS.

Partition type			Ranking Right Hand	Ranking Left Hand
MALES				
	A	So	R1>R4>R5>R2>R3	L1>L4>L5>L3>L2
		Po	R1>R4>R5>R3>R2	L1>L4>L5>L3>L2
	C	En	R1>R4>R5>R3>R2	L1>L4>L5>L3>L2
		We	R1>R4>R5>R3>R2	L1>L4>L5>L3>L2
	D	En	R1>R4>R5>R2>R3	L1>L4>L5>L3>L2
		We	R1>R4>R5>R3>R2	L1>L4>L5>L3>L2
	B	So	R1>R4>R5>R2>R3	L1>L4>L5>L3>L2
		Po	R1>R4>R5>R3>R2	L1>L4>L5>L3>L2
	E	En	R1>R4>R5>R2>R3	L1>L4>L5>L3>L2
		We	R1>R4>R5>R3>R2	L1>L4>L5>L3>L2
FEMALES	A	So	R1>R4>R5>R2>R3	L1>L4>L5>L3>L2
		Po	R1 R4 R5 R2 R3	L1>L4>L5>L3>L2
	C	En	R1>R4>R5>R2>R3	L1>L4>L5>L3>L2
		We	R1>R4>R5>R3>R2	L1>L4>L5>L3>L2
	D	En	R1>R4>R5>R2>R3	L1>L4>L5>L3>L2
		We	R1>R4>R5>R3>R2	L1>L4>L5>L3>L2
	B	So	R1>R4>R5>R2>R3	L1>L4>L5>L3>L2
		Po	R1>R4>R5>R3>R2	L1>L4>L5>L3>L2
	E	En	R1>R4>R5>R2>R3	L1>L4>L5>L3>L2
		We	R1>R4>R5>R3>R2	L1>L4>L5>L3>L2

Table 28

FINGER AND PALMAR RIDGE COUNTS. BASIC PARAMETERS.

	MALES					FEMALES				
	mean	s.d	g2	g1	g2(T)	mean	s.d	g2	g1	g2(T)
RT1	19.29	6.16	1.169	-0.861	0.089	16.93	6.55	0.474	-0.812	-0.187
RT2	11.75	7.48	-0.944	-0.011	-0.938	11.31	7.50	-1.064	-0.069	-0.057
RT3	11.82	6.46	-0.287	-0.063	0.239	11.33	6.14	-0.320	-0.126	-0.257
RT4	16.39	6.41	0.315	-0.479	0.334	15.76	6.76	-0.029	-0.447	0.023
RT5	14.35	5.67	-0.321	-0.418	-0.480	13.34	5.89	-0.692	-0.257	-0.767
LT1	16.98	6.36	0.479	-0.648	0.129	14.95	6.54	0.032	-0.690	-0.455
LT2	11.10	7.14	-0.768	0.083	0.832	10.38	7.20	-0.999	0.117	-1.075
LT3	12.17	6.68	-0.645	-0.289	-0.520	10.96	6.75	-0.802	-0.101	-0.752
LT4	16.59	6.46	0.356	-0.476	0.267	15.40	6.95	-0.154	-0.405	-0.210
LT5	14.58	5.46	-0.048	-0.594	-0.343	13.34	5.89	-0.534	-0.387	-0.153
FR1	25.43	12.02	-0.560	0.247	-0.404	21.58	11.61	-0.261	0.385	-0.202
FR2	15.39	11.88	-0.673	0.539	-1.001	15.13	12.26	-0.661	0.585	-1.055
FR3	14.25	10.41	1.188	1.094	-0.078	13.09	9.46	2.447	1.308	0.304
FR4	22.66	12.20	-0.191	0.366	-0.365	20.67	11.90	-0.096	0.493	-0.302
FR5	15.72	7.50	0.460	0.450	0.219	14.45	7.52	0.382	0.530	-0.005
FL1	20.95	10.97	-0.100	0.490	-0.021	18.93	11.13	-0.288	0.427	-0.287
FL2	14.25	11.38	-0.143	0.759	-0.825	13.81	11.70	-0.474	0.709	-1.034
FL3	14.54	10.60	1.059	1.012	-0.120	13.16	10.53	1.334	1.115	-0.339
FL4	20.48	11.28	0.205	0.598	0.011	19.53	11.56	0.090	0.568	-0.173
FL5	15.52	6.85	1.217	0.387	0.822	14.32	7.37	0.761	0.478	0.285
RFRC	73.61	25.54	0.029	-0.324	-0.098	68.70	26.42	-0.278	-0.345	-0.445
LFRC	71.44	25.71	-0.097	-0.319	-0.135	65.08	26.99	-0.468	-0.254	-0.550
TFRC	145.03	50.24	-0.011	-0.334	-0.110	133.80	52.48	-0.364	-0.308	-0.505
RFAC	93.45	43.83	0.115	0.470	*	84.96	43.28	0.060	-0.532	*
LFAC	86.10	41.04	0.407	0.571	*	79.76	42.67	0.200	0.594	*
TFAC	179.49	83.04	0.204	0.497	*	164.77	84.34	0.104	0.540	*
RPTOT	106.15	13.88	0.731	-0.023	0.735	106.36	14.01	0.632	0.026	0.622
LPTOT	105.05	15.29	0.680	-0.249	0.460	105.59	15.27	0.276	-0.028	0.283
TPRC	211.22	28.18	0.393	-0.128	0.336	211.95	28.36	0.306	0.009	0.301
RAB	40.76	5.93	1.482	0.313	-1.521	41.05	5.58	1.708	0.385	1.243
RBC	26.68	8.30	2.640	-1.331	-0.724	26.26	8.47	2.381	01.300	0.187
RCD	36.45	9.94	5.762	-2.142	0.899	36.52	10.49	4.971	-2.030	0.541
LAB	42.05	5.62	1.549	0.356	1.663	42.44	5.72	1.314	0.499	0.826
LBC	25.59	9.21	2.023	-1.360	0.148	25.31	9.52	1.567	-1.269	0.084
LCD	33.92	11.86	2.539	-1.657	0.352	34.12	12.15	2.491	-1.674	-0.022
N=	1548					1614				

(*) indicates no estimate recorded.

Finger Triradii Frequencies.

Table 29

Males	Number of Triradii 0	1	2	$\bar{x}$	N
RD1	.018	.568	.414	1.396	1548
RD2	.061	.614	.324	1.263	
RD3	.050	.761	.189	1.139	
RD4	.015	.485	.500	1.485	
RD5	.010	.847	.143	1.134	
LD1	.032	.680	.288	1.255	
LD2	.065	.648	.287	1.224	
LD3	.065	.762	.174	1.109	
LD4	.017	.633	.349	1.332	
LD5	.008	.904	.087	1.079	

Females	Number of Triradii 0	1	2	$\bar{x}$	N
	.040	.625	.335	1.295	1614
	.079	.586	.335	1.257	
	.064	.799	.136	1.072	
	.021	.571	.408	1.387	
	.015	.862	.123	1.108	
	.068	.628	.304	1.236	
	.087	.603	.310	1.222	
	.091	.742	.167	1.076	
	.029	.628	.344	1.315	
	.024	.877	.100	1.076	

Palmar Triradii.

Males	Number of Triradii 0	1	2	$\bar{x}$	N
TR	.654	.345	.001	0.346	1548
TL	.632	.366	.001	0.369	
T1R	.353	.597	.050	0.698	
T1L	.366	.587	.047	0.682	
T2R	.935	.063	.002	0.067	
T2L	.943	.057	-	0.057	
TBR	.694	.306	-	0.306	
TBL	.734	.266	-	0.266	
TEFR	.932	.045	.021	0.092	
TEFL	.868	.083	.049	0.182	
TZR	1.0	-	-		
TZL	1.0	-	-		
TZ1R	.999	.001	-	0.001	
TZ1L	.999	.001	-	0.001	
TZ2R	.999	.001	-	0.001	
TZ2L	.998	.002	-	0.002	
TDR	.849	.119	.032	0.185	
TDL	.839	.141	.200	0.183	

Females	Number of Triradii 0	1	2	$\bar{x}$	N
	.682	.313	.005	0.323	1614
	.661	.338	.001	0.340	
	.342	.613	.045	0.703	
	.349	.913	.038	0.688	
	.911	.086	.002	0.091	
	.927	.073	-	0.073	
	.641	.359	.001	0.360	
	.708	.291	.001	0.292	
	.934	.042	.024	0.090	
	.877	.071	.052	0.175	
	1.0	-	-		
	1.0	-	-		
	1.0	-	-		
	1.0	-	-		
	1.0	-	-		
	1.0	-	-		

	0	1	2	3	4	$\bar{x}$	N
TDR	.865	.116	.016	.002	.001	0.157	1614
TDL	.838	.145	.014	.002	-	0.181	

Table 30

Combinations of Palmar Triradii.

N=1548 Males	Right	Left	N=1614 Female	Right	Left
None	.0213	.0090		.0217	.0136
T	.2919	.3180		.2680	.2810
T1	.5387	.5360		.5500	.5600
T2	.0206	.0200		.0290	.0303
TT	.0006	.0012		.0049	.0006
T1T1	.0497	.0460		.0400	.0371
T2T2	-	-		.0006	-
TT1	.0322	.0303		.0260	.0322
TT2	.0167	.0174		.0160	.0229
T1T2	.0232	.0193		.0370	.0190
TT1T1	-	-		.0006	.0006
TT2T2	-	-		.0006	-
TT1T2	-	-		.0012	.0006
T1T1T2	-	-		.0018	-
T1T2T2	-	-		.0012	-

Finger and Palmar Intensity Indices.

Number of Triradii

N=1614 Female	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
RFPII	.004	.006	.012	.030	.042	.339	.208	.130	.115	.080	.340										
LFPII	.006	.010	.015	.040	.058	.324	.222	.139	.095	.064	.028										
TFPII	.003	.002	.004	.006	.006	.009	.015	.016	.039	.043	.216	.135	.119	.083	.068	.072	.054	.040	.039	.019	.014
RPPII					.026	.475	.335	.128	.027	.005	.001	.001									
LPPII					.035	.479	.332	.107	.035	.009	.003										(21)
TPPII									.007	.030	.336	.221	.214	.098	.054	.020	.010	.005	.003	.001	.001

Males N=1548																					
RFPII	.001	.005	.013	.011	.037	.280	.223	.166	.123	.097	.045										
LFPII	.003	.005	.012	.022	.045	.379	.216	.128	.103	.063	.024										
TFPII	.001	.001	.003	.004	.006	.005	.005	.012	.019	.035	.213	.145	.124	.096	.089	.061	.059	.044	.043	.019	.014
RPPII					.020	.511	.311	.124	.023	.008	.002	.001									
LPPII					.029	.491	.317	.116	.037	.008	.002										(21)
TPPII									.006	.028	.348	.231	.194	.105	.047	.018	.012	.007	.003	.001	.001

Finger and Palmar Intensity Indices.

Table 31

Female	$\bar{x}$	Male	$\bar{x}$
RFPII	6.118		6.414
LFPII	5.925		5.997
TFPII	12.045		12.406
RPPII	5.675		5.649
LPPII	5.669		5.667
TPPII	11.344		11.316
N=	1614		1548

Table 32

Palmar Pattern Frequencies.

Male	Number of Patterns 0	1	2	$\bar{x}$	N	Females	Number of Patterns 0	1	2	$\bar{x}$	N
PTR	.966	.031	.003	.036	1548		.961	.036	.003	.042	1614
PTL	.919	.080	.001	.081			.917	.082	.001	.084	
RTR	.943	.056	.001	.059			.942	.058	-	.058	
RTL	.892	.107	.001	.109			.905	.094	.001	.095	
P2R	.935	.065	-	.065			.967	.033	-	.033	
P2L	.978	.022	-	.022			.980	.013	-	.013	
PT2R	1.0	-	-				1.0	-	-		
PT2L	1.0	-	-				1.0	-	-		
C2R	.999	.001	-	.001			1.0	-	-		
C2L	.999	.001	-	.001			1.0	-	-		
P3R	.445	.555	-	.555			.493	.507	.001	.508	
P3L	.734	.266	-	.266			.714	.286	.001	.287	
P3TR	.926	.074	-	.074			.935	.065	-	.065	
P3TL	.895	.105	-	.105			.895	.105	-	.105	
C3R	.999	.001	-	.001			.999	.001	-	.001	
C3L	1.0	-	-				.998	.002	-	.002	
P4R	.567	.424	.008	.441			.511	.479	.010	.499	
P4L	.346	.603	.051	.705			.361	.605	.034	.673	
P4TR	.999	.001	-	.001			1.0	-	-		
P4TL	1.0	-	-				1.0	-	-		
C4R	.995	.005	-	.005			.993	.007	-	.007	
C4L	.989	.011	-	.011			.987	.013	-	.013	
U4R	.999	.001	-	.001			.999	.001	-	.001	
U4L	.995	.005	-	.005			.998	.002	-	.002	
PHR	.877	.121	.003	.126			.880	.116	.003	.123	
PHL	.886	.114	-	.114			.889	.110	.001	.112	
CHR	.739	.260	.001	.262			.698	.300	.001	.303	
CHL	.754	.246	-	.246			.734	.266	-	.266	
RHR	.970	.030	-	.030			.959	.041	-	.041	
RHL	.989	.011	-	.011			.980	.020	-	.020	
PAR	.996	.004	-	.004			.991	.009	-	.009	
PAL	.999	.001	-	.001			.997	.003	-	.003	
RAHR	.979	.021	-	.021			.978	.022	-	.022	
RAHL	.991	.009	-	.009			.986	.014	-	.014	

Mainline Termination Frequencies. Table 33

	Termination Area									
Female	0	1	3	4	5	7	9	11	13	N
MAINAR	-	.033	.310	.422	.234	.002	-	-	-	1612
MAINAL	-	.159	.430	.293	.118	.001	-	-	-	1614
MAINBR	-	.001	.001	.009	.443	.525	.022	-	-	1613
MAINBL	.001	-	.003	.024	.627	.345	-	-	-	1614
MAINCR	.050	.065	-	-	.123	.273	.467	.022	-	1613
MAINCL	.079	.105	-	-	.216	.313	.286	.002	-	1614
MAINDR	.001	-	-	-	-	.120	.332	.545	.002	1613
MAINDL	.001	.002	-	-	-	.215	.439	.344	.001	1614
Male										
MAINAR	-	.035	.270	.437	.253	.005	-	-	-	1548
MAINAL	-	.152	.439	.287	.122	-	-	-	-	1548
MAINBR	-	-	.001	.005	.418	.540	.037	-	-	1547
MAINBL	.001	-	.001	.029	.662	.307	-	-	-	1547
MAINCR	.043	.074	-	-	.101	.241	.504	.037	-	1547
MAINCL	.072	.105	-	-	.195	.361	.267	-	-	1547
MAINDR	.001	-	-	-	-	.103	.322	.568	.006	1547
MAINDL	.003	-	-	-	-	.197	.493	.308	-	1547

Mainline Indices.

	Index Value																
Female	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	N	$\bar{x}$
MAINADR	.001	-	.007	.001	.081	.044	.154	.148	.132	.230	.202	.001	-	-	.001	1612	8.67
MAINADL	.001	-	.053	.002	.200	.030	.231	.139	.139	.123	.082	-	-	-	-	1613	7.46
Male																	
MAINADR	-	-	.005	.003	.072	.043	.140	.145	.121	.254	.217	-	-	-	.001	1548	8.81
MAINADL	.001	-	.048	.001	.193	.034	.254	.144	.144	.106	.077	-	-	-	-	1547	7.43

Table 34

PROBABILITY OF HETEROGENEITY BETWEEN SUBSETS ON A T-TEST.

	MALES										FEMALES									
	-A-	-C-	-D-	-B-	-E-	A(T)	C(T)	D(T)	B(T)	E(T)	-A-	-C-	-D-	-B-	-E-	A(T)	C(T)	D(T)	B(T)	E(T)
RT1	.465	.001	.389	.634	.535	.597	.740	.122	.925	.956	.026	.844	.785	.658	.889	.057	.690	.541	.522	.755
RT2	.610	.497	.826	.567	.862	.601	.508	.562	.580	.877	.000	.077	.016	.650	.430	.900	.472	.874	.830	.414
RT3	.122	.000	.344	.448	.264	.102	.298	.274	.367	.212	.005	.355	.511	.570	.496	.821	.380	.510	.509	.461
RT4	.004	.096	.194	.395	.381	.113	.178	.544	.564	.579	.259	.012	.513	.357	.366	.506	.813	.783	.597	.513
RT5	.448	.091	.459	.546	.632	.382	.084	.342	.718	.763	.351	.845	.248	.505	.726	.671	.845	.421	.693	.925
LT1	.055	.004	.728	.647	.822	.929	.977	.637	.979	.788	.148	.329	.710	.139	.427	.573	.361	.688	.187	.354
LT2	.277	.004	.794	.582	.576	.280	.991	.802	.719	.704	.415	.367	.480	.805	.834	.497	.359	.437	.909	.928
LT3	.413	.608	.236	.592	.905	.212	.484	.680	.272	.539	.891	.595	.606	.420	.443	.959	.562	.589	.386	.410
LT4	.649	.551	.684	.493	.109	.530	.382	.627	.404	.141	.646	.790	.550	.694	.744	.899	.888	.971	.991	.546
LT5	.001	.008	.776	.773	.694	.837	.156	.861	.843	.755	.280	.002	.795	.185	.435	.832	.509	.702	.340	.638
FR1	.127	.299	.833	.151	.086	.087	.256	.694	.164	.095	.318	.750	.476	.596	.489	*	*	*	.717	.522
FR2	.352	.504	.930	.653	.724	.780	.124	.417	.208	.296	.767	.384	.898	.657	.932	*	*	*	.365	.610
FR3	.027	.020	.012	.225	.162	.249	.689	.156	.684	.950	.847	.416	.894	.618	.869	*	*	*	.971	.865
FR4	.115	.096	.296	.911	.894	.138	.094	.190	.722	.683	.715	.944	.777	.610	.933	*	*	*	.859	.678
FR5	.716	.256	.596	.543	.894	.841	.211	.420	.476	.792	.041	.730	.088	.056	.155	*	*	*	.051	.157
FL1	.348	.939	.293	.491	.483	.324	.793	.241	.815	.758	.711	.115	.470	.191	.199	*	*	*	.173	.263
FL2	.127	.761	.599	.776	.871	.362	.452	.783	.407	.426	.435	.523	.877	.493	.808	*	*	*	.831	.711
FL3	.195	.992	.756	.231	.364	.641	.880	.642	.929	.800	.184	.461	.926	.773	.562	*	*	*	.853	.747
FL4	.849	.063	.434	.526	.426	.938	.291	.600	.573	.282	.424	.228	.193	.923	.921	*	*	*	.749	.911
FL5	.422	.277	.831	.688	.576	.545	.167	.498	.845	.505	.096	.973	.660	.013	.065	*	*	*	.013	.066
RFRC	.093	.476	.276	.818	.754	.118	.528	.567	.993	.624	.145	.723	.355	.292	.490	.400	.472	.637	.507	.665
LFRC	.604	.809	.996	.927	.999	.719	.905	.673	.773	.778	.323	.346	.944	.310	.503	.641	.282	.685	.549	.704
TFRC	.268	.567	.623	.904	.872	.339	.677	.935	.913	.700	.107	.441	.702	.268	.456	.438	.316	.992	.461	.618
RFAC	.091	.291	.191	.752	.552	*	*	*	1.0	.577	.393	.497	.533	.251	.219	.011	.858	.084	.616	.416
LFAC	.491	.675	.797	.810	.682	*	*	*	.940	.960	.306	.541	.739	.319	.334	.049	.564	.392	.534	.219
TFAC	.200	.456	.418	.790	.621	.084	.177	.130	.951	.764	.303	.479	.629	.258	.254	.036	.682	.227	.382	.691
RPTOT	.118	.210	.108	.061	.318	.135	.197	.654	.056	.313	.304	.890	.619	.725	.663	.831	.901	.620	.741	.675
LPTOT	.649	.051	.623	.733	.464	.511	.065	.594	.624	.362	.604	.100	.104	.685	.452	.570	.104	.105	.680	.449
TPRC	.282	.149	.293	.288	.303	.232	.142	.640	.225	.271	.914	.390	.486	.720	.527	.869	.386	.437	.700	.416
RAB	.064	.212	.452	.434	.161	.186	.308	.788	.302	.099	.135	.100	.011	.317	.599	.029	.149	.016	.330	.690
RBC	.270	.576	.114	.205	.004	.926	.477	.908	.238	.011	.332	.180	.089	.851	.642	.981	.905	1.0	.307	.508
RCD	.031	.866	.002	.236	.006	.386	.817	.555	.570	.331	.172	.003	.001	.248	.163	.828	.071	.050	.616	.412
LAB	.188	.608	.507	.570	.449	.575	.832	.116	.572	.476	.825	.080	.080	.816	.623	.144	.095	.010	.113	.046
LBC	.223	.854	.184	.048	.009	.344	.603	.375	.173	.035	.166	.616	.310	.083	.069	.862	.720	.681	.606	.584
LCD	.168	.466	.083	.027	.010	.154	.829	.761	.184	.084	.033	.386	.118	.012	.008	.957	.602	.681	.411	.344

(*) indicates no estimate recorded.

Table 35

FINGER AND PALMAR RIDGE COUNTS.
T-TEST PROBABILITIES. SINGLE PARAMETERS AND SELECTED POPULATIONS.

	MALES										FEMALES									
	-A-	-C-	-D-	-B-	-E-	A(T)	C(T)	D(T)	B(T)	E(T)	-A-	-C-	-D-	-B-	-E-	A(T)	C(T)	D(T)	B(T)	E(T)
RT1	.869	.410	.765	.974	.992	.623	.497	.996	.960	.924	.140	.437	.590	.409	.608	.269	.402	.578	.408	.542
RT2	.024	.028	.030	.101	.068	.024	.029	.050	.101	.068	.209	.436	.329	.090	.286	.059	.253	.186	.090	.284
RT3	.107	.035	.187	.090	.064	.100	.058	.314	.089	.062	.274	.916	.880	.298	.770	.135	.881	.899	.290	.757
RT4	.535	.944	.659	.209	.061	.134	.621	.784	.229	.064	.093	.156	.423	.138	.158	.114	.253	.471	.152	.171
RT5	.440	.945	.809	.811	.671	.361	.922	.667	.877	.710	.012	.727	.497	.204	.316	.015	.712	.585	.225	.331
LT1	.980	.671	.707	.233	.124	.666	.915	.726	.228	.105	.055	.595	.608	.313	.699	.078	.413	.517	.427	.804
LT2	.251	.044	.162	.060	.099	.147	.075	.182	.060	.099	.299	.059	.223	.130	.371	.317	.073	.259	.131	.369
LT3	.508	.585	.989	.311	.150	.456	.603	.971	.296	.145	.318	.371	.888	.633	.657	.324	.356	.670	.613	.638
LT4	.498	.512	.847	.561	.158	.501	.465	.765	.586	.187	.221	.367	.478	.410	.502	.234	.381	.539	.436	.480
LT5	.552	.379	.464	.546	.654	.737	.835	.340	.547	.676	.002	.750	.236	.173	.328	.003	.908	.251	.219	.373
FR1	.702	.667	.636	.921	.679	.809	.742	.605	.994	.763	.466	.353	.984	.284	.486	*	*	*	.302	.531
FR2	.042	.120	.135	.275	.178	.046	.042	.081	.155	.106	.390	.304	.390	.425	.762	*	*	*	.288	.635
FR3	.173	.041	.118	.231	.165	.261	.065	.278	.183	.152	.312	.568	1.0	.458	.843	*	*	*	.432	.859
FR4	.300	.358	.587	.525	.272	.380	.476	.718	.492	.252	.389	.726	.613	.291	.456	*	*	*	.269	.410
FR5	.980	.750	.627	.923	.629	.970	.649	.559	.864	.618	.183	.729	.609	.854	.837	*	*	*	.663	.694
FL1	.446	.566	.166	.408	.273	.521	.608	.233	.412	.285	.039	.351	.623	.510	.996	*	*	*	.417	.896
FL2	.175	.138	.184	.292	.342	.269	.084	.164	.187	.228	.506	.137	.431	.260	.646	*	*	*	.230	.546
FL3	.637	.656	.698	.465	.232	.710	.628	.812	.428	.195	.995	.459	.844	.789	.769	*	*	*	.818	.826
FL4	.582	.211	.648	.834	.278	.588	.306	.701	.772	.219	.766	.744	.719	.719	.955	*	*	*	.661	.988
FL5	.847	.945	.555	.644	.832	.874	.846	.501	.648	.870	.031	.803	.472	.611	.820	*	*	*	.475	.679
RFRC	.119	.218	.305	.209	.120	.079	.184	.443	.206	.106	.028	.357	.412	.114	.287	.037	.337	.469	.129	.307
LFRC	.430	.511	.918	.266	.139	.388	.479	.979	.254	.132	.049	.268	.320	.197	.405	.062	.217	.319	.233	.446
TFRC	.234	.352	.577	.225	.121	.182	.308	.675	.222	.109	.035	.307	.360	.147	.339	.045	.270	.383	.169	.367
RFAC	.207	.233	.435	.428	.235	*	*	*	.456	.323	.273	.407	.640	.320	.582	.098	.468	.401	.481	.383
LFAC	.403	.517	.938	.488	.230	*	*	*	.490	.255	.242	.476	.680	.463	.824	.110	.570	.556	.364	.401
TFAC	.279	.369	.667	.447	.223	.491	.543	.898	.455	.268	.255	.435	.662	.383	.704	.124	.502	.500	.396	.639
RPTOT	.902	.649	.388	.776	.997	.913	.647	.562	.781	.999	.661	.055	.296	.485	.453	.661	.055	.297	.484	.452
LPTOT	.518	.799	.829	.722	.942	.525	.868	.579	.726	.719	.703	.022	.166	.899	.794	.700	.022	.168	.900	.797
TPRC	.679	.931	.580	.738	.858	.696	.902	.560	.756	.839	.673	.029	.206	.684	.614	.668	.029	.204	.682	.612
RAB	.830	.490	.627	.326	.859	.792	.522	.645	.304	.804	.191	.042	.143	.210	.241	.144	.034	.111	.189	.229
RBC	.412	.626	.250	.692	.612	.485	.472	.716	.860	.959	.932	.890	.490	.646	.478	.882	.850	.700	.621	.472
RCD	.423	.809	.059	.478	.271	.669	.687	.462	.532	.393	.226	.799	.807	.906	.920	.210	.156	.443	.829	.734
LAB	.620	.834	.433	.441	.925	.603	.841	.479	.427	.904	.173	.049	.070	.536	.406	.188	.054	.058	.551	.363
LBC	.288	.822	.472	.184	.342	.341	.826	.896	.293	.626	.409	.481	.835	.182	.144	.868	.299	.565	.303	.256
LCD	.654	.530	.445	.529	.508	.980	.564	.463	.983	.921	.258	.311	.876	.313	.309	.456	.069	.666	.725	.772

(*) indicates no estimate recorded.

Table 36

FINGER AND PALMAR RIDGE COUNTS.

MANN-WHITNEY PROBABILITIES. SINGLE PARAMETERS.

	MALES					FEMALES				
	-A-	-C-	-D-	-B-	-E-	-A-	-C-	-D-	-B-	-E-
RT1	.361	.295	.531	.775	.784	.162	.911	.501	.275	.636
RT2	.020	.029	.041	.165	.360	.046	.225	.176	.121	.826
RT3	.167	.070	.355	.230	.661	.115	.746	.803	.299	.497
RT4	.140	.658	1.0	.247	.846	.129	.375	.614	.141	.623
RT5	.352	.676	.440	.959	.363	.021	.682	.624	.227	.735
LT1	.566	.944	.891	.383	.880	.122	.442	.556	.402	.393
LT2	.154	.090	.143	.099	.518	.287	.069	.247	.149	.557
LT3	.720	.431	.714	.533	.696	.290	.335	.680	.544	.880
LT4	.414	.546	.901	.585	.754	.272	.512	.906	.502	.520
LT5	.684	.687	.244	.526	.142	.004	.948	.381	.207	.755
FR1	.677	.688	.743	.870	.398	.436	.300	.734	.300	.554
FR2	.047	.058	.087	.189	.610	.238	.321	.285	.304	.979
FR3	.336	.096	.342	.402	.660	.153	.584	.964	.361	.566
FR4	.390	.493	.528	.570	.862	.688	.969	.878	.442	.894
FR5	.753	.589	.532	.979	.543	.092	.631	.465	.589	.726
FL1	.458	.516	.229	.641	.370	.059	.388	.610	.357	.176
FL2	.266	.104	.155	.232	.733	.545	.162	.438	.274	.836
FL3	.882	.522	.617	.515	.755	.602	.634	.477	.695	.637
FL4	.487	.521	.786	.728	.769	.735	.839	.738	.841	.937
FL5	1.0	1.0	.578	.761	.406	.016	.766	.522	.366	.543
RFRC	.043	.142	.322	.260	.827	.062	.453	.688	.190	.597
LFRC	.316	.383	.654	.358	.953	.079	.210	.383	.256	.997
TFRC	.114	.209	.434	.285	.873	.068	.292	.497	.247	.806
RFAC	.211	.243	.427	.486	.900	.293	.550	.692	.305	.699
LFAC	.383	.447	.742	.530	.814	.198	.502	.676	.456	.618
TFAC	.260	.314	.540	.473	.990	.227	.498	.641	.378	.665
RPTOT	.620	.777	.659	.364	.722	.929	.044	.228	.376	.667
LPTOT	.323	.750	.582	.491	.377	.879	.025	.184	.840	.774
TPRC	.390	1.0	.572	.403	.536	.857	.028	.183	.581	.731
RAB	.327	.477	.683	.251	.654	.307	.014	.062	.183	.198
RBC	.552	.394	.693	.820	.449	.758	.530	1.0	.849	.264
RCD	.783	.542	.649	.377	.822	.182	.066	.230	.792	.242
LAB	.121	.907	.446	.285	.687	.359	.030	.060	.518	.048
LBC	.296	.907	1.0	.214	.543	.786	.213	.397	.450	.338
LCD	1.0	.715	.283	.830	.310	.774	.024	.418	.873	.453

Table 37

FINGER AND PALMAR RIDGE COUNTS.

T-TEST PROBABILITIES. DUAL PARTITION.

FEMALES

	-T-	-V-	-J-	-K-	-G-	-H-	-U-	-W-	-N-	-P-	-L-	-M-
RT1	.207	.453	.989	.970	.291	.203	.595	.243	.135	.733	.888	.171
RT2	.011	.795	.432	.865	.028	.180	.178	.421	.738	.521	.131	.064
RT3	.531	.114	.643	.655	.379	.286	.404	.139	.025	.884	.635	.027
RT4	.159	.376	.614	.719	.418	.187	.378	.404	.925	.849	.402	.302
RT5	.038	.101	.118	.530	.021	.167	.914	.188	.498	.802	.782	.320
LT1	.099	.288	.803	.790	.114	.040	.519	.211	.063	.661	.879	.023
LT2	.046	.687	.130	.644	.050	.999	.252	.820	.707	.945	.412	.088
LT3	.436	.685	.566	.782	.396	.975	.721	.530	.747	.815	.930	.937
LT4	.183	.548	.486	.798	.182	.657	.110	.944	.321	.598	.082	.657
LT5	.002	.116	.170	.235	.000	.224	.444	.234	.588	.587	.299	.144
FR1	.626	.607	.883	.677	.431	.771	.708	.159	.284	.544	.861	.310
FR2	.095	.845	.206	.542	.061	.956	.483	.715	.842	.535	.305	.323
FR3	.501	.381	.928	.642	.332	.486	.676	.391	.150	.925	.706	.126
FR4	.432	.637	.835	.895	.615	.660	.884	.442	.553	.799	.754	.342
FR5	.152	.528	.382	.456	.053	.752	.699	.872	.644	.960	.735	.870
FL1	.066	.276	.993	.555	.050	.103	.312	.234	.097	.363	.932	.289
FL2	.136	.656	.173	.473	.070	.786	.381	.906	.687	.692	.321	.143
FL3	.873	1.0	.342	.711	.644	.335	.842	.610	.924	.788	.961	.734
FL4	.800	.614	.833	.353	.282	.992	.535	.848	.790	.387	.214	.766
FL5	.015	.317	.174	.138	.001	.524	.830	.658	.612	.530	.501	.343
RFRC	.050	.224	.861	.824	.063	.085	.773	.160	.219	.676	.582	.068
LFRC	.032	.412	.290	.565	.024	.379	.520	.451	.582	.687	.435	.171
TFRC	.037	.304	.519	.675	.036	.188	.640	.274	.365	.676	.496	.106
RFAC	.234	.622	.555	.626	.153	.664	.979	.346	.333	.700	.769	.251
LFAC	.161	.638	.358	.348	.046	.802	.892	.551	.586	.450	.479	.410
TFAC	.191	.633	.441	.462	.081	.734	.963	.430	.437	.556	.607	.318
RPTOT	.578	.788	.585	.081	.284	.269	.842	.735	.727	.670	.860	.505
LPTOT	.366	.461	.778	.066	.332	.289	.931	.620	.878	.506	.515	.914
TPRC	.444	.600	.671	.064	.290	.263	.963	.922	.801	.568	.663	.708
RAB	.132	.917	.895	.173	.918	.184	.471	.793	.824	.352	.969	.210
RBC	.597	.923	.066	.760	.471	.111	.398	.948	.325	.152	.673	.685
RCD	.384	.289	.190	.285	.127	.491	.980	.967	.621	.751	.787	.472
LAB	.093	.883	.964	.060	.816	.169	.241	.383	.355	.193	.931	.946
LBC	.825	.296	.616	.388	.368	.695	.186	.481	.395	.631	.549	.854
LCD	.615	.191	.601	.641	.446	.858	.141	.530	.223	.889	.356	.802

Table 38

FINGER AND PALMAR RIDGE COUNTS.

MANN-WHITNEY PROBABILITIES. DUAL PARTITIONS.

FEMALES

	-T-	-V-	-J-	-K-	-G-	-H-	-U-	-W-	-N-	-P-	-L-	-M-
RT1	.166	.434	.495	.790	.201	.584	.809	.203	.279	.913	.930	.189
RT2	.007	.781	.453	.884	.023	.121	.174	.646	.758	.634	.104	.051
RT3	.486	.109	.599	.615	.315	.210	.485	.232	.028	.781	.628	.016
RT4	.188	.336	.966	.953	.282	.280	.250	.485	.893	.825	.329	.351
RT5	.060	.114	.653	.382	.018	.286	.997	.190	.516	.760	.789	.383
LT1	.119	.503	.804	.801	.141	.228	.714	.507	.169	.677	.953	.086
LT2	.043	.691	.168	.696	.045	.842	.231	.998	.648	.827	.421	.057
LT3	.326	.473	.421	.620	.284	.981	.896	.569	.874	.947	.991	.827
LT4	.330	.355	.540	.414	.118	.807	.145	.964	.338	.657	.133	.662
LT5	.004	.101	.169	.126	.000	.291	.527	.202	.626	.451	.311	.182
FR1	.452	.742	.705	.799	.397	.758	.889	.221	.372	.652	.761	.294
FR2	.049	.930	.244	.752	.053	.574	.371	.800	.953	.603	.289	.182
FR3	.446	.183	.613	.810	.413	.203	.560	.324	.062	.811	.711	.028
FR4	.750	.648	.959	.967	.901	.879	.912	.549	.679	.873	.860	.459
FR5	.092	.343	.297	.505	.043	.736	.693	.491	.578	.942	.849	.740
FL1	.081	.357	.968	.704	.079	.116	.409	.227	.151	.404	.909	.263
FL2	.136	.625	.228	.603	.103	.999	.357	.978	.686	.857	.363	.120
FL3	.716	.579	.552	.618	.496	.761	.636	.581	.717	.812	.892	.877
FL4	.763	.569	.658	.318	.222	.910	.511	.994	.689	.460	.275	.777
FL5	.015	.152	.178	.117	.001	.491	.800	.304	.481	.400	.432	.248
RFRC	.117	.234	.840	.563	.078	.259	.918	.265	.227	.669	.660	.091
LFRC	.043	.465	.250	.515	.029	.542	.574	.614	.593	.850	.477	.175
TFRC	.066	.363	.465	.523	.039	.415	.748	.468	.385	.790	.543	.132
RFAC	.291	.606	.643	.703	.211	.629	.908	.477	.456	.680	.618	.223
LFAC	.137	.503	.378	.398	.051	.663	.878	.633	.612	.517	.514	.310
TFAC	.173	.579	.452	.511	.096	.695	.881	.549	.473	.613	.580	.303
RPTOT	.661	.431	.553	.041	.150	.288	.625	.802	.777	.684	.974	.440
LPTOT	.515	.377	.733	.055	.199	.328	.930	.802	.981	.618	.634	.992
TPRC	.546	.405	.647	.040	.180	.296	.865	.787	.866	.643	.837	.721
RAB	.123	.614	.957	.041	.525	.158	.290	.827	.827	.267	.977	.234
RBC	.970	.967	.193	.384	.524	.116	.544	.994	.494	.365	.695	.725
RCD	.717	.069	.962	.024	.027	.765	.471	.661	.828	.255	.681	.539
LAB	.115	.464	.951	.044	.487	.167	.136	.215	.215	.152	.959	.918
LBC	.799	.44	.982	.193	.362	.660	.375	.871	.638	.552	.834	.756
LCD	.863	.374	.809	.167	.249	.697	.373	.601	.274	.905	.522	.695

FINGER AND PALMAR RIDGE COUNTS.

T-TEST PROBABILITIES. DUAL PARTITION.

MALES

	-T-	-V-	-J-	-K-	-G-	-H-	-U-	-W-	-N-	-P-	-L-	-M-
RT1	.851	.753	.968	.892	.791	.843	.367	.442	.949	.691	.717	.454
RT2	.033	.403	.955	.134	.688	.089	.487	.227	1.0	.518	.983	.519
RT3	.260	.303	.703	.327	.969	.164	.227	.244	.700	.860	.281	.535
RT4	.910	.088	.397	.903	.988	.357	.973	.242	.904	.784	.818	.906
RT5	.700	.156	.246	.978	.752	.298	.604	.579	.974	.480	.874	.668
LT1	.796	.518	.761	.703	.891	.588	.728	.081	.973	.982	.786	.779
LT2	.187	.553	.692	.156	.830	.131	.481	.158	.871	.802	.735	.404
LT3	.731	.313	.247	.293	.242	.284	.948	.387	.842	.720	.745	.833
LT4	.806	.242	.925	.863	.966	.922	.926	.681	.562	.634	.654	.513
LT5	.254	.549	.294	.806	.507	.865	.042	.548	.203	.989	.147	.856
FR1	.936	.424	.530	.262	.370	.429	.660	.548	.862	.459	.825	.517
FR2	.061	.384	.843	.386	.463	.180	.702	.387	.934	.871	.869	.803
FR3	.145	.692	.687	.205	.894	.409	.432	.402	.717	.901	.626	.805
FR4	.618	.391	.782	.485	.838	.458	.971	.634	.878	.949	.938	.823
FR5	.551	.501	.413	.889	.563	.661	.928	.806	.631	.459	.621	.475
FL1	.652	.073	.930	.042	.142	.644	.641	.116	.810	.159	.447	.464
FL2	.198	.595	.922	.240	.982	.353	.927	.400	.807	.794	.889	.704
FL3	.900	.700	.699	.413	.548	.570	.835	.507	.945	.877	.968	.924
FL4	.790	.568	.501	.863	.955	.588	.951	.745	.285	.347	.407	.174
FL5	.386	.617	.624	.995	.500	.832	.387	.944	.992	.746	.368	.225
RFRC	.452	.189	.571	.409	.916	.203	.868	.204	.968	.977	.886	.918
LFRC	.924	.305	.561	.673	.657	.565	.760	.204	.811	.952	.784	.974
TFRC	.743	.231	.568	.514	.763	.351	.947	.195	.918	.983	.947	.942
RFAC	.370	.374	.914	.592	.816	.540	.892	.431	.781	.809	.775	.810
LFAC	.853	.314	.961	.959	.850	.923	.763	.360	.771	.889	.844	.521
TFAC	.584	.322	.935	.818	.821	.720	.938	.388	.771	.693	.803	.657
RPTOT	.646	.942	.505	.826	.869	.701	.893	.444	.746	.707	.858	.728
LPTOT	.484	.665	.782	.891	.657	.796	.642	.196	.264	.533	.897	.317
TPRC	.542	.846	.629	.855	.747	.947	.748	.280	.459	.598	.876	.472
RAB	.598	.990	.948	.759	.900	.731	.524	.263	.604	.806	.776	.213
RBC	.668	.533	.830	.618	.932	.540	.969	.571	.716	.394	.535	.591
RCD	.180	.897	.377	.805	.192	.942	.501	.755	.629	.699	.416	.948
LAB	.458	.843	.920	.664	.862	.634	.645	.067	.236	.941	.710	.234
LBC	.696	.204	.628	.970	.787	.368	.859	.050	.423	.169	.213	.217
LCD	.412	.977	.672	.968	.548	.870	.987	.255	.473	.278	.603	.464

FINGER AND PALMAR RIDGE COUNTS.

MANN-WHITNEY PROBABILITIES. DUAL PARTITION.

MALES

	-T-	-V-	-J-	-K-	-G-	-H-	-U-	-W-	-N-	-P-	-L-	-M-
RT1	.701	.440	.916	.510	.831	.834	.543	.655	.906	.930	.867	.583
RT2	.027	.395	.852	.129	.518	.078	.435	.435	.987	.448	.982	.544
RT3	.333	.429	.627	.284	.858	.184	.486	.305	.663	.743	.297	.780
RT4	.748	.102	.639	.921	.721	.399	.382	.870	.852	.915	.997	.984
RT5	.735	.101	.237	.756	.917	.264	.823	.630	.942	.314	.690	.722
LT1	.823	.309	.833	.761	.912	.680	.209	.773	.801	.716	.676	.494
LT2	.156	.653	.718	.130	.827	.134	.320	.417	.798	.677	.861	.374
LT3	.836	.691	.436	.189	.242	.526	.860	.943	.955	.615	.762	.945
LT4	.998	.253	.889	.767	.796	.843	.806	.864	.666	.425	.444	.623
LT5	.287	.693	.443	.606	.726	.992	.817	.102	.292	.561	.394	.892
FR1	.934	.512	.591	.373	.464	.567	.658	.540	.884	.391	.926	.405
FR2	.053	.525	.988	.180	.618	.088	.401	.622	.919	.697	.985	.619
FR3	.399	.677	.793	.266	.722	.329	.539	.585	.727	.927	.834	.989
FR4	.629	.477	.815	.448	.761	.549	.731	.946	.849	.888	.911	.768
FR5	.534	.252	.331	.959	.624	.570	.719	.775	.763	.412	.703	.500
FL1	.650	.082	.860	.105	.320	.829	.279	.589	.745	.265	.673	.325
FL2	.201	.835	.844	.203	.986	.375	.434	.660	.945	.866	.846	.667
FL3	.776	.899	.528	.147	.172	.676	.701	.909	.903	.614	.578	.755
FL4	.785	.433	.607	.968	.825	.693	.732	.869	.291	.338	.330	.198
FL5	.534	.604	.710	.913	.718	.948	.771	.272	.720	.767	.558	.487
RFRC	.225	.161	.835	.376	.777	.192	.501	.542	.643	.745	.460	.976
LFRC	.802	.338	.756	.551	.767	.552	.513	.907	.839	.944	.899	.884
TFRC	.419	.226	.855	.442	.983	.361	.519	.725	.855	.896	.783	.985
RFAC	.391	.424	.904	.482	.869	.583	.598	.748	.649	.795	.704	.606
LFAC	.751	.376	.867	.874	.933	.878	.517	.881	.673	.696	.932	.546
TFAC	.516	.362	.876	.679	.902	.730	.511	.873	.600	.785	.806	.538
RPTOT	.695	.558	.703	.950	.800	.971	.195	.805	.597	.583	.561	.322
LPTOT	.369	.418	.876	.963	.520	.518	.147	.807	.273	.431	.791	.185
TPRC	.449	.449	.767	.933	.603	.694	.159	.996	.412	.511	.909	.201
RAB	.456	.436	.944	.912	.622	.545	.226	.485	.456	.740	.849	.169
RBC	.965	.559	.456	.251	.352	.379	.507	.633	.327	.674	.935	.306
RCD	.444	.995	.317	.695	.380	.602	.286	.777	.951	.586	.679	.622
LAB	.140	.326	.851	.959	.283	.353	.051	.837	.239	.957	.926	.209
LBC	.885	.171	.333	.642	.750	.199	.088	.701	.248	.401	.358	.076
LCD	.433	.458	.427	.466	.957	.790	.639	.398	.345	.598	.905	.614

Table 41

QUANTITATIVE FINGER PATTERNS.
SUMMATION OVER ALL FINGERS.

	T-TEST PROBABILITIES					MANN-WHITNEY PROBABILITIES		
FEMALES.	-C-	-A-	-D-	-B-	-E-	-C-	-A-	-B-
True Arch	.706	.023	.579	.063	.762	.479	.025	.086
Tented Arch	.339	.539	.633	.928	.167	.604	.680	.987
Ulnar Loop	.646	.034	.702	.183	.463	.703	.046	.226
Radial Loop	.664	.255	.274	.542	.381	.986	.339	.452
Whorl	.651	.601	.857	.876	.647	.879	.721	.789
Double Loop	.703	.485	.294	.822	.580	.978	.788	.670
Ulnar C.P. Loop	.591	.233	.305	.623	.075	.635	.345	.565
Radial C.P. Loop	.787	.436	.371	.142	.791	.647	.571	.220
Amalgamated Patterns								
Arch	.582	.018	.637	.064	.908	.515	.026	.115
Loop	.751	.021	.515	.159	.366	.767	.025	.197
Whorl	.980	.286	.681	.612	.375	.911	.659	.937
MALES.								
True Arch	.329	.481	.891	.112	.490	.096	.554	.006
Tented Arch	.579	.081	.283	.011	.271	.511	.070	.081
Ulnar Loop	.821	.632	.775	.302	.296	.942	.615	.275
Radial Loop	.682	.757	.532	.109	.192	.814	.745	.142
Whorl	.411	.584	.572	.926	.936	.354	.303	.570
Double Loop	.866	.995	.811	.783	.314	.830	.660	.707
Ulnar C.P. Loop	.130	.929	.369	.180	.442	.082	.474	.215
Radial C.P. Loop	.128	.066	.031	.067	.004	.209	.153	.250
Amalgamated Patterns								
Arch	.280	.740	.728	.041	.374	.066	.230	.001
Loop	.741	.726	.932	.155	.168	.757	.750	.115
Whorl	.887	.852	.940	.583	.339	.808	.811	.636

Table 42

ULNAR AND RADIAL FINGER RIDGE COUNTS.

FEMALES	T-TEST PROBABILITIES								MALES	T-TEST PROBABILITIES							
	-A-	-B-	-C-	-D-	A(T)	B(T)	C(T)	D(T)		-A-	-B-	-C-	-D-	A(T)	B(T)	C(T)	D(T)
RADCR	.028	.246	.447	.503	.014	.193	.522	.369		.251	.393	.285	.594	.740	.412	.601	.951
ULNCR	.768	.561	.480	.876	.998	.270	.564	.482		.258	.568	.304	.421	.509	.892	.489	.468
RADCL	.035	.107	.355	.394	.025	.096	.517	.368		.532	.391	.463	.821	.801	.521	.713	.940
ULNCL	.818	.626	.764	.835	.769	.918	.829	.765		.397	.741	.700	.918	.784	.869	.825	.640
TRC	.028	.155	.392	.438	.016	.128	.493	.362		.363	.374	.367	.690	.692	.433	.649	.963
TUC	.766	.952	.595	.977	.648	.326	.764	.693		.283	.629	.484	.731	.581	.696	.583	.814

LEAST ATD ANGLES

	MANN-WHITNEY PROBABILITIES					T-TEST PROBABILITIES							
FEMALES	-A-	-B-	-C-	-D-	-E-	-A-	-B-	-C-	-D-	A(T)	B(T)	C(T)	D(T)
RLATD	.004	.015	.212	.236	.879	.008	.103	.233	.168	.015	.094	.308	.288
LLATD	.012	.007	.398	.084	.419	.013	.003	.966	.427	.013	.002	.970	.432
MALES													
RLATD	.000	.019	.100	.218	.554	.003	.070	.111	.324	.002	.065	.069	.278
LLATD	.118	.428	.374	.376	.792	.233	.750	.368	.352	.244	.805	.537	.376

Table 43

FINGER TRIRADII.
FEMALES.

	X^2 PROBABILITIES															MANN-WHITNEY PROBABILITIES				
	-A-	-B-	-C-	-G-	-H-	-J-	-K-	-T-	-V-	-L-	-M-	-N-	-P-	-U-	-W-	-A-	-B-	-C-	-D-	-E-
RD1	.869	.676	.703	.853	.891	.893	.536	.846	.731	.776	.735	.655	.458	.938	.175	.866	.632	.656	.524	.404
RD2	.709	.566	.613	.293	.747	.322	.667	.457	.967	.769	.364	.882	.945	.912	.102	.648	.561	.632	.664	.719
RD3	.785	.713	.816	.711	.483	.783	.963	.777	.355	.766	.375	.985	.953	.969	.663	.782	.665	.752	1.0	.644
RD4	.157	.479	.510	.143	.324	.981	.560	.224	.349	.551	.946	.336	.678	.128	.752	.152	.463	.314	.898	.199
RD5	.136	.034	.606	.995	.155	.101	.780	.107	.114	.357	.157	.603	.490	.398	.073	.116	.027	.786	.334	.682
LD1	.108	.392	.866	.214	.071	.351	.518	.698	.030	.711	.450	.079	.388	.368	.148	.082	.361	.844	.668	.072
LD2	.835	.749	.945	.247	.610	.981	.507	.524	.284	.361	.227	.655	.546	.992	.135	.836	.706	.964	.930	.744
LD3	.981	.371	.983	.971	.052	.848	.953	.444	.894	.478	.505	.988	.721	.856	.426	.876	.361	1.0	.816	.971
LD4	.335	.880	.320	.499	.920	.541	.962	.222	.389	.548	.358	.168	.986	.249	.477	.362	.858	.324	.458	.381
LD5	.566	.656	.475	.596	.431	.714	.862	.348	.233	.654	.828	.720	.707	.790	.511	.566	.614	.454	.916	.924

T-TEST PROBABILITIES

	-A-	-B-	-C-	-D-	B(T)	A(T)	C(T)	D(T)
RD1	.908	.666	.788	.460	.672	.932	.812	.450
RD2	.425	.448	.591	.565	.492	.495	.592	.594
RD3	.738	.648	.837	.997	.607	.692	.906	.988
RD4	.192	.536	.525	.994	.546	.195	.529	.982
RD5	.125	.014	.569	.316	.405	.794	.898	.800
LD1	.076	.341	.799	.675	.341	.076	.800	.675
LD2	.712	.613	.870	.911	.639	.747	.885	.915
LD3	.796	.327	.961	.819	.316	.746	.963	.823
LD4	.435	.974	.354	.540	.959	.480	.382	.587
LD5	.494	.619	.443	.933	.816	.341	.426	.952

Table 44

MALES.
FINGER TRIRADII.

	X^2 PROBABILITIES															MANN-WHITNEY PROBABILITIES				
	-A-	-B-	-C-	-G-	-H-	-J-	-K-	-T-	-V-	-L-	-M-	-N-	-P-	-U-	-W-	-A-	-B-	-C-	-D-	-E-
RD1	.984	.396	.870	.364	.487	.733	.153	.449	.794	.751	.550	.729	.458	.172	.961	1.0	.370	.808	.336	.173
RD2	.297	.654	.347	.754	.081	.401	.710	.583	.487	.962	.644	.562	.887	.837	.644	.276	.619	.422	.836	.644
RD3	.976	.427	.236	.920	.976	.788	.547	.359	.375	.725	.963	.843	.419	.541	.531	1.0	.395	.280	.580	.394
RD4	.843	.403	.513	.449	.822	.854	.132	.518	.378	.970	.257	.389	.925	.997	.376	.842	.377	.534	.200	.740
RD5	.282	.652	.968	.390	.716	.996	.656	.810	.507	.768	.992	.736	.924	.384	.817	.354	.605	.888	.846	.425
LD1	.728	.781	.384	.139	.984	.692	.033	.645	.102	.529	.437	.934	.088	.642	.710	.678	.742	.376	.084	.102
LD2	.880	.737	.163	.377	.315	.081	.990	.211	.640	.659	.657	.620	.634	.297	.917	.876	.737	.196	.312	.862
LD3	.585	.647	.998	.221	.839	.970	.293	.732	.442	.833	.805	.953	.926	.469	.806	.640	.609	.888	.832	.637
LD4	.990	.769	.527	.979	.560	.437	.803	.931	.606	.636	.077	.214	.380	.962	.472	1.0	.731	.632	.638	.647
LD5	.122	.330	.571	.100	.395	.703	.627	.093	.292	.599	.054	.393	.983	.043	.087	.110	.292	.424	.352	.900

T-TEST PROBABILITIES

	-A-	-B-	-C-	-D-	B(T)	A(T)	C(T)	D(T)
RD1	.858	.339	.809	.317	.337	.837	.803	.313
RD2	.343	.520	.282	.692	.526	.338	.285	.693
RD3	.965	.336	.238	.518	.251	.924	.264	.618
RD4	.710	.431	.498	.201	.346	.907	.496	.181
RD5	.272	.583	.989	.955	.754	.229	.933	.886
LD1	.775	.757	.405	.112	.775	.848	.447	.164
LD2	.886	.639	.113	.230	.616	.884	.103	.220
LD3	.583	.483	.960	.707	.396	.611	.947	.733
LD4	.934	.747	.451	.494	.772	.887	.404	.472
LD5	.106	.282	.514	.483	.216	.078	.319	.229

Table 45

PALMAR TRIRADII.

	X^2 PROBABILITIES															MANN-WHITNEY PROBABILITIES				
	-A-	-B-	-C-	-G-	-H-	-J-	-K-	-T-	-V-	-L-	-M-	-N-	-P-	-U-	-W-	-A-	-B-	-C-	-D-	-E-
FEMALES.																				
TR	.067	.386	.923	.112	.438	.910	.421	.239	.195	.199	.661	.252	.487	.332	.626	.052	.380	.916	.908	.769
TL	.114	.939	.279	.319	.560	.598	.915	.113	.785	1.0	.826	.870	.904	.869	.952	.114	.888	.284	.266	.860
T1R	.273	.642	.661	.122	.835	.366	.375	.359	.791	.489	.383	.445	.440	.988	.725	.214	.634	.644	.808	.791
T1L	.192	.509	.086	.967	.215	.958	.228	.215	.816	.388	.690	.911	.188	.957	.564	.200	.502	.078	.194	.330
T2R	.559	.843	.354	.928	.845	.845	.594	.574	.965	.713	.575	.750	.788	.792	.628	.516	.776	.338	.420	.971
T2L	.999	.325	.763	.648	.481	.975	.185	.538	.853	.739	.275	.900	.071	.492	.881	1.00	.251	.690	.258	.079
TBR	.883	.436	.821	.984	.331	.421	.956	.971	.518	.669	.476	.965	.852	.737	.479	.832	.393	.910	.816	.954
TBL	.914	.958	.876	.982	.544	.812	.624	.797	.985	1.0	.672	.638	.895	.869	.807	.874	.866	.838	.752	.719
TEFR	.148	.522	.846	.137	.365	.692	.885	.111	.543	.439	.991	.933	.455	.993	.667	.138	.455	.818	.360	.675
TEFL	.377	.715	.774	.088	.654	.172	.422	.226	.863	.437	.190	.188	.483	.796	.373	.376	.669	.744	.498	.956
TDR	.390	.620	.210	.599	.850	.590	.825	.239	.856	.935	.885	.691	.370	.444	.345	.370	.598	.206	.406	.221
TDL	.597	.507	.475	.910	.705	.702	.940	.371	.967	.341	.652	.984	.502	.687	.626	.602	.445	.470	.906	.883
MALES.																				
TR	.826	.974	.650	.130	.409	.343	.139	.822	.692	.796	.269	.274	.912	.853	.526	.806	.933	.630	.668	.785
TL	.988	.539	.425	.454	.786	.593	.619	.722	.993	.378	.050	.047	.532	.629	.357	.952	.474	.410	.934	.755
T1R	.607	.730	.817	.170	.354	.242	.250	.890	.990	.518	.302	.138	.968	.529	.407	.588	.693	.802	.964	.421
T1L	.902	.730	.514	.723	.824	.989	.897	.225	.174	.944	.169	.091	.607	.622	.109	.898	.693	.502	.828	.220
T2R	.889	.146	.350	.416	.769	.694	.878	.270	.860	.762	.991	.933	.346	.687	.842	.862	.122	.324	.448	.263
T2L	.700	.113	.593	.830	.745	.875	.893	.944	.893	.649	.846	.291	.617	.065	.783	.616	.073	.520	1.0	.044
TBR	.866	.135	.178	.996	.699	.688	.883	.982	.636	.452	.763	.375	.915	.384	.941	.824	.109	.158	.698	.532
TBL	.937	.143	.239	.380	.195	.609	.074	.434	.914	.253	.978	.818	.192	.947	.284	.900	.115	.214	.178	.404
TEFR	.530	.600	.794	.967	.734	.534	.679	.867	.540	.748	.419	.511	.898	.748	.696	.510	.554	.776	.434	.805
TEFL	.439	.563	.130	.665	.870	.263	.323	.092	.591	.223	.448	.859	.818	.365	.173	.424	.532	.124	.056	.552
TDR	.219	.724	.255	.134	.141	.777	.688	.262	.188	.890	.108	.120	.594	.919	.078	.208	.692	.244	.766	.348
TDL	.842	.390	.985	.837	.959	.550	.254	.152	.676	.244	.205	.007	.543	.010	.131	.820	.356	1.0	.160	.010

Table 46

FEMALES.
PALMAR PATTERNS.

	X^2 PROBABILITIES															MANN-WHITNEY PROBABILITIES				
	-A-	-B-	-C-	-G-	-H-	-J-	-K-	-T-	-V-	-L-	-M-	-N-	-P-	-U-	-W-	-A-	-B-	-C-	-D-	-E-
PTR	.462	.192	.322	.830	.966	.970	.514	.831	.866	1.0	.352	.968	.276	-	-	.418	.116	.294	.468	.283
PTL	.977	.047	.503	.204	.538	.221	.516	.488	.810	1.0	.036	.215	.315	-	-	.474	.032	.474	.668	.292
RTR	.139	.333	.524	.101	.481	.793	.632	.129	.296	.616	.952	.750	.707	.858	.667	.902	.241	.450	.538	.845
RTL	.803	.663	.961	.091	.319	.167	.188	.166	.188	.713	.454	.628	.554	.511	.749	.614	.563	.614	.934	.719
P2R	.774	.711	.764	.864	.908	.795	.870	.864	.909	.434	.830	.174	.866	.020	-	.674	.533	.670	.828	.021
P2L	.207	.177	.068	.338	.883	.294	.992	-	-	-	.589	-	.632	-	-	.134	.081	.040	.122	.173
P3R	.003	.113	.012	.242	.025	.385	.040	.001	.912	.541	.718	.411	.572	.095	.980	.002	.099	.010	.000	.108
P3L	.942	.504	.280	.295	.956	.706	.086	.617	.163	1.0	.812	.176	.078	.153	.105	.984	.419	.266	.128	.013
P3TR	.966	.456	.026	1.0	.733	.125	.228	.095	.210	.523	.571	.050	.492	.035	.749	.999	.344	.020	.020	.008
P3TL	.102	.114	.154	.463	.613	.564	.680	.110	.995	.163	.877	.325	.647	.225	.890	.120	.085	.130	.162	.614
P4R	.170	.971	.704	.986	.013	.384	.147	.076	.480	1.0	.536	.706	.741	.950	.975	.140	.910	.686	.190	.822
P4L	.578	.947	.340	.445	.325	.883	.089	.415	.925	.511	.783	.557	.101	.750	.145	.616	.902	.326	.170	.118
PHR	.817	.913	.823	.983	.833	.639	.807	.955	.755	.758	.961	.873	.918	.900	.900	.774	.997	.808	.510	.957
PHL	.905	.537	.235	.451	.971	.973	.556	.900	.650	1.0	.614	.899	.979	.955	.650	.914	.444	.218	.830	.830
CHR	.552	.097	.729	.864	.920	.561	.529	.625	.900	.651	.178	.698	.887	.457	.370	.406	.090	.710	.664	.770
CHL	.832	.867	.511	.932	.451	.662	.707	.950	.955	.819	.375	.489	.982	.920	.504	.758	.798	.472	.844	.687
RHR	.553	.062	.935	.853	.947	.799	.804	.895	.955	1.0	.163	.927	.128	.501	.750	.484	.034	.872	.620	.110
RHL	.831	.727	.538	.903	.978	.859	.745	.999	.980	.477	.589	-	.641	-	-	.428	.491	.428	.734	.912
PAR	.989	.650	.910	.769	.277	.331	.801	-	-	-	.901	-	.859	-	-	.758	.915	.758	.776	-
PAL	.698	.939	.117	.633	-	.685	-	-	-	-	-	-	-	-	-	.048	.474	.048	.074	-

Underlined probabilities are based on small cell numbers (<5) for pattern occurrence.
(-) indicates no probability estimate possible due to a zero in the crosstabulation table.

Table 47

MALES.
PALMAR PATTERNS.

	X_1^2 PROBABILITIES															MANN-WHITNEY PROBABILITIES				
	-A-	-B-	-C-	-G-	-H-	-J-	-K-	-T-	-V-	-L-	-M-	-N-	-P-	-U-	-W-	-A-	-B-	-C-	-D-	-E-
PTR	.405	.930	.330	.421	.955	.934	.392	.951	.025	-	.695	.854	.533	.	-	.368	.818	.296	.430	.329
PTL	.067	.625	.027	.043	.753	.005	.612	.005	.600	.904	.893	.798	.622	.325	.910	.060	.504	.024	.006	.209
RTR	.380	.990	.897	.843	.549	.361	.822	.700	.551	.904	.644	.844	.937	.900	.700	.352	.816	.910	.344	.995
RTL	.886	.981	.434	.737	.975	.973	.441	.893	.710	.611	.988	.967	.892	.650	.900	.888	.898	.410	.425	.858
P2R	.345	.243	.445	.674	.058	.453	.679	.210	.235	.904	.215	.844	.675	.275	.650	.306	.177	.382	.390	.242
P2L	.662	.490	.613	.628	.988	.617	.369	.851	.901	-	.669	-	.607	-	-	.528	.288	.512	.054	.148
P3R	.151	.297	.897	.419	.669	.872	.985	.283	.661	.888	.352	.690	.790	.900	.850	.134	.254	.860	.590	.743
P3L	.774	.050	.837	.446	.276	.422	.465	.906	.150	.020	.090	.509	.020	.450	.001	.726	.038	.798	.478	.170
P3TR	.546	.847	.121	.368	.967	.900	.132	.851	.432	.868	.920	.887	.346	.910	.550	.470	.995	.096	.222	.222
P3TL	.152	.962	.159	.410	.757	.810	.292	.912	.290	.594	.989	.970	.900	.500	.910	.126	.832	.132	.378	.815
P4R	.916	.162	.466	.982	.997	.967	.910	.991	.981	.922	.674	.981	.450	.900	.900	.888	.156	.450	.868	.495
P4L	.712	.732	.391	.576	.416	.667	.716	.123	.158	.570	.905	.354	.664	.475	.980	.694	.215	.376	.810	.388
PHR	.781	.938	.707	.587	.651	.953	.924	.613	.708	.615	.810	.866	.649	.900	.990	.752	.927	.688	.864	.938
PHL	.605	.885	.805	.936	.046	.080	.816	.999	.146	.050	.334	.171	.105	.450	.900	.544	.767	.752	.744	.795
CHR	.776	.188	.686	.904	.975	.890	.726	.970	.325	.873	.981	.936	.971	.500	.910	.756	.153	.800	.644	.588
CHL	.810	.252	.296	.412	.229	.492	.157	.675	.912	.592	.718	.536	.190	.650	.750	.754	.208	.266	.374	.139
RHR	.494	.849	.372	.411	.548	.978	.605	.701	.801	.281	.377	.327	.326	.900	-	.398	.940	.296	.508	.794
RHL	.705	.013	.928	.628	.890	.956	.478	.801	-	.155	.589	.190	.640	-	-	.500	.003	1.0	.360	.010
PAR	.106	.178	.649	.179	.868	.252	-	-	-	-	.823	-	.644	-	-	.044	.062	.488	.196	-
PAL	.764	-	.459	.868	-	-	-	-	-	-	-	-	-	-	-	.336	-	.216	.202	-

Underlined probabilities are based on small cell numbers (<5) for pattern occurrence.
(-) indicates no probability estimate possible due to a zero in the crosstabulation table.

Table 48

FINGER AND PALMAR INTENSITY INDICES.

	X^2_2 PROBABILITIES							MANN-WHITNEY PROBABILITIES				
FEMALES	-A-	-B-	-C-	-D-	A(T)	C(T)	D(T)	-A-	-B-	-C-	-D-	-E-
RFPII	.697	.888	.799	.861	.720	.806	.854	.740	.899	.986	.986	.783
LFPII	.496	.483	.595	.663	.512	.596	.654	.414	.539	.604	.724	.240
TFPII	.888	.615	.881	.882	.905	.886	.876	.738	.676	.798	.876	.416
RPPII	.849	.393	.358	.412	.999	.340	.324	.798	.612	.328	.312	.697
LPPII	.890	.104	.421	.806	.896	.662	.809	.902	.152	.562	.836	.689
TPPII	.852	.143	.320	.550	.988	.444	.485	.808	.195	.448	.566	.991
MALES												
RFPII	.930	.937	.480	.570	.913	.481	.757	.746	.927	.546	.648	.938
LFPII	.751	.967	.741	.977	.713	.731	.974	.850	.915	.684	.886	.448
TFPII	.869	.964	.639	.930	.850	.533	.932	.706	.846	.572	.702	.679
RPPII	.572	.620	.879	.630	.711	.934	.815	.774	.382	1.0	.816	.420
LPPII	.250	.484	.257	.359	.361	.352	.514	.620	.329	.204	.460	.668
TPPII	.312	.483	.450	.409	.420	.551	.550	.892	.204	.350	.552	.469

MAINLINE TERMINATIONS AND INDICES.

Table 49

MANN-WHITNEY PROBABILITIES

MALES	-A-	-B-	-C-	-D-	-E-	wp /es	ws /ep	-J-	-K-	-G-	-H-	wp /es	ws /ep	-N-	-P-	-L-	-M-
MAINAR	.541	.751	.683	.709	.411	.359	.904	.995	.907	.415	.417	.165	.118	.304	.807	.164	.838
MAINAL	.960	.825	.637	.760	.924	.632	.623	.297	.631	.427	.420	.786	.600	.086	.940	.775	.811
MAINBR	.210	.101	.924	.738	.619	.348	.375	.924	.885	.374	.406	.937	.039	.290	.749	.853	.184
MAINBL	.641	.890	.323	.916	.663	.797	.719	.774	.843	.703	.912	.494	.521	.166	.712	.410	.265
MAINCR	.292	.676	.671	.389	.762	.427	.418	.604	.598	.850	.964	.849	.493	.756	.472	.504	.884
MAINCL	.888	.043	.287	.430	.598	.256	.380	.928	.718	.602	.381	.180	.177	.969	.058	.013	.221
MAINDR	.307	.098	.757	.809	.586	.700	.267	.859	.534	.387	.615	.880	.035	.402	.668	.816	.413
MAINDL	.925	.931	.986	.490	.666	.527	.605	.895	.556	.999	.708	.653	.430	.348	.976	.724	.423
MAINADR	.819	.207	.804	.495	.452	.591	.342	.874	.539	.918	.849	.348	.019	.260	.990	.389	.511
MAINADL	.657	.731	.948	.915	.833	.884	.676	.362	.543	.687	.230	.704	.942	.583	.866	.684	.761
FEMALES																	
MAINAR	.001	.010	.153	.066	.260	.004	.127	.712	.448	.119	.023	.008	.096	.169	.447	.015	.363
MAINAL	.075	.024	.214	.100	.564	.034	.911	.872	.188	.622	.043	.370	.066	.328	.563	.745	.041
MAINBR	.056	.232	.092	.008	.661	.006	.833	.389	.053	.701	.185	.160	.777	.340	.474	.108	.882
MAINBL	.033	.127	.171	.278	.978	.228	.177	.328	.120	.679	.029	.393	.133	.139	.258	.163	.237
MAINCR	.002	.042	.001	.000	.039	.000	.850	.038	.045	.182	.191	.024	.463	.059	.482	.350	.854
MAINCL	.792	.385	.628	.177	.074	.639	.856	.484	.137	.330	.721	.277	.800	.202	.162	.794	.587
MAINDR	.011	.180	.118	.016	.956	.007	.468	.569	.077	.568	.092	.246	.361	.422	.295	.093	.876
MAINDL	.119	.152	.166	.097	.948	.248	.506	.904	.044	.382	.212	.500	.113	.319	.352	.249	.542
MAINADR	.000	.013	.065	.010	.559	.001	.142	.673	.082	.271	.013	.049	.064	.332	.371	.029	.427
MAINADL	.036	.027	.100	.040	.834	.041	.621	.942	.046	.793	.046	.905	.038	.216	.389	.612	.095

Table 50

FINGER AND PALMAR RIDGE COUNTS.
ONEWAY ANALYSIS OF VARIANCE PROBABILITIES, PARAMETRIC TEST.

	MALES								FEMALES							
	-R-	R(T)	-S-	S(T)	(B) -R-	(B) R(T)	(B) -S-	(B) S(T)	-R-	R(T)	-S-	S(T)	(B) -R-	(B) R(T)	(B) -S-	(B) S(T)
RT1	.705	.691	.983	.971	.083	.249	.480	.841	.430	.619	.762	.697	.063	.372	.844	.964
RT2	.498	.497	.138	.138	.977	.978	.880	.882	.033	.034	.208	.210	.988	.988	.831	.832
RT3	.557	.544	.525	.524	.781	.743	.675	.631	.117	.113	.741	.731	.974	.977	.981	.981
RT4	.552	.466	.295	.273	.438	.441	.430	.484	.333	.350	.713	.741	.869	.872	.577	.493
RT5	.422	.407	.084	.087	.957	.991	.841	.921	.305	.359	.906	.934	.365	.488	.270	.433
LT1	.298	.242	.839	.831	.429	.580	.188	.684	.144	.158	.918	.921	.773	.956	.703	.813
LT2	.377	.413	.007	.006	.614	.723	.782	.723	.289	.314	.458	.457	.589	.613	.717	.712
LT3	.371	.321	.564	.542	.024	.010	.599	.609	.288	.231	.804	.807	.951	.949	.913	.974
LT4	.377	.494	.311	.332	.047	.038	.011	.057	.753	.727	.986	.980	.715	.664	.981	.989
LT5	.419	.577	.124	.112	.427	.809	.215	.303	.149	.203	.659	.711	.933	.994	.521	.501
FR1	.319	.350	.810	.846	.756	.645	.949	.939	.552	.506	.496	.524	.321	.327	.955	.905
FR2	.197	.293	.367	.300	.588	.899	.741	.601	.027	.017	.230	.158	.665	.900	.863	.889
FR3	.561	.719	.700	.725	.039	.435	.012	.366	.070	.101	.780	.846	.000	.357	.252	.818
FR4	.330	.399	.362	.399	.251	.296	.381	.411	.610	.594	.959	.945	.886	.925	.682	.811
FR5	.665	.693	.156	.160	.172	.161	.242	.271	.595	.473	.986	.981	.333	.377	.076	.057
FL1	.256	.295	.686	.731	.683	.795	.718	.525	.132	.123	.742	.784	.904	.907	.519	.564
FL2	.199	.496	.114	.032	.032	.744	.619	.294	.121	.239	.481	.458	.077	.408	.507	.663
FL3	.206	.293	.536	.526	.000	.123	.400	.839	.353	.316	.803	.779	.081	.480	.657	.930
FL4	.625	.715	.714	.674	.077	.038	.414	.136	.734	.777	.984	.989	.859	.861	.963	.957
FL5	.565	.488	.065	.070	.318	.279	.028	.047	.335	.275	.846	.814	.199	.211	.221	.216
RFRC	.620	.543	.366	.374	.467	.621	.304	.563	.172	.203	.633	.655	.976	.997	.734	.835
LFRC	.499	.488	.231	.233	.316	.266	.235	.528	.283	.309	.824	.850	.928	.968	.822	.930
TFRC	.574	.520	.295	.299	.400	.478	.228	.542	.214	.243	.726	.750	.962	.993	.672	.824
RFAC	.390	*	.459	.517	.162	*	.236	.004	.283	*	.798	.689	.659	*	.898	.409
LFAC	.374	*	.388	.399	.044	*	.260	.014	.357	*	.869	.795	.611	*	.763	.310
TFAC	.373	.520	.414	.449	.093	.009	.231	.016	.318	*	.846	.750	.648	*	.848	.401
RPTOT	.876	.868	.487	.490	.222	.222	.080	.081	.859	.842	.593	.591	.328	.326	.753	.767
LPTOT	.891	.906	.436	.491	.386	.399	.033	.107	.514	.504	.839	.833	.938	.931	.207	.198
TPRC	.914	.927	.434	.457	.500	.615	.024	.033	.688	.667	.756	758	.818	.822	.649	.656
RAB	.839	.786	.094	.105	.047	.044	.041	.055	.757	.580	.430	.418	.287	.106	.106	.142
RBC	.776	.954	.152	.192	.000	.161	.027	.660	.815	.847	.504	.548	.001	.382	.100	.868
RCD	.150	.306	.497	.477	.000	.813	.003	.570	.858	.830	.375	.527	.000	.554	.001	.111
LAB	.751	.629	.272	.295	.006	.010	.156	.242	.519	.240	.803	.675	.007	.077	.002	.003
LBC	.916	.975	.375	.391	.000	.364	.040	.213	.452	.520	.298	.277	.117	.596	.662	.933
LCD	.411	.354	.593	.634	.063	.294	.026	.426	.689	.777	.773	.668	.000	.603	.021	.124

(*) indicates no estimate recorded.

FINGER TRIRADII.

ONEWAY ANALYSIS OF VARIANCE PROBABILITIES. PARAMETRIC TEST. Table 51

	MALES								FEMALES							
	-R-	R(T)	-S-	S(T)	(B) -R-	(B) R(T)	(B) -S-	(B) S(T)	-R-	R(T)	-S-	S(T)	(B) -R-	(B) R(T)	(B) -S-	(B) S(T)
RD1	.724	.728	.328	.333	.972	.949	.890	.865	.319	.324	.234	.245	.707	.397	.772	.689
RD2	.371	.365	.407	.405	.552	.572	.541	.569	.015	.016	.100	.108	.000	.018	.464	.597
RD3	.864	.874	.411	.400	.075	.037	.005	.005	.208	.225	.881	.893	.001	.000	.641	.722
RD4	.985	.994	.730	.654	.784	1.0	.966	1.0	.684	.688	.990	.990	.997	.995	.980	.973
RD5	.610	.432	.572	.443	.000	.000	1.0	.000	.911	.000	.478	.000	.000	.070	.036	.001
LD1	.600	.602	.376	.360	.577	.164	.248	.046	.151	.151	.691	.691	.311	.309	.572	.579
LD2	.641	.647	.416	.419	.691	.661	.323	.291	.148	.146	.528	.543	.247	.302	.798	.859
LD3	.494	.494	.250	.250	.352	.235	.169	.110	.476	.482	.491	.484	.057	.046	.638	.619
LD4	.756	.777	.712	.735	.480	.038	.635	.284	.839	.864	.730	.741	.666	.401	.946	.861
LD5	.679	.190	.534	.441	.000	.000	.001	.000	.689	.588	.900	.863	.000	.000	.232	.032

ULNAR AND RADIAL FINGER RIDGE COUNTS.

ONEWAY ANALYSIS OF VARIANCE PROBABILITIES. PARAMETRIC TEST.

	MALES								FEMALES							
	-R-	R(T)	-S-	S(T)	(B) -R-	(B) R(T)	(B) -S-	(B) S(T)	-R-	R(T)	-S-	S(T)	(B) -R-	(B) R(T)	(B) -S-	(B) S(T)
RADCR	.553	.782	.524	.464	.615	.000	.472	.001	.182	.123	.670	.719	.920	.000	.766	.058
ULNCR	.459	.708	.283	.313	.412	.735	.315	.949	.442	.742	.912	.623	.012	.990	.487	.995
RADCL	.619	.640	.277	.302	.317	.008	.118	.001	.397	.300	.753	.645	.912	.211	.843	.242
ULNCL	.141	.340	.372	.091	.000	.944	.053	.998	.235	.181	.665	.296	.143	.990	.583	.069
TRC	.577	.663	.426	.403	.457	.000	.149	.001	.259	.174	.728	.700	.936	.065	.670	.110
TUC	.227	.425	.317	.189	.016	.479	.116	.961	.318	.415	.907	.466	.006	.940	.329	.599

LEAST ATD ANGLES.

ONEWAY ANALYSIS OF VARIANCE PROBABILITIES. PARAMETRIC TEST.

	MALES								FEMALES							
	-R-	R(T)	-S-	S(T)	(B) -R-	(B) R(T)	(B) -S-	(B) S(T)	-R-	R(T)	-S-	S(T)	(B) -R-	(B) R(T)	(B) -S-	(B) S(T)
RLATD	.000	*	.287	.169	.000	*	.001	.003	.032	.000	.446	.460	.000	.000	.001	.001
LLATD	.015	*	.114	.126	.000	*	.251	.023	.157	.017	.406	.404	.000	.000	.001	.000

(*) indicates no estimate recorded

FINGER AND PALMAR INTENSITY INDICES.

ONEWAY ANALYSIS OF VARIANCE PROBABILITIES. PARAMETRIC TEST.

Table 52

	MALES								FEMALES							
	-R-	R(T)	-S-	S(T)	(B) -R-	(B) R(T)	(B) -S-	(B) S(T)	-R-	R(T)	-S-	S(T)	(B) -R-	(B) R(T)	(B) -S-	(B) S(T)
RFPII	.780	.778	.449	.458	.061	.036	.143	.121	.412	.411	.850	.851	.100	.097	.938	.931
LFPII	.550	.538	.494	.511	.047	.014	.041	.031	.406	.409	.744	.745	.130	.152	.679	.697
TFPII	.801	.799	.617	.629	.041	.019	.076	.066	.381	.381	.848	.848	.071	.080	.823	.840
RPPII	.485	.160	.994	.990	.000	.000	.084	.268	.907	.857	.214	.242	.066	.821	.249	.478
LPPII	.365	.137	.667	.591	.000	.000	.884	.972	.811	.800	.549	.659	.127	.860	.479	.898
TPPII	.334	.149	.962	.952	.000	.000	.328	.605	.965	.960	.413	.523	.023	.783	.084	.529

PALMAR TRIRADII.

ONEWAY ANALYSIS OF VARIANCE PROBABILITIES. PARAMETRIC TEST.

	MALES		FEMALES	
	-R-	-S-	-R-	-S-
TR	.442	.287	1.0	.566
TL	.884	.222	.816	.083
T1R	.232	.370	.888	.176
T1L	.754	.462	.775	.801
T2R	.411	.884	.998	.644
T2L	.757	.391	1.0	.884
TBR	.215	.876	.560	.117
TBL	.004	.193	.268	.693
TEFR	.440	.827	.466	.920
TEFL	.175	.649	.867	.571
TDR	.314	.194	.769	.778
TDL	.772	.201	.507	.738

Table 53

KRUSKAL-WALLIS ONEWAY ANALYSIS OF VARIANCE PROBABILITIES, NONPARAMETRIC TEST.

	MALES		FEMALES	
	-R-	-S-	-R-	-S-
RT1	.687	.919	.747	.723
RT2	.442	.281	.039	.347
RT3	.545	.758	.099	.760
RT4	.365	.475	.375	.537
RT5	.252	.149	.331	.947
LT1	.266	.887	.212	.927
LT2	.338	.018	.265	.446
LT3	.222	.646	.213	.758
LT4	.309	.401	.588	.922
LT5	.637	.111	.262	.714
FR1	.812	.791	.905	.317
FR2	.042	.302	.017	.196
FR3	.072	.926	.196	.853
FR4	.306	.456	.961	.952
FR5	.504	.231	.912	.992
FL1	.357	.706	.639	.788
FL2	.593	.036	.573	.467
FL3	.257	.677	.702	.748
FL4	.473	.626	.997	.962
FL5	.685	.072	.754	.849
RFRC	.436	.526	.830	.661
LFRC	.430	.384	.835	.758
TFRC	.464	.453	.817	.703
RFAC	.486	.529	.854	.744
LFAC	.559	.345	.883	.798
TFAC	.510	.413	.869	.735
RPTOT	.944	.529	1.0	.317
LPTOT	.862	.680	1.0	.655
TPRC	.922	.575	1.0	.496
RAB	.824	.105	1.0	.503
RBC	.846	.154	.999	.511
RCD	.396	.322	.970	.596
LAB	.796	.310	.994	.764
LBC	.925	.457	.995	.223
LCD	.249	.341	1.0	.582

	MALES		FEMALES	
	-R-	-S-	-R-	-S-
RFPII	.660	.344	.903	.820
LFPII	.576	.169	.993	.815
TFPII	.828	.299	.916	.783
RPPII	.766	.999	.820	.207
LPPII	.475	.540	.842	.672
TPPII	.782	.888	.955	.435
TR	.442	.287	1.0	.566
TL	.884	.222	.816	.983
T1R	.232	.270	.888	.176
T1L	.754	.462	.775	.801
T2R	.411	.884	.998	.644
T2L	.757	.391	1.0	.884
TBR	.215	.876	.500	.117
TBL	.004	.193	.268	.693
TEFR	.440	.827	.466	.920
TEFL	.175	.649	.867	.571
TDR	.818	.080	.769	.778
TDL	.772	.097	.507	.738
RD1	.642	.313	.349	.228
RD2	.310	.400	.021	.074
RD3	.728	.432	.196	.946
RD4	.990	.697	.657	.999
RD5	.577	.516	.902	.427
LD1	.494	.404	.260	.718
LD2	.573	.346	.161	.548
LD3	.445	.257	.476	.609
LD4	.353	.636	.768	.658
LD5	.673	.504	.719	.920
RADCR	.369	.729	.883	.622
ULNCR	.579	.346	.945	.683
RADCL	.516	.248	.798	.742
ULNCR	.332	.173	.654	.351
TRC	.455	.502	.846	.716
TUC	.453	.249	.828	.495

	MALES		FEMALES	
	-R-	-S-	-R-	-S-
MAINAR	.831	.884	.139	.273
MAINAL	.756	.831	.357	.011
MAINBR	.242	.497	.006	.241
MAINBL	.776	.706	.043	.306
MAINCR	.576	.833	.107	.048
MAINCL	.929	.473	.339	.556
MAINDR	.382	.589	.050	.196
MAINDL	.588	.815	.172	.583
MAINADR	.542	.719	.008	.182
MAINADL	.701	.983	.208	.062
RLATD	.000	.069	.000	.426
LLATD	.047	.279	.132	.461
PTR	.228	.640	1.0	.453
PTL	.393	.847	.957	.128
RTR	.597	.830	1.0	.768
RTL	.259	.756	.996	.679
P2R	.657	.398	1.0	.462
P2L	.496	.438	1.0	.524
P3R	.439	.637	.179	.272
P3L	.778	.882	.262	.381
P3TR	.878	.864	1.0	.028
P3TL	.803	.896	1.0	.212
P4R	.179	.761	.273	.893
P4L	.239	.614	.385	.689
PHR	.516	.706	.904	.969
PHL	.097	.952	1.0	.323
CHR	.077	.412	.678	.230
CHL	.001	.204	.317	.326
RHR	.659	.689	1.0	.731
RHL	.899	.398	1.0	.385
PAR	.042	.340	1.0	.670
PAL	.998	1.0	1.0	1.0

Figure 9

FEMALE.
Mean Total Finger Ridge Count.
Child's Birth Place.
Principal Population Centres.
Scale. Km.
0 5 10 15
1
128·01
10
138·76
11
137·66
3
9
126·44
2
131·01
12
142·82
13
139·39
139·40
4
139·05
122·02
5
14
15
135·21
130·58
140·86
6
124·48
7
130·52
8

Figure 10

MALE.
Mean Total Finger Ridge Count.
Child's Birth Place.
Principal Population Centres
Scale. Km.
0 5 10 15
1
145-30
10
146-19
11
147-52
3
154-02
141-29
9
2
138-56
12
161-79
13
136-90
4
138-14
145-84
5
142-30
15
14
148-58
141-12
6
143-77
7
142-53
8

Discriminant Function Analysis.

Table 54

Female. Child's Birth Place. Reduced Matrix.

Groups	Salop(1)	Powys(2)	Total
Sample Size	455	700	1155

Standardized Discriminant Function Coefficients.

	Func(1)
RFU1	-.25181
RFR3	.34880
RFU3	.32663
LFU1	.43001
LFU3	-.57589
LFR5	.66387
RCD	-.26742
LAB	.31850
RFPII	-.55391
RLATD	-.20322
LLATD	-.33888

C.C. .197

Total Amount of Explained Variance on 1 Function = .03880

% Correctly Classified Cases = 59.83

F-value = 4.1800

D^2 = .1682

Df. = 11,1143

Discriminant Function Analysis.

Table 55.

Female. Child's Birth Place. Complete Matrix.

Groups	Salop(1)	Powys(2)	Total
Sample Size	455	699	1154

Standardized Discriminant Function Coefficients.

	Func(1)
RFU3	.13983
RFU4	.46422
LFU1	.27296
LFU3	-.62434
LFR5	.39655
LFU5	-.26488
LAB	.20396
LBC	-.26905
RD1	-.25368
RD4	-.50187
RD5	-.18134
LD3	.40280
LD4	-.15024
LD5	.37440
PTR	-.34636
P2R	.22256
P2L	-.18198
P3R	-.23095
P3L	.25972
CHR	-.13142
RHR	.12906
RAHL	-.15386
TEFR	.35967
TDR	-.13452
MAINBL	.32548
MAINDR	.37175
MAINADR	-.70150
MAINADL	.17386
RLATD	-.15816
LLATD	-.31037

% Correctly Classified Cases	=	61.09
F-value	=	3.5465
D^2	=	.3312
Df.	=	30,1123

C.C. .294

Total Amount of Explained Variance on 1 Function = .08643

Discriminant Function Analysis.

Table 56

Males. Child's Birth Place. Reduced Matrix.

Groups	Salop(1)	Powys(2)	Total
Sample Size	403	726	1129

Standardized Discriminant Function Coefficients.

	Func(1)
RFU2	.64215
RFR3	.46481
RFR5	.35665
RFU5	-.33814
LFU1	.35450
LFU4	.27367
LFR5	-.57611
LFU5	.35352
LFPII	-.95001
RLATD	-.54737

C.C.	.167	
Total Amount of Explained Variance on 1 Function	=	.02788
% Correctly Classified Cases	=	57.31
F-value	=	3.1930
D^2	=	.1242
Df.	=	10,1118

Discriminant Function Analysis.

Table 57

Male. Child's Birth Place. Complete Matrix.

Group	Salop(1)	Powys(2)	Total
Sample Size	403	726	1129

Standardized Discriminant Funcyion Coefficients.

	Func(1)
RFR2	.18787
RFU2	.42626
LFU1	.24329
LFR5	-.33126
LFAC	.67791
LD4	.32237
PTR	.27746
PTL	-.21106
P3TL	-.20511
PAR	.23290
PAL	.16500
RAHL	-.19676
TDR	-.26647
MAINBR	.31795
MAINBL	-.16770
MAINCR	-.32270
TFPII	-1.13566
RLATD	-.41550

C.C. .229

Total Amount of Explained Variance on 1 Function = .05244

% Correctly Classified Cases = 60.94

F-value = 3.4276

D^2 = .2417

Df. = 18,1110

Discriminant Function Analysis.

Female. Parent's Common Birth Place. Reduced Matrix. Table 58

Groups	Salop(1)	Powys(2)	Total
Sample Size	165	433	598

Standardized Discriminant Function Coefficients.

	Func(1)
RFR2	-.27909
RFU5	-.32614
LFR2	.68975
LFU2	-.23775
LFR5	.28633
RAB	.33125
LBC	-.24542
LPPII	-.25889
LLATD	-.53463

C.C. .239

Total Amount of Explained Variance on 1 Function = .05712

% Correctly Classified Cases = 63.04

F-value = 3.9552

D^2 = .3020

Df. = 9,588

Discriminant Function Analysis. Table 59

Female. Parent's Common Birth Location. Complete Matrix.

Groups	Salop(1)	Powys(2)	Total
Sample Size	165	433	598

Standardized Discriminant Function Coefficients.

	Func(1)
RFR2	-.23018
LFR2	.47843
LFR3	-.16985
LBC	-.47724
RFRC	.28711
RPTOT	.29536
RD5	-.29522
PTR	-.28178
PTL	-.20829
RTR	.37751
P2R	.29767
P2L	-.16730
P3L	.12311
P3TR	.12330
P3TL	-.14873
RHR	.40382
RHL	-.23175
RAHL	-.14471
TR	.12498
TL	-.25599
T2L	.28057
TBR	-.29984
TDR	-.17092
MAINAR	-.25181
MAINAL	.16991
MAINADL	-.33762
LLATD	-.49751

F-value = 3.9469
D^2 = .9326
Df. = 27,570

C.C. .397
Total Amount of Explained Variance on 1 Function = .1576
% Correctly Classified Cases = 70.90

Discriminant Function Analysis.

Male Parent's Common Birth Place. Reduced Matrix. Table 60

Groups	Salop(1)	Powys(2)	Total
Sample Size	136	421	557

Standardized Discriminant Function Coefficients.

	Func(1)
RFR1	-.50221
RFU2	.25841
RFR3	.46146
RFR4	.61505
LFR1	.68618
LFR2	.46313
LFR3	-.43965
LFR5	-.71464
LBC	-.31594
LFPII	-.42438
RLATD	-.47885
LLATD	.25986

C.C. .219

Total Amount of Explained Variance on 1 Function = .04796

% Correctly Classified Cases = 58.71

F-value = 2.2789

D^2 = .27149

Df. = 12,544

Discriminant Function Analysis.

Table 61

Male. Parent's Common Birth Place. Complete Matrix.

Groups	Salop(1)	Powys(2)	Total
Sample Size	136	421	557

Standardized Discriminant Function Coefficients.

	Func(1)
RFR1	-.31088
RFU1	.38378
LFU2	-.25010
LFR3	-.46910
LFR5	-.73883
LBC	-.12295
TFRC	1.68676
RD1	-.51635
RD4	-.23378
RD5	.20441
LD5	-.17539
P2L	-.19429
P3R	.13990
P3L	-.27461
PHR	-.18649
CHL	.77155
RHR	-.20266
RHL	.52090
PAR	.20639
RAHL	-.14938
TL	-.17203
T2R	.30689
TBL	-.60818
TDL	.19543
MAINBR	.38270
MAINBL	-.24444
MAINCR	-.14300
RLATD	-.26596

F-value = 3.071
D^2 = .8792
Df. = 28,528

C.C. .374
Total Amount of Explained Variance on 1 Function = .13987
% Correctly Classified Cases = 68.94

Discriminant Function Analysis. Table 62

Female. English/Welsh. Reduced Matrix.

Groups	English(1)	Welsh(2)	Total
Sample Size	604	641	1245

Standardized Discriminant Function Coefficients.

	Func(1)
RFU3	.30583
LFU1	.40173
LFR2	.51437
LFU2	.55812
LFU4	-.45451
RAB	.51241
LFPII	-.78175
RLATD	-.30543

C.C. .124

Total Amount Of Explained Variance On 1 Function = .01537

% Correctly Classified Cases = 53.73

F-value = 2.4306

D^2 = .0628

Df. = 8,1236

Discriminant Function Analysis.

Table 63

Females. English/Welsh. Complete Matrix.

Groups	English(1)	Welsh(2)	Total
Sample Size	603	641	1244

Standardized Discriminant Function Coefficients.

	Func(1)
RFR2	.21493
RFU3	.23298
LFU1	.64380
LFU4	-.43069
RBC	-.34337
LPTOT	.59261
RD5	.16513
LD1	-.59869
P2L	-.27144
P3TR	.36870
P3TL	-.19724
RHR	.16548
RHL	-.20888
PAL	.28458
RAHR	-.25091
TL	-.35398
T1R	.26874
T1L	-.57918
RLATD	-.25638

C.C. .197

Total Amount Of Explained Variance On 1 Function = .197

% Correctly Classified Cases = 57.40

F-value = 2.6141

D^2 = .1622

Df. = 19,1224

Discriminant Function Analysis.

Table 64

Male. English/Welsh. Reduced Matrix.

Groups	English(1)	Welsh(2)	Total
Sample Size	568	595	1163

Standardized Discriminant Function Coefficients.

	Func(1)
RFR3	.66686
RFU4	.49113
RFU5	-.26295
LFU1	-.27503
LFR2	.49871
LFR3	-.57322
LFR5	-.42146
LCD	.24807
LPPII	-.29416
RLATD	-.41033

C.C. .134

Total Amount Of Explained Variance On 1 Function = .01795

% Correctly Classified Cases = 56.5

F-value = 2.0945

D^2 = .0726

Df. =10,1152

Discriminant Function Analysis. Table 65

Male. English/Welsh. Complete Matrix.

Groups	English(1)	Welsh(2)	Total
Sample Size	567	595	1162

Standardized Discriminant Function Coefficients.

	Func(1)
RFR3	-.29761
RFU5	.18268
LFR2	-.28638
LFR3	.38456
LFU4	-.31602
LFR5	.39545
LFU5	-.38945
TFRC	-.50450
LD1	.25631
LD3	.22261
LD5	.42039
PTL	.27570
P3TR	-.14750
P3TL	-.33479
PHR	.13929
CHR	-.45226
PAR	.17003
PAL	-.16687
TBL	.40411
MAINBR	-.34559
MAINCL	-.38074
MAINDR	-.50675
RLATD	.21644

C.C. .216

Total Amount Of Explained Variance On 1 Function = .04666

% Correctly Classified Cases = 57.06

F-value = 2.4269

D^2 = .1957

Df. = 23,1138

Discriminant Function Analysis. Table 68

Female. Ancestry. All Categories. Complete Matrix.

Groups	4 English Surnames/ 0 Welsh Surnames(1)	3 English Surnames/ 1 Welsh Surnames(2)	2 English Surnames/ 2 Welh Surnames(3)
Sample Size	254	349	360
	1 English Surnames/ 3 Welsh Surnames(4)	0 English Surnames/ 4 Welsh Surnames(5)	Total
	356	285	1604

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)
RFU1	.25857	-.17759
RFR2	-.01104	.25609
RFR4	.24405	-.49627
RFU5	-.18886	-.57982
LFU2	.68698	-.02616
LFR3	-.37397	-.02151
LFU4	.26050	.24446
LFR5	.22113	.38504
LAB	.10954	.10130
RD3	-.16791	-.24594
RD4	-.23479	.27762
RD5	.09560	.11841
LD3	-.37225	-.08573
P2R	.04610	-.37989
P2L	-.16781	.24541
P3TR	.29181	-.32084
PHR	-.22364	-.45736
PAL	-.00556	-.21119
TL	.50667	.10577
T1L	.56352	.26959
T2R	.23605	.31577
MAINBL	-.01408	-.21307
MAINDL	-.07536	-.18603
LLATD	.04109	-.28949

C.C	.192	.184

Total Amount of Explained Variance on 4 Functions= .1059
% Correctly Classified Cases =27.18

Discriminant Function Analysis. Table 69

Males. Ancestry. All Categories. Complete Matrix.

Groups	4 English Surnames/ 0 Welsh Surnames(1)	3 English Surnames/ 1 Welsh Surnames(2)	2 English Surnames/ 2 Welsh Surnames(3)
Sample Size	259	308	375
	1 English Surnames/ 3 Welsh Surnames(4)	0 English Surnames/ 4 Welsh Surnames(5)	Total
	346	249	1537

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)	Func(3)
RFR2	-.27023	-.09054	.17655
RFR3	.06388	-.05166	.47302
RFU4	.13909	.27590	.06606
RFR5	.18602	-.24875	.41643
RFU5	-.33240	-.15378	.16364
LFU1	.40865	-.00771	.13795
LFU3	.11777	-.50639	-.10744
RCD	.06145	.31168	.04658
LFRC	-.19193	.10784	-.95569
RD2	.23003	-.00125	-.37895
RD3	.02397	.32866	.26642
RD4	-.23748	.16914	.14461
PTL	.19386	-.27244	-.50978
P3TR	.18197	.24989	.22600
P4R	-.16147	-.06721	.25560
CHL	-.34746	1.02708	-.44933
PAL	-.31872	.00676	.05896
RAHR	-.07679	.28141	-.53980
RAHL	-.27281	-.38041	.30656
TBR	-.26446	.35737	-.04899
TBL	.77673	-1.29255	.50843
TEFR	.14525	.15214	-.45821

Table 69 cont.

TEFL	.06604	.00911	.81738
MAINBR	.34704	.37557	.09271
MAINCL	-.38671	-.24207	-.18189
RLATD	-.30495	.09427	.05509
LLATD	.04917	-.31533	-.25076
C.C.	.196	.185	.161

Total Amount of Explianed Variance on 4 Functions = .1179

% Correctly Classified Cases =28.69

Table 70

ANCESTRY. ALL CATEGORIES. COMPLETE MATRIX.

Females

Group	1	2	3	4	5
1		2.200	1.429	2.234	2.259
2	0.350		1.298	1.608	1.762
3	0.226	0.171		1.694	1.482
4	0.365	0.221	0.226		2.366
5	0.395	0.268	0.226	0.377	

Df.=24,1576

Males

Group	1	2	3	4	5
1		2.153	1.507	1.225	1.782
2	0.420		1.833	1.596	2.024
3	0.270	0.298		1.383	1.745
4	0.227	0.269	0.211		1.828
5	0.386	0.404	0.320	0.347	

Df.=27,1506

Upper Triangular Matrix = F values

Lower Triangular Matrix = D^2 values

Figure 11

Ancestry. All Categories. Complete Matrix.

Discriminant Function Analysis.

Table 66

Females. Language. Reduced Matrix.

Groups	English(1)	English & Welsh(2)	Total
Sample Size	1343	260	1603

Standardized Discriminant Function Coefficients.

	Func(1)
RFR2	-.39608
RFU4	.59593
RFR5	.41855
LFU3	.47281
LFR5	-.61669
RAB	-.27546
RBC	.28240
RFPII	-.76867
LLATD	-.27161

C.C .122

Total Amount of Explained Variance on 1 Function = .01488

% Correctly Classified Cases = 57.58

F-value = 2.6725

D^2 = .1108

Df. = 9,1593

Discriminant Function Analysis.

Table 67

Males. Language. Reduced Matrix.

Groups	English(1)	English & Welsh(2)	Total
Sample Size	1274	262	1537

Standardized Discriminant Function Coefficients.

	Func(1)
RFR3	.71180
LFU1	.35697
LFU3	-.57931
LFU5	-.42299
LLATD	.51552

C.C. .078

Total Amount of Explained Variance on 1 Function = .00608

% Correctly Classified Cases = 54.52

F-value = 1.8610

D^2 = .0429

Df. = 5,1531

Discriminant Function Analysis.

Table 71

Female. Child's Birth Place X Ancestry. Reduced Matrix.

Groups	Salop-English(1)	Salop-Welsh(2)	Powys-English(3)	Powys-Welsh(4)	Total
Sample Size	196	126	140	413	875

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)
RFR2	.24584	-.29112
RFR4	-.27486	.33954
RFU5	-.22128	-.35477
LFU2	.03008	-.61681
LFU3	-.53426	-.54295
LFR5	.89508	-.39104
RAB	.26645	.11098
RCD	-.27916	.22049
LFPII	.11441	1.21964
LLATD	-.32744	.03347
C.C.	204	.166

Total Amount of Explained Variance on 3 Functions = .0744
% Correctly Classified Cases = 31.20

Discriminant Function Analysis.

Table 72

Female. Parent's Common Birth Location X Ancestry. Reduced Matrix.

Groups	Salop-English(1)	Salop-Welsh(2)	Powys-English(3)	Powys-Welsh(4)	Total
Sample Size	48	52	48	311	459

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)
RFR3	.47722
RFU5	-.50635
LFR2	.89049
LFR3	-.62901
LFR4	-.03207
LPPII	-.27297
LLATD	-.35507

C.C. .257
Total Amount of Explained Variance on 3 Functions = .1048
% Correctly Classified Cases = 23.75

Discriminant Function Analysis.

Table 73

Female. Child's Birth Place X Ancestry X Childs Language. Reduced Matrix.

Groups	Salop-English(1)	Salop-Welsh(2)	Powys-English -English(3)	Powys-English -Welsh
Sample Size	196	125	125	15

	Powys-Welsh -English(4)	Powys-Welsh -Welsh(5)	Total
	275	138	874

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)	Func(3)
RFR2	-.04242	.55287	.14303
RFU5	-.30023	.36504	.13261
LFU2	.13634	-.25547	.77160
LFU3	-.64220	-.24997	.64117
LFR5	.51589	.51174	.30511
RAB	.30703	.04717	.04557
RBC	-.02105	-.39233	-.17014
LFPII	.55522	-.38890	-1.23462
RLATD	-.45499	.53576	-.38202
LLATD	.06164	-.39800	.06627
C.C.	.220	.177	.160

Total Amount of Explained Variance on 5 Functions = .1265
% Correctly Classified Cases = 23.11

Discriminant Function Analysis. Table 74

Female. Common Parent's Birth Place X Ancestry X Childs Language. Reduced Matrix.

Groups	Salop-English(1)	Salop-Welsh(2)	Powys-English -English(3)	Powys-English -Welsh
Sample Size	48	52	46	2

Powys-Welsh -English(4)	Powys-Welsh -Welsh(5)	Total
216	95	459

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)
RFR3	-.18133	.79141
RFU5	-.62093	-.10677
LFR2	.75047	-.21386
LFU2	.03309	-.71601
RBC	.27269	.44303
RCD	.04739	.04357
LCD	-.40836	.08270
LPPII	-.31910	.05936
LLATD	-.34991	-.07210
C.C.	.258	.233

Total Amount of Explained Variance on 5 Functions = .1815
% Correctly Classified Cases = 28.10

Table 75

FEMALES. REDUCED MATRIX.

Child's Birth Place X Ancestry

Group	1	2	3	4
1		2.251	2.972	2.738
2	0.297		1.933	2.745
3	0.368	0.295		0.763
4	0.208	0.287	0.074	

Df.=10,862

Parent's Birth Place X Ancestry

Group	1	2	3	4
1		2.527	2.240	2.503
2	0.718		3.219	3.841
3	0.662	0.915		0.486
4	0.427	0.612	0.083	

Df.=7,449

Child's Birth Place X Ancestry X Language

Group	1	2	3	4	5
1		2.258	2.549	2.170	3.041
2	0.299		2.259	2.439	3.186
3	0.338	0.365		0.797	1.032
4	0.192	0.287	0.094		1.904
5	0.380	0.491	0.159	0.209	

Df.=10,859

Parent's Birth Place X Ancestry X Language

Group	1	2	3	4	5
1		1.171	1.851	1.845	1.713
2	0.430		2.141	2.503	2.136
3	0.722	0.804		0.484	1.622
4	0.430	0.547	0.117		2.156
5	0.492	0.582	0.480	0.299	

Df.=9,445

Upper Triangular Matrix = F values

Lower Triangular Matrix = D^2 values

Figure 12

FEMALES. PRINCIPAL FUNCTION PLOTS. REDUCED MATRIX.

Figure 13

FEMALES. MINISSA M.D.S. PLOT. REDUCED MATRIX.

Kruskal's Stress = 0·000

Kruskal's Stress = 0·000

Discriminant Function Analysis.

Table 76

Male. Child's Birth Place X Ancestry. Reduced Matrix.

Groups	Salop-English(1)	Salop-Welsh(2)	Powys-English(3)	Powys-Welsh(4)	Total
Sample Size	178	101	125	417	821

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)
RFU1	-.04745	.32565
RFR2	.54308	.36395
RFU2	.65678	-.11477
RFR3	.52493	.12192
LFU1	.03700	-1.25556
LFR3	-.33899	-.09150
LFR5	-.41510	-.18459
RFPII	-.01242	-.21519
LFPII	-.59816	.65926
LPPII	-.27554	-.05687
RLATD	-.48690	.25743
C.C	.186	.149

Total Amount of Explained Variance on 3 Functions = .0751
% Correctly Classified Cases = 32.40

Discriminant Function Analysis.

Table 77

Male. Parent's Common Birth Place X Ancestry. Reduced Matrix.

Groups	Salop-English(1)	Salop-Welsh(2)	Powys-English(3)	Powys-Welsh(4)	Total
Sample Size	50	40	44	280	414

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)
RFR3	-.85199
LFU1	-.04019
LFR5	.74591
LFU5	-.50942
LBC	.03592
LFPII	.48420
LPPII	-.26679
RLATD	.35161

C.C. .239
Total Amount of Explained Variance on 3 Functions = .1045
% Correctly Classified Cases = 30.42

Discriminant Function Analysis.

Table 78

Male. Child's Birth Place X Ancestry X Childs Language. Reduced Matrix.

Groups	Salop-English(1)	Salop-Welsh(2)	Powys-English -English(3)	Powys-English -Welsh
Sample Size	178	101	110	14

	Powys-Welsh -English(4)	Powys-Welsh -Welsh(5)	Total
	274	143	820

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda

	Func(1)
RFU1	-.02606
RFU2	-.57682
RFU4	-.82764
LFU1	.09407
LFR5	.48805
RFPII	.55545
RLATD	.63004

C.C. .189
Total Amount of Explained Variance on 4 Functions = .0749
% Correctly Classified Cases = 25.00

Discriminant Function Analysis. Table 79

Male. Parent's Common Birth Place X Ancestry X Childs Language. Reduced Matrix.

Groups	Salop-English(1)	Salop-Welsh(2)	Powys-English -English(3)	Powys-English -Welsh
Sample Size	50	40	39	5

Powys-Welsh -English(4)	Powys-Welsh -Welsh(5)	Total
186	94	414

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)
RFR4	1.04008
RFR5	-.71715
LFU1	-.48960
LFR2	.31822
LFR4	-1.04496
LFR5	.77398
LFU5	-.11906
RLATD	.40573

C.C. .240
Total Amount of Explained Variance on 5 Functions = .1440
% Correctly Classified Cases = 24.15

Table 80

MALES. REDUCED MATRIX.

Child's Birth Place X Ancestry

Group	1	2	3	4
1		1.431	1.794	2.413
2	0.247		1.737	1.888
3	0.272	0.346		1.682
4	0.215	0.259	0.195	

Df.=11,807

Parent's Birth Place X Ancestry

Group	1	2	3	4
1		1.971	2.045	3.041
2	0.722		1.259	1.165
3	0.711	0.489		1.313
4	0.583	0.271	0.281	

Df.=8,403

Child's Birth Place X Ancestry X Language

Group	1	2	3	4	5
1		1.092	2.268	3.691	0.577
2	0.120		1.739	1.512	0.728
3	0.235	0.233		2.185	1.337
4	0.241	0.145	0.196		2.288
5	0.051	0.087	0.152	0.172	

Df.=7,808

Parent's Birth Place X Ancestry X Language

Group	1	2	3	4	5
1		2.497	2.072	2.473	1.647
2	0.915		0.640	1.315	0.963
3	0.770	0.264		1.180	0.598
4	0.511	0.325	0.298		0.388
5	0.411	0.280	0.177	0.051	

Df.=8,401

Upper Triangular Matrix = F values

Lower Triangular Matrix = D^2 values

Figure 14

MALE. PRINCIPAL FUNCTION PLOTS. REDUCED MATRIX.

Figure 15

MALES. MINISSA M.D.S. PLOT. REDUCED MATRIX.

Discriminant Function Analysis. Table 81

Female. Child's Birth Place - Four new redefined regions. Reduced Matrix.

Groups	Region One(1)	Region Two(2)	Region Three(3)	Region Four(4)	Total
Sample Size	510	219	301	127	1157

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)
RFU1	.50168	.23365
RFR2	.49994	-.02562
RFR3	-.31984	-.11505
RFU3	-.55451	.02725
RFR5	-.43427	.12836
LFR1	-.14700	-.04548
LFR2	.32042	.44849
LFU2	.51286	-.12003
LFU3	-.29563	-.31394
LFU4	.09681	-.48455
LFR5	.00150	.39552
LBC	-.02682	.41660
RLATD	.27676	-.43141
C.C.	.179	.150

Total Amount of Explained Variance on 3 Functions = .0647
% Correctly Classified Cases = 31.29

Discriminant Function Analysis. Table 82

Female. Child's Birth Place - Four new redefined regions. Complete Matrix.

Groups	Region One(1)	Region Two(2)	Region Three(3)	Region Four(4)	Total
Sample Size	510	219	300	127	1156

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda

	Func(1)	Func(2)	Func(3)
RFU1	-.13283	-.31117	-.44706
RFU3	-.40371	-.01765	-.03333
RFR5	-.28802	-.19795	.22785
LFR1	-.12724	-.10701	.37042
LFR2	.44789	-.08689	-.23945
LFU2	.56893	.39014	-.07534
LFU3	-.19696	-.14829	.67999
LFR5	-.10122	.08477	-.63179
LFU5	.32597	.11767	.24687
RBC	.19840	.33819	-.21366
LBC	-.08150	-.60836	.25355
RD1	.49523	.13636	.28879
RD4	.04485	.37741	.18133
LD2	-.28219	-.64916	.17426
LD3	.01137	.50157	-.39433
LD5	-.31814	-.13646	-.56675
P2R	.00421	-.40813	-.22563
P2L	-.04574	.31126	-.11958
P3TL	.18729	-.10656	-.11332
RAHL	.24406	-.07344	-.00355
TDR	.58412	.23875	-.07428
MAINBL	-.26117	.33069	.18498
MAINADR	.13959	-.00185	.43647
RPPII	-.30778	-.00159	.37547
RLATD	.33219	.27957	.00792
C.C.	.240	.218	.180

Total Amount of Explained Variance on 3 Functions = .1375
% Correctly Classified Cases = 35.21

Discriminant Function Analysis. Table 83

Females. Parent's Common Birth Place - Four new redefined regions. Reduced Matrix.

Groups	Region One(1)	Region Two(2)	Region Three(3)	Region Four(4)	Total
Sample Size	215	66	152	42	475

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)	Func(3)
RFR2	.39104	.73478	-.82994
RFU2	-.47541	.43909	.00621
RFR3	-.22003	-.71126	.02507
LFU1	.02253	.30558	.41187
LFR2	.02230	.35281	.96489
LFU3	.32832	-.34122	.22409
LBC	.42646	.12202	-.12346
LFPII	-.52382	-.52608	-.67856
RLATD	-.68075	.39305	-.29329
LLATD	.36473	-.26235	-.05369
C.C.	.215	.211	.188

Total Amount of Explained Variance on 3 Functions = .1260
% Correctly Classified Cases = 36.21

Discriminant Function Analysis.

Table 84

Female. Parent's Common Birth Place - Four new redefined regions. Complete Matrix.

Groups	Region One(1)	Region Two(2)	Region Three(3)	Region Four(4)	Total
Sample Size	215	66	152	42	475

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)	Func(3)
RFR2	.42105	-.35131	-.71810
RFU2	.16167	-.42624	.19482
RFR3	-.09982	.49246	.26064
LFR2	-.26604	-.29809	.40525
LFU2	.16130	.30718	.20299
LFU4	-.75454	.11784	-.11587
LBC	.11812	-.11217	-.56339
LD4	.84297	.23323	.09797
PTL	.28039	.27712	-.24573
RTR	-.23947	-.24171	.01935
P2R	.12303	-.59016	.33223
P2L	-.11248	.31834	-.02018
P3L	-.15901	.22687	.16578
PAR	-.35464	.26046	-.05453
T2L	-.20706	-.25053	-.13669
TBR	-.08127	.20240	-.34154
TDR	.27255	.73511	-.10579
TDL	-.10242	-.43042	.00013
MAINAR	.07661	.03484	-.44488
MAINBR	-.33377	.15524	.19906
RLATD	.37453	-.01099	.16999
C.C.	.318	.299	.275

Total Amount of Explained Variance on 3 Functions = .2642
% Correctly Classified Cases = 42.74

Figure 16

Upper Triangle = F values
Lower " = D^2 "

Maximum Link Cluster | Single Link Cluster | N° of Clusters. | Proximity Level for M.L.C.

Female. Childs Birth Place. Reduced Matrix.
New Redefined Regions.

Group	1	2	3	4
1		1.396	2.538	1.547
2	0.119		1.709	2.325
3	0.176	0.177		2.355
4	0.199	0.380	0.346	

Df. =13,1141

N° of Clusters.	Proximity Level for M.L.C.
4	
3	0.119
2	0.177
1	0.380

Female. Childs Birth Place. Complete Matrix.
New Redefined Regions.

Group	1	2	3	4
1		1.595	2.601	2.260
2	0.265		1.852	2.283
3	0.278	0.373		2.595
4	0.567	0.693	0.742	

Df. =25,1128

N° of Clusters.	Proximity Level for M.L.C.
4	
3	0.265
2	0.373
1	0.742

Female. Parents Birth Place. Reduced Matrix.
New Redefined Regions.

Group	1	2	3	4
1		2.188	1.863	2.145
2	0.441		1.839	2.179
3	0.213	0.407		2.084
4	0.622	0.865	0.645	

Df. =10,462

N° of Clusters.	Proximity Level for M.L.C.
4	
3	0.213
2	0.441
1	0.865

Females. Parents Birth Place. Complete Matrix.
New Redefined Regions.

Group	1	2	3	4
1		1.808	2.277	2.163
2	0.785		1.878	2.011
3	0.560	0.895		2.342
4	1.350	1.719	1.561	

Df. =21,451

N° of Clusters.	Proximity Level for M.L.C.
4	
3	0.560
2	0.895
1	1.719

Figure 17

Minissa M.D.S. Plot. Female. New Redefined Regions.
Childs Birth Place

Figure 18

Minissa M.D.S. Plot. Females. New Redefined Regions.
Parent's Birth Place

Discriminant Function Analysis. Table 85

Male. Child's Birth Place - Four new redefined regions. Reduced Matrix.

Groups	Region One(1)	Region Two(2)	Region Three(3)	Region Four(4)	Total
Sample Size	511	183	304	131	1129

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)	Func(3)
RFU2	.46944	.09738	-.26767
RFU3	.17422	.24641	.44284
LFR2	.18721	-.21050	-.71274
LFR4	-.29238	.54021	-.30629
RAB	-.04412	.52073	-.00878
RCD	.36253	.16845	.39370
LAB	.08759	-.98089	-.21638
RFPII	-.40901	-.95634	.40716
RPPII	.09816	-.22442	.26961
RLATD	-.69859	-.15433	.38616
LLATD	-.30648	.33750	-.42164
C.C.	.198	.164	.136

Total Amount of Explained Variance on 3 Functions = .0845
% Correctly Classified Cases = 35.70

Discriminant Function Analysis.

Table 86

Male. Child's Birth Place - Four new redefined regions. Complete Matrix.

Groups	Region One(1)	Region Two(2)	Region Three(3)	Region Four(4)	Total
Sample Size	511	183	304	131	1129

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)	Func(3)
RFU3	.04345	.17012	.36568
RFU4	-.30582	-.08292	-.06164
LFU1	-.23027	-.03900	-.04357
LFR2	-.25304	.07140	-.39006
LFU2	.00754	.37145	-.02374
LFR4	.02733	-.40615	.08873
RCD	-.25898	.11713	.42988
LAB	.06033	.25328	-.34853
LD2	-.38195	-.26428	.31523
LD3	.07587	-.28245	-.02494
LD5	.25029	.10608	.07258
PTR	-.43045	-.02465	-.16889
RTL	-.22911	-.41509	-.01563
P2L	.24886	.09805	.02912
CHR	.04702	-.05556	.46612
CHL	-.50072	-.02450	-.01086
RAHR	.37698	-.14083	-.32485
TL	-.19521	-.39986	-.46707
T1L	-.36554	-.16856	-.14063
T2L	-.25951	-.10882	-.14062
TEFL	.28037	.17839	.61820
TDR	-.02368	-.35802	.13347
TDL	-.26192	.21764	-.04955
MAINBR	-.16558	-.40682	-.02698
MAINCR	.23084	.23466	.00026
MAINADL	.06393	-.24787	.05919
RFPII	.57910	.39339	-.54922
TPPII	.47580	.51567	-.38092
RLATD	.75609	-.27168	-.34553
LLATD	-.10073	-.41783	.00739
C.C.	.284	.257	.230

Total Amount of Explained Variance on 3 Functions = .1996
% Correctly Classified Cases = 38.44

Discriminant Function Analysis. Table 87

Male. Parent's Common Birth Place - Four new redefined regions. Reduced Matrix.

Groups	Region One(1)	Region Two(2)	Region Three(3)	Region Four(4)	Total
Sample Size	226	56	150	36	468

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)
RFU2	-.56943
RFR3	.38207
LFR2	-.64311
LFU4	-.07189
RAB	.30377
LFPII	.44675
LPPII	-.30638
RLATD	.50407

C.C. .262
Total Amount of Explained Variance on 3 Functions = .1073
% Correctly Classified Cases = 36.75

Discriminant Function Analysis.

Table 88

Male. Common Parent's Birth Place - Four new redefined regions. Complete Matrix.

Groups	Region One(1)	Region Two(2)	Region Three(3)	Region Four(4)	Total
Sample Size	226	56	150	36	468

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)	Func(3)
RFU1	-.01227	.21882	.25336
RFU2	-.54127	.16830	-.14981
RFR3	.23486	.15600	.05924
RFU3	-.04110	-.27299	.10866
LFR2	-.35213	.15485	.16501
LFR4	-.03140	.29994	-.39495
RAB	.45618	.41180	-.19127
LBC	.19143	.21842	-.41540
RPTOT	-.44472	-.63408	.14320
PTR	.20468	.34667	.57679
PTL	.11483	-.17096	-.37690
RTR	.96670	-.32382	.44528
RTL	-.26574	-.03031	-.46458
P2L	.05489	-.22561	-.25694
P4R	.38061	.05935	-.14496
P4L	-.16771	.25695	.12565
CHR	-.23366	-.17521	-.36430
CHL	-.28024	.17226	-.19314
RAHR	.33721	-.04754	.23344
T1L	-.30825	-.22125	-.07432
T2R	-.09533	.22875	-.11210
TEFR	-1.16958	.06896	-.77092
MAINBR	-.12598	.76193	-.40259
MAINBL	.31462	.16875	-.07191
MAINDR	.15091	.61038	-.51278
RFPII	.49567	-.47133	.14566
TPPII	.04313	-.00893	.83088
RLATD	.54426	-.14688	-.07168
C.C.	.421	.354	.285

Total Amount of Explained Variance on 3 Functions = .3837
% Correctly Classified Cases = 49.57

Figure 19

Upper Triangle = F_2 values
Lower " = D^2 "

Maximum Link Cluster | Single Link Cluster | N° of Clusters. | Proximity Level for M.L.C.

Male. Childs Birth Place. Reduced Matrix.
New Redefined Regions.

Group	1	2	3	4
1		2.228	3.724	3.339
2	0.184		2.407	3.054
3	0.217	0.234		2.582
4	0.356	0.444	0.313	

Df. =11,1115

N° of Clusters.	Proximity Level for M.L.C.
4	
3	0.183
2	0.233
1	0.444

Male. Childs Birth Place. Complete Matrix.
New Redefined Regions.

Group	1	2	3	4
1		2.160	2.827	2.579
2	0.494		2.989	2.420
3	0.457	0.806		2.650
4	0.762	0.976	0.891	

Df. =30,1096

N° of Clusters.	Proximity Level for M.L.C.
4	
3	0.456
2	0.805
1	0.976

Male. Parents Birth Place. Reduced Matrix.
New Redefined Regions.

Group	1	2	3	4
1		1.049	3.811	2.411
2	0.190		1.250	1.271
3	0.343	0.249		1.498
4	0.630	0.471	0.419	

Df. =8,457

N° of Clusters.	Proximity Level for M.L.C.
4	
3	0.190
2	0.343
1	0.630

Male. Parents Birth Place. Complete Matrix.
New Redefined Regions.

Group	1	2	3	4
1		2.157	3.307	1.970
2	1.428		2.032	1.382
3	1.090	1.482		1.886
4	1.886	1.875	1.932	

Df. =28,437

N° of Clusters.	Proximity Level for M.L.C.
4	
3	1.090
2	1.482
1	1.932

Figiur 20

Minissa M.D.S. Plot. Male. Childs Birth Place.

New Redefined Regions.

Figure 21

Minissa M.D.S. Plot. Males. Parents Birth Place.
New Redefined Regions

Discriminant Function Analysis. Table 89

Female. Child's Birth Place - Four new redefined regions X Ancestry. Reduced Matrix.

Groups	Region One -English(1)	Region One -Welsh(2)	Region Two -English(3)	Region Two -Welsh(4)
Sample Size	139	253	93	58
	Region Three -English(5)	Region Three -Welsh(6)	Region Four -English(7)	Region Four -Welsh(8)
	56	184	49	43

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)
RFR1	-.02422	.77205
RFR2	.16115	-.43699
RFU3	-.19322	.10869
LFR2	.55562	.04064
LFR4	-.45959	.00311
LFU4	-.40613	.11853
LFR5	.41953	-.79043
RAB	-.35834	-.57897
RCD	-.52484	.14072
LAB	.55833	.51343
LCD	.61587	.10180
RFPII	.04271	.30549
RLATD	-.20595	-.06273
C.C.	.228	.183

Total Amount of Explained Variance on 7 Functions = .1589
% Correctly Classified Cases 16.11

Discriminant Function Analysis. Table 90

Male. Child's Birth Place - Four new redefined regions X Ancestry. Reduced Matrix.

Groups	Region One -English(1)	Region One -Welsh(2)	Region Two -English(3)	Region Two Welsh(4)
Sample Size	128	267	86	45

	Region Three -English(5)	Region Three -Welsh(6)	Region Four -English(7)	Region Four -Welsh(8)	Total
	42	174	47	32	821

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)	Func(3)
RFU3	-.40158	.30372	-.01812
RFR4	.29209	-.22810	.04773
LFR1	.22884	.53836	.07237
LFU1	-.14884	-.51849	.32150
LFR2	-.34240	-.25996	.24040
LFU2	-.36635	.11868	.29366
LFR4	.25945	-.28434	-.58385
LFU5	.13752	.31931	-.50634
RBC	.01686	-.00535	-.57474
LAB	.14879	-.66616	.07746
RFPII	.31937	.03807	.46037
RLATD	.66932	.39054	.44287
C.C.	.235	.207	.174

Total Amount of Explained Variance on 7 Functions = .1882
% Correctly Classified Cases = 17.66

Table 91

NEW REDEFINED REGIONS X ANCESTRY. CHILD'S BIRTH PLACE.
REDUCED MATRIX.

Males

Group	1	2	3	4	5	6	7	8
1		1.380	2.150	2.162	1.918	2.416	1.693	1.946
2	0.194		1.523	1.974	2.156	2.269	1.445	2.259
3	0.509	0.285		1.758	2.202	2.386	2.281	2.039
4	0.790	0.624	0.724		1.743	1.211	2.062	0.999
5	0.738	0.723	0.949	0.976		1.603	1.189	2.045
6	0.399	0.262	0.504	0.412	0.577		1.228	1.747
7	0.599	0.440	0.913	1.092	0.652	0.404		1.782
8	0.925	0.962	1.064	0.650	1.370	0.786	1.139	

Df. = 12,802

Females

Group	1	2	3	4	5	6	7	8
1		1.069	2.011	0.958	0.956	1.834	2.249	2.047
2	0.157		1.726	1.034	0.867	1.195	1.666	2.221
3	0.476	0.335		1.428	1.645	2.137	2.265	2.756
4	0.309	0.289	0.527		1.029	1.125	1.915	1.726
5	0.316	0.249	0.620	0.476		0.607	1.925	2.110
6	0.305	0.148	0.456	0.336	0.187		1.494	1.666
7	0.819	0.535	0.931	0.951	0.971	0.509		1.258
8	0.822	0.797	1.236	0.922	1.144	0.630	0.724	

Df. = 13,855

Upper Triangular Matrix = F values

Lower Triangular Matrix = D^2 values

Figure 22

Kruskal's Stress = 0·086

Kruskal's Stress = 0·076

Figure 23

Female. Maximum Link Cluster. Childs Birth Place.
New Redefined Regions X Ancestry

N° of Clusters	Proximity Level
8	—
7	0.147
6	0.249
5	0.308
4	0.476
3	0.620
2	0.724
1	1.123

Male. Maximum Link Cluster. Childs Birth Place.
New Redefined Regions X Ancestry

N° of Clusters	Proximity Level
8	—
7	0.194
6	0.398
5	0.508
4	0.650
3	0.652
2	0.949
1	1.137

Discriminant Function Analysis. Table 92

Female. Child's Birth Place - New Locations X Ancestry X Child's Language. Complete Matrix.

Groups	Salop -English(1)	Salop -Welsh(2)	Rhayader +Knighton(3)	Valley -English(4)	Valley -Welsh(5)
Sample Size	129	58	49	90	235

Western Hills -Welsh -Welsh(6)	Western Hills -Welsh -English(7)	Oswestry -English(8)	Oswestry -Welsh(9)	Total
107	41	67	67	843

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)	Func(3)
RFR2	-.36125	.44000	-.03659
RFU4	-.42463	-.41093	.40404
RFR5	-.15762	.02384	.35543
LFU2	.08497	.31190	-.31215
LFU3	.51772	.32171	.05206
LFR4	.27101	-.09123	-.52850
LFR5	-.30755	-.17694	-.85338
RBC	.20528	-.30951	.18975
LFRC	-.86441	1.97357	.36981
TFRC	.83722	-1.91214	.33249
LPTOT	-.16006	.24120	.14432
RD2	-.24944	.11879	.35239
RD4	.66401	.41739	-.42581
RD5	.17657	.24381	.01336
PTL	-.20104	.13925	-.21262
P2L	.21810	-.08490	-.21019
P3L	-.22888	-.06735	-.19288
P4R	.08911	-.32378	.03569
T2R	.04852	-.15044	-.44866
MAINBL	.06197	-.56781	-.06594
MAINCR	.36486	.29223	.04852
MAINADR	.47990	.33819	.25490
MAINADL	.03244	-.41083	-.04637
LFPII	-.37716	-.72228	-.22041
RLATD	.20652	.12369	-.17728
C.C.	.313	.283	.230

Total Amount of Explained Variance on 8 Functions = .3803
% Correctly Classified Cases = 22.06

Discriminant Function Analysis. Table 93

Male. Child's Birth Place - New Locations X Ancestry X Childs Language. Complete Matrix.

Groups	Salop -English(1)	Salop -Welsh(2)	Rhayader +Knighton(3)	Valley -English(4)	Valley -Welsh(5)
Sample Size	115	42	42	80	226

	Western Hills -Welsh -Welsh(6)	Western Hills -Welsh -English(7)	Oswestry -English(8)	Oswestry -Welsh(9)	Total
	124	44	59	63	795

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)	Func(3)	Func(4)	Func(5)	Func(6)
RFR4	.15431	.27463	-.22712	-.52725	-.11916	.15248
RFU4	-.11831	.16306	.35457	-.26693	.22193	-.14784
LFU1	-.09585	.24764	.35531	-.46394	.18072	-.07923
LFR2	-.16926	-.11795	.71152	-.22244	-.16116	-.25960
LFU2	-.11896	-.37609	1.03552	-.25952	.27248	.23427
LFR3	-.09861	-.07681	.72861	-.05609	.29109	.65766
LFU3	.27741	.29184	.40505	-.07544	-.03307	.08399
LFU5	.47761	.04592	-.04311	-.16744	.15705	.05218
LBC	.17946	.18030	-.04504	.49502	-.26709	.50801
LCD	.26153	.01663	-.04599	-.56711	.17936	-.13525
RFRC	.53110	-.77272	.75126	-.64431	-.21579	-.10214
LFAC	-.84685	-2.00829	-2.97460	-.50758	.56284	.15582
TFAC	-.04470	2.83487	.45959	2.14747	-.60601	-.53390
RD2	.16002	-.13019	.37828	-.32000	-.30577	.23712
LD2	.44047	.36953	-.95489	.45884	.36693	.07542
PTR	.02067	.28344	.17547	-.12625	-.04483	-.21582
PTL	-.07257	-.20336	-.10250	-.38913	.17776	.50279
P3L	-.04626	-.39295	.26771	.19343	-.25834	.04495
P4L	-.02241	-.11006	.31449	-.11514	-.22933	-.10001
PHR	-.13734	.19316	-.19474	-.22021	-.39101	.01391
CHL	.04656	.36287	.36384	-.07681	.16920	.42369
PAR	-.01897	-.32533	-.06181	-.34790	.11711	-.00965
PAL	.33207	.00497	-.10262	-.00279	-.00715	-.15580
RAHR	-.24500	-.15456	-.15774	.23383	-.38033	-.15468
TR	-.22494	.05047	-.09774	.11438	-.11468	-.29511
TBR	.18295	-.32428	-.16038	.05551	-.23757	.10047

Table 93 cont.

MAINAL	.01110	.16597	-.22658	-.05145	-.14820	.30878
MAINBR	.01299	.14988	.15317	-.14796	-.41302	.08990
MAINCR	.13630	.17412	-.27780	-.06222	.43764	-.09520
RFPII	.51275	-1.01495	-1.82563	-.60420	.43768	-.86650
TFPII	-.84386	.46926	1.87493	.64289	-.63430	.78948
LPPII	.05007	.06632	-.35937	.61285	-.26868	-.05427
TPPII	-.14594	-.07186	.37138	-.06136	.52675	-.27267
RLATD	-.48984	-.05082	-.24695	.19335	-.22156	.06073
LLATD	-.24206	.15825	-.07426	-.26979	-.11927	.03514
C.C.	.325	.292	.299	.262	.235	.226

Total Amount of Explained Variance on 8 Functions = .5447

% Correctly Classified Cases = 27.92

Table 94

FEMALE. NEW LOCATIONS X ANCESTRY X LANGUAGE.

CHILD'S BIRTH PLACE. COMPLETE MATRIX.

Group	1	2	3	4	5	6	7	8	9
1		2.357	2.067	1.637	1.413	2.236	1.188	1.293	1.237
2	1.517		1.639	2.009	2.290	2.152	1.850	1.472	1.924
3	1.498	1.589		1.559	1.941	1.411	1.404	2.064	2.339
4	0.795	1.467	1.260		1.095	0.959	0.978	1.648	1.669
5	0.437	1.267	1.232	0.433		1.702	1.102	1.491	1.830
6	0.984	1.473	1.081	0.505	0.596		1.527	1.788	2.079
7	0.983	1.983	1.619	0.894	0.813	1.326		1.648	1.462
8	0.755	1.220	1.878	1.105	0.736	1.117	1.669		0.958
9	0.723	1.593	2.128	1.119	0.904	1.299	1.480	0.737	

Upper Triangular Matrix = F values

Lower Triangular Matrix = D^2 values

Df. =25,810

MALES. NEW LOCATIONS X ANCESTRY X LANGUAGE

Table 95

CHILD'S BIRTH PLACE. COMPLETE MATRIX.

Group	1	2	3	4	5	6	7	8	9
1		1.479	1.342	1.369	1.527	1.278	1.366	1.777	2.242
2	1.760		1.513	1.766	1.759	1.493	1.432	1.698	1.832
3	1.596	2.636		1.369	1.162	1.286	1.265	1.475	1.592
4	1.062	2.347	1.819		1.592	1.438	1.274	1.335	2.032
5	0.733	1.817	1.201	0.986		1.499	1.563	1.745	2.254
6	0.784	1.742	1.500	1.082	0.685		1.252	1.655	1.874
7	1.571	2.439	2.155	1.642	1.553	1.411		1.487	1.314
8	1.667	2.533	2.200	1.439	1.365	1.515	2.159		1.982
9	2.015	2.660	2.312	2.110	1.674	1.642	1.856	2.381	

Upper Triaggular Matrix = F values

Lower Triangular Matrix = D^2values

Df.=35,752

Figure 24

NEW LOCATIONS X ANCESTRY X LANGUAGE.
MINISSA M.D.S. PLOT. CHILD'S BIRTH PLACE.
COMPLETE MATRIX

Figure 25

NEW LOCATIONS X ANCESTRY X LANGUAGE.
SINGLE LINK CLUSTER. CHILD'S BIRTH PLACE.
COMPLETE MATRIX

Figure 26

NEW LOCATIONS X ANCESTRY X LANGUAGE.
MAXIMUM LINK CLUSTER. CHILD'S BIRTH PLACE.
COMPLETE MATRIX

Number of Clusters	Proximity Level
9	-
8	0.685
7	0.784
6	1.082
5	1.642
4	2.110
3	2.200
2	2.381
1	2.660

Number of Clusters	Proximity Level
9	-
8	0.433
7	0.596
6	0.723
5	0.755
4	1.266
3	1.589
2	1.669
1	2.128

Discriminant Function Analysis.

Table 96

Female. Child's Birth Place - 15 Regions. Reduced Matrix.

Groups	Llanfyllin(1)	Welshpool(2)	Llanfair Caereinion(3)	Machynlleth(4)	Newtown(5)
Sample Size	99	139	44	69	144
	Llanidloes(6)	Rhayader(7)	Knighton(8)	Meifod(9)	Oswestry(10)
	113	25	40	27	187
	Ellesmere(11)	Pontesbury(12)	Shrewsbury(13)	Bishops Castle(14)	
	63	45	74	48	
	Church Stretton(15)	Total			
	37	1154			

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)
RFU1	.17234	-.29489
RFR2	.47904	-.13433
RFU2	.17858	-.60781
LFR1	.09951	-.29106
LFU1	.15807	.58565
LFU2	.46148	-.10518
LFR3	.06465	.17948
LFU3	-.60950	-.29076
LFR5	-.47050	.81713
LBC	-.27768	-.34093
RLATD	.50842	.12506
C.C.	.209	.195

Total Amount of Explained Variance on 11 Functions = .1885
% Correctly Classified Cases = 12.39

FEMALE. REDUCED MATRIX. 15 REGIONS. CHILD'S BIRTH PLACE. Table 97

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1		0.704	0.654	1.146	1.011	1.835	1.203	0.753	1.595	1.479	1.227	1.399	1.847	1.721	1.467
2	0.135		0.508	1.589	0.556	1.555	1.372	0.761	1.448	1.253	0.537	1.053	1.469	2.037	1.542
3	0.238	0.169		0.902	0.635	0.320	1.190	0.666	1.382	0.451	0.543	0.763	0.482	1.558	0.938
4	0.313	0.382	0.373		2.229	2.485	1.442	0.292	1.661	1.536	1.340	1.651	2.641	1.966	2.425
5	0.191	0.087	0.209	0.530		1.695	1.495	1.124	1.629	1.931	0.835	1.445	1.460	2.341	1.958
6	0.386	0.277	0.112	0.644	0.297		1.620	1.535	2.233	2.333	1.476	0.958	1.224	3.529	1.767
7	0.669	0.719	0.829	0.872	0.779	0.879		1.345	1.299	2.142	1.311	0.803	1.884	0.978	1.411
8	0.259	0.237	0.322	0.115	0.347	0.506	0.908		1.356	1.159	1.015	1.509	1.956	2.023	1.753
9	0.835	0.711	0.917	0.950	0.795	1.137	1.111	0.871		1.846	1.140	1.449	1.305	1.333	1.558
10	0.254	0.174	0.141	0.338	0.263	0.368	1.078	0.337	0.869		0.572	1.279	1.470	2.114	1.616
11	0.354	0.138	0.233	0.452	0.212	0.405	0.813	0.414	0.670	0.135		0.821	1.147	1.393	1.455
12	0.502	0.344	0.381	0.673	0.468	0.331	0.555	0.721	0.953	0.392	0.347		1.240	1.528	1.339
13	0.484	0.338	0.194	0.821	0.332	0.304	1.119	0.746	0.732	0.308	0.374	0.492		1.988	1.396
14	0.591	0.634	0.753	0.771	0.722	1.163	0.661	0.936	0.857	0.614	0.568	0.730	0.758		1.280
15	0.605	0.586	0.518	1.118	0.738	0.704	1.050	0.931	1.108	0.581	0.693	0.732	0.628	0.680	

Upper Triangular Matrix = F values

Lower Triangular Matrix = D^2 values

Df. =11,1129

Figure 27

MINISSA M.D.S. PLOT. FEMALE. REDUCED MATRIX. 15 REGIONS.
CHILD'S BIRTH PLACE.

Kruskal's Stress = 0·091

Figure 28

FEMALE. REDUCED MATRIX. 15 REGIONS. CHILD'S BIRTH PLACE.

Discriminant Function Analysis. Table 98

Female. Child's Birth Place - 15 Regions. Complete Matrix

Groups	Llanfyllin(1)	Welshpool(2)	Llanfair Caereinion(3)	Machynlleth(4)	Newtown(5)
Sample Size	99	139	44	69	143
	Llanidloes(6)	Rhayader(7)	Knighton(8)	Meifod(9)	Oswestry(10)
	113	25	40	27	187
	Ellesmere(11)	Pontesbury(12)	Shrewsbury(13)	Bishops Castle(14)	
	63	45	74	48	
	Church Stretton(15)	Total			
	37	1153			

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)	Func(3)
RFR2	.25124	-.09227	.40122
RFR4	.54678	-.10015	-.22588
LFU2	-.04391	-.53013	.09745
LFR3	-.22893	-.21107	.18471
LFR5	.24763	.15541	-.33181
LBC	-.00411	.53872	.07089
RFRC	-.84193	.09351	-.16895
LPTOT	.14765	-.36116	.22685
RD1	.19546	-.16605	.23067
RD2	-.35979	-.02017	.26078
RD3	.04552	.29314	-.21680
RD4	.06874	-.16357	-.13057
LD2	.11568	.42488	.01589
P2L	-.10052	-.03221	.08454
P3R	.03615	-.21069	-.28307
P3L	-.51436	-.02891	-.02424
P4R	.03377	-.59094	-.16379
CHL	-.31763	.33155	-.08995
RHR	-.41230	.10661	-.09354
T2R	.06509	-.13891	-.27458
TBR	.17377	-.19482	.06511
TEFR	.04876	-.30572	.01477
TEFL	.23413	.09183	-.20485

Table 98 cOnt.

TDR	.26426	.40310	.26938
TDL	-.08836	-.29509	.16854
MAINAR	.02528	-.03753	.35103
MAINBR	.07050	-.22511	-.48016
MAINBL	-.37670	-.17598	-.19471
MAINCR	.20086	.26901	-.00456
MAINDL	.32154	.01628	-.16345
RLATD	.20921	-.21341	.42772
C.C.	.311	.293	.277

Total Amount of Explained Variance on 14 Functions = .5474
% Correctly Classified Cases = 17.17

FEMALE. COMPLETE MATRIX. 15 REGIONS. CHILD'S BIRTH PLACE Table 99

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1		1.009	1.338	1.303	1.869	1.251	1.558	1.511	1.281	1.534	1.327	2.047	1.394	1.716	1.658
2	0.556		0.775	0.785	1.368	1.374	1.488	1.664	1.356	1.308	1.061	1.991	1.289	1.139	1.527
3	1.399	0.738		0.790	0.774	1.244	1.108	1.867	1.000	0.960	1.522	1.329	0.722	1.546	1.142
4	1,021	0.543	0.937		1.559	1.717	1.476	1.432	1.220	1.023	1.183	1.543	1.324	1.079	1.514
5	1.018	0.618	0.733	1.067		2.122	1.342	2.465	1.228	2.321	1.790	1.902	1.233	1.967	1.561
6	0.755	0.702	1.251	1.276	1.070		1.850	1.523	2.001	1.708	1.722	1.906	1.003	2.310	1.776
7	2,486	2.237	2.214	2.562	2.008	2.877		1.647	1.348	1.957	1.633	0.941	1.677	1.555	1.451
8	1.690	1.706	2.838	1.801	2.512	1.642	3.410		2.186	1.614	1.426	1.651	1.842	1.920	1.147
9	1.923	1.910	1.904	2.003	1.723	2.924	3.307	4.319		1.536	1.350	1.477	1.168	1.483	1.489
10	0.755	0.522	0.859	0.647	0.912	0.772	2.827	1.560	2.073		1.512	1.423	0.958	1.617	1.354
11	1.098	0.779	1.872	1.145	1.304	1.356	2.906	1.857	2.275	1.022		1.625	1.754	1.030	1.480
12	2,107	1.865	1.902	1.805	1.770	0.989	1.865	2.483	2.788	1.249	1.972		1.544	2.232	1.121
13	1.049	0.850	0.834	1.818	0.805	0.714	2.848	2.259	1.881	0.576	1.642	1.758		1.509	1.400
14	1.690	1.017	2.145	1.214	1.743	2.184	3.013	2.803	2.734	1.348	1.205	3.060	1.651		1.943
15	1.960	1.664	1.810	2.002	1.692	2.029	3.098	1.901	3.038	1.396	2.022	1.759	1.808	2.961	

Upper Triangular Matrix = F values

Lower Triangular Matrix = D^2 values
Df. = 31,1108

Figure 29

Minissa M.D.S. Plot. Female. Complete Matrix. 15 Regions
Childs Birth Place

Kruskal's Stress = 0·090

Figure 30

Female. Complete Matrix. 15 Regions. Childs Birth Place.

Discriminant Function Analysis.

Table 100

Male. Child's Birth Place - 15 Regions. Reduced Matrix.

Groups	Llanfyllin(1)	Welshpool(2)	Llanfair Caereinion(3)	Machynlleth(4)	Newtown(5)
Sample Size	114	148	42	74	144

	Llanidloes(6)	Rhayader(7)	Knighton(8)	Meifod(9)	Oswestry(10)
	118	22	47	17	171

	Ellesmere(11)	Pontesbury(12)	Shrewsbury(13)	Bishops Castle(14)
	44	43	52	41

	Church Stretton(15)	Total
	52	1129

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)	Func(3)
RFR1	-.19232	-.60620	.17897
RFU2	-.58974	-.18223	-.02120
RFU5	-.26568	-.36457	.16618
LFR1	.41943	.53994	-.50665
LFR2	-.34984	-.10299	.00892
LFU3	.02461	-.05986	-.17949
LFR4	-.11910	.47152	.43730
LFU4	.12868	-.37965	-.52188
LFR5	.18572	.06630	-.06267
RCD	-.44660	.08563	.07014
LAB	-.07112	-.28556	-.40210
RFPII	.56133	.28127	-1.24630
LFPII	.01279	-.03508	1.44918
LPPII	-.11580	-.26168	.02828
RLATD	.56215	-.68686	.27913
LLATD	.30029	.60127	.01167
C.C.	.243	.224	.195

Total Amount of Explained Variance on 14 Functions = .2933
% Correctly Classified Cases = 12.84

MALE. REDUCED MATRIX. 15 REGIONS. CHILD'S BIRTH PLACE. Table 101

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1		1.301	0.992	0.951	1.658	2.857	1.843	2.114	1.295	1.185	1.703	1.591	1.115	1.144	1.484
2	0.328		0.961	1.042	1.508	2.107	1.235	1.552	1.569	1.548	1.502	0.965	1.266	1.026	1.339
3	0.524	0.477		1.116	0.479	1.229	1.359	1.318	1.495	1.300	0.899	0.827	0.719	0.896	1.127
4	0.344	0.343	0.676		1.260	1.974	1.737	2.016	1.125	1.422	1.205	1.098	1.011	0.671	1.014
5	0.423	0.335	0.239	0.418		1.939	1.461	1.668	1.245	2.453	1.310	1.787	0.667	0.913	1.742
6	0.799	0.521	0.644	0.704	0.485		1.485	1.992	1.772	2.936	1.470	1.809	1.843	2.051	1.852
7	1.622	1.047	1.527	1.661	1.242	1.300		1.152	1.907	1.074	1.568	1.253	1.579	1.109	1.300
8	1.031	0.706	0.964	1.138	0.763	0.961	1.247		1.861	2.441	1.882	1.980	1.649	1.743	0.998
9	1.420	1.669	2.005	1.321	1.328	1.934	3.226	2.419		1.628	1.417	1.981	1.243	1.315	1.409
10	0.281	0.316	0.625	0.447	0.509	0.682	0.894	1.074	1.708		1.837	1.324	1.513	0.890	2.029
11	0.870	0.719	0.679	0.709	0.631	0.744	1.735	1.343	1.875	0.852		1.285	1.101	1.168	1.441
12	0.827	0.470	0.632	0.655	0.876	0.931	1.397	1.431	2.638	0.625	0.958		1.576	0.840	1.363
13	0.507	0.534	0.502	0.537	0.284	0.829	1.657	1.084	1.574	0.615	0.750	1.086		0.458	1.794
14	0.616	0.519	0.701	0.413	0.464	1.094	1.257	1.291	1.775	0.437	0.893	0.649	0.325		1.435
15	0.674	0.565	0.787	0.539	0.740	0.832	1.365	0.656	1.784	0.826	0.981	0.939	1.119	1.015	

Upper Triangular Matrix = F values

Lower Triangular Matrix = D^2 values

Df. = 16,1099

Figure 31

Minissa M.D.S. Plot. Male. Reduced Matrix 15 Regions.
Childs Birth Place

Kruskal's Stress =0·092

Figure 32

Males. Reduced Matrix. 15 Regions. Childs Birth Place.

Discriminant Function Analysis.

Table 102

Male. Child's Birth Place - 15 Regions. Complete Matrix.

Groups	Llanfyllin(1)	Welshpool(2)	Llanfair Caereinion(3)	Machynlleth(4)	Newtown(5)
Sample Size	114	148	42	74	144
	Llanidloes(6)	Rhayader(7)	Knighton(8)	Meifod(9)	Oswestry(10)
	118	22	47	17	171
	Ellesmere(11)	Pontesbury(12)	Shrewsbury(13)	Bishops Castle(14)	
	44	43	52	41	
	Church Stretton(15)	Total			
	52	1129			

Standardized Discriminant Function Coefficients.
Minimum significance to include a function = .05 on Wilks Lambda.

	Func(1)	Func(2)	Func(3)	Func(4)	Func(5)
RFU1	-.34024	.11185	-.08496	-.05749	-.15734
RFR5	.03497	-.14915	-.18123	-.06510	-.21498
RFU5	.44644	.51920	.02740	.36613	.46812
LFR2	.03019	.24303	.26860	.13402	-.22952
LFU2	.17977	-.06868	.52042	-.02432	-.29025
LFU3	-.08570	-.00540	.36217	.53246	-.19205
LFU4	-.00137	-.04626	-.01863	.04509	.20395
RCD	.37169	.07726	.28904	-.24646	.00915
RD2	-.17745	-.26483	.27386	-.01910	-.43636
RD5	-.39928	-.62631	.31105	-.45454	-.22698
LD2	.22220	.34753	-.57562	-.01954	.52212
LD3	-.08608	-.00631	-.55073	-.09301	.34594
PT1	.22754	-.28265	-.12546	.04385	.28508
RTR	.15670	-.75622	.00043	.32486	-.31044
RHL	-.23515	.28187	.21041	-.22146	.04451
CHR	.41450	-.31421	-.02296	.33961	-.19596
CHL	-.12798	.54576	.18814	.33851	-.06451
PAR	.26322	.10763	-.00731	-.27357	.11561
RAHR	-.38991	-.08416	-.24926	.60652	.25562
RAHL	-.11513	-.18458	.24988	-.41793	-.15091
TL	-.33131	.02690	-.12082	-.02047	-.16896
TEFR	-.07859	1.03499	.18472	-.13055	.22514
MAINAR	.35985	-.10052	-.66963	.13269	-.28197

Table 102 cOnt.

MAINBR	-.20761	.44074	-.59930	-.39145	-.24546
MAINDR	.34933	.16888	-1.05412	-.54229	-.45664
MAINADR	-.65922	.10072	.93700	.18660	.22668
RPPII	-.39127	-.23907	.04264	-.21251	.08601
RLATD	-.56876	-.29881	-.07524	.56349	.89710
LLATD	-.21368	.00418	-.28684	-.09407	-.61637
C.C.	.297	.277	.252	.237	.231

Total Amount of Explained Variance on 14 Functions = .5426

% Correctly Classified Cases = 16.47

MALE. COMPLETE MATRIX. 15 REGIONS. CHILD'S BIRTH PLACE. Table 103

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1		1.120	1.249	1.188	1.815	2.126	1.324	1.834	1.469	1.636	1.516	1.739	1.589	1.271	1.179
2	0.518		0.968	1.281	1.654	2.010	0.887	1.129	1.517	1.825	1.553	1.376	1.693	1.087	0.921
3	1.211	0.881		1.189	0.927	1.533	0.880	0.969	1.580	1.367	0.927	1.283	1.499	1.294	0.981
4	0.788	0.773	1.321		1.556	2.264	1.128	1.415	1.425	1.484	1.076	1.737	1.775	1.187	1.368
5	0.849	0.674	0.848	0.947		1.529	1.271	1.640	1.652	2.390	1.418	2.045	1.972	1.353	1.745
6	1.091	0.911	1.473	1.481	0.702		1.042	1.743	1.920	2.699	1.801	1.801	2.043	1.459	1.288
7	2.137	1.378	1.815	1.979	1.983	1.672		0.724	1.353	0.866	1.038	1.216	1.196	0.897	0.840
8	1.640	0.941	1.300	1.465	1.377	1.543	1.439		1.464	1.630	1.305	1.970	1.787	1.375	0.879
9	2.955	2.961	3.886	3.069	3.234	3.845	4.199	3.490		1.493	1.593	1.825	1.196	1.497	1.353
10	0.712	0.685	1.206	0.855	0.910	1.150	1.322	1.316	2.873		1.600	2.381	2.425	1.306	1.856
11	1.421	1.362	1.285	1.160	1.252	1.672	2.106	1.709	3.867	1.360		1.313	1.621	1.264	1.502
12	1.657	1.229	1.797	1.901	1.835	1.700	2.486	2.610	4.457	2.061	1.797		1.255	1.063	1.441
13	1.324	1.309	1.920	1.729	1.536	1.684	2.303	2.154	2.779	1.810	2.024	1.587		1.253	1.383
14	1.254	1.008	1.856	1.339	1.261	1.427	1.865	1.869	3.706	1.175	1.773	1.507	1.626		1.410
15	0.982	0.713	1.257	1.333	1.359	1.062	1.616	1.060	3.142	1.385	1.875	1.822	1.583	1.830	

Upper Triangular Matrix = F values

Lower Triangular Matrix = D^2 values

Df. = 29,1086

Figure 33

MINISSA M.D.S. PLOT. MALE. COMPLETE MATRIX. 15 REGIONS.
CHILD'S BIRTH PLACE

Kruskal's Stress=0·111

Figure 34

MALES. COMPLETE MATRIX. 15 REGIONS. CHILD'S BIRTH PLACE.

MARRIAGE MOVEMENT MATRIX. TWO GENERATIONS COMBINED. Table 104

Regions	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.0	0.063	0.163	0.020	0.028	0.012	0.004	0.002	0.128	0.093	0.017	0.006	0.002	0.008	0.000	0.060
2		0.0	0.094	0.012	0.161	0.035	0.004	0.002	0.050	0.083	0.017	0.086	0.022	0.059	0.016	0.056
3			0.0	0.054	0.081	0.043	0.006	0.006	0.041	0.011	0.005	0.006	0.003	0.000	0.000	0.020
4				0.0	0.064	0.071	0.004	0.003	0.007	0.003	0.006	0.000	0.007	0.000	0.000	0.039
5					0.0	0.209	0.028	0.022	0.012	0.015	0.005	0.016	0.010	0.027	0.004	0.070
6						0.0	0.097	0.014	0.002	0.004	0.004	0.004	0.004	0.000	0.000	0.041
7							0.0	0.093	0.004	0.004	0.000	0.008	0.000	0.028	0.010	0.022
8								0.0	0.000	0.007	0.004	0.008	0.000	0.123	0.015	0.039
9									0.0	0.030	0.011	0.004	0.008	0.000	0.000	0.015
10										0.0	0.102	0.014	0.025	0.007	0.009	0.124
11											0.0	0.049	0.037	0.023	0.008	0.042
12												0.0	0.124	0.065	0.041	0.027
13													0.0	0.022	0.053	0.043
14														0.0	0.105	0.041
15															0.0	0.037
16																0.0

Region 16 is the general region for birth locations outside the borderland i.e. Regions 1-15.

Marriage Movement Matrix
Two Generations Combined
Minissa M.D.S. Plot

Figure 35

Based on 8195 marriage links.

Figure 36

MARRIAGE MOVEMENT MATRIX. TWO GENERATIONS COMBINED.
MAXIMUM LINK CLUSTER

Number of Clusters	Proximity Level
15	-
14	0.209
13	0.163
12	0.124
11	0.123
10	0.102
9	0.064
8	0.063
7	0.041
6	0.041
5	0.028
4	0.008
3	0.002
2	0.0
1	0.0

Figure 37

MARRIAGE MOVEMENT MATRIX. TWO GENERATIONS COMBINED. SINGLE LINK CLUSTER.

Correlation Matrices Between Biological, Marriage and Geographical Distances for 15 Regions. Table 105

Pearson

N= 105

		AA	BB	CC	DD	EE	FF	GG	HH	II	JJ
Kendal	AA	*	.810	.201	.077	-.597	-.589	-.558	-.621	.209	.232
	BB	-1.0	*	-.113	.074	.622	.632	.548	.639	-.077	-.018
	CC	.116	-.116	*	.575	-.200	-.142	-.087	-.152	.721	.725
	DD	.076	-.076	.440	*	-.225	-.185	-.233	-.231	.580	.866
	EE	-.557	.557	-.259	-.184	*	.865	.836	.968	-.252	-.206
	FF	-.551	.551	-.158	-.164	.658	*	.779	.922	-.195	-.166
	GG	-.457	.457	-.121	-.206	.553	.566	*	.917	-.181	-.187
	HH	-.580	.580	-.200	-.164	.811	.775	.684	*	-.226	-.204
	II	.127	-.127	.534	.416	-.229	-.170	-.205	-.201	*	.616
	JJ	.158	-.158	.551	.611	-.218	-.146	-.181	-.183	.422	*
Spearman	AA	*									
	BB	-1.0	*								
	CC	.173	-.173	*							
	DD	.105	-.105	.614	*						
	EE	-.737	.737	-.361	-.267	*					
	FF	-.728	.728	-.225	-.228	.801	*				
	GG	-.608	.608	-.165	-.286	.686	.699	*			
	HH	-.765	.765	-.279	-.241	.926	.910	.813	*		
	II	.180	-.180	.737	.585	-.322	-.238	-.278	-.285	*	
	JJ	.224	-.224	.747	.783	-.306	-.208	-.248	-.260	.594	*

AA = Distance in miles between regions
BB = 1/Distance in miles between regions
CC = D^2 estimates between regions, females, complete matrix
DD = " " " " males " "
EE = Marriage movement index(I) between regions for child's parents
FF = " " " " " " mothers "
GG = " " " " " " fathers "
HH = " " " " " " all recorded marriages
II = D^2 estimates between regions, females, reduced matrix
JJ = " " " " males " "

Table 106

Multiple Regression Analysis. Cumulative R^2.

D^2 between 15 regions(Dependent Variable, D.V.)
Demographic predictors(Independent Variables, I.V.)

Males				Females			
Reduced Matrix		Complete Matrix		Reduced Matrix		Complete Matrix	
I.V.	R^2	I.V.	R^2	I.V.	R^2	I.V.	R^2
Am	.58651	Am	.45551	Af	.46933	Af	.60533
Bm	.63424	D	.46786	C	.48174	D	.62148
C	.64321	I	.50855	Bf	.48486	I	.64025
D	.66303	Bm	.51846	E	.48676	E	.65679
E	.66537	G	.52248	G	.49210	G	.66606
F	.67110	F	.52489	F	.49599	Bf	.66933
I	.67517	K	.52563	H	.49752	C	.67119
H	.67819	H	.53162	K	.49908	J	.67252
G	.67987	J	.53564	D	.49954	H	.67429
K	.68096	E	.53575	I	*	K	.67508
J	.68644	C	.53582	J	*	F	*

Am = 'Error Variance' estimator, male.
Af = " " " female.
Bm = Summation of sample sizes for two regions i,j, , male.
Bf = " " " " " " " " female.
C = Distance(miles) between regions i,j,.
D = 1/Distance between regions i,j,.
E = Frequency of spoken Welsh in regions i,j,.
F = " " Welsh by ancestry in regions i,j,.
G = " " nonconformity " " " .
H = Marriage index(I) between regions i,j, for parents.
I = " " " " " " father's parents.
J = " " " " " " mother's "
K = " " " " " " combined generations.

(i,j = 1-15)

* = F value less than minimum(.01) to include variable.

Table 107

Females.
Means and Standard Deviations for
breakdown subsets produced by analysis
New Locations X Ancestry X Language.
(Childs Birth Place)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	Total
RFR1	17.1008	17.3276	14.7347	16.4333	16.8128	15.6636	18.6097	17.0746	17.6866	16.7627
RFU1	4.9767	3.6552	4.0612	4.6889	4.9872	3.8972	5.4390	5.1642	3.7910	4.6109
RFR2	9.6899	6.5000	6.3673	7.7000	8.5106	7.3645	9.8293	9.9701	8.6866	8.3903
RFU2	6.8682	6.4310	5.8980	6.4000	6.8936	6.3178	7.1707	6.7612	8.7313	6.8232
RFR3	11.5581	11.4138	10.4694	10.3000	10.8766	10.5981	12.5610	11.9104	10.6716	11.0451
RFU3	2.3798	1.8793	2.3673	1.9556	1.8128	2.2710	1.7805	2.0597	2.1343	2.0534
RFR4	16.2093	16.5000	15.3469	15.1000	15.2894	14.5327	16.0975	15.6119	15.3284	15.4686
RFU4	5.7364	5.6897	4.5714	4.9556	5.3617	5.2897	5.3902	4.4030	4.8209	5.2254
RFR5	13.9302	13.9138	12.0612	12.1333	13.3149	12.4112	13.8293	13.8060	14.2537	13.2752
RFU5	1.2045	0.4138	1.5918	1.6444	1.2426	1.0935	1.6629	0.9851	1.1791	1.2337
LFR1	15.1938	14.9828	12.4898	14.5556	14.7702	13.3364	16.1463	16.0000	15.7612	14.7556
LFU1	5.2558	3.5517	2.8571	3.8778	4.2255	3.3738	5.3171	5.5672	4.1493	4.2657
LFR2	7.8450	6.5690	4.6735	6.9556	7.0468	6.8037	7.2683	8.0746	7.2836	7.0688
LFU2	7.3566	5.1034	6.5102	5.8556	6.3787	5.3271	9.2683	6.1194	7.0896	6.4353
LFR3	11.0465	10.8621	8.8980	10.3000	10.5105	9.7664	11.6341	10.7015	11.0299	10.5172
LFU3	2.7132	1.6897	3.2041	2.2333	2.4383	3.2617	3.2927	1.2836	1.6716	2.4448
LFR4	16.5891	15.6034	15.3061	14.3333	15.6000	14.3084	15.8293	15.3582	15.0000	15.3796
LFU4	4.5581	4.2586	4.5306	3.6444	5.0766	3.5981	5.8293	4.5075	3.5821	4.4413
LFR5	15.2326	14.0517	12.5102	12.2556	13.3319	12.1215	14.7317	13.7015	13.9254	13.5006
LFU5	1.1240	0.8966	1.1224	0.9889	1.0596	0.6262	1.2439	0.7015	0.7164	0.9526
RAB	41.6512	41.5172	40.5714	41.1111	40.6128	40.5888	41.6829	41.3880	40.9403	41.0213
RBC	25.6124	26.5000	27.0000	25.6778	25.5489	27.4019	25.8537	28.1791	26.0298	26.2195
RCD	35.8527	37.6207	37.2449	37.5222	36.1574	36.6075	37.1219	36.7910	35.5821	36.5291
LAB	42.8605	42.3448	41.1020	42.6778	42.1106	41.7663	42.0975	43.0746	42.7015	42.3226
LBC	25.0233	23.6724	24.8979	25.2444	24.8553	25.9252	25.8780	27.2239	25.1642	25.2420
LCD	33.5194	32.6897	30.4694	34.5889	33.9234	33.8972	36.0244	35.4627	33.4776	33.8327
RFRC	72.6279	70.8793	63.0612	66.0778	67.9702	64.9439	73.1463	71.8806	71.8298	68.8173
LFRC	70.3411	65.0172	58.8367	62.0555	64.9915	59.8224	71.5854	67.0298	67.1940	65.1423
TFRC	142.9690	135.8965	121.8979	128.1333	132.9617	124.7663	144.7317	138.9104	138.2239	133.9597
RFAC	89.7442	83.7241	77.4694	81.3111	85.1021	79.4392	92.3902	87.7463	87.2836	84.8885
LFAC	86.9147	77.5690	72.1020	75.0000	80.4383	72.5234	90.5610	82.0149	80.2090	79.7616
TFAC	176.6589	161.2931	149.5714	156.3111	165.5404	151.9626	182.9512	169.7612	167.4925	164.6501
RPTOT	105.8139	106.1897	104.8163	106.8333	105.5319	105.4860	106.1951	107.8955	107.2388	106.0676
LPTOT	105.4651	104.5345	101.4286	106.4444	104.4340	104.8318	104.0000	107.2090	105.9104	105.0059
TPRC	211.2791	210.7241	206.2449	213.2778	209.9659	210.3177	210.1951	215.1045	213.1492	211.0735

Table 107 cont.

RD1	1.2946	1.2586	1.2245	1.2778	1.3064	1.2150	1.3902	1.3284	1.2388	1.2823
RD2	1.2791	1.2069	1.1020	1.2444	1.2851	1.1682	1.3659	1.3134	1.3881	1.2633
RD3	1.0930	1.0862	1.0816	1.0556	1.0596	1.0374	1.1220	1.1194	1.0746	1.0735
RD4	1.3953	1.4138	1.4082	1.4222	1.4128	1.3551	1.4878	1.3134	1.2985	1.3903
RD5	1.1395	1.0517	1.1429	1.1444	1.1021	1.1028	1.1707	1.0746	1.1045	1.1127
LD1	1.2636	1.3103	1.0816	1.2333	1.2511	1.1121	1.2927	1.3582	1.2537	1.2384
LD2	1.2481	1.2414	1.0408	1.1556	1.2043	1.1682	1.3659	1.2687	1.2386	1.2100
LD3	1.0930	1.1379	1.0612	1.0556	1.0511	1.0467	1.2195	1.0448	1.0299	1.0700
LD4	1.3178	1.3276	1.3673	1.3111	1.3660	1.2243	1.4634	1.3731	1.2836	1.3310
LD5	1.1065	1.1207	1.1020	1.0778	1.0681	1.0280	1.1220	1.0896	1.0448	1.0783
PTR	0.0310	0.0517	0.1020	0.0111	0.0468	0.0374	0.0488	0.0299	0.0597	0.0427
PTL	0.1008	0.0690	0.0816	0.0667	0.1149	0.0280	0.0976	0.0597	0.1343	0.0878
RTR	0.0775	0.0690	0.0612	0.0444	0.0596	0.0467	0.0	0.0746	0.1045	0.0617
RTL	0.1163	0.0517	0.0612	0.0667	0.1149	0.0841	0.0732	0.0746	0.1194	0.0937
P2R	0.0310	0.0345	0.0	0.0222	0.0340	0.0280	0.0244	0.0299	0.0299	0.0285
P2L	0.0	0.0345	0.0408	0.0111	0.0170	0.0093	0.0488	0.0	0.0	0.0142
P3R	0.4341	0.4655	0.5306	0.4778	0.6128	0.5607	0.5366	0.4627	0.3582	0.5136
P3L	0.3101	0.2931	0.2857	0.2000	0.3574	0.2150	0.2195	0.3284	0.2388	0.2883
P3TR	0.0930	0.0517	0.1020	0.0444	0.0553	0.0280	0.0488	0.0299	0.0896	0.0593
P3TL	0.0775	0.1034	0.0612	0.1333	0.1021	0.1215	0.1951	0.0896	0.0597	0.1020
P4R	0.5039	0.6379	0.6327	0.5778	0.4213	0.4953	0.4634	0.5821	0.6269	0.5184
P4L	0.6357	0.6897	0.6735	0.7333	0.5915	0.7664	0.6829	0.7015	0.7761	0.6750
PHR	0.1085	0.1207	0.1837	0.1111	0.1064	0.0841	0.1707	0.1194	0.0746	0.1115
PHL	0.1318	0.1207	0.1429	0.0667	0.1106	0.1121	0.0732	0.1045	0.0896	0.1079
CHR	0.2791	0.2241	0.3469	0.3111	0.2894	0.3364	0.3659	0.2985	0.3433	0.3037
CHL	0.2481	0.2586	0.2449	0.2556	0.2681	0.2897	0.2195	0.2090	0.2836	0.2586
RHR	0.0388	0.0517	0.0408	0.0444	0.0340	0.0467	0.0244	0.0299	0.0448	0.0391
RHL	0.0388	0.0172	0.0204	0.0222	0.0255	0.0187	0.0	0.0149	0.0	0.0214
PAR	0.0078	0.0172	0.0204	0.0111	0.0043	0.0093	0.0244	0.0299	0.0	0.0107
PAL	0.0078	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0149	0.0024
RAHR	0.0233	0.0	0.0204	0.0222	0.0170	0.0280	0.0	0.0299	0.0448	0.0214
RAHL	0.0155	0.0172	0.0	0.0222	0.0170	0.0280	0.0	0.0299	0.0149	0.0178
TR	0.3333	0.3448	0.3061	0.2667	0.2979	0.2991	0.3902	0.3881	0.4328	0.3262
TL	0.4186	0.3103	0.2245	0.3556	0.3234	0.3271	0.3415	0.3881	0.3284	0.3416
TIR	0.6899	0.7069	0.7347	0.7556	0.7191	0.7196	0.5854	0.7015	0.5522	0.6975
TIL	0.6512	0.6724	0.8163	0.6000	0.7191	0.7290	0.6585	0.6269	0.5567	0.6845

Table 107 cont.

T2R	0.0698	0.1379	0.1633	0.0778	0.0809	0.0467	0.1981	0.0448	0.0746	0.0854
T2L	0.0543	0.0862	0.1020	0.0778	0.0553	0.0187	0.0732	0.0597	0.0896	0.0617
T8R	0.3411	0.2759	0.3878	0.3667	0.3362	0.3925	0.3902	0.3433	0.4030	0.3547
T8L	0.2946	0.2759	0.2653	0.2889	0.3106	0.3178	0.2195	0.2687	0.2836	0.2918
TEFR	0.1085	0.1207	0.1224	0.0556	0.0851	0.0654	0.0488	0.1045	0.1642	0.0937
TEFL	0.2093	0.1207	0.1429	0.1333	0.2255	0.1121	0.1463	0.1343	0.2537	0.1779
TDR	0.1395	0.2414	0.2245	0.1889	0.1872	0.1402	0.0976	0.1343	0.1791	0.1708
TDL	0.1318	0.2414	0.2245	0.2000	0.1830	0.1963	0.1463	0.1493	0.2537	0.1862
MAINAR	6.2058	5.6207	6.2041	6.6778	7.2043	6.7196	6.5610	5.3134	5.5373	6.4603
MAINAL	4.2636	4.1724	4.5510	4.2444	4.8511	5.0280	5.1220	3.7761	4.0597	4.5196
MAINBR	14.7984	14.2759	15.5102	13.8889	12.1702	13.3084	12.6098	14.1343	15.5821	13.6880
MAINBL	15.1860	18.3448	18.4490	15.4556	15.0809	16.0934	13.4634	17.7612	15.8358	15.8802
MAINCR	9.5736	9.3966	9.2857	10.1444	9.2809	10.1028	10.2927	9.6269	8.5672	9.5504
MAINCL	10.8295	8.6034	10.4286	10.3778	9.7489	10.7664	10.6098	10.9403	10.7313	10.2859
MAINDR	9.6977	9.8276	9.5531	9.8222	10.0723	9.9159	9.9268	9.7761	9.6567	9.8636
MAINDL	9.2791	9.3448	8.8367	9.1444	9.5021	9.0935	9.3902	9.0896	8.9851	9.2491
MAINADR	6.4031	8.5517	8.6122	8.6111	8.9872	8.8318	8.8049	8.4478	8.2537	8.6762
MAINADL	7.3256	7.6897	7.0612	7.2778	7.7872	7.5794	7.8049	6.9701	7.2090	7.4769
RFPII	6.2015	6.0172	5.9592	6.1444	6.1660	5.6785	6.5366	6.1493	6.1045	6.1222
LFPII	6.0310	6.1379	5.6531	5.8333	5.9404	5.5794	6.4636	6.1343	5.8507	5.9276
TFPII	12.2326	12.1552	11.6122	11.9778	12.1064	11.4579	13.0000	12.2836	11.9552	12.0498
RPPII	5.6202	5.7759	5.9184	5.6444	5.6468	5.6636	5.7073	5.7015	5.7313	5.6833
LPPII	5.6744	5.6034	5.6327	5.6000	5.7404	5.6168	5.6098	5.5821	5.7910	5.6690
TPPII	11.2946	11.3793	11.5510	11.2444	11.3872	11.2804	11.3171	11.2836	11.5224	11.3523
RLATD	41.5969	42.5862	42.4694	43.0555	42.9332	41.3508	42.0122	41.1492	39.7463	42.0569
LLATD	41.6938	43.4569	43.7653	42.7667	42.8660	41.0514	42.3537	40.7313	40.6343	42.2301

Females

STANDARD DEVIATIONS

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8	GROUP 9	TOTAL
RFR1	6.53 9	5.4625	7.1757	6.8517	7.0915	7.2723	5.8725	5.5496	5.8575	6.6835
RFU1	7.6121	6.8327	7.1046	7.1022	7.3708	6.9104	7.6389	7.5047	6.8347	7.2425
RFR2	7.3674	5.9479	6.6636	6.6289	6.9868	6.8189	6.6742	7.4467	7.1567	6.9970
RFU2	8.7280	8.6696	8.5055	8.2091	8.3296	8.5214	8.5888	8.5901	9.0848	8.5200
RFR3	6.1121	5.9028	5.5419	5.8106	6.0537	5.5641	5.0351	8.2447	6.6364	5.8819
RFU3	6.4093	5.3988	6.2540	5.1623	5.5199	6.2247	5.3175	5.4129	5.5128	5.7169
RFR4	6.7346	6.2077	6.0710	6.6096	7.0068	7.9554	5.4259	6.8644	7.0547	6.6660
RFU4	7.6562	7.5909	6.2015	6.8563	6.9781	7.4416	6.8370	7.9217	7.9752	7.1909
RFR5	6.0714	5.9539	5.5506	5.6810	6.2834	6.2313	5.4996	5.1441	4.9216	5.9135
RFU5	3.4830	2.2008	3.9047	4.0344	3.5498	3.4134	4.0954	3.5781	3.5587	3.5796
LFR1	6.9429	4.6472	6.9496	6.0077	6.7702	6.9783	6.5976	5.4993	5.9366	6.5052
LFU1	7.7825	5.9859	6.1644	6.8266	6.5591	6.4815	7.9355	7.5763	7.3263	6.9401
LFR2	7.4900	6.5514	6.1522	6.7423	6.6591	6.4449	6.4538	7.0137	7.2672	6.8164
LFU2	8.4961	7.1542	8.2415	7.1195	8.0928	7.2395	8.6661	7.8268	8.4185	7.9542
LFR3	7.2391	5.8142	6.7090	6.4118	6.7148	6.5855	6.0073	6.6924	6.6696	6.6508
LFU3	5.8406	4.6158	6.6175	5.2189	6.0142	7.0166	6.1856	4.3859	4.9433	5.8167
LFR4	7.1901	5.8936	5.5798	6.2979	7.4508	8.0182	6.3989	6.7973	7.2426	7.0642
LFU4	7.0820	6.8609	6.4875	6.2212	7.1098	6.5139	6.7783	7.0654	6.2478	6.8026
LFR5	5.6313	5.5927	5.7776	5.6540	6.1283	6.2294	5.3058	5.5405	5.7322	5.9081
LFU5	3.3657	2.6602	3.4073	3.2688	3.4239	2.6724	3.6999	2.3614	2.9326	3.1540
RAB	5.0633	5.5260	4.1081	5.4967	5.7364	5.9638	5.8372	4.8555	4.7543	5.4013
RBC	8.7771	6.9617	6.4453	8.5956	8.8969	7.2891	6.3347	7.7047	9.0971	8.2249
RCD	11.0115	7.8780	5.7538	11.3665	10.7309	6.9293	5.0559	8.1883	11.9686	10.0506
LAB	5.5267	5.1762	4.7622	5.0545	5.6432	6.0543	5.8002	5.7981	5.3909	5.5965
LBC	9.9109	10.4770	10.7573	9.4040	9.4515	9.0655	6.5659	7.5314	9.7010	9.3791
LCD	12.4626	13.9072	13.8174	12.6890	12.0055	11.2703	7.4917	9.1575	13.1546	12.0307

Table 107 cont.

RFRC	25.7743	21.5017	25.3257	24.9279	28.0818	28.8395	23.4655	22.6520	25.9721	26.2116
LFRC	27.2479	21.3817	26.3703	25.9067	28.3303	28.4982	24.9038	24.4473	26.9761	26.9586
TFRC	52.0873	41.8670	50.4994	50.1229	55.5868	55.9828	47.1971	45.6709	51.8788	52.1566
RFAC	43.7663	36.1648	40.8183	39.9539	45.7473	45.1246	41.3376	41.3109	44.0289	43.1765
LFAC	43.7907	35.3595	41.3488	39.3800	44.7539	44.0971	42.7546	40.4343	41.6820	42.6268
TFAC	85.6485	69.1455	80.3216	77.8989	88.7938	87.5994	82.9221	80.1257	83.8230	84.0701
RPTOT	13.4196	14.6798	12.4297	14.2178	13.1539	14.2346	12.2912	12.6004	15.3557	13.5832
LPTOT	14.0587	15.6412	15.1372	13.4919	15.0567	16.3597	13.7677	14.3303	15.0393	14.8341
TPRC	26.8505	29.4984	26.5714	26.7599	27.4106	29.3211	25.1594	26.2603	28.5631	27.4188
RD1	0.5646	0.4417	0.5502	0.5811	0.5388	0.5499	0.5421	0.5042	0.4635	0.5348
RD2	0.5725	0.4086	0.6534	0.5671	0.6335	0.5744	0.6227	0.5283	0.4910	0.5803
RD3	0.4039	0.3395	0.4489	0.4587	0.4091	0.4936	0.3313	0.4446	0.4374	0.4241
RD4	0.5217	0.4968	0.5369	0.5188	0.5429	0.5365	0.5533	0.5283	0.4928	0.5278
RD5	0.3479	0.2234	0.3536	0.4122	0.3786	0.3617	0.4417	0.2648	0.3082	0.3553
LD1	0.6062	0.4667	0.5714	0.5204	0.5705	0.5880	0.5587	0.5135	0.5028	0.5590
LD2	0.5732	0.4317	0.7348	0.6165	0.6139	0.5744	0.5365	0.5100	0.6053	0.5887
LD3	0.4912	0.3951	0.5919	0.5270	0.4865	0.5727	0.4750	0.4057	0.4596	0.4957
LD4	0.5152	0.4734	0.5281	0.5115	0.5644	0.5196	0.5522	0.4873	0.5166	0.5279
LD5	0.3364	0.3286	0.3058	0.3741	0.3515	0.3209	0.3997	0.2877	0.2715	0.3356
PTR	0.2143	0.2234	0.3677	0.1054	0.2310	0.2349	0.2181	0.1715	0.2387	0.2246
PTL	0.3270	0.2556	0.2766	0.2508	0.3196	0.1659	0.3004	0.2387	0.3436	0.2873
RTR	0.2685	0.2556	0.2422	0.2072	0.2372	0.2121	0.0	0.2648	0.3082	0.2407
RTL	0.3218	0.2234	0.2422	0.2508	0.3196	0.2789	0.2637	0.2648	0.3267	0.2916
P2R	0.1740	0.1841	0.0	0.1482	0.1817	0.1659	0.1552	0.1715	0.1715	0.1664
P2L	0.0	0.1841	0.1999	0.1054	0.1296	0.0967	0.2181	0.0	0.0	0.1185
P3R	0.4976	0.5032	0.5042	0.5023	0.4882	0.4986	0.5049	0.5024	0.4831	0.5001
P3L	0.4643	0.4592	0.4564	0.4022	0.4803	0.4127	0.4191	0.4732	0.4296	0.4532
P3TR	0.2916	0.2234	0.3058	0.2072	0.2291	0.1659	0.2181	0.1715	0.2877	0.2363
P3TL	0.2685	0.3072	0.2422	0.3418	0.3035	0.3282	0.4012	0.2877	0.2387	0.3028
P4R	0.5173	0.5197	0.4871	0.5188	0.5118	0.5386	0.5049	0.5546	0.4873	0.5209
P4L	0.5440	0.5029	0.5548	0.5959	0.5262	0.5062	0.5215	0.5509	0.4868	0.5349
PHR	0.3123	0.3286	0.3912	0.3498	0.3090	0.2789	0.4417	0.3267	0.2648	0.3224
PHL	0.3396	0.3286	0.3536	0.2508	0.3144	0.3170	0.2637	0.3082	0.2877	0.3105
CHR	0.4503	0.4207	0.4809	0.4655	0.4844	0.4747	0.4877	0.4611	0.5091	0.4627
CHL	0.4336	0.4417	0.4345	0.4386	0.4439	0.4558	0.4191	0.4096	0.4541	0.4381

Table 107 cont.

RHR	0.1938	0.2234	0.1999	0.2072	0.1817	0.2121	0.1562	0.1715	0.2084	0.1941
RHL	0.1938	0.1313	0.1429	0.1482	0.1591	0.1361	0.0	0.1222	0.0	0.1446
PAR	0.0880	0.1313	0.1429	0.1054	0.0652	0.0967	0.1562	0.1715	0.0	0.1028
PAL	0.0880	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1222	0.0487
RAHR	0.1513	0.0	0.1429	0.1482	0.1296	0.1659	0.0	0.1715	0.2084	0.1446
RAHL	0.1240	0.1313	0.0	0.1482	0.1296	0.1659	0.0	0.1715	0.1222	0.1323
TR	0.4732	0.4795	0.4657	0.4447	0.4675	0.4600	0.4939	0.5492	0.4992	0.4766
TL	0.4953	0.4667	0.4216	0.4814	0.4688	0.4714	0.4861	0.4910	0.4732	0.4745
T1R	0.5420	0.4959	0.5692	0.5260	0.5369	0.5459	0.4988	0.5777	0.5016	0.5360
T1L	0.5398	0.5091	0.5273	0.4926	0.5208	0.5919	0.5296	0.5459	0.4784	0.5295
T2R	0.2557	0.3951	0.3734	0.3082	0.2732	0.2121	0.4593	0.2084	0.2648	0.2921
T2L	0.2274	0.2831	0.3058	0.2693	0.2291	0.1361	0.2637	0.2387	0.2877	0.2407
TBR	0.4759	0.4509	0.4923	0.4846	0.4734	0.4906	0.4939	0.4784	0.4942	0.4787
TBL	0.4576	0.4509	0.4461	0.4558	0.4637	0.4875	0.4191	0.4466	0.4541	0.4575
TEFR	0.3588	0.4221	0.4845	0.2748	0.3715	0.2839	0.2181	0.3944	0.5104	0.3705
TEFL	0.5402	0.3783	0.4564	0.4293	0.5957	0.3718	0.4775	0.4227	0.5863	0.5057
TDR	0.4960	0.6015	0.4216	0.4948	0.4703	0.3749	0.3004	0.3852	0.4237	0.4564
TDL	0.4027	0.5065	0.4216	0.4547	0.4941	0.4438	0.4220	0.3590	0.4717	0.4517
MAINAR	5.3477	4.9941	4.8131	5.7842	5.9986	5.8586	6.0706	5.0188	6.0312	5.6007
MAINAL	4.0497	3.4648	5.2799	3.9500	4.7806	4.4307	5.1049	4.0892	3.5840	4.3685
MAINBR	8.3847	8.2394	8.6461	8.0062	7.6770	7.9544	7.6449	7.9485	8.4623	8.0892
MAINBL	8.0115	8.0993	7.6077	7.9974	7.9581	7.9948	7.4836	7.9413	7.9001	8.0029
MAINCR	7.0852	5.7794	5.8595	6.8950	5.8746	5.8984	6.5584	5.7626	6.3633	6.2348
MAINCL	8.4170	7.3388	8.4779	8.7558	7.6399	8.7573	8.4169	7.9979	8.3059	8.1662
MAINDR	1.4716	1.3526	1.3777	1.4346	1.3362	1.4084	1.4898	1.3907	1.3208	1.3936
MAINDL	1.5958	1.2503	1.7242	1.5834	1.4803	1.7020	1.6864	1.4114	1.8463	1.5814
MAINADR	2.0521	1.8934	1.8464	2.0701	1.8593	1.8657	1.9264	1.7606	1.8937	1.9214
MAINADL	2.2540	1.7392	2.0657	2.3845	2.2201	2.0969	2.3262	1.9846	2.0710	2.1742
RFPII	1.6881	1.2495	1.7555	1.8876	1.8403	1.7842	1.7335	1.6538	1.5583	1.7322
LFPII	1.6533	1.3436	1.9208	1.8004	1.8937	1.8936	1.5984	1.4449	1.7879	1.7595
TFPII	3.1238	2.3605	3.4023	3.4867	3.5363	3.5189	3.1781	2.9429	3.0323	3.2911
RPPII	0.9370	0.8992	0.9539	0.8652	0.9051	0.8681	0.9551	0.7980	0.8975	0.8963
LPPII	0.9696	0.9540	0.9508	0.8843	1.0605	0.7848	0.9716	0.7618	1.0230	0.9517
TPPII	1.6836	1.5765	1.6591	1.4481	1.7367	1.4653	1.5723	1.4122	1.7439	1.6210
RLATD	8.8119	6.5502	8.5273	7.2187	8.6486	8.0673	4.5889	9.0943	9.0149	8.2522
LLATD	7.2432	8.0194	7.1363	8.3999	8.0521	7.0918	5.8196	9.3750	8.9839	7.9187

Table 108

Males.
Means and Standard Deviations for
breakdown subsets produced by analysis
New Locations X Ancestry X Language.
(Childs Birth Place)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	Total
RFR1	18.7652	19.5714	17.9286	19.4750	18.7655	18.9919	19.0227	18.3729	18.4603	18.8314
RFU1	7.6522	6.2857	5.8333	5.4500	7.2965	6.7419	5.1136	5.1695	5.2698	6.5057
RFR2	8.5652	7.6190	7.0238	7.5250	6.5177	7.1210	6.9091	7.3729	6.3968	7.1698
RFU2	9.3652	9.2381	6.7619	7.0125	7.3717	9.1855	7.6818	8.7119	8.0952	8.1472
RFR3	11.7565	12.6190	11.1429	11.4250	10.4911	11.0806	10.6818	11.0847	10.5873	11.0692
RFU3	4.1304	3.1667	1.6429	3.1625	2.7965	4.0242	2.2727	2.6780	3.2698	3.1761
RFR4	15.7 [illegible]	18.2381	16.0714	15.3500	15.9159	16.0484	15.0227	15.5085	15.7619	15.8893
RFU4	7.8435	7.7857	6.4286	6.7375	6.2566	7.6048	3.7045	5.7288	5.6190	6.6038
RFR5	14.3826	15.3333	15.1429	14.1875	14.4159	14.3871	13.2955	14.6610	13.4762	14.3522
RFU5	1.4348	1.6667	1.0238	1.4000	1.6726	1.5484	1.0909	0.9322	1.1905	1.4314
LFR1	16.8956	15.7619	16.1667	17.0875	16.7743	16.5887	16.4545	16.3220	15.9365	16.5912
LFU1	5.3565	5.3571	2.9524	2.4750	4.7434	4.9194	3.4091	4.0000	2.1429	4.2340
LFR2	8.8348	7.9762	7.9762	8.1500	7.0708	7.9113	6.0909	7.5424	6.9683	7.6340
LFU2	7.6609	6.6429	5.0476	6.1875	5.8894	7.8790	5.9773	7.3729	5.1270	6.5358
LFR3	12.1043	12.3571	12.6667	11.9125	10.9690	12.4919	10.9545	12.2034	9.6032	11.6113
LFU3	3.8000	4.0000	2.4286	2.6375	2.3628	3.6210	2.4545	1.6441	1.8730	2.7975
LFR4	16.4783	16.6667	17.7857	15.6500	16.1283	16.5403	14.9773	15.8983	15.4603	16.1774
LFU4	5.6174	4.9286	3.6667	4.5625	4.6062	4.9758	2.6818	2.9322	3.3333	4.4415
LFR5	13.9565	14.7857	15.0238	14.1250	14.7743	14.6290	13.0682	14.3729	13.7460	14.3761
LFU5	0.8087	1.1667	1.1667	0.6250	0.9558	1.2823	0.6591	0.5932	1.6032	0.9824
RAB	40.9391	40.3333	40.6190	40.6125	40.8761	39.9839	40.2045	40.4576	39.3016	40.4843
RBC	25.8174	27.3095	26.1667	26.4125	26.7168	26.4839	29.2954	25.7627	28.1270	26.7057
RCD	34.5217	36.7857	35.9286	36.4625	36.6549	36.1290	38.0682	36.5254	37.1270	36.3195
LAB	42.1138	42.0000	41.1905	41.8250	42.1150	41.1693	42.0682	41.3729	40.5555	41.7019
LBC	24.5043	26.9762	26.7143	25.3000	25.2876	24.7097	28.3864	22.8983	26.4286	25.3346
LCD	31.8000	35.6190	33.2143	32.6250	33.7832	32.8145	36.8409	32.0678	34.7936	33.4176
RFRC	75.1739	79.0952	72.5476	73.1250	71.2566	74.1452	69.4091	72.9322	71.0635	72.9509
LFRC	72.2696	73.1429	71.7619	70.7875	69.5088	72.8064	66.0909	71.0169	65.9048	70.4994
TFRC	147.4435	152.2381	144.3095	143.9125	140.7655	146.9516	135.5000	143.9491	136.9682	143.4503
RFAC	99.6087	101.5238	89.0000	91.7250	91.5000	96.7339	84.7954	90.2203	88.1270	93.1761
LFAC	91.5130	89.6429	84.8810	83.4125	84.2743	90.8387	76.7273	82.6813	75.7936	85.3811
TFAC	191.1217	191.1667	173.8810	175.1375	175.7743	187.5726	161.5227	173.1017	163.9206	178.5572
RPTOT	105.1652	108.3571	105.2381	104.6625	105.9867	104.2500	108.3864	105.1186	105.3651	105.5685
LPTOT	103.6783	106.8333	103.6429	103.7375	104.5752	103.1452	108.8409	102.4576	103.8254	104.2277
TPRC	208.8435	215.1905	208.8810	208.4000	210.5619	207.3952	217.2273	207.8763	209.1905	209.7962

Table 108 cont.

RD1	1.4174	1.3571	1.3333	1.3750	1.4336	1.4435	1.3409	1.3729	1.3492	1.4013
RD2	1.3043	1.3095	1.2143	1.2125	1.2080	1.2177	1.2955	1.3559	1.1905	1.2440
RD3	1.1565	1.1429	1.0238	1.1625	1.1327	1.1694	1.1136	1.1356	1.1429	1.1396
RD4	1.5391	1.5714	1.5000	1.5250	1.4956	1.5242	1.3864	1.4576	1.4603	1.5019
RD5	1.1304	1.1667	1.0952	1.1500	1.1637	1.1371	1.1136	1.1017	1.1111	1.1384
LD1	1.3043	1.3333	1.1667	1.1750	1.2699	1.3145	1.1818	1.2203	1.1429	1.2516
LD2	1.3043	1.1190	1.2619	1.1500	1.1637	1.2903	1.1591	1.1525	1.1905	1.2063
LD3	1.1304	1.1429	1.1190	1.1375	1.0664	1.1613	1.1364	1.0508	0.9841	1.1006
LD4	1.4000	1.4048	1.3333	1.3375	1.3540	1.3306	1.2727	1.2203	1.2540	1.3346
LD5	1.0609	1.0952	1.0952	1.0875	1.1018	1.1210	1.0682	1.0508	1.0317	1.0855
PTR	0.0522	0.0952	0.0	0.0250	0.0354	0.0484	0.0227	0.0169	0.0317	0.0377
PTL	0.0261	0.0714	0.1429	0.0750	0.0929	0.1048	0.0682	0.1356	0.0159	0.0885
RTR	0.0609	0.0952	0.0714	0.0500	0.0575	0.0726	0.0227	0.0678	0.0159	0.0579
RTL	0.1217	0.0952	0.1667	0.1000	0.1106	0.1290	0.1136	0.1356	0.0952	0.1170
P2R	0.0522	0.0476	0.0476	0.0875	0.0841	0.0806	0.0682	0.0	0.0317	0.0642
P2L	0.0087	0.0238	0.0	0.0125	0.0310	0.0323	0.0	0.0169	0.0	0.0189
P3R	0.4783	0.5238	0.5476	0.5875	0.5885	0.5484	0.5000	0.5424	0.5873	0.5522
P3L	0.2696	0.1190	0.2857	0.3750	0.2522	0.2661	0.3409	0.2712	0.2381	0.2692
P3TR	0.0783	0.0476	0.1190	0.1250	0.0487	0.0806	0.0682	0.0847	0.0635	0.0742
P3TL	0.1043	0.0714	0.1190	0.0750	0.1106	0.0645	0.1364	0.0847	0.0794	0.0943
P4R	0.4870	0.4762	0.3810	0.4750	0.4469	0.4435	0.5227	0.4237	0.3968	0.4516
P4L	0.7217	0.8810	0.6190	0.7250	0.6991	0.7097	0.7045	0.6780	0.7460	0.7145
PHR	0.1217	0.1667	0.1190	0.1125	0.1593	0.0645	0.0909	0.0678	0.0794	0.1157
PHL	0.1565	0.0714	0.0952	0.1250	0.1549	0.1048	0.1364	0.0508	0.0952	0.1233
CHR	0.2174	0.2143	0.2619	0.3125	0.2080	0.2581	0.3409	0.2542	0.3175	0.2503
CHL	0.2696	0.2619	0.2143	0.2250	0.1991	0.3065	0.4318	0.1525	0.1905	0.2415
RHR	0.0348	0.0238	0.0	0.0375	0.0487	0.0242	0.0455	0.0169	0.0159	0.0327
RHL	0.0	0.0238	0.0238	0.0	0.0088	0.0161	0.0	0.0169	0.0317	0.0113
PAR	0.0	0.0	0.0	0.0	0.0044	0.0	0.0	0.0339	0.0	0.0038
PAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0159	0.0013
RAHR	0.0261	0.0	0.0238	0.0500	0.0177	0.0	0.0227	0.0169	0.0317	0.0201
RAHL	0.0087	0.0	0.0	0.0375	0.0133	0.0	0.0227	0.0	0.0159	0.0113
TR	0.3913	0.2857	0.1905	0.2750	0.3894	0.3065	0.4091	0.3390	0.3333	0.3421
TL	0.3913	0.3333	0.3095	0.3125	0.3717	0.3387	0.3636	0.3390	0.3492	0.3535
TIR	0.6522	0.7619	0.8333	0.7250	0.6593	0.7339	0.6136	0.7119	0.6667	0.6931
TIL	0.6783	0.6667	0.6905	0.7375	0.6858	0.7419	0.6591	0.6780	0.7143	0.6981

Table 108 cont

T2R	0.0522	0.1190	0.0714	0.0625	0.0929	0.0403	0.0455	0.0339	0.0476	0.0654
T2L	0.0783	0.0714	0.0952	0.0375	0.0752	0.0242	0.0909	0.0339	0.0317	0.0591
TBR	0.2696	0.2381	0.2857	0.3625	0.2655	0.2823	0.4091	0.2881	0.3492	0.2943
TBL	0.2696	0.2857	0.2619	0.2375	0.2212	0.3226	0.4545	0.1695	0.2222	0.2604
TEFR	0.1130	0.1429	0.0714	0.0750	0.0885	0.1210	0.0455	0.0847	0.0159	0.0893
TEFL	0.1304	0.0952	0.3095	0.1750	0.2080	0.2339	0.1818	0.2712	0.1111	0.1925
TDR	0.1652	0.1429	0.1429	0.2875	0.2124	0.2177	0.2045	0.1017	0.0952	0.1887
TDL	0.2435	0.1429	0.0952	0.2875	0.1814	0.1774	0.2273	0.1864	0.1270	0.1925
MAINAR	6.5913	7.1190	7.2381	7.2375	6.9558	6.9919	6.7045	7.4746	8.0317	7.0704
MAINAL	4.6261	4.0000	5.8571	4.0750	4.5885	4.4677	4.7500	4.4746	4.7143	4.5698
MAINBR	14.4261	16.3810	14.7619	12.4500	13.2035	12.5645	14.7273	12.4576	14.0794	13.5535
MAINBL	17.1304	18.9524	18.5714	17.1625	16.3540	16.7177	17.5454	15.3220	16.0794	16.8264
MAINCR	8.0957	9.1905	8.8095	8.1000	9.5398	10.1774	8.7045	7.9322	9.6825	9.0742
MAINCL	9.4000	12.0476	9.1429	9.7500	9.2345	9.3710	10.7500	8.1695	11.2063	9.6365
MAINDR	9.9913	9.6190	9.9524	10.1750	9.9646	9.9113	9.8182	10.1864	9.8889	9.9648
MAINDL	9.1304	8.7619	9.1429	9.2250	9.2522	9.2258	9.0000	9.4746	8.9841	9.1774
MAINADR	8.8870	8.6429	8.7143	9.0375	8.8850	8.8226	8.5682	9.0508	8.8889	8.8642
MAINADL	7.4957	6.9524	7.5952	7.4250	7.4779	7.4919	7.4091	7.4237	7.3492	7.4377
RFPII	6.5478	6.5476	6.1667	6.4250	6.4336	6.4919	6.2500	6.4237	6.2540	6.4252
LFPII	6.2000	6.0952	5.9762	5.8875	5.9558	6.2177	5.8182	5.6949	5.6032	5.9786
TFPII	12.7478	12.6429	12.1429	12.3125	12.3894	12.7097	12.0682	12.1186	11.8571	12.4038
RPPII	5.5739	5.6429	5.4286	5.8000	5.6814	5.6613	5.6818	5.5254	5.5238	5.6352
LPPII	5.7043	5.5238	5.5714	5.7375	5.6770	5.7581	5.9545	5.5424	5.5079	5.6780
TPPII	11.2783	11.1667	11.0000	11.5375	11.3584	11.4194	11.5364	11.0678	11.0317	11.3132
RLATD	41.7348	41.7619	43.5000	42.2062	43.1084	41.6492	40.6364	40.9407	38.2460	41.8578
LLATD	41.6652	42.5119	43.4643	41.1687	42.4447	40.7621	39.7614	40.9237	39.0476	41.4679

Table 108 cont

Males
STANDARD DEVIATIONS

	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6	GROUP 7	GROUP 8	GROUP 9	TOTAL
RFR1	6.6189	6.4246	6.6016	5.2579	6.1596	5.8609	6.5528	6.0683	5.6735	6.1308
RFU1	9.7841	8.2795	8.5737	7.6917	8.8003	8.2864	8.0586	7.3371	7.6648	8.4317
RFR2	7.3606	7.0709	6.3457	7.2862	6.8093	7.3976	6.8601	7.0562	7.2168	7.0762
RFU2	9.5911	8.6977	8.5306	8.1404	8.4556	9.4871	8.4186	8.3996	8.6504	8.7970
RFR3	6.6552	6.1603	5.5768	5.8737	5.8433	6.2815	6.2720	5.7933	5.7492	6.0530
RFU3	7.9819	7.0604	4.5790	6.8037	6.2973	7.6949	5.4404	6.0727	6.9264	6.8071
RFR4	7.0122	6.8068	6.5198	5.9323	6.1692	6.9969	6.6595	5.5534	7.3873	6.5436
RFU4	7.9886	8.1974	6.9040	7.7013	7.3922	8.1638	5.5973	7.0242	7.3296	7.5757
RFR5	6.3641	5.6898	5.7534	5.3251	5.2725	5.9779	5.8133	4.7908	5.6707	5.6273
RFU5	3.6638	4.0344	3.2422	3.5671	3.8849	3.8727	3.2907	3.1396	3.5508	3.6780
LFR1	6.4255	7.0704	6.5255	6.5298	6.3209	6.4367	6.3336	6.0471	5.6049	6.3341
LFU1	8.1188	7.6248	6.4655	5.4749	7.4712	7.5886	7.0918	6.8808	5.3245	7.2059
LFR2	7.1204	7.2308	6.2410	6.7601	6.7544	7.1261	5.8541	6.9613	7.0824	6.8680
LFU2	8.7868	9.0979	7.2008	8.4839	7.5077	8.8369	8.2363	8.7117	7.2856	8.2202
LFR3	6.9804	7.6056	5.0831	6.1525	6.5384	7.1312	6.9482	5.8480	6.9805	6.6884
LFU3	7.7212	8.6560	5.5750	5.9709	5.8811	7.1187	5.8606	5.3394	5.1634	6.4670
LFR4	6.8112	7.3407	5.5592	6.3047	6.0330	7.9750	6.7186	5.0878	6.5865	6.5743
LFU4	7.5493	6.6714	5.8379	6.9261	6.7974	7.5185	5.4550	5.9939	6.5031	6.8658
LFR5	5.8240	5.4529	5.9037	4.8034	5.1457	5.9503	5.6749	4.3108	5.7809	5.4262
LFU5	2.7431	3.4846	3.1072	2.5025	3.1337	3.7385	2.5421	2.3276	4.2142	3.1610
RAB	5.5257	6.0995	7.4963	6.2855	6.1495	4.9651	6.3488	6.1988	5.4349	5.9331
RBC	9.6515	8.5583	8.4419	7.6219	8.2586	8.0905	7.1548	7.7088	6.9387	8.2292
RCD	12.0920	11.1805	9.6485	8.6023	9.6368	9.4714	8.0099	9.8879	8.5920	9.8471
LAB	5.7535	6.4995	7.0096	5.3292	5.6778	4.7212	5.1824	5.6260	5.3154	5.5782
LBC	10.9131	7.7255	8.3791	9.1325	9.4480	9.6490	7.2761	9.7763	8.4867	9.4209
LCD	14.0976	11.0343	10.1008	11.4055	12.3739	12.9020	8.0231	14.0306	10.5879	12.2703
RFRC	29.2969	24.8329	22.4491	22.8669	23.9976	27.9947	26.9395	21.8546	25.9646	25.4813
LFRC	27.2044	29.4433	23.9041	24.7427	24.0439	30.1611	26.1079	21.3958	25.0154	25.8882
TFRC	55.6095	52.7623	45.0365	46.7146	46.9824	57.4093	51.9716	41.9145	50.0630	50.3290

Table 108 cont.

RFAC	51.8747	45.6634	33.7162	40.2779	42.5701	48.2962	41.5035	39.8879	40.7291	44.1386
LFAC	46.1119	45.9495	34.5749	39.1272	39.8779	47.8641	37.4473	35.9953	34.6444	41.4962
TFAC	96.1012	89.3801	66.2262	78.0195	80.7936	94.4743	76.7487	74.1995	74.3995	83.8975
RPTOT	14.4328	18.3941	13.9984	13.7989	14.3861	12.1435	14.2085	13.9609	13.5463	14.0975
LPTOT	16.8388	15.3355	14.3613	13.4682	16.7860	14.8969	14.8828	15.0614	14.8897	15.6124
TPRC	30.0828	32.2407	27.6608	26.2469	30.1361	26.0495	28.0668	28.3403	27.6951	28.6355
RD1	0.5458	0.5768	0.5258	0.5366	0.5228	0.4988	0.4795	0.5219	0.5130	0.5228
RD2	0.[illegible]800	0.5626	0.4704	0.5203	0.5782	0.6319	0.5494	0.5497	0.6185	0.5730
RD3	0.5395	0.4722	0.4679	0.4341	0.4808	0.5056	0.4428	0.3921	0.5034	0.4807
RD4	0.5507	0.5009	0.5522	0.5025	0.5270	0.5626	0.4925	0.5357	0.5630	0.5344
RD5	0.3867	0.3772	0.2971	0.3930	0.4052	0.3681	0.3210	0.3048	0.3168	0.3701
LD1	0.5327	0.5703	0.4371	0.4713	0.5438	0.4833	0.4952	0.5592	0.3958	0.5114
LD2	0.5800	0.5038	0.6270	0.5301	0.6144	0.5670	0.5258	0.5817	0.4703	0.5724
LD3	0.5047	0.5213	0.5038	0.4428	0.4899	0.5317	0.4621	0.3436	0.5234	0.4891
LD4	0.5429	0.5437	0.5258	0.5017	0.5150	0.5517	0.4505	0.4574	0.4741	0.5155
LD5	0.3321	0.2971	0.4311	0.2844	0.3030	0.3274	0.2550	0.2216	0.2520	0.3057
PTR	0.2597	0.3702	0.0	0.1571	0.1852	0.2155	0.1508	0.1302	0.2520	0.2096
PTL	0.1601	0.2607	0.3542	0.2651	0.3059	0.3076	0.2550	0.3453	0.1260	0.2768
RTR	0.2401	0.2971	0.2607	0.2193	0.2334	0.2605	0.1508	0.2536	0.1260	0.2336
RTL	0.3284	0.2971	0.3772	0.3019	0.3144	0.3366	0.3210	0.3453	0.2959	0.3216
P2R	0.2234	0.2155	0.2155	0.2843	0.2781	0.2734	0.2550	0.0	0.1767	0.2452
P2L	0.0933	0.1543	0.0	0.1118	0.1736	0.1774	0.0	0.1302	0.0	0.1361
P3R	0.5017	0.5055	0.5038	0.4954	0.4932	0.4997	0.5058	0.5025	0.4963	0.4976
P3L	0.4457	0.3278	0.4572	0.4872	0.4352	0.4437	0.4795	0.4484	0.4293	0.4438
P3TR	0.2698	0.2155	0.3278	0.3328	0.2157	0.2734	0.2550	0.2809	0.2458	0.2623
P3TL	0.3070	0.2607	0.3278	0.2651	0.3144	0.2467	0.3471	0.2809	0.2725	0.2925
P4R	0.5192	0.5055	0.4915	0.5025	0.5071	0.5304	0.5053	0.4984	0.4932	0.5080
P4L	0.6004	0.5038	0.5389	0.5025	0.5479	0.5525	0.5094	0.6000	0.5671	0.5523
PHR	0.3541	0.4371	0.3278	0.3180	0.3787	0.2467	0.2908	0.2536	0.2725	0.3317
PHL	0.3649	0.2607	0.2971	0.3328	0.3626	0.3076	0.3471	0.2216	0.2959	0.3290
CHR	0.4143	0.4153	0.4450	0.4664	0.4068	0.4393	0.4795	0.4392	0.4692	0.4335
CHL	0.4457	0.4450	0.4153	0.4202	0.4002	0.4629	0.5011	0.3626	0.3958	0.4283
RHR	0.1840	0.1543	0.0	0.1912	0.2157	0.1543	0.2107	0.1302	0.1260	0.1780
RHL	0.0	0.1543	0.1543	0.0	0.0939	0.1268	0.0	0.1302	0.1767	0.1059
PAR	0.0	0.0	0.0	0.0	0.0668	0.0	0.0	0.1825	0.0	0.0614
PAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1260	0.0355

Table 108 cont.

RAHR	0.1601	0.0	0.1543	0.2193	0.1321	0.0	0.1508	0.1302	0.1767	0.1405
RAHL	0.0933	0.0	0.0	0.1912	0.1147	0.0	0.1508	0.0	0.1260	0.1059
TR	0.4902	0.4572	0.3974	0.4493	0.4887	0.4629	0.4974	0.5123	0.4752	0.4774
TL	0.4902	0.4771	0.4679	0.4664	0.4843	0.4752	0.4866	0.4774	0.4805	0.4783
T1R	0.5780	0.4844	0.5372	0.5271	0.5764	0.4957	0.5377	0.5269	0.5080	0.5418
T1L	0.6148	0.4771	0.5174	0.5680	0.5444	0.5826	0.6078	0.5065	0.5800	0.5606
T2R	0.2597	0.3952	0.2607	0.2436	0.2910	0.1975	0.2107	0.1825	0.2147	0.2574
T2L	0.2598	0.2607	0.2971	0.1912	0.2643	0.1543	0.2908	0.1825	0.1767	0.2360
TBR	0.4[illegible]7	0.4311	0.4572	0.4838	0.4426	0.4519	0.4974	0.4568	0.4805	0.4560
TBL	0.4457	0.4572	0.4450	0.4282	0.4160	0.4694	0.5037	0.3784	0.4191	0.4391
TEFR	0.4139	0.4722	0.2607	0.3091	0.3665	0.4150	0.2107	0.3367	0.1260	0.3561
TEFL	0.4087	0.2971	0.6435	0.4975	0.5626	0.5426	0.5401	0.6111	0.3642	0.5162
TDR	0.4379	0.4174	0.3542	0.5779	0.4890	0.5189	0.5094	0.3048	0.2959	0.4650
TDL	0.4700	0.3542	0.2971	0.5080	0.4500	0.4606	0.4756	0.4345	0.3356	0.4426
MAINAR	5.4899	5.3702	6.4233	6.8237	5.8801	6.3444	6.6142	6.5135	6.5179	6.1265
MAINAL	4.1262	3.2460	6.0830	3.5285	4.3659	4.4107	4.1993	4.9840	4.6885	4.3789
MAINRR	8.5707	8.3402	8.7145	7.8594	8.0864	7.9972	8.5464	7.5460	8.3845	8.2971
MAINRL	8.1203	7.2514	7.6578	8.0841	8.2364	8.2744	7.5003	8.2010	7.9804	8.0751
MAINCR	5.2615	5.7858	6.1455	4.8329	5.8682	6.7355	5.0605	4.3306	5.9074	5.7332
MAINCL	8.0805	0.0633	7.1246	7.3717	7.5397	7.2173	8.2719	6.5841	8.4742	7.6885
MAINDR	1.2207	1.2870	1.4134	1.2607	1.4138	1.7438	1.3856	1.1215	1.3809	1.4004
MAINDL	1.6088	1.4109	1.2797	1.3499	1.5065	1.3303	1.4306	1.3046	1.9050	1.4829
MAINADR	1.7410	1.6052	1.9790	1.8380	1.9125	1.9591	2.0046	1.8885	2.0954	1.8904
MAINADL	1.9393	2.0357	1.9762	2.0424	2.1002	2.0262	2.0722	2.2066	2.2587	2.0638
RFPII	1.9022	1.8106	1.4637	1.6209	1.7783	1.8935	1.4647	1.6210	1.6261	1.7430
LFPII	1.8267	1.7364	1.7598	1.5831	1.7858	1.7229	1.4022	1.5565	1.3019	1.6911
TFPII	3.5165	3.3917	2.9925	3.0298	3.3624	3.4187	2.5826	3.0062	2.7503	3.2327
RPPII	0.8278	1.0317	1.0852	0.9987	0.8971	0.9273	0.9344	0.7510	0.6686	0.8980
LPPII	0.8981	0.7404	1.2715	1.0403	0.9785	0.9990	0.9139	0.9883	0.7378	0.9651
TPPII	1.4663	1.5129	2.1864	1.7426	1.6193	1.7065	1.5566	1.3880	1.1636	1.6057
RLATD	7.9799	6.6161	9.3391	8.2419	7.5017	6.6826	8.7806	8.8167	6.3144	7.7627
LLATD	5.6971	7.0023	8.2974	6.3095	6.9365	5.5208	8.2980	6.4233	7.0247	6.7021

Programme: FM
Programme to read an F matrix produced by the Discriminant Function Analysis programme in S.P.S.S..

The following programme, written in Fortran was produced to assist in the conversion of an F matrix produced by the discriminant programme to a matrix of Mahalanobis' D^2. The F matrix is square and symmetric and denoted by Fm= $X_{i,j}$ (i,j = 1,N), containing N(N-1)/2 unique elements. To read the F matrix the output file from the discriminant programme must be placed onto a permanent file. The relevant section of the output is then copied out (to -A), unwanted lines are removed until the F matrix represents the complete file with no blank lines. At line 0.5 the size of the matrix (N) is edited in using an I5 format.

To run the programme at NUMAC.,

```
£r *fortran scards=fm
£r -load# 5=-a(0.5) 6=-b
```

Output on unit 6 is a line of numbers under a 1x,f10.5 format, of the N(N-1)/2 unique elements of the matrix in the order:

$X_{1,2}$
$X_{1,3}$
.
.
$X_{1,N}$
.
.
$X_{2,3}$
.
.
$X_{N-1,N}$

Maximum size of the input matrix = 40 for the given programme.

Programme: FM Conversion of F matrix to D^2 matrix.

```
      DIMENSION A(100,10),B(40,40)
      READ(5,1,END=20)K,((A(I,J),J=1,10),I=1,100)
    1 FORMAT(I5/(14X,10F12.5))
   20 N=K-1
      DO 10 I=1,N
      DO 10 J=1,10
      B(I,J)=A(I,J)
   10 CONTINUE
      IA=N+1
      IB=(2*N)-10
      DO 11 I=IA,IB
      DO 11 J=1,10
      M=I-N+10
      L=J+10
      B(M,L)=A(I,J)
   11 CONTINUE
      IIA=(2*N)-10+1
      IIB=(3*N)-30
      DO 12 I=IIA,IIB
      DO 12 J=1,10
      MM=I-(2*N)+30
      LL=J+20
      B(MM,LL)=A(I,J)
   12 CONTINUE
      IIIA=(3*N)-30+1
      IIIB=(4*N)-60
      DO 13 I=IIIA,IIIB
      DO 13 J=1,10
      MMM=I-(3*N)+60
      LLL=J+30
      B(MMM,LLL)=A(I,J)
   13 CONTINUE
      DO 14 NY=1,N
      DO 14 NX=1,NY
      WRITE(6,15)B(NY,NX)
   15 FORMAT(1X,F10.5)
   14 CONTINUE
      STOP
      END
```

Table 111

Programme: MCON

Programme to convert the F values from the discriminant analysis to Mahalanobis' D^2 .

Input to the programme is a column of numbers produced by the programme FM or a file prepared specifically. If the output is from FM the following must be edited in at the head of the file from line 0.001. If the file is being prepared from the beginning the following can be input from line 1 and the F values inserted at the end.

Assume output from programme FM is available;

1) Insert at line 0.001; Number of groups, Total sample size, Number of variables, under a 3I5 format.

2) Insert at line 0.002 the sample size of group number 1.
" " " 0.003 " " " " " " 2
"
" " " " " " " " " N
(" using a 1x,I5 format.)

(4) Insert F values if output of FM not available; use the same element sequence as FM produced under a 1x,f10.5 format.

To run the programme from NUMAC.,

```
£r *fortran scards=mcon
£r -load# 5=-b 6=-c 9=-d
```

Output is:

On unit 9. a D^2 matrix in an Osiris type 2 format.
On unit 6, a) The number of input groups.
b) " total number of variables.
c) " " sample size.
d) " individual group sample sizes.
e) Data concerning the elements involved in each individual D^2 calculation.

(Output on unit 6 should be checked to see the input data is correct.)

Programme: MCON

```
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION F(100,100),IB(100),IC(100),DIST(100,100)
      READ(5,1)IG,N,IR
    1 FORMAT(3I5)
      WRITE(6,2)IG,N,IR
    2 FORMAT(20X,3I5)
      DO 10 I=1,IG
      READ(5,3)IB(I)
    3 FORMAT(1X,I5)
      K=I
   10 IC(K)=IB(I)
      WRITE(6,4)(IB(I),I=1,IG)
      WRITE(6,4)(IC(K),K=1,IG)
    4 FORMAT(20X,10I5/)
      IP=IG-1
      DO 12 M=1,IP
      J=1+N
      DO 11 L=1,M
      READ(5,5)F(J,L)
    5 FORMAT(1X,F10.5)
      F(L,J)=F(J,L)
      F(J,J)=0
      F(L,L)=0
      I=L
      K=J
      X=(IR*(N-IG))*(IB(I)+IC(K))
      Y=(N-IG-IR+1)*IB(I)*IC(K)
      DIST(J,L)=(F(J,L)*X)/Y
      DIST(L,J)=DIST(J,L)
      DIST(J,J)=0
      DIST(L,L) =0
      WRITE(6,7)J,L,I,K
    7 FORMAT(10X,4I5)
   11 WRITE(6,6)IB(I),IC(K),F(J,L),DIST(J,L)
    6 FORMAT(10X,2I5,2F10.5//)
   12 CONTINUE
      IK=IG-1
      DO 20 IA=1,IK
      ID=IA+1
      WRITE(9,21)(DIST(IA,L),L=ID,IG)
   21 FORMAT(8F10.5)
   20 CONTINUE
      WRITE(9,30)
      WRITE(9,30)
   30 FORMAT(' ')
      STOP
      END
```

Programme: SIMI
Programme to produce a matrix of associations using my own (Williams') and Kendall's indices, from an input matrix of marriage linkages.

Input to the programme is a square matrix, such as the mother's birth locations x the father's birth locations read under a 20f4.0 format.

Line 1 of the input file (e) contains the size of the matrix under an I3 format (N). Maximum = 200.

Line 2 onward contains the matrix elements $Z_{i,j}$.

To run the programme at NUMAC.,

```
£r *fortran scards=simi
£r -load# 5=-e  6=-f  9=-g  10=-h
```

Out to temporary files.
On unit 9, Kendall's similarity matrix in an Osiris type 2 format.
On unit 10, Williams' " " " " " " .
On unit 6, a) Input matrix.
b) Input row totals.
c) Input column totals.
d) Lower triangle of Kendall's matrix
e) Lower triangle of Williams' matrix.

The given programme is a more general form of the one utilized in the present thesis and has not had extensive testing at the time of writing.

Programme: SIMI

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C   PROGRAMME TO CALCULATE TWO SIMILARITY COEFFICIENTS FROM AN ENDOGAMY/EXOGAMY
C   MIGRATION MATRIX. INPUT - SQUARE NON-SYMMETRIC CROSSTABULATION OF FATHERS'
C   AND MOTHERS' BIRTHPLACES SPECIFIED IN GROUPING AREAL UNITS (GAU'S).
C   OUTPUT - TWO SIMILARITY MEASURES IN THE FORMAT OF OSIRIS TYPE 2 MATRIX
C
C
C   PROGRAMMER  W.R.WILLIAMS
C
C
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION Z(200,200), Y(200), X(200), SIMIK(200,200), SIMID(200,20
     10), NN(200)
      READ(5,99)N
   99 FORMAT(I3)
      I=N
      J=N
      DO 11 I=1,N
      READ(5,10)(Z(I,J),J=1,N)
   10 FORMAT(20F4.0)
   11 CONTINUE
      DO 12 I=1,N
      Y(I)=0
      DO 12 J=1,N
      Y(I)=Y(I)+Z(I,J)
   12 CONTINUE
      DO 13 J=1,N
      X(J)=0
      DO 13 I=1,N
      X(J)=X(J)+Z(I,J)
   13 CONTINUE
      DO 23 MM=1,N
   23 NN(MM)=MM
C
      M=N-1
      DO 14 I=1,M
      JJ=I+1
      DO 14 J=JJ,N
C   KENDALL'S  SIMILARITY COEFFICIENT (SIMIK)
C
      A=Z(I,J)*(X(J)+Y(J))
      B=Z(J,J)*(Y(I)+X(I))
      C=Z(J,I)*(Y(I)+X(I))
      D=Z(I,I)*(X(J)+Y(J))
      IF(B .EQ. 0.0)GO TO 30
      G=(A/B)
      GO TO 31
```

```
   30 G=0.0
   31 IF(D .EQ. 0.0)GO TO 32
      H=(C/D)
      GO TO 33
   32 H=0.0
   33 SIMIK(I,J)=(G+H)
    2 SIMIK(J,I)=SIMIK(I,J)
      SIMIK(I,I)=0
      SIMIK(J,J)=0
C  WILLIAMS' SIMILARITY COEFFICIENT (SIMID)
C
      E=Z(I,J)+Z(J,I)
      F=Y(I)+Y(J)+X(I)+X(J)-(Z(I,J)+Z(J,I)+Z(I,I)+Z(J,J))
      IF(F .EQ. 0)GO TO 3
      SIMID(I,J)=E/F
      GO TO 4
    3 SIMID(I,J)=0
    4 SIMID(J,I)=SIMID(I,J)
      SIMID(I,I)=0
      SIMID(J,J)=0
   14 CONTINUE
C
C  ORIGINAL MATRIX TO BE WRITTEN OUT
      WRITE(6,81)
   81 FORMAT(10X,15HORIGINAL MATRIX)
      WRITE(6,82)
   82 FORMAT(/)
      DO 15 I=1,14
      IE=15*I
      IEE=IE-14
      IF(IE-N)181,181,190
  190 IF(N .LT. IEE)GO TO 15
      IE=N
      WRITE(6,82)
  181 WRITE(6,24)(NN(MM),MM=IEE,IE)
      WRITE(6,82)
      DO 180 IEF=1,N
  180 WRITE(6,16)(Z(IEF,J),J=IEE,IE)
   24 FORMAT(3X,15(I3,2X))
   16 FORMAT(1X,20(1X,F4.0))
   21 FORMAT(1X,15(1X,F6.0))
   15 CONTINUE
      WRITE(6,20)
   20 FORMAT(////)
      WRITE(6,83)
   83 FORMAT(10X,10HROW TOTALS)
      WRITE(6,82)
      WRITE(6,21)(Y(I),I=1,N)
      WRITE(6,20)
      WRITE(6,84)
   84 FORMAT(10X,13HCOLUMN TOTALS)
```

```
      WRITE(6,82)
      WRITE(6,21)(X(I),I=1,N)
C
C      SIMIK AND SIMID TO BE WRITTEN OUT
C
      WRITE(6,20)
      WRITE(6,87)
   87 FORMAT(10X,27HKENDALL'S SIMILARITY MATRIX)
      WRITE(6,82)
      CALL SATRX(N,NN,SIMIK)
      WRITE(6,88)
   88 FORMAT(10X,27HWILLIAMS' SIMILARITY MATRIX)
      CALL SATRX(N,NN,SIMID)
      IK=N-1
      DO 17 IA=1,IK
      ID=IA+1
      WRITE(9,18)(SIMIK(IA,L),L=ID,N)
   18 FORMAT(8F10.5)
   17 CONTINUE
      IF(N .LE. 80)GO TO 40
      IF(N .GT. 80 .AND. N .LE. 160)GO TO 41
      WRITE(9,22)
      WRITE(9,22)
      WRITE(9,22)
      WRITE(9,22)
      WRITE(9,22)
      WRITE(9,22)
      GO TO 50
   41 WRITE(9,22)
      WRITE(9,22)
      WRITE(9,22)
      WRITE(9,22)
      GO TO 50
   40 WRITE(9,22)
      WRITE(9,22)
   22 FORMAT(' ')
   50 IK=N-1
      DO 19 IA=1,IK
      ID=IA+1
      WRITE(10,18)(SIMID(IA,L),L=ID,N)
   19 CONTINUE
      IF(N .LE. 80)GO TO 43
      IF(N .GT. 80 .AND. N .LE. 160)GO TO 44
      WRITE(10,22)
      WRITE(10,22)
      WRITE(10,22)
```

```
      WRITE(10,22)
      WRITE(10,22)
      WRITE(10,22)
      GO TO 45
   44 WRITE(10,22)
      WRITE(10,22)
      WRITE(10,22)
      WRITE(10,22)
      GO TO 45
   43 WRITE(10,22)
      WRITE(10,22)
   45 CONTINUE
      STOP
      END
      SUBROUTINE SATRX(N,NN,SATR)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION NN(200), SATR(200,200)
      II=N
      DO 114 IN=1,14
      IL=15*IN
      ILL=IL-14
      IF(ILL .GT. II)GO TO 411
      IE=15*IN
      IEE=IE-14
      IF(IE-N)301,301,302
  302 IF(N .LT. IEE)GO TO 114
      IE=N
      WRITE(6,117)
  301 WRITE(6,300)(NN(MM),MM=IEE,IE)
  300 FORMAT(3X,15(I3,5X))
      WRITE(6,117)
  117 FORMAT(/)
      IB=0
      DO 114 IP=ILL,II
      IPP=IP
      IB=IB+1
      IA=IP-IB
      ID=IA+1
      IF(IPP .GT. IL)IPP=IL
      WRITE(6,86)(SATR(IP,IS),IS=ID,IPP)
   86 FORMAT(2X,15(F6.4,2X))
  114 CONTINUE
      WRITE(6,117)
      WRITE(6,117)
  411 RETURN
      END
```