

Blood groups of the Irish

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Summary. Some 1800 blood donors from the Republic of Ireland and Northern Ireland have been tested for the antigens A A₁ B H; M N Ss Henshaw; C c C^w D D^u E e Ce; Wr^a; P₁; Lu^a; K k Kp^a; Fy^a Fy^b; and Rd (Radin). The results are compared with those already available for Ireland and an attempt is made to interpret them in terms of populations movements. With the exception of the high O frequency in the West, believed to represent the remnants of Mesolithic peoples, the blood groups are very similar to those in the rest of Europe, and show no significant differences between the different provinces in Ireland.

1. Introduction

Although several surveys have been carried out of the ABO and Rhesus (D) blood group distributions in Ireland, there are relatively few that have included other blood group systems. A county by county survey of blood groups in Ireland was therefore started in 1969, and continued for approximately two years in collaboration with the Blood Transfusion Services of the Republic and of Northern Ireland.

2. Subjects and methods

Blood samples were collected by the Belfast, Cork, Dublin and Limerick Blood Transfusion Centres, and despatched to London for testing. All samples were received within a few days of collection and the majority were in excellent condition. The bloods were collected during routine donor sessions; all known relatives of other donors included were screened out, and all individuals but the first with a particular surname, bled at any one session, were also excluded. The donors were classified by their place of birth into the separate counties of the north and south, but in addition Dublin city was treated as a separate area owing to the known large-scale migration from the country regions to the city. Until recently, the Irish Blood Transfusion Service, unlike the British, did not bleed many females. This has led to a preponderance of males in the sample from the Republic.

Tests were carried out for the following antigens: A, A₁, B, H, Wr^a, M, N, S, s, Henshaw, P₁, Lu^a, C, c, C^w, D, D^u, E, e, Ce, K, k, Kp^a, Rd, Fy^a and Fy^b. The methods used were the standard tube and anti-human-globulin techniques.

Although some 1800 specimens were tested, when results are subdivided according to individual counties, the sample in each is small. For this reason the county data have been combined into provincial units.

3. Results

The ABO blood group phenotypes and the gene frequencies calculated from them are given in table 1. No discernible pattern can be seen from these, though there is a suggestion that the B gene frequency may be lower in Ulster. Of the subgroups of A,

Provinces	A ₁	A ₂	B	A ₁ B	A ₂ B	O	p ₁	p ₂	q	r	χ ²
Connaught	43	22	29	5	2	133	0·11	0·05	0·09	0·75	1·4
Leinster	140	48	77	14	2	375	0·13	0·04	0·07	0·76	2·9
Munster	82	30	31	11	2	222	0·13	0·04	0·06	0·77	5·6
Ulster											
(Republic Counties)	43	19	11	4	3	127	0·12	0·06	0·04	0·78	6·3
(Northern Ireland)	65	25	24	7	4	193	0·12	0·05	0·06	0·77	5·7
*Eire total	361	134	183	36	12	973	0·13	0·04	0·07	0·76	4·4

Table 1. ABO blood group system.

* Dublin City has not been included in Leinster but has been taken into account in the total figure for Eire; this applies to all the tables.

the relative frequencies are similar to those for the rest of the British Isles. For the Rhesus groups again no clear distribution pattern can be seen (tables 2 and 3), but there is a suggestion that the *cde* complex is of lower frequency, and the *CDe* complex of higher, in the west, in the provinces of Connaught and Munster. The frequency of the C^w antigen for the whole of Ireland is similar to that for other parts of the British Isles, but with a suggestion that this antigen is less frequent in the eastern counties.

Rhesus phenotype	Connaught	Leinster	Munster	Ulster (Republic Counties)	Ulster (Northern Ireland)	Eire total
R ₁ R ₁	61	102	73	29	54	283
R ₁ ^w R ₁	4	4	5	1	1	14
R ₁ R ₂	61	87	52	21	45	230
R ₁ r	107	198	106	68	90	510
R ₁ R ₂	0	1	0	0	0	1
R ₁ ^w R ₁ ^w	0	0	0	0	1	0
R ₁ ^w R ₂	1	2	1	0	2	5
R ₁ ^w r	4	7	5	0	5	16
R ₂ R ₂	9	18	8	6	8	44
R ₂ r	39	75	58	23	31	211
rr	52	137	62	51	75	333
r'r	2	1	1	0	0	6
r ^w r	1	3	0	1	1	5
Ror	2	8	5	3	5	2
R ₁ ^w r	2	0	4	1	1	7
R ₂ ^w r	0	5	0	0	0	5
Total	345	648	380	204	319	1692

Table 2. Rhesus blood group system (phenotypes).

Provinces	R_1	R_1^w	R_2	r	r'	r''	R_0	R_1^u	R_2^u	R_z	χ^2	D.F.
Connaught	0.417	0.013	0.170	0.374	0.008	0.004	0.007	0.007	—	—	3.6	11
Leinster	0.379	0.010	0.145	0.435	0.002	0.006	0.012	—	0.009	0.002	7.6	14
Munster	0.395	0.014	0.167	0.390	0.004	—	0.015	0.015	—	—	5.7	8
Ulster (Republic Counties)	0.360	0.002	0.134	0.479	—	0.006	0.014	0.005	—	—	4.2	9
Ulster (Northern Ireland)	0.380	0.016	0.144	0.437	—	0.005	0.014	0.004	—	—	26.0*	9
Eire total	0.385	0.010	0.153	0.421	0.004	0.004	0.014	0.005	0.004	0.003	15.6	16

Table 3. Rhesus blood group system (allele frequencies).

* Large proportion of χ^2 contributed by finding of one example of the rare phenotype $R_1^w R_1^w$.

The MNSs frequencies (table 4) are very similar to those reported for England, and do not support the suggestion of Ikin *et al.* (1952), on a small sample of 106 specimens from Northern Ireland, that the *MS* complex is lower in frequency and the *Ms* higher than in England. No positives were found when testing with anti- W_r^a , anti-Henshaw or anti- Di^a (100 specimens only). Among the 552 specimens tested with anti- Kp^a five positives were found. The Lu^a frequencies were on average lower

Provinces	MSMS	MSMs	MsMs	MSNS	MNSs	MsNs	NSNs	NsNs	NsNs	<i>MS</i>	<i>Ms</i>	<i>NS</i>	<i>Ns</i>	χ_s^2
Connaught	30	57	34	8	75	72	1	13	52	0.28	0.30	0.05	0.37	2.0
Leinster	53	95	55	17	165	164	2	24	79	0.28	0.30	0.05	0.37	7.0
Munster	15	51	39	14	99	81	1	17	63	0.23	0.30	0.07	0.40	6.5
Ulster (Repub. Counties)	14	30	22	11	51	41	4	7	26					
Ulster (Northern Ireland)	14	30	22	11	51	41	4	7	26					
Ulster (Northern Ireland)	26	44	21	6	84	72	5	9	51	0.28	0.26	0.05	0.41	21.5
Eire total	121	248	164	53	422	375	9	65	241	0.27	0.30	0.06	0.37	7.2

Table 4. MNSs blood group system.

than those for the rest of Western Europe (table 5). The Kell frequencies (table 6) resemble those in the rest of the British Isles, and are not comparable to the extremely high frequencies found by Casey, Hale, Casey, Hogg and Kynerd (1969) of the *K* gene in the border hills of Kerry and Cork, though it is of interest that in the present study this gene appears to congregate in localities near by. In the Duffy system

Provinces	Lu^a+	<i>N</i>	Lu^a	Lu^b
Connaught	10	343	0.01	0.99
Leinster	27	645	0.02	0.98
Munster	16	381	0.02	0.98
Ulster (Republic Counties)	6	206	0.01	0.99
Ulster (Northern Ireland)	13	316	0.02	0.98
Eire total	63	1690	0.02	0.98

Table 5. Lutheran blood group system.

Provinces	KK	Kk	kk	χ_1^2	<i>K</i>	<i>k</i>
Connaught	0	23	320	0.4	0.03	0.97
Leinster	0	67	589	1.9	0.05	0.95
Munster	0	36	345	0.9	0.05	0.95
Ulster (Republic Counties)	1	12	193	2.6	0.03	0.97
Ulster (Northern Ireland)	0	29	290	0.7	0.05	0.95
Eire total	1	146	1554	1.7	0.04	0.96

Table 6. Kell blood group system.

Provinces	Fy(a+b-)	Fy(a+b+)	Fy(a-b+)	χ_1^2	Fy ^a	Fy ^b
Connaught	66	170	107	0.0	0.44	0.56
Leinster	145	295	216	5.3	0.45	0.55
Munster	67	171	141	1.5	0.40	0.60
Ulster (Republic Counties)	25	87	89	0.3	0.34	0.66
Ulster (Northern Ireland)	53	156	109	0.1	0.41	0.59
Eire total	321	772	601	6.7	0.42	0.58

Table 7. Duffy blood group system.

(table 7) the average figure for Eire (42 per cent) is considerably higher than the figure of 30 per cent found by Walter and Pálsson (1973). Again there is a suggestion of slightly lower Fy^a frequencies in the Republic counties of Ulster, and this area also seems to have a slightly elevated frequency of the P₁ gene, though again no clear distribution pattern emerges (table 8), possibly on account of small sample size or the difficulties in using weak antisera with specimens several days old.

Provinces	<i>N</i>	P ₁ +	P ₁	P ₂ + <i>p</i>
Connaught	311	226	0.48	0.52
Leinster	630	463	0.49	0.51
Munster	372	275	0.49	0.51
Ulster (Republic Counties)	145	112	0.52	0.48
Ulster (Northern Ireland)	319	221	0.45	0.55
Eire total	1540	1138	0.49	0.51

Table 8. P blood group system.

4. Discussion

The lack of a clear geographical pattern, though disappointing, is perhaps to be expected on account of the relatively small sample sizes in the present study. However, a number of interesting suggestions emerge, and for their interpretation it is necessary to take into account other existing biological evidence.

(a) Blood groups

The earlier surveys carried out on the ABO and Rh(D) distribution for the Republic of Ireland include those of Hooper (1947), Dawson (1952), Hackett, Dawson and Dawson (1956), Hackett and Dawson (1958), Hackett (1958), Hackett and Folan (1958), Dawson (1958) and Dawson (1964). Ryan (1962) carried out a survey in Cork, Kerry and the south of Tipperary. More detailed studies have been carried out

in the southwest particularly in the Slieve Lougher mountains by Casey, Hale and Casey (1963), Casey *et al.* (1969), Barham, Holland, Downey, Dupertuis and Casey (1971), Dupertuis, Casey, McGowan, Barham and Holland (1972), and Casey, Dupertuis, Holland, Barham, McGowan and Downey (1972). Pálsson, Walter and Bajatzadeh (1970) and Walter and Pálsson (1973) studied 295 individuals taken from a wide range of towns, and Sunderland, Tills, Bouloux and Doyle (1973) sampled 490 individuals from three towns. Northern Ireland has been the subject of fewer surveys. The major studies include those of Hart (1944), Ikin, Kopeć, Mourant, Parkin and Walby (1952), Huth, Ikin and Mourant (1953), and Kopeć (1970). Some information is also included for ABO and Rh(D) in Hackett *et al.* (1956).

For ABO distribution the paper by Dawson (1964), besides quoting most of the data previously published for the Republic of Ireland, is also the largest survey, with 120 007 individuals, representing 1:18 of the population. The data by Kopeć (1970) consist of the records of 65 516 donor cards from the Belfast Blood Transfusion Centre, analysed by postal districts; to give a comparison with the results of Dawson, we have recalculated them on a county basis. The recalculated results are set out in table 9 and plots of them have been added to Dawson's maps, so as to show the ABO gene frequencies for all Ireland (figures 1-3). The cities of Belfast and Dublin have been omitted from the maps.

County	O gene	A gene	B gene	Total	χ^2
Antrim	0·7378	0·1973	0·0649	12 415	0·43
Armagh	0·7339	0·2121	0·0540	3204	1·05
Belfast	0·7404	0·1980	0·0616	25 586	0·66
Derry	0·7418	0·1913	0·0669	5947	0·28
Down	0·7372	0·1982	0·0646	1341	2·52
Fermanagh	0·7287	0·2195	0·0518	953	0·83
Tyrone	0·7439	0·1854	0·0707	4001	5·58

Table 9. Kopeć's ABO data by county.

From these maps it is clear that the distribution of the genes in the ABO system divides the population of Ireland into a number of sub-populations. The A gene (figure 1) has its highest frequencies in the east of the Republic and in Northern Ireland, and this can be interpreted as a reflection of the settlement pattern of Ireland. The high frequencies of A in the east, the "English Pale", can be attributed to settlement from England and Wales, and that of Northern Ireland in part to the "Plantation" of James I. The O gene clearly has a high frequency (figure 3) in the west, and again there is similarity between Northern Ireland and the eastern counties of the Republic.

In all early papers the distribution of the B gene (figure 2) was reported to be very patchy, but with the large increase in data in Dawson's (1964) paper a pattern emerged, and he observed that "The main features of this pattern are the high frequencies in the central and south western counties and the low frequencies in all the counties adjoining Northern Ireland". Kopeć showed that the B gene frequency was lower in Northern Ireland than in the counties bordering it, and this distinction remains when the data are recalculated on a county basis; the whole of the region has a low B gene level except for County Tyrone figures (table 9) and this may be untypical as shown by the high χ^2 value, for agreement between observed and expected phenotype numbers ($\chi^2 = 5·58$, $0·02 < P < 0·01$).

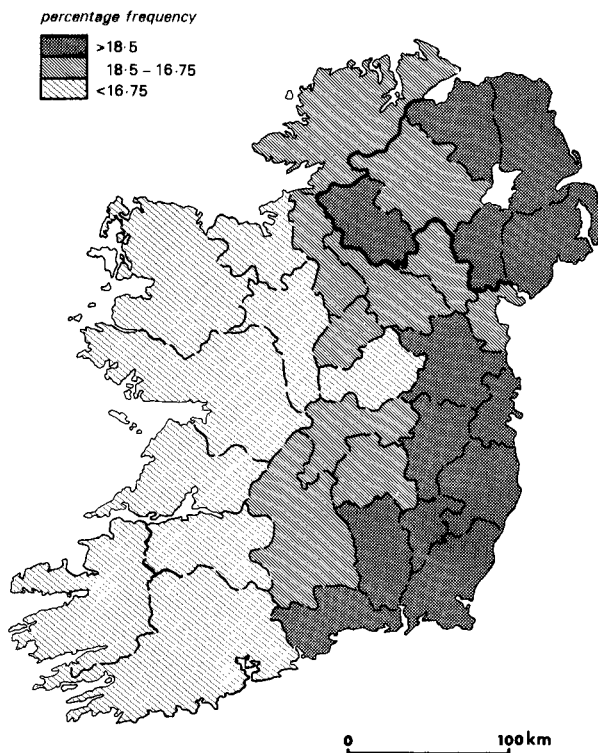


Figure 1. Percentage *A* gene per county.

The information on Rh(D) positive and Rh(D) negative frequencies given by Dawson (1964) and Kopeć (1970) is shown in figure 4, table 10 giving the recalculated Northern Ireland county results. The lower frequency of Rh(D) negatives in the west is clearly shown and the resemblances between Northern Ireland and the "Pale" are again demonstrated.

County	Rh(D) negative	Total	<i>d</i> gene
Antrim	1549	9249	0.4092
Armagh	480	2801	0.4140
Belfast	3623	21 456	0.4109
Derry	790	4778	0.4066
Down	1988	11 710	0.4120
Fermanagh	138	835	0.4065
Tyrone	629	3426	0.4285

Table 10. Rh(D) data recalculated from Kopeć (1970).

Other blood groups give little information on regional variation in Ireland, but help to clarify the position of the Irish in relation to other European populations. Casey *et al.* (1963, 1969, 1972) examined over 1000 individuals in counties Kerry and Cork, finding a higher *K* gene frequency and an unusually low *S* gene frequency, particularly in the Slieve Lougher region, but all other blood group frequencies agree fairly well with those available for European populations in general. Walter and

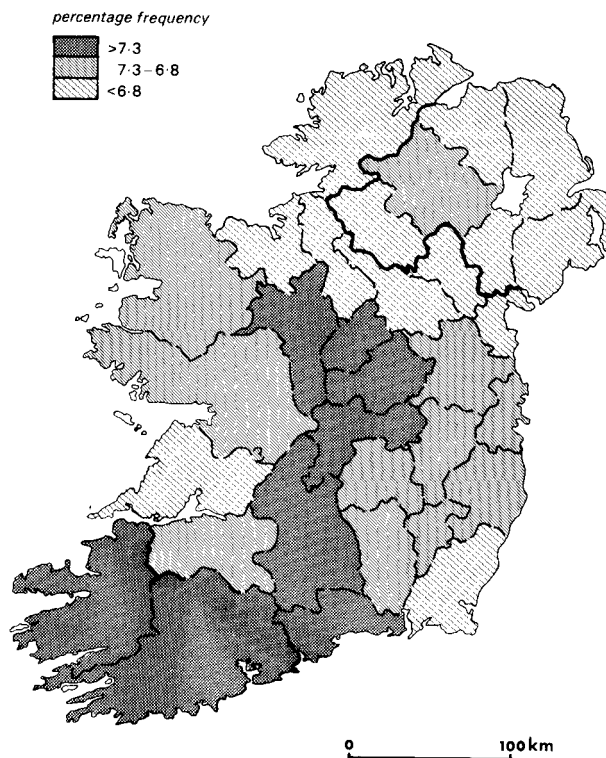


Figure 2. Percentage *B* gene per county.

Pálsson (1973) in a smaller widely distributed sample found a high *O* frequency of 0.79, which fits in well with other Irish values, but lower *P* (0.26) and *Fy^a* (0.30) gene frequencies than in most European populations; other systems showed no marked differences. Information for Northern Ireland is also scanty. The results for the Rh system of Huth *et al.* (1953) show similar frequencies to those of England with however a Rh(D) negative frequency (0.46) much higher than that found for Ireland in any other survey. Ikin *et al.* (1952) found gene frequency values close to those for the rest of Europe in all except the MNSs system (table 11).

Country	Complex frequencies (per cent)				Number tested	Reference
	<i>MS</i>	<i>Ms</i>	<i>NS</i>	<i>Ns</i>		
N. Ireland	19	41	5	35	106	Ikin <i>et al.</i> , 1952
N. Ireland	28	26	5	41	316	Present study
Eire	27	30	6	37	1698	Present study
England	24	30	6	41	1166	Ikin <i>et al.</i> , 1952

Table 11. *MNSs* frequencies in British Isles populations.

(b) *Physical traits*

The large amount of information on measurable physical traits in the survey of Hooton and Dupertuis (1955) is also of relevance. Although the means for nearly all the factors which they examined shows an east-west trend, there is a much wider

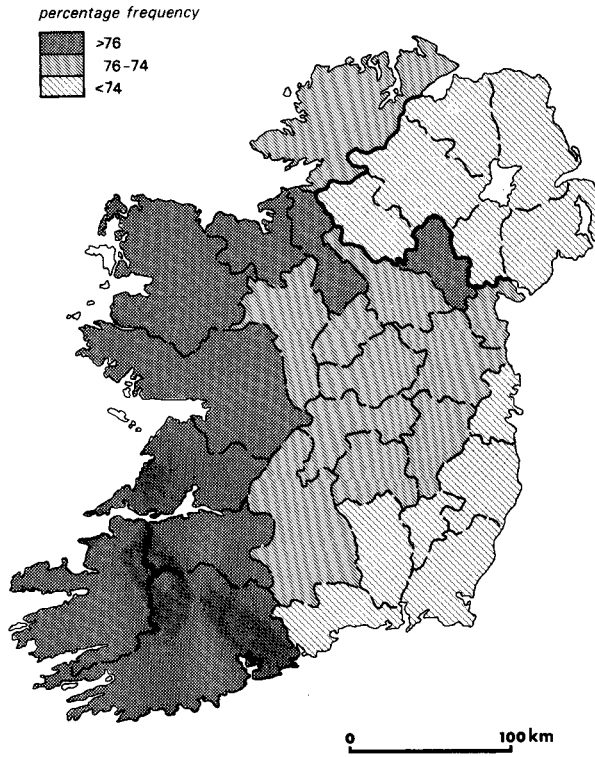


Figure 3. Percentage frequency of *O* gene.

variation about this trend than occurs in the ABO system. This variability may well be a function of sample size. Hooton and Dupertuis examined 10 000 individuals which is a large sample for an anthropometric survey, but small compared with the combined blood group data of Dawson and of Kopeć, which includes tests on 185 523 people. As Dawson has pointed out, the distinct occurrence of low B in the north did not become clear until the sample size was increased considerably. For most physical characteristics the regions in the south and west of high *O* gene frequency differ greatly from the north and east, while in the east "The Pale" often shows some similarity with the northern counties, although for some physical traits the northern region is divided within itself.

(c) *The present study*

The results of the present study can now be appreciated. The lack of pattern in the ABO blood groups is almost certainly due to the small sample size. The whole range of the *B* gene frequencies in the counties shown in figure 2 is barely more than 2 per cent, based on a total material of nearly 190 000 donors (Dawson 120 000, Kopeć 55 000) and it is not surprising that our own small sample is less informative. For the Rhesus group, the country appears in figure 4 to be divided into three distinct parts, with low Rh(D) negatives in the western counties, moderate levels in the centre and higher ones in the east and north. The present suggestion of a low frequency of *cde* and a high frequency of *CDe* and of *cDE* complexes in the west is in agreement with this. Interesting results appear if the Rhesus complexes are correlated

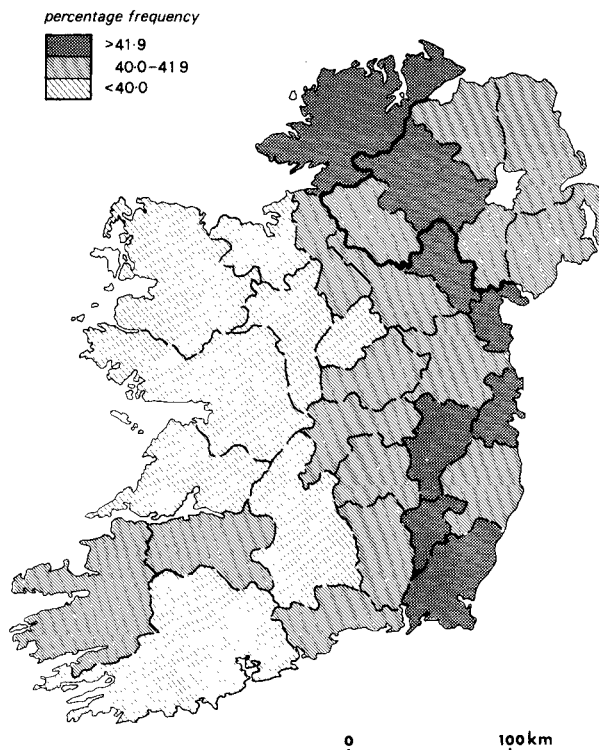


Figure 4. Percentage of Rhesus *d* gene.

with zones defined not geographically but by ABO frequency, using the 4-fold division obtained by Dawson (table 12).

Data from the remaining systems are too few for any useful regional discussion, but they show how close is the relationship between the Irish population in its blood frequencies with those of other parts of the British Isles and of north-west Europe generally.

ABO frequency	Present data		
	<i>cde</i>	<i>CDe</i>	<i>cDE</i>
High A	42%	39.4%	14.9%
High B	43%	36.9%	15.3%
High O	39%	41.7%	15.6%
Low B	44%	38.4%	15.1%

Table 12. Frequencies of Rh allele frequencies in relation to Dawson's ABO divisions.

A major criticism of frequency data based on blood donor material is that an element of self-selection occurs, and in particular the frequency of Rh(D) negatives and that of blood group O is higher than is found in the general population. The town data of Sunderland *et al.* (1973) provide a useful opportunity of evaluating any error which may have been introduced by such sample selection. In table 13 whereas the present county donor data show a Rh(D) negative frequency larger than that in

the towns, no such difference occurs in the O blood group distribution, so it seems probable that much if not all of the 6.3 per cent excess of Rhesus D negatives in the donors is due to selection. The lack of increase in blood group O may be due to the lesser necessity for selection of this group in a population that has a much higher O frequency than most of the rest of the British Isles. If sampling selection does in fact occur, then it is possible that there may be differential selection in the different regions, in which case one hesitates to place any great reliance on the distribution of Rhesus frequencies. However, while bearing this caution in mind, it is worth making some attempt at interpretation.

	Rh(D)-frequency	O blood group	Number tested
Eire county donors	19.76%	57.27%	1692
Towns	13.46%	55.88%	485

Table 13. Comparison of county donors with random town samples.

(d) *Interpretation*

As Dawson has suggested, the divisions of Ireland based on the frequencies of the ABO and Rh(D) types show a moderately good fit with those based on the population history of the country. Beddoe (1885) noted the dark hair and other special physical features of the inhabitants of the mountainous west; Hooton and Dupertuis (1955) and Evans (1973) identified them as the probable descendants of the first Mesolithic inhabitants, subsequently driven into the mountains by later comers. The peoples of the west with their high O and low Rh-negative (*cde*) frequencies thus appear likely to be descended mainly from these first inhabitants. Ulster might then have been colonized by populations low in the B gene frequency from south-west Scotland and northern England and these have been the people who built the extensive prehistoric earthwork known as Black Pig's Dyke linking the Drumlins, lakes and bogs to form a barrier with the south. They might also have been those who brought the Court-Cairn culture to Ulster to which this type of megalithic structure is almost completely restricted. Supporting evidence for such settlement of Ulster comes from the ABO gene frequencies in south-west Scotland which closely resemble those of Ulster (O gene 0.70, A gene 0.25 and B gene 0.05). This difference of the north of the island would have been maintained and accentuated by the plantation of James I.

Dawson suggests that there was a further influx of people from the south-east who had high frequencies of the B gene. We consider it more likely that these people entered both from the south-east and the east displacing the original high O frequency peoples into the west. In turn these high B frequency people were pushed westwards by the high frequency A and Rh(D) negative peoples from England, Wales and Scotland.

If these suggestions are correct, i.e. that the high O frequency people are Mesolithic remnants, that Ulster was settled by people of the Court-Cairn culture from Scotland, and that the high A frequencies in the eastern counties are due to migration from the rest of the British Isles, with perhaps a contribution from the Danish vikings, then it remains to determine who were the people who were high in frequency of the B gene. The distribution of high B frequency fits the pattern of settlement of the Beaker People and the Celts, for the distribution is restricted to that found for Wedge or Gallery

graves and early metal working; the finding of a few Wedge graves in the other areas of Ireland would be explained by cultural diffusion.

If this interpretation is correct, and it is possible to detect population movements at such a distant period, then the ABO groups and perhaps the Rh(D) types of these subpopulation groups in Ireland must have remained relatively constant for a long period. If this is so, it is reasonable to expect that similar differences will emerge in other genetic systems. It is unfortunate that the sample size in this survey, though appreciable in total, is small by region and it is important to extend the enquiries into area differences for the other systems for which we tested. Overall, the present results do, however, provide a reasonably large sample for use in comparing the Irish with other European populations and the present analysis tends to show that the Irish, with the exception of the high O frequency population in the west, are very similar to other European populations.

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Zusammenfassung. Etwa 1800 Spenderblute aus der Republik Irland und aus Nordirland wurden auf folgende Antigene getestet: A, A₁, B, H; M, N, Ss, Henshaw; C, c, C^w, D, D^u, E, e, Ce; Wr^a; P₁; Lu^a; K, k, Kp^a; Fy^a, Fy^b; Rd (Radin). Die Ergebnisse werden mit bereits verfügbaren aus Irland verglichen, und es wird versucht, sie mit Hilfe von Bevölkerungsbewegungen zu interpretieren. Mit der Ausnahme der hohen Frequenz von O im Westen, die wohl Reste mesolithischer Völker darstellt, sind die Blutgruppen dem übrigen Europa sehr ähnlich und zeigen keine signifikanten Unterschiede zwischen den verschiedenen Provinzen Irlands.

Résumé. 1800 donneurs de sang de la République d'Irlande et de l'Irlande du Nord ont été déterminés pour les antigènes A A₁ B H; M N Ss Henshaw; C c C^w D D^u E e Ce; Wr^a; P₁; Lu^a; K K Kp^a; Fy^a; Fy^b; et Rd (Radin). Les résultats ont été comparés aux données déjà disponibles sur l'Irlande et il est tenté de les interpréter en termes de mouvements de populations. A l'exception d'une fréquence élevée de O dans l'Ouest, qui représenterait les restes des peuples mésolithiques, les groupes sanguins sont très semblables à ceux du reste de l'Europe, et ne montrent aucune différence significative entre les différentes provinces de l'Irlande.