THE BLOOD GROUPS OF THE PEOPLES OF THE MEDITERRANEAN AREA

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INTRODUCTION

The distribution of the ABO and Rh blood groups in most of the countries north of the Pyrenees and the Alps has been the subject of much investigation and study. The broad outlines have been known for some years and further advances in knowledge will depend on intensive studies of those remote areas where the picture has not been confused by recent large-scale mixing of populations.

The data for the countries surrounding the Mediterranean Sea are much less complete even for the ABO groups, and still less so for the Rh groups, but recent investigations into the latter have yielded data which, though patchy, are highly suggestive. It has thus become worth while to bring together all the available data and to see whether any underlying regularities can yet be glimpsed, or any suggestions of correlation with the data of anthropology or with historical movements of peoples. It must be emphasized that most of the conclusions reached can as yet only be regarded as tentative; only in a few cases are the numbers of persons tested sufficiently large to enable the suggested correlations and contrasts to stand the tests of statistical significance. They may however be a valuable guide to the directions in which further research is likely to be fruitful.

It will help in focussing our ideas if we regard the Mediterranean basin as a great melting pot with streams of human life flowing towards and through it from the surrounding land masses. The streams, to change the metaphor, are colored by their blood groups but the ABO groups give us a very limited palette. The Rh groups with their great variety enable us to make much finer distinctions and even to trace one stream after it has mingled with others, but only in parts of the picture has the dark varnish of the ages been removed allowing us to appreciate these more delicate tints.

Most of the data on the ABO groups have been obtained from the paper of Vallois (1944) and the compilations of Boyd (1939), Elsdon Dew (1939) and De Hoyos Sainz (1947). The frequencies of the Rh groups and a certain amount of ABO data are contained in a large number of papers listed among the references. Specific reference to individual papers is not in all cases made in the text of this paper.

THE BLOOD GROUPS OF THE PEOPLES OF EUROPE AND AFRICA

Before studying in detail the blood groups of the Mediterranean peoples we must therefore consider in broad outline the blood group distributions of northern and central Europe and of Africa south of the Sahara Desert.

Northern and central Europe can be divided into three main zones on the basis of the distribution of the ABO blood groups. East of a line running down the Baltic Sea and across central Germany to the head of the Adriatic Sea is a region of high B frequencies. West of this line is an area of high A frequencies, while in the extreme west, in Scotland, Ireland, and Iceland, O frequencies are high and B still low though slightly higher than in the high A zone. Over the whole area Rh frequencies are almost uniform with about 40 per cent each of CDe(R_1) and cde(r) chromosomes.

In Africa south of the Sahara, blood group distributions again appear to be relatively simple with, in general, A highest in the south, B in the center and O near the coasts. As in Europe, Rh frequencies vary little though they differ completely from those found in Europe, with cDe(R_0) about 60 per cent and cde(r) about 20 per cent.

THE ABO GROUPS IN THE MEDITERRANEAN AREA

In the Mediterranean area the distribution of the ABO groups is complex and is best followed, on the European side at least, by distribution maps of the three genes concerned (Figs. 1, 2 and 3).

The east European zone of high B is continued into the Balkan Peninsula excluding Greece. B is also high in most of Asia Minor, Syria and Palestine.

West of the Adriatic Sea and in Greece, A frequencies are mostly high and in general higher

THE DISTRIBUTION OF BLOOD GROUP GENE A IN THE MEDITERRANEAN AREA.

The lines connect points of equal gene frequency. The numbers represent percentages.

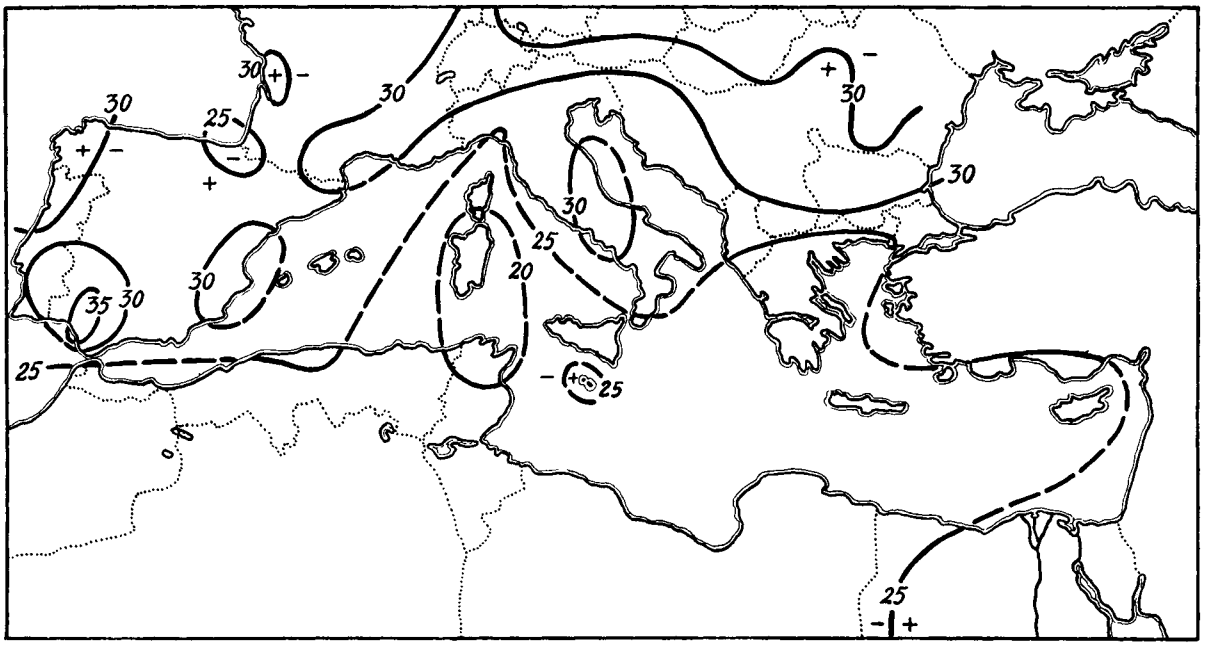


FIG. 1. The distribution of blood group gene A in the Mediterranean area.

than in northern Europe. Gene frequencies of A exceeding 30 per cent are found in patches in Italy, Spain and Portugal, and along a band following roughly the line of the Alps. Similar high frequencies are found in Scandinavia, but have not been found in Asia; and in Africa have been found very rarely, and only in frankly Negroid peoples. Thus the high A peoples of Europe, wherever they may originally have come from, are to be regarded as essentially European and *sui generis*. Had less been known of African blood groups, the presence of high A frequencies in Andalusia and especially in Cadiz, just opposite the coast of Africa, might have suggested an African derivation. We know, however, that very high A frequencies are reported in the aboriginal Guanches of the Canary Islands and De Hoyos Sainz (1947) has in fact suggested a connection between them and the population of the extreme south of Spain.

There is no single zone of high O frequency in the Mediterranean area but a number of isolated populations show a combination of high O and low B, similar to that of the Scots, the Irish and the Icelanders. Such are the Basques, the Sardinians, the Cretans, a few Berber tribes in north Africa and, rather to the east of the region, the peoples of the western Caucasus. The Basques differ from the other high O peoples both of the Mediterranean region and of north-western Europe in their extremely low B frequency which is the lowest in Europe.

In north Africa, apart from Egypt, the mixed nature of the people and the tribal organization and nomadic habits of many of them make it almost impossible to represent their blood distribution completely by means of a map.

Egypt shows a very high B frequency. The scattered observations on populations in the remainder of north Africa, from Libya to Morocco, have been discussed by Elsdon-Dew (1939) who classified most of them as Libyans, with average gene frequencies A = 21 per cent, B = 12 per cent, O = 67 per cent, and Berbers, with an average of A = 25 per cent, B = 11 per cent, O = 64 per cent. There is a well defined group of Berbers with gene frequencies very near A = 20 per cent, B = 5 per cent, O = 75 per cent, figures closely similar to those of the high O peoples of Sardinia and the islands of north western Europe; the tribes concerned are described as Berbers of Beni Qunif; Douiret from near Tatahouine, Tunisia; and Toureg of Tamanrasset, Hoggar.

The Rh Groups in the Mediterranean Area

There are many gaps in our knowledge of the circum-Mediterranean distribution of the ABO groups; within those gaps it is probable that in some cases highly aberrant ABO distributions will be found; but none of the gaps is so wide that we cannot make a plausible guess at what it holds. When we consider the Rh groups, on the other hand, much of the map might well be labelled "Here be dragons." Were the Rh groups in the Mediterranean basin as uniformly distributed as in northern Europe or in Negro Africa, the existing data might suffice for us to interpolate over the whole area. On the contrary there are wide variations in Rh frequencies, so that many more observations are needed before a complete map can be drawn.

It is however possible from a consideration of three populations, the Italians, the Basques and the Sardinians, to erect a provisional framework within which most of the known Rh distributions of the Mediterranean can find a place.

In Italy the Rh data for Milan and for Naples show a picture almost identical with that found all over northern and central Europe. Such differences as exist are in the direction of a slight excess of the CDe(R_1) chromosome. The ABO frequencies found in Italy are likewise typical of the areas to the north.

The Basques have the highest cde(r) frequency in the world, together with a low cDE(R_2) and a fairly high CDe(R_1) frequency. Thus both ABO and Rh groups show that this population stands apart from all the rest of Europe in that its genetic constitution is incompatible with anything more than a limited interbreeding with the surrounding populations. The other physical features, the language, and the traditions of the Basques are in accordance with this conclusion, and the writer and his colleagues (Chalmers, Ikin and Mourant, 1950) have suggested that the Basques represent the relatively unmixed descendants of a stock which occupied much of Europe in Palaeolithic times and which throughout the greater part of the continent interbred with invaders from Asia who were mainly D positive, the ancestors of the Basques thus being the main contributors to Europe of the d gene. It must however be noticed that besides the commonest Rh chromosome, cde(r), the Basques show a marked excess of CDe(R_1) relative to cDE(R_2) as compared with northern Europe.

THE DISTRIBUTION OF BLOOD GROUP GENE B IN THE MEDITERRANEAN AREA.

The lines connect points of equal gene frequency. The numbers represent percentages.

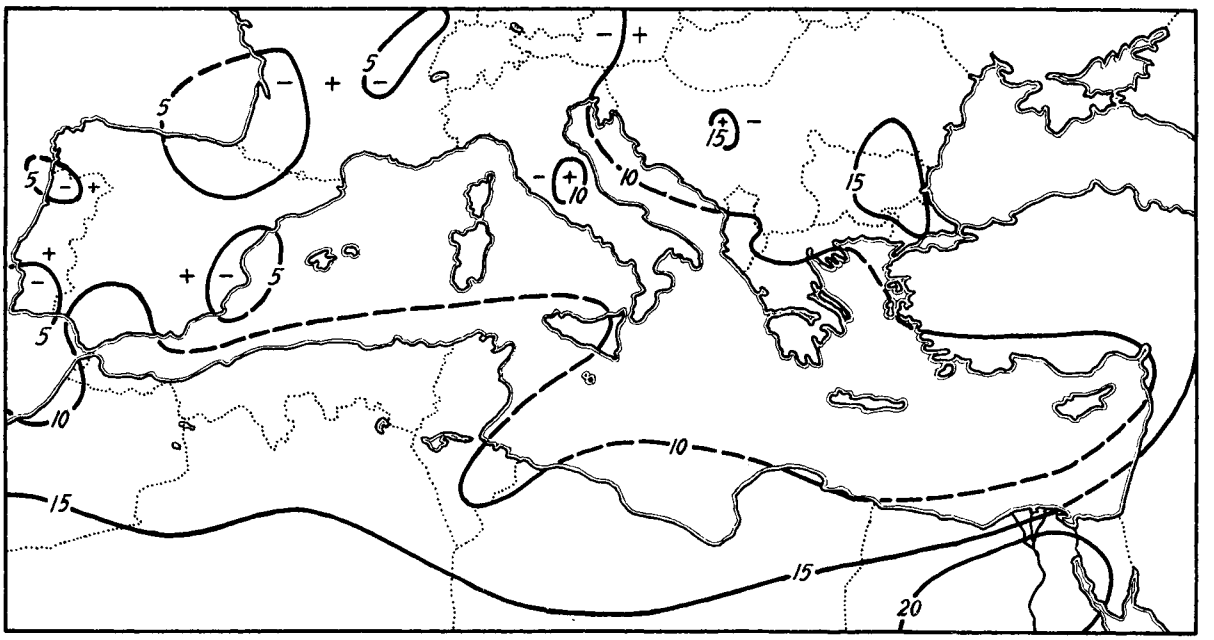


FIG. 2. The distribution of blood group gene B in the Mediterranean area.

THE DISTRIBUTION OF BLOOD GROUP GENE O IN THE MEDITERRANEAN AREA.

The lines connect points of equal gene frequency. The numbers represent percentages.

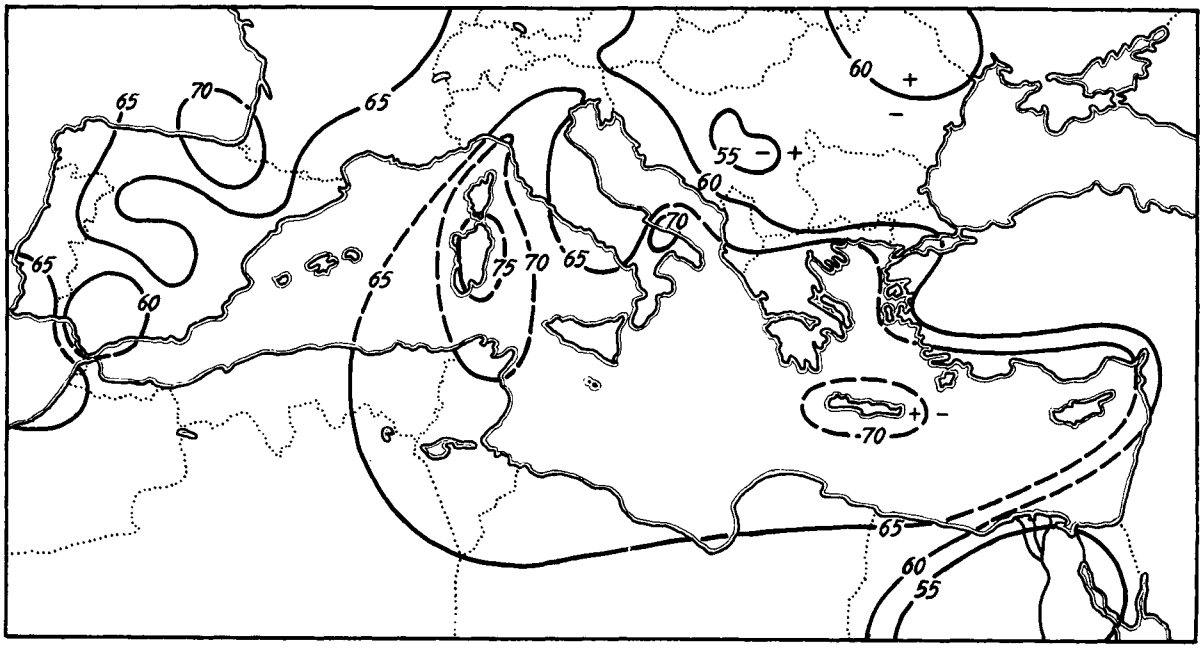


FIG. 3. The distribution of blood group gene O in the Mediterranean area.

In Sardinia an Rh distribution is found which is unique as far as Europe is concerned both in the lowness of the cde(r) frequency and in the high frequency of CDe(R_1). The cDE(R_2) chromosome is slightly less frequent than in northern Europe. Once again aberrant Rh and ABO distributions are found in the same population. Sardinia with a very high O frequency resembles Scotland, Ireland and Iceland in its ABO distribution but Iceland and Ireland certainly and Scotland probably share the north European Rh distribution. Sardinians differ from Basques not only in having an extremely different Rh distribution but in having a somewhat higher B frequency. Incidentally, Sardinia also shows a very high M frequency.

Catalonia has been shown (Race, Lawler, Bertinshaw, Grifols Lucas, Grifols Lucas, Ibarz Roqueta and Oppenheimer, 1949) to have a typical northern European cde(r) frequency but a much higher CDe(R_1) than northern Europe. This is readily explained if the Catalonians are mainly a blend of the stocks represented by the Basques and the Sardinians, that is to say, if the Rh positive stock which combined with the primitive Rh negative race was principally the high CDe(R_1) stock which we seem to be finding all over the Mediterranean basin, and only to a lesser extent the one with lower CDe(R_1) and higher cDE(R_2) which combined similarly north of the Alps and Pyrenees. That this is not the complete story is shown by the fact that A is higher in Catalonians than in Basques or Sardinians.

If indeed the ancestors of the Basques were almost exclusively cde(r) the presence of a proto-Sardinian component must also be the explanation of why in the modern Basques themselves the ratio of CDe(R_1) to cDE(R_2) is so much higher than in the peoples to the north. Here too is the probable reason why the populations of Milan and Naples though almost identical in their Rh composition with the northern Europeans show a slight excess of CDe(R_1).

Next to the Sardinians the isolated population of Ferrara near the mouth of the River Po has in common with the Galicians the lowest known cde(r) frequency in Europe. Its gene composition could be derived from a suitable combination of Sardinians and of northern Europeans or of Milanese. The people of Ferrara have however an Rh composition almost identical with that found by Wiener, Sonn and Belkin (1945) and by Prasad, Ikin and Mourant (1949) for the people of India. The ABO frequencies of the Ferrarese, which we

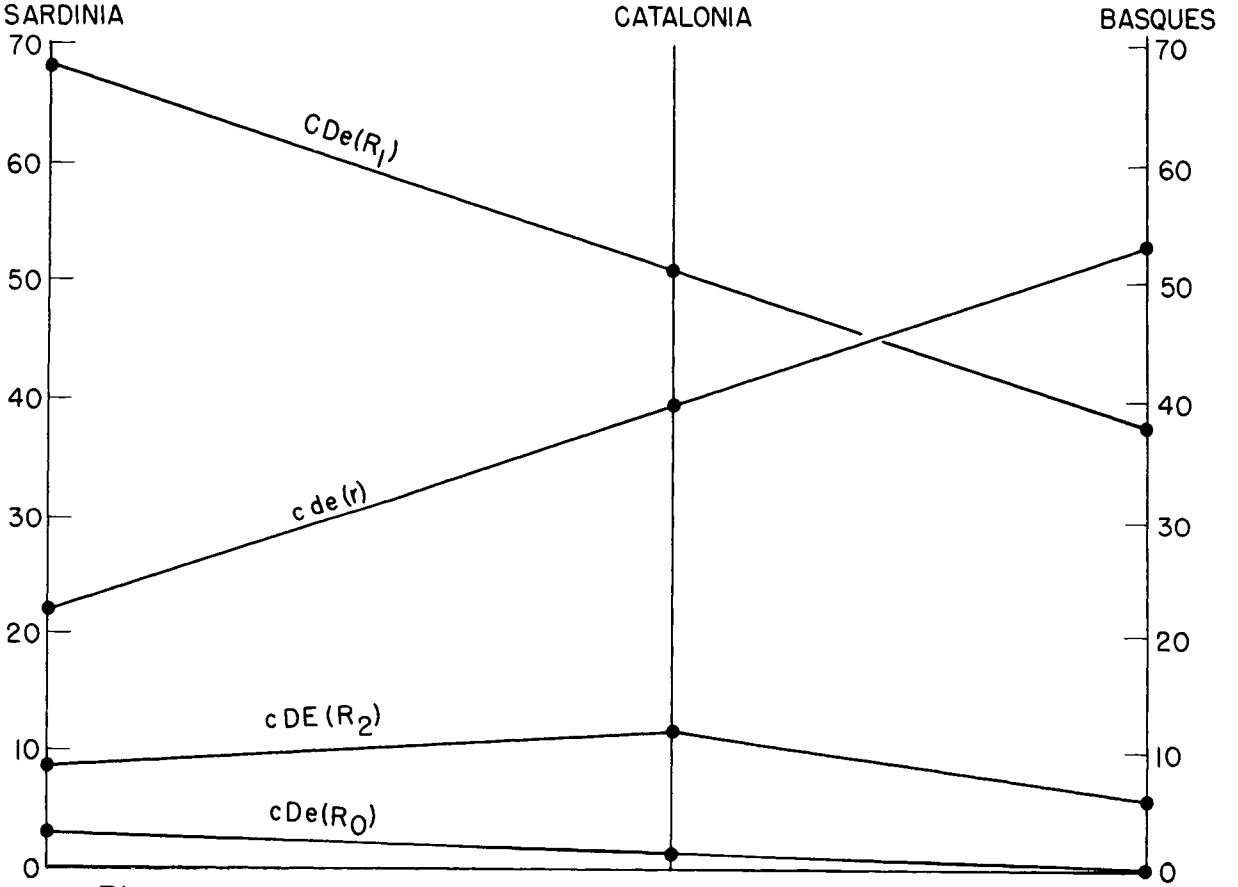
unfortunately do not know, would be a most valuable clue to their affinities since the very high B frequencies found in India are widely different from anything known in Europe.

Using the Rh groups alone we are in fact making the problem appear too simple. So long as only three chromosome combinations, cde(r) CDe(R_1) and cDE(R_2) have frequencies above five per cent in any population subjected to analysis, and so long as the frequency of cDE(R_2) remains less than that found in northern Europe, almost any Rh constitution that we are likely to meet can be synthesized approximately from a suitable mixture of the three stocks already mentioned. Speculation can only be controlled by using other blood group systems, especially ABO, at the same time, and by finding that any given hypothetical mixture is only present in a situation which appears reasonable on the basis of historical or demonstrable prehistoric movements of population or of their present geographical relationships. For instance, Morganti, Panella and Cresseri (1949) have produced historical evidence that there has been immigration into Ferrara from the east.

When we find cDe(R_0) frequencies exceeding the normal 2 to 3 per cent of Europe it is necessary to call upon another source of supply which can hardly be other than the Negroes with 60 per cent of cDe(R_0). There is now practically no population which we cannot readily synthesize in imagination but if we need to bring in all four combinations of chromosomes repeatedly our whole theoretical structure must be suspect.

Three populations living in or near the Mediterranean area have been found to possess relatively high cDe(R_0) frequencies; the Egyptians, the Arabs of Iraq and the Galicians of north-west Spain.

The Egyptian Rh distribution can be derived from that of the Sardinians together with a negro admixture. This hypothesis is strongly supported, at least with regard to the negro contribution, by work now in progress which shows an almost continuous change along the Nile Valley from



Rh CHROMOSOME FREQUENCIES (per cent) IN THE WESTERN MEDITERRANEAN.

FIG. 4. Rh chromosome frequencies (per cent) in the western Mediterranean area.

Egyptian to Negro. Moreover, the relatively high B frequency of Egyptians may have some connection with even higher B frequencies found in central Africa. The Rh constitution of the Arabs of Iraq lies between that of the Egyptians and that of the Latvians of east central Europe. The negro element in Egypt and Iraq is moreover easily explained by the progressive assimilation of negro slaves which is known to have taken place.

The Galicians are near enough to the Sardinians to leave little doubt as to the main source of their Rh genes. Their 7 per cent of cDe(R_o) chromosomes can however hardly be other than of negro origin. As only 97 persons were tested the slight excess of cde(r) and cDE(R_2) unaccounted for by such a mixture may be due to sampling errors but if confirmed on larger numbers would require a northern and possibly a proto-Basque contribution.

We have now considered all the circum-Mediterranean populations for which full Rh statistics are available. Two other populations, the Indians and the Jews, appear to bear some relation to the peoples of this area. Chown, Peterson, Lewis and Hall (1949) have determined the full ABO and Rh groups of 3,000 of the inhabitants of Manitoba, Canada, and classified them according to their European or other country of origin, Hebrews being classified separately. The northern and central European nations show almost completely uniform Rh gene frequencies together with divergent ABO frequencies. The Hebrews, agreeing closely in this series with Poles and Ukrainians in their ABO groups and especially in their high B frequency, differ from all the others with regard to Rh. In a highly mixed emigrant population such as that of Canada one cannot be sure of getting a true sample of any European stock but the good general agreement of the findings of Chown and his colleagues with what is known of the blood groups found in the countries of origin of the peoples concerned is a cause for confidence in his Hebrews being a representative sample of European Jews. Their Rh constitution is a typical Mediterranean one. They have a cDe(R_o) frequency higher than has been found anywhere in Europe except in Galicia though considerably lower than in Egypt and Iraq. This can hardly be other than the result of a negro component, probably received through Egypt. Otherwise they appear Mediterranean with a considerable added population component of the central and north European type. The latter is clearly the result of proselytization and intermarriage in recent centuries and the writer must confess his surprise at finding the Mediterranean stock not only distinctly recognizable but predominant.

Closely agreeing observations on the Rh groups of Indians by Wiener, Sonn and Belkin (1945) and by Prasad, Ikin and Mourant (1949) suggest a near relationship between northern India with 10 per cent of D-negatives on the one hand and Europe and the Mediterranean basin on the other. Southern India with only about 2 per cent of D-negatives is much nearer to eastern Asia in this respect.

It was suggested by Chalmers, Ikin and Mourant (1949) that the Indians were the descendants of a mainly D-positive population other members of which, mixing with a mainly D-negative race akin to the modern Basques had given rise to the present population of Europe. This hypothesis is supported in a broad sense not only by the Rh distribution of the Indians but by their ABO and MN groups which are a culmination, in high B and M frequencies, of the general European trend. The present paper shows however that the situation is much more complex than we supposed. In particular central and northern Europeans have a higher cDE(R_2) frequency than either Basques or Indians, while in Europe itself, in the Mediterranean basin, we find close parallels to the Indians in both Rh and MN though not in ABO groups. As was suggested by Chalmers, Ikin and Mourant (1950), if Indians represent one of the main stocks contributory to modern Europe, we still have to seek, probably to the north east, a source for the abundance of cDE(R_2) chromosomes.

Mediterranean Anaemia

The abnormality of the red blood cells, giving rise to the condition known as Mediterranean anaemia, or thalassaemia, appears to be mainly confined to populations of Mediterranean origin. The condition is inherited as a Mendelian dominant, the heterozygotes having a mild anaemia while the rare homozygotes suffer from a severe and usually fatal disease, Cooley's anaemia. The distribution of the condition in continental Italy and in Sicily has been studied in detail by Silvestroni and Bianco (1949). They find frequencies of about 10 per cent in Ferrara and the neighbouring town of Rovigo, and of about 5 per cent in most parts of Sicily. In most other parts of Italy the frequency is about one per cent. Most of the positive persons found in Rome come from Sicily and Sardinia, but no local investigations were done in Sardinia. It will be seen, however, that a high frequency of Mediterranean anaemia was found in natives of just those parts

of Italy, namely Ferrara and Sardinia, where a high frequency of R_1(CDe) was found by other workers.

A survey of the distribution of this condition in other Mediterranean lands would probably yield valuable data and it would not be difficult to combine it with a blood group survey. At the same time a search should be made for another haematological abnormality, the sickle-cell trait. This also is inherited as a Mendelian dominant and many workers consider that only the homozygotes show clinical symptoms. The condition is almost wholly confined to Africa and its frequency varies from about one per cent to 40 per cent in different tribes. It might be a useful additional index of the presence of a negro element in Mediterranean and other populations.

Throughout the Mediterranean basin we find a similar distribution recurring but with evidence of dilution with other neighboring stocks. Perhaps the most interesting of the latter is the negro component which appears at both ends of the basin. In the east the Semitic speaking peoples including the Jews of Europe have received it along the Nile or the east coast of Africa. The Galicians in the west must have received it along the Atlantic coast and further research will probably demonstrate this stream of migration more fully in other parts of the Iberian peninsula.

Wide variations of ABO frequencies have been recorded for populations whose Rh groups have not yet been tested. It is impossible to predict the results of such testing but certain peoples are likely to yield results of special interest. The very high A frequencies found in the inhabitants of Cadiz and in the Guanches of the Canary Islands, and the peculiar skeletal features of the latter, call for full Rh and MN testing of these populations. The Berbers with their high O frequency will surely prove to be related to one of the similar peoples in Europe, the Sardinians, the Basques or the north Atlantic islanders. Each of these has a different and readily recognizable distribution of the Rh groups. The Libyans, too, demand investigation, and ultimately when the difficult problems of organization have been overcome an examination of the nomads of the Sahara should connect the Mediterranean area with negro Africa along a continuous front. As to what will be discovered it is idle to speculate, as it is regarding the Rh groups of the inhabitants of the long stretch of coast from Naples to Cairo. Whatever is found is sure to throw fresh light on the relationships and movements of mankind

TABLE 1. RH CHROMOSOME FREQUENCIES IN THE MEDITERRANEAN AND RELATED PEOPLES EXPRESSED AS PERCENTAGES TO THE NEAREST INTEGER

	Egypt	Iraq	Canadian Jews	Sardinia	Ferrara	Milan	Catalonia	Basques	Galicia	England	Latvia	India
CDe(R_1)	49	44	53	67	53	45	49	38	56	42	42	57
cDE(R_2)	9	15	12	9	12	13	11	7	11	14	18	10
cde(r)	24	27	27	22	25	38	38	53	25	39	35	25
cDe(R_0)	17	11	5	2	3	3	1	0	7	3	1	4
Cde(R')	0	2	3	0	6	1	0	1	0	1	2	4
cdE(R'')	0	1	0	0	2	0	1	0	2	1	1	0
CDE(R_z)	0	0	1	...	...	...	0	0	0	0	0	0

These figures are based on the papers listed in the bibliography. In most cases chromosome frequencies have been recalculated by the author of the present paper.

CONCLUSIONS

We may sum up the ABO distribution by saying that B is high in the east of the area, and A and O in a somewhat patchy manner high in the west. As in some other areas of continental dimensions, the Rh groups seem to vary less than the ABO and a very clear Mediterranean distribution of Rh groups emerges of which the extreme type is found in Sardinia. The important work of Morganti, Panella and Cresseri (1949) in this island has indeed served as a point of reference in the whole of the present study. It might have been expected that in an island the rather extreme ABO, MN and Rh distributions would prove to be the results of random fluctuations of gene frequencies in a small and isolated population. On the contrary, however, had we not the actual results of the observations carried out in Sardinia it would have been necessary to postulate a primitive Mediterranean race with almost precisely such an Rh distribution.

in what is beyond dispute the most important area in the world from the standpoint of history.

SUMMARY

Blood group A shows high frequencies in the European lands bordering the Western Mediterranean and in Greece. Group B has a high frequency all around the Eastern Mediterranean. The Sardinians, the Basques and certain Berber tribes in North Africa have a high O frequency. The Rh blood groups of the Mediterranean lands differ considerably from those of Northern Europe. Two main strains can be recognized, typified by the Basques with high cde(r) and the Sardinians with high CDe(R_1). These, together with a north European and a negro strain, are suffiicient to account for the Rh groups of all the Mediterranean populations yet examined.

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DISCUSSION

BUZZATI-TRAVERSO: I wish to comment on some points in Dr. Mourant's paper. (1) First, regarding the occurrence of a peculiar dialect in the province of Bergamo and its correlation with a high r frequency, I think that one cannot rely on such coincidence to draw conclusions on the origin of such population. In fact, approximately the same gene frequency occurs in the provinces of Brescia and Torino (according to Morganti's summarizing paper), where the local dialects do not show any phonetic peculiarity. (2) In connection with such high frequency of r in the neighborhood of the Alps as compared with the low frequency of the same gene in Southern Italy, I wish to call attention to the interrelationships between the distribution of gene frequencies and demographic factors, since it seems to me likely that the cline in r frequencies throughout the Italian peninsula might be brought about by the higher fertility of Southern populations and by their corresponding migration towards Northern regions. (3) In connection with the peculiar distribution of blood groups in Sardinia, I would like to stress that the *m* gene has a frequency of 0.75, as compared to 0.55 of other Italian populations, and that this fact might be of importance if taken into consideration together with the high frequency of thalassemia minor. (4) Concerning the point raised by Dr. Dobzhansky on the validity of Darlington's

theory of the genetic component of language, I would like to point out that in respect to the threshold value of 68 per cent O gene frequency chosen by this author to discriminate between populations having the "th" sound in their language, Italy represented an exception, as it was considered to have just that frequency. The maps shown by Dr. Mourant, however, show that Italy shows a lower frequency of O group, and therefore this might be considered as evidence in favor of Darlington's ideas. I would like to add, however, that I have tried to check such theory on the population living in the province of Belluno, the dialect of which has a typical "th" sound. A sample of some thousand individuals gave a gene frequency for O of about 62 per cent, this not being in accord to the said theory.

MOURANT: (1) If indeed the slightly higher r frequency in Bergamo above that found, for instance, in Milan, is significantly so, it is not surprising to find that the increased frequency extends beyond the present limits of the Bergamasque dialect as it does beyond those of the Basque language. It would be most interesting to know whether any or all of the very high r areas also show significant deviations in their ABO frequencies. I do not however regard the coexistence of a high r frequency and a peculiar dialect and physique in the Bergamo region as anything more than a hint to guide future research.

DOBZHANSKY: It may be useful to clarify here an issue which, I believe, is a purely semantic one. The blood group distributions in the Mediterranean area can be described as resulting from mixture of racial "elements" approached by the present inhabitants of Sardinia, the Basque Country, and Africa. These "elements" may easily be mistaken for the "primary" or "pure" races of classical anthropology. In Dr. Mourant's usage, there is however no implication of any such assumption of race purity in bygone days. The "elements" are simply the extreme points in a multi-dimensional surface of gene frequencies. Ancient human populations were polymorphic, just as the modern ones are, although the genetic variance has probably grown in recent times owing to greater mobility of populations and their consequent mixing.

MOURANT: I am entirely in agreement with the speaker. In the title of my communication I deliberately applied the term "Mediterranean" to the area and not to the peoples so as to avoid any implication of identification with a race or races in the sense of the older anthropology. I do not regard the "elements" which I have used in my attempted analysis as anything more than rather extreme but transient integrations in a constant process of mutation, selection, genetic drift and interbreeding. I shall endeavor in revising my paper for publication to correct any suggestion that these "elements" have any absolute connotation.

KEMP: The blood-types are rather constant, and probably no certain exceptions from their regular inheritance are known. But still during generations it may be supposed that new types arise through mutations such as A_3, A_4, etc. and a long time ago type A and B are supposed to have arisen through mutation from type O.

MOURANT: The presence of all the groups A, B, and O among the great apes, and of A-like and B-like antigens in a variety of mammals, suggests that these groups may have been present in the human stock from the beginning. I personally support the suggestion of Boyd and others that this was so, and that the present distribution is mainly the result of local genetic drift at a time when man was a rare animal. This does not exclude the possibility that a very small amount of mutation is taking place between the three major genes, as well as mutations from O or A_1 to A_2, A_3, and A_4; or that there is a slow selection on a geographical basis. The almost complete limitation of A_2 to European, African and South East Asiatic populations suggests that the A_2 gene is also an ancient one; though in this case again, selection in relation to the geographic environment might account for the distribution.

HUNT: I think that not only simple genetic traits, but complex morphological features, may have differential potentialities for survival in a population. In man, where the history of a racial group is unknown, this may be an important source of error in the anthropometric study of living populations.

MAYR: The analysis of the geographical distribution of blood groups provides a magnificent means for the study of the history of human populations. Dr. Mourant has applied this method most effectively to reconstruct the migrations of peoples in the Mediterranean area. If the blood group genes are not neutral, but represent another case of balanced polymorphism, as appears now possible, the usefulness of this method will be particularly great to demonstrate migrations in the recent past before selection has had an opportunity to change the ratios too drastically.

MOURANT: A full consideration of the effect of selection on blood group frequencies would require a paper to itself. The effect of hemolytic

disease in eliminating the D gene in most countries which have both D and d genes is well known but it is probable, as suggested by Fisher and by Wiener that this is compensated, at least in part. There is probably a similar selection against the A and B genes in favor of the O gene due to direct effects of maternal immunisation. Hemolytic disease due to the Rh factor is accompanied by a selection of A and B and against O. The mechanism of the latter effect is unknown but its existence as shown by the statistics of numerous workers is beyond doubt. The Kell gene (K) is also being selectively eliminated. There ought soon to be plentiful data available for the calculation of the magnitude of the above effects but not perhaps for the size of any compensatory effects.

In addition to selection related solely to the blood group distribution in the population there may be selective influences of the external environment on the blood groups, especially perhaps on the MN groups as Dr. Race has just suggested. Much more information on the whole subject could probably be obtained by large-scale testing of populations and families.

Until such information is available some reserve must be maintained in using blood group data as evidence of population movements and mixing which may have taken place more than about one thousand years ago. There is considerable evidence that blood groups can be used almost unreservedly for tracing events in the last few hundred years, and strong indications such as those detailed in my paper, that they can apply to happenings in a much more distant past. If further work shows that the different blood group systems give consistent results this will be strong evidence for the slowness of any selective action. On the other hand anthropological evidence may serve to show that selection is acting much more strongly in some blood group systems than in others.

MONTAGU: Dr. Mourant has called his paper "largely speculative." If it may be so described I think we would all agree that the more we have of such speculation the better. In America "speculation" is frowned upon, so that to make Dr. Mourant feel more at home I should like to tell him of a "speculative venture" carried out by Dr. W. C. Boyd and myself in 1944 or 1945. We were interested in discovering where Rh-negative may have originated. We therefore drew up a "weather-map" of the genic distribution of Rh-negative. The resulting isogenic map led us to conclude that Rh-negative originated in Southwestern France. We conjectured the period at about 50,000 years, and the population probably a Neanderthaloid-like (!) one. I hope there are no Basques here, but I think you will agree that we were remarkably close to the facts in our "speculation." If we can do this sort of thing with the distribution of serological characters, I believe it will be generally agreed that they are not without value in the attempt to reconstruct something of the genetic history of man.

MOURANT: I am most interested to hear that Dr. Montagu and Dr. Boyd had independently concluded that the climax of Rh-negative frequency should be sought in Southwestern France. Somewhat later, on different grounds, namely their ABO blood groups and their physical anthropology and language, I had suspected that the Basques might represent the high Rh-negative population postulated by Haldane and by Wiener and I had made arrangements to obtain specimens of their blood, but before I actually received the specimens which proved my assumption to be correct I became aware that Etcheverry had already shown it to be true in 1945; but his work remained unknown to most English-speaking workers until 1947. Vallois and other workers have stated that both the Basques and certain inhabitants of the Dordogne show a considerable skeletal resemblance to Cro-Magnon man. Not all anthropologists would agree to this precise attribution.

SANGHVI: A word might be said about the column "India" in the table of the Rh chromosome frequencies. Our study of the distribution of Rh factor in Bombay, mentioned by Dr. Mourant (1945, Nature, Lond. *155*: 427) constituted a sample of 100 individuals of which only two were Rh-negative. One of these Rh-negatives was among the 14 Parsees and one was among the 11 Indian Christians. All 70 Hindus in the sample, which consisted mainly of Marathas, were Rh-positive. Our later work (1947, Ind. J. Med. Sci. *1*: 45) on the distribution of Rh factor in Parsees, Indian Christians and Marathas with a sample of 200 individuals each, showed eight per cent Rh-negatives among Parsees, six per cent among Indian Christians and 1.5 per cent among Marathas.

The situation has however completely changed by our subsequent study (1949, Ann. Eugen. *15*: 52–76) mentioned at the end of the paper read by Dr. Race. Among the six endogamous groups belonging to the Hindu community, the range of variation is from 12 per cent Rh-negative among one endogamous group to 1.5 per cent among another. On the basis of this study it might be stated in a general way that the future studies on the distri-

bution of genetical characters of the people of India, should take into careful consideration the endogamous groups.

MOURANT: The Indian Rh chromosome frequencies quoted in my paper are based on the only two studies of Indians using several anti-Rh sera, those of Wiener, Sonn and Belkin (1945) and of Prasad, Ikin and Mourant (1949). In the latter paper we made it clear that we were aware of the great heterogeneity of the population of India and quoted previous observations showing wide variations in the frequency of the Rh-positive and Rh-negative groups. I am at present collaborating in further studies in which much fuller details, including those of caste, are being recorded.

TORTORA: Over a random population of 1,006 people studied in the Department of Obstetrics and Gynecology of the University of Naples, we found 8.7 per cent of Rh-negative. We are now extending our research to the different provinces of Campania. The results will be presented at the next meeting of the International Society of Hematology in Cambridge, England. As concerns Sardinia, according to the data collected by Morganti (in press) there is a significant difference in the Rh-negative distribution between the two provinces of Cagliari and Sassari. The Rh-negative distribution in Cagliari is almost the same as in Naples and Sicily. It must be referred to the different ethnical constitution of these two provinces.

MOURANT: I am interested to see how the observations of Dr. Tortora and numerous other unpublished observations on Rh groups in Italy, recently sent to me by Dr. Morganti of the Institute of Human Genetics at Milan, give general support to my suggestion of two main stocks having contributed to the present population of Italy.

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