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ANTHROPOLOGICAL INVESTIGATIONS OF THE POPULATION OF GREENLAND

BY

IB PERSSON

WITH 3 FIGURES AND 16 TABLES IN THE TEXT

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OLAFUR BJARNASON
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Errata

p. 12 line 5 from below they, read: they also

p. 45 last line elements read: elements originated,

p. 76 line 25 (8, 37, 39) read: (8, 27, 29)

Author's Previous Publications on this Subject.

1. I. Persson and P. Tingsgaard (1965). A deviating Gc Type. Acta genet. Vol. 15 pp. 51–56. Basel.
2. Aa. Gilberg and I. Persson (1967). Serum protein types in Polar Eskimos. Acta genet. Vol. 17, pp. 422–432. Basel.
3. I. Persson and P. Tingsgaard (1968). Serum protein types in East Greenland Eskimos. Acta genet. Vol. 18, pp. 61–69. Basel.
4. I. Persson (1968). The distribution of serum types in West Greenland Eskimos. Acta genet. Vol. 18 pp. 261–270. Basel.

PREFACE

This study was carried out in Medical Department F, Gentofte Hospital, Copenhagen during my appointment as registrar.

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IB PERSSON

Chapter 1
INTRODUCTION

The Eskimos, who form the original population of Greenland, call themselves 'inuit', which is the plural of 'inuk', meaning man. The Eskimos consider themselves as the true men, in contradistinction to all others. The Norsemen who settled in Greenland about 1000 years ago called them the "Skrællinger". On the other hand, they do not use the term 'eskimo'. This was used for the first time by pastor Biard in 1611, in a description of the Jesuit mission to New France, and it is thought to have originated from the Wabenaki Indian expression 'eskimantsik', which means eaters of raw meat.

During the last approximately 700 years the population of Greenland has been in increasing contact with Europeans. In the beginning, peasants from Iceland settled in the south of Greenland, later came whale hunters from many nations; but in the past few hundred years it has been primarily Norwegians and Danes who settled in Greenland and served as contact between the Eskimos and the Europeans. Gradually the races have become mixed; this is especially true in West Greenland, and it has become a particularly common occurrence during the present century. In only a few places, such as Thule, Angmagssalik and Scoresbysund, are there still pure Eskimos, partly because of the isolated geographical position, and partly because these isolated settlements were not discovered until relatively late.

With the movement of the population resulting from the immensely improved forms of transportation and the entire economic advance which is at present taking place in Greenland, it can be expected that within a few decades the distinctive features of the Eskimos, including the serological ones, will have disappeared.

The scientific investigation of Greenland and the living conditions of the Greenlanders has, during the last century, been very extensive, the research being concentrated mainly on ethnological and archaeological problems. Where Danish research is concerned, Rink founded modern eskimology in the middle of the 19th century. In the field of anthropology valuable Danish investigations have been carried out within recent years by, in particular, Pedersen (1949), Jørgensen (1953) and Skeller (1954).

LANDSTEINER's discovery in 1900 of the ABO blood groups has been of the greatest importance both for practical medicine and for human genetics. By 1910 DUNGERN and HIRSZFELD had already demonstrated that the ABO blood groups were hereditary, and in 1919 the first investigations into the distribution of the different ABO blood groups in various populations were published (HIRSZFELD and HIRSZFELD). Since that time numerous investigations of the distribution of a great number of blood groups have been carried out throughout the world, as evidenced by the impressive reviews of MOURANT (1954) and MOURANT, KOPEC and DOMANIEWSKA-SOBCZAK (1958). When erythrocyte types were first used in population-genetic studies it was thought that they were selectively neutral, but in 1953 (AIRD, BENTALL and ROBERTS) and 1959 (ROBERTS) it was demonstrated with certainty that the ABO blood groups are not selectively neutral. Variation which is found in the distribution of the erythrocyte types may therefore also be due to selection, but when due attention is paid to this and other factors which may contribute to blood group variation, which will be discussed later, serological investigations have been and will be of tremendous importance in anthropology.

However, where the Eskimos are concerned the determination of the erythrocyte types has so far been of limited importance. This is partly because the collection of samples is exceptionally difficult, and partly because the time taken to transport the samples is often so long that it would be impossible to obtain reliable results within some of the blood group systems.

In 1955 the Canadian SMITHIES described a new electrophoretic method for the investigation of serum proteins which revealed that there are inherited variations in different serum proteins. The discovery of the various serum protein systems has been of utmost importance for anthropological research. Where the investigation of Eskimos is concerned these new types have the advantage that long transportation times have relatively little or no effect on the possibility of determining the serum types, in contrast to what was the case with the blood groups which had hitherto been used.

The special conditions which pertain to Greenland, where the inhabited areas are strictly confined to the coastal regions, have meant that systematic serological investigations have been particularly suitable for supplementing the results of other anthropological methods.

It therefore seemed that the investigation of the distribution of the genetically determined serum protein types in the present population of Greenland, before a mixing of the races takes place, was an obvious study.

THE PURPOSE OF THE PRESENT INVESTIGATIONS

The aim of the present work has been to bring together all the information so far collected concerning the anthropology of both the present and the past populations of Greenland. The additional and detailed evidence brought forward through the studies of the present author seemed to suggest new possibilities for more penetrating analyses of the genetic relations between the various populations in Greenland, as well as between these and those groups in North America and Europe which are known to have contributed to the gene pool of the present Greenland population. Even if no solution to these problems were expected, it was hoped that the results would clarify the situation and point towards more promising leads to the investigations of the immediate future which could fill the gaps in our knowledge. The results of the serological studies performed by the present author seem for the first time to have created a more comprehensive basis for a comparison and combination of the results of anthropometric and seroanthropological observations in a way which has not been attempted previously.

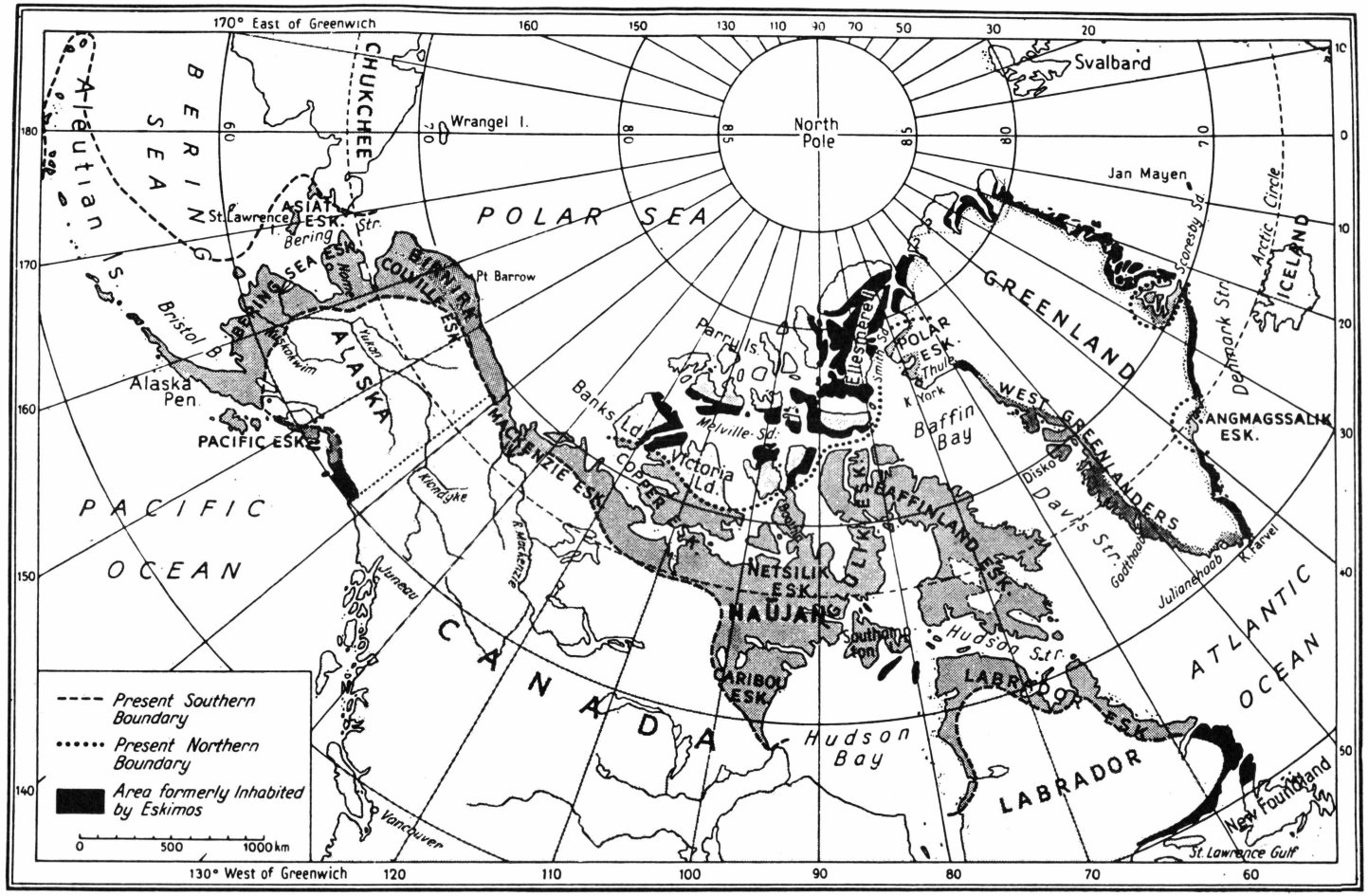

Fig. 1. Distribution of the Eskimos. (After BIRKET-SMITH 1927)

Chapter 2

REVIEW OF THE ORIGIN AND HISTORY OF THE POPULATION OF GREENLAND

By means of the most recent archeological investigations it has been possible to establish that the first men reached Greenland about 4,000 years ago. Diggings at Sermermiut, now an unsettled site on Jakobshavns Isfjord, have given important assistance in the elucidation of the various cultures which have dominated in Greenland (Larsen and Meldgård 1958). The oldest forms of culture, comprising Independence I, the Sarqaq Culture, Independence II, and the Dorset Culture, are included in the term Palæo-eskimo Culture. These cultures had strong inland traits, with hunting of the reindeer playing an essential role. The term eskimo culture form is rather misleading, as nothing is known of the races to which these peoples belonged because very few objects of organic nature have been preserved. The expression is used only in connection with the cultural forms themselves.

Very little is known about the origins of the Palæo-eskimos, but discoveries in North America, Alaska and Asia indicate that the first settlers of Greenland came from the west, via the North American islands, crossed the narrow Smith Sund, and thereafter followed the north coast of Greenland. In all events, the earliest traces of man as yet found in Greenland were in the north-eastern corner in the Independence Fjord and Danmark Fjord. This immigration seems to have been favoured by a warmer and drier climate in these areas than is found at the present time. The earliest settlers belonged to a culture which is called Independence I, and which seems to have been an earlier phase of the Sarqaq Culture—so-called from the first finds which were discovered near Sarqaq on the Nugssuaq peninsula. A thousand years later a new wave of people wandered in across Northeastern Greenland; they belonged to another culture which is called Independence II. The earliest inhabitants of Greenland did not, however, remain in Northeastern Greenland, they also moved southwards, and in about the year 100 B.C. they reached the area around Disko Bugt. Finds of their settlements suggest, however, that from Thule they also moved eastwards and further south, so that in reality they came to live along all the coasts of Greenland. In

about 500 B.C. the climate once again became colder and wetter, and it is possible that during the centuries until the birth of Christ Greenland lay deserted and unpopulated.

At around the time of the birth of Christ a new eskimo culture came to the northeastern parts of Greenland. This culture is called the Dorset Culture, after the site of the first finds near Cape Dorset in North America (MELDGÅRD 1955). As has been mentioned, the Dorset Culture was very much an inland culture and hunting of reindeer seems to have played a very important part; but hunting of seals over the ice was probably also of importance. Despite its obvious eskimo traits, this culture also had an islet of Indian Culture, and the areas of its extension through Central Canada and Labrador seem to point more to the south than to the west. As the climate of Greenland gradually improved these people also spread along the coasts. They often settled on the same sites as the earlier Sarqaqs.

There is evidence that in about 500 A.D. there was a reduction in the extent of the Dorset Culture, possibly due to a deterioration in the climate. At the same time a new people, the Neo-Eskimos or the Thule people came to Greenland. The origin of this people is uncertain, but everything seems to indicate that they came from North-East Asia, whence they crossed over the Bering Strait and spread over North America and further eastwards to Greenland in the Thule region. The Thule people were sea-faring Eskimos, whose way of life was far more adapted to the new climatic conditions. It is as yet not known whether the Dorset people were driven out or absorbed by the Thule people, but about 1,000 years ago the Dorset almost disappeared from the coasts of Greenland.

At about the time that the Thule people advanced through North America, peasants from Iceland began to settle along the fjords in South-West Greenland. Whilst it is not possible to give an exact date for the settlement of the Thule people, it is known that the first Icelander, ERIK THE RED, settled in Greenland in 982 A.D. He remained in Greenland for three years and in 985 or 986 he returned to Greenland followed by many other immigrants. They settled partly in the Julianehåb district where they founded Østerbygden, and partly near Godthåbsfjord, where they founded Vesterbygden (BRUUN 1931, NØRLUND 1942, INGSTAD 1960, GAD 1967).

From these settlements they went on long hunting expeditions to the north, as far as Upernavik where they left a runic stone, but they went south and westwards and reached Baffin Island, Labrador and as far as Newfoundland. The Norsemen in Østerbygden and Vesterbygden lived as peasants and were able to supply most of their own needs, but it was necessary for them to obtain grain, wood and iron from elsewhere.

For this reason the inhabitants suffered great hardship when the sea passages from Scandinavia to Greenland, which were indispensible to them, were interrupted for long periods around 1400 A.D. The Norsemen also experienced difficulties from other directions. The Thule Eskimos spread along the west coast of Greenland, where they presumably came up against the Norsemen, who called the Eskimos "Skrællingerne", in about the year 1200. The Thule Culture seems to have been influenced during this encounter, and it cannot be excluded that some mixing of the races may also have taken place, but as a whole the Thule people did not mix with the Europeans during the Middle Ages. For reasons which are as yet only partly understood, the Thule people continued to spread, whilst the Norsemen disappeared. Vesterbygden was the first settlement to be destroyed, in about 1350, and Østerbygden followed about 150 years later. The last definite documentary information about the Norsemen dates from 1410. Meanwhile archaeological investigations by Nørlund (1942) have definitely shown that there must have been connection with Europe up to about 1480. The ultimate fate of the Norsemen has so far remained unknown, and all that is known is that when ships once again reached Greenland from Europe in about 1580, no Norsemen were encountered. However, at this time only the coast north of Julianehåb was reached because of the ice around South Greenland.

In contrast to the earlier cultures the Thule Culture depended on hunting marine animals from kayaks and umiaks. The Thule people not only introduced a new hunting technique, but also a new way of life in other fields, such as those connected with hunting equipment, clothing, houses, and the use of materials. The Thule Culture spread further round the west coast and during this extension the cultural form was altered and an entirely new West Greenland culture developed, called the Inugsuk Culture, after the first site on which it was found near Upernavik. This culture form did not remain confined to the west coast of Greenland but spread round Kap Farvel and northwards along the east coast, reaching as far as Scoresbysund. By retrograde spread northwards the Inugsuk Culture spread round the northern part of Greenland.

By admixture of the waves of Eskimos from North America with Thule Culture a particular form of culture developed in North-East Greenland, containing Inugsuk elements and late Thule elements. There is only one single description of a meeting with these North-East Greenlanders in life; this is by the Englishman Clavering, who in 1823 landed on the island which later came to bear his name. Here he met a small group of Eskimos and remained in contact with them for several days. But when at the end of the last century the north-east coast was more closely explored, there were no longer any living Eskimos in the area.

In the Thule district itself there had throughout the centuries been immigration by new groups from North America—the last arriving about 1865—so that an independent tribe called the Polar Eskimos developed in Thule.

As stated, the Norsemen may have disappeared from Greenland in about the year 1500, but it was not long before the Eskimos once again came into contact with Europeans. There are completely reliable reports of the rediscovery of Greenland from 1576, when FROBISHER reached the west coast of Greenland. During the 17th and 18th centuries numerous whaling ships touched the coasts of Greenland. People from many nations took part in these whaling expeditions but it was particularly the Basques. Some mixing of the races also took place, and this came to affect the population of the central part of the west coast of Greenland, especially in the region from Frederikshåb northwards to Umanak. The most southern part of Greenland thus remained isolated and without any particular contact with Europeans until modern times.

The Danish colonization of Greenland began in 1721. The driving force behind this was the Norwegian priest HANS EGEDE, who in 1721 settled near Godthåbsfjord (EGEDE 1738). HANS EGEDE endured the hard conditions for 15 years, and during this time several new colonies were established along the west coast of Greenland. This colonization continued during the following years and within 50 years there was a continuous line of colonies extending from Frederikshåb to Upernavik. It is worth emphasizing that the largest proportion of the colonists were Danes and Norwegians, and that they included only five Icelanders (KNUDSEN 1939–41). These conditions continued until Denmark and Norway were separated in 1814. The majority of the immigrants came to Greenland as bachelors, and many married Greenland women, so that in this way many mixed families were founded.

In 1818 the Englishman JOHN Ross reached Thule, where he was the first European to encounter the Polar Eskimos. However, it was not until 1892 that they established more permanent contact with foreigners; in that year the American, PEARY, began his exploration of North Greenland. Exploration was also carried out by Danes, for example the naval officer GRAAH, who in 1829 reached as far north as Dannebrog Ø, only 100 km from Angmagssalik, before being obliged to turn back. It was not until 1884 that GUSTAV HOLM reached Angmagssalik, where he found the last remaining Angmagssalik Eskimos, whose numbers were diminishing rapidly (HOLM 1888–1889).

The result of the progress of the various tribes of Eskimos to Greenland and the admixture of foreign elements has been that the population

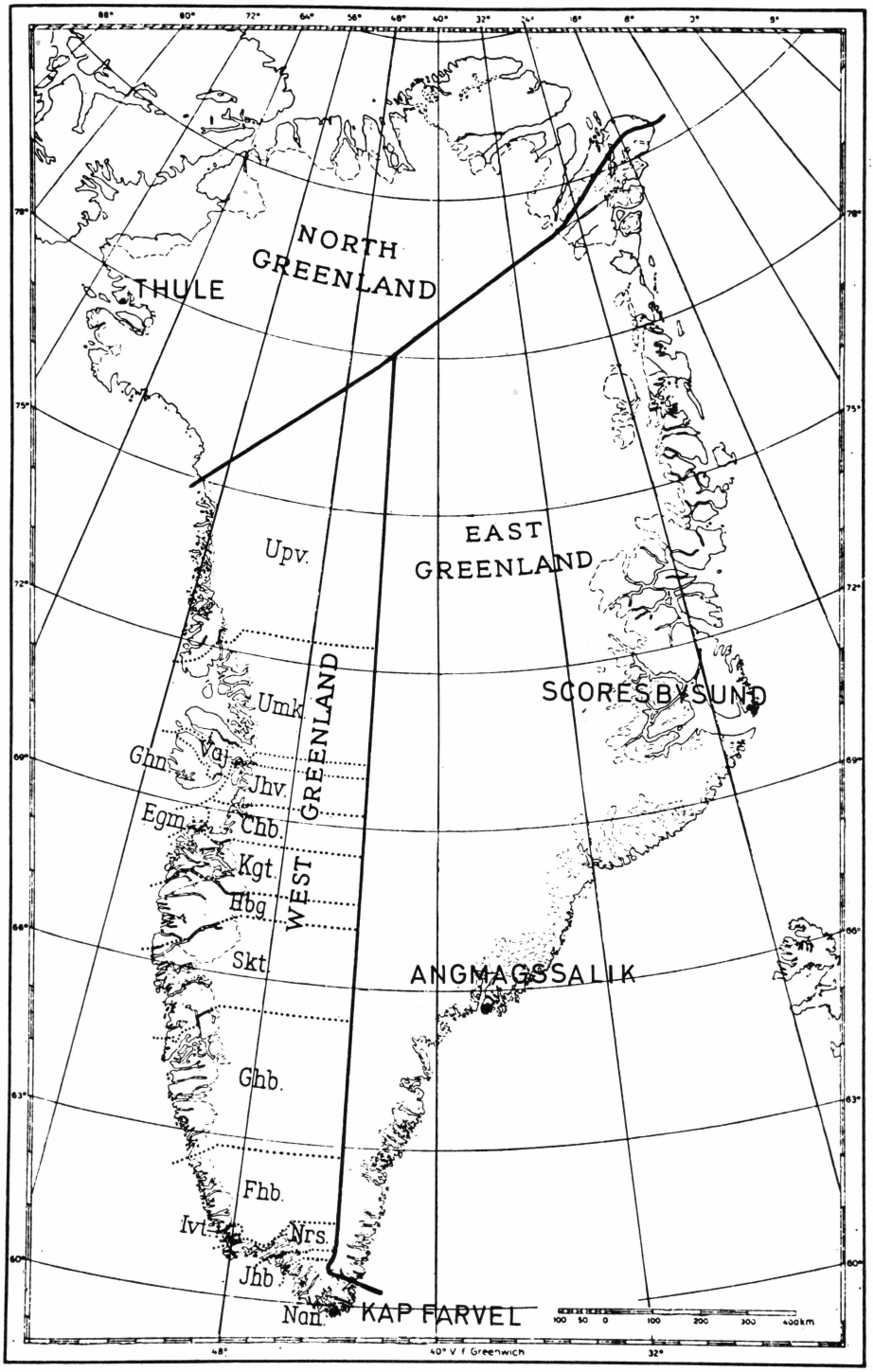

Fig. 2. The administrative division of Greenland (Abbreviations see Fig. 3)

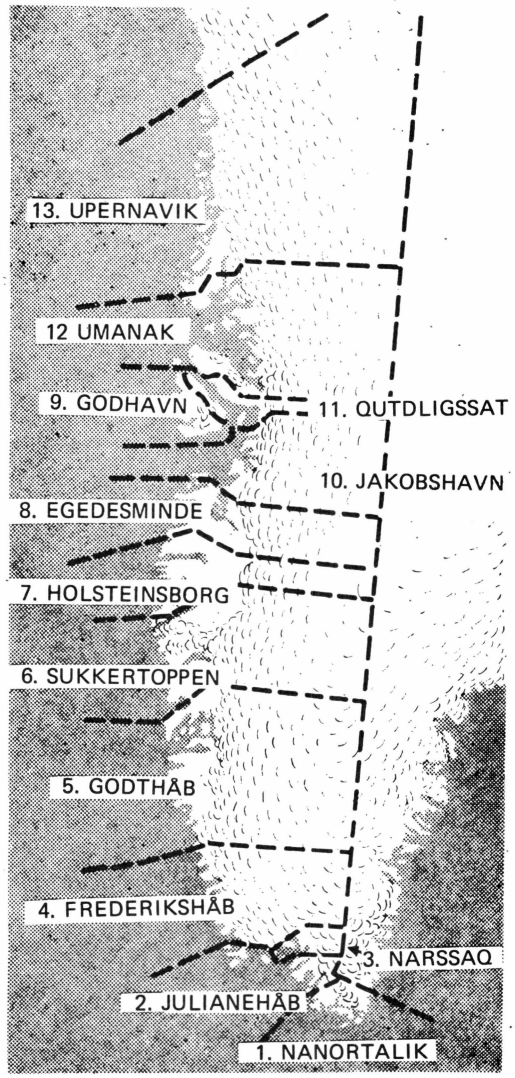

Fig. 3. West Greenland. Public health districts

of the west coast of Greenland consists of a mixture of Eskimos and Europeans, among others Norwegians and Netherlanders, and later mainly Danes. A relatively pure tribe of Eskimos renewed by immigration from North America still exists in the Thule district and these are called the Polar Eskimos. Another almost pure tribe of Eskimos isolated for centuries is to be found in the Angmagssalik region and in Scoresbysund, which was founded in 1925 and populated with hunters from Angmagssalik.

This population pattern corresponds with the present administrative division into three main regions (fig. 2): North, East and West Greenland; the last comprises 13 public health districts (fig. 3) which also constitute areas which are geographically quite clearly delimited from one another. The serological determinations to be discussed in the following have, especially as far as the serum groups are concerned, been carried through and analysed for each district separately.

Chapter 3

ANTHROPOMETRICAL INVESTIGATIONS OF THE GREENLANDERS AND RELATED ETHNIC GROUPS

The first description of the Eskimo cranium was published in 1722 by Winsløw. Later further anthropometrical descriptions followed, but the methods used were unsatisfactory. It was not until 1874 that Pansch gave a good description of crania of Eskimos from North-East Greenland, although this was based on only a small series of 11 samples. In 1875 Bessels published an anthropometrical investigation of an extraordinarily interesting collection of 101 crania of Eskimos from Etah on Smith Sund. These crania originated from graves dated at any rate only a few years later than the arrival of the first European expedition in Thule. Unfortunately he had to give up any attempt at a sex determination of the crania. Hoessly's examination of 29 crania from a small island near Angmagssalik appeared in 1916. The graves were from the period before the discovery of Angmagssalik in 1884 by Holm.

Fürst and Hansen in 1915 published their comprehensive investigations of 380 crania from all parts of Greenland, but the dating as a rule was altogether uncertain and there was in many cases no information as to the places where the crania were found; moreover there was no differentiation between the sexes. In 1938 Fischer-Møller's description of limb bones from old Greenland graves originating from before the year 1750 appeared.

In 1953 Jørgensen published his comprehensive investigations of 245 crania and 121 whole skeletons from Greenland. All the bones from West and South-East Greenland were collected into one group as they had been found under circumstances which permit them definitely to be placed in the same culture period, the Inugsuk Culture, *i.e.*, the time before the mixing with the Europeans, whilst the skeletons from North-East Greenland belong to the now vanished Eskimos with the North-East Greenland Culture. In addition he had a small collection of skeletons from Thule which could not be dated with certainly and some small series from different places outside Greenland. The investigations showed two different physical types, differing from each other in both the

structure of the cranium and that of the limb bones. These two types correspond each to its own culture, Inugsuk and North-East Greenland Culture. In addition he demonstrated that the pure Inugsuk crania and later mixed West Greenland crania were decisively different. Comparison between the cranial measurements for the medieval Norsemen and the corresponding measurements for the Inugsuk Eskimos has not revealed any features in the Eskimos which may be interpreted as results of a mixture between these people.

Anthropometrical investigations of living Eskimos in Greenland have also given corresponding results. As the only European, CLAVERING in 1823 met the North-East Eskimos and gave a short description of them. HANSEN has in 1886 and 1893 published investigations about South-East and West-Greenlanders. Most remarkably, he demonstrated among these a special dolichocephalic type in the Upernavik district. He explains this fact by presuming that Eskimos from Thule have immigrated to this region comparatively late. POULSEN (1909) has investigated the Angmagssalik Eskimos who lived in the last half of the 19th century and found very few differences from the West Greenlanders who lived at that time.

STEENSBY and HRDLICKA in 1910 both described the Polar Eskimos in the Thule district and around Smith Sund. In both cases the material was very scanty, but both mention that these Eskimo almost gave the impression of belonging to a race quite different from the West Greenlanders. In 1949 FABRICIUS-HANSEN published the results of the measurements of individuals from the Julianehåb district. The measurements diverge somewhat from those formerly known from the east as well as the west coast, but she considered this difference insufficient to attach any importance to it.

To summarize: the Eskimo skeletal material from Greenland shows two different physical types, each corresponding to its own culture, the North-East Greenland and Inugsuk Culture, the latter being found in South-West and South-East Greenland.

In 1930 HRDLICKA published the measurements of old skeletons from Point Barrow in Alaska excavated from some old collapsed house ruins, "old igloo mounds". In the beginning it was thought that the finds were from the Thule Culture, but later investigations have shown that it was a somewhat older period, the Birnirk period.

FISCHER-MØLLER has in 1937 published the results of some important skeletal finds from Naujan near Hudson Bay. The most interesting was that the skeletons from this region differed decisively from the Birnirk Eskimos, which may be dated to almost the same culture period. In 1939 STEWART measured and described the Eskimos from Labrador, partly living persons and partly skeletons from old graves. He showed

that the population in earlier times were more dolichocephalic than at present and that they very closely resembled the population in Greenland at that time. They diverged both from the Birnirk people and from the Eskimos on Southampton Island in Hudson Bay (HRDLICKA 1910).

In 1943 HRDLICKA published a small series from Saint Lawrence Island at Bering Strait. The material is of great interest because it can be dated back to the old Bering Sea Culture, the earliest of the Eskimo coastal cultures.

Through anthropometrical investigations, of which JØRGENSEN's (1953) are the most thorough, the question of the origin of the Eskimos of Greenland has been elucidated. The Inugsuk crania from South-West and South-East Greenland in nearly all dimensions and proportions showed identity with crania from Labrador, and very close to these two groups lie the crania from the Birnirk Eskimo group in Alaska. The North-East Greenland type in contrast corresponded to the Eskimos with the Thule Culture from Naujan and Southampton Island in Hudson Bay. Measurements of Eskimos and Indians show such great differences in the crania that no close relationship seems to exist between the two groups. The final results of the investigations were that there has been a direct evolution from Birnirk to Inugsuk Culture people in Greenland, without the population known to have lived round Hudson Bay at the time of the Thule Culture, which later reached the north-east coast of Greenland, as an intermediate stage. This evolution corresponds in all essentials to the culture development and wandering demonstrated archaeologically.

Chapter 4

THE SEROANTHROPOLOGY OF THE GREENLANDERS AND RELATED ETHNIC GROUPS

A. Erythrocyte groups

I. The Greenland Population

The ABO blood groups

Investigations within the ABO system have previously been carried out in a total of about 4,000 Greenlanders. The results are shown in Tables I and II (partly after Mourant, Kopeć and Domaniewska-Sobsczak 1958). The values of D/σ as published by these authors are also quoted here. This is an expression of the agreement between the observed and expected distribution, where the expected figures are worked out by means of the gene frequencies, calculated from the proportions of A, B and O phenotypes found in the material by the method of Bernstein (1930). The sign of D/σ shows whether group AB is in deficiency or in excess, and the value may be considered significant if it lies outside ± 2.0. A high value may be due to technical inaccuracies or heterogeneity of the sample, or both. None of the samples, with the sole exception of the material from Kap York (Thule), show significant D/σ values.

It is obvious from the tables that the ABO groups of the Greenland population are not yet known in sufficient detail; this applies specifically to the northern part of the west coast, and to the Thule region, which is represented only by one relatively small sample. Where repeated sampling from the same region has been made it appears that the internal consistency is quite good if the size and origin of the materials (pure or mixed population) are taken into consideration. The Eskimos of East Greenland seem to have been examined very thoroughly, two large samples showing quite similar results having been published. The total range of variation as evidenced by the figures of Tables I and II is very remarkable.

The observations from Thule (Kap York) show the population examined here to stand out as a group strikingly different from the rest of the Greenland population. The high D/σ value of this sample may of

Table I. *The ABO Blood Groups. Greenland*

Place	Population	Authors	Numbers	O	A	B	AB	p	q	r	D/σ
West Greenland											
Kap Farvel and Nanortalik	Isolated Eskimos	BAY-SCHMITH 1930	484	200 41.32	260 53.72	17 3.51	7 1.44	33.07	2.51	64.42	+ .47
Kap Farvel and South of Nanortalik.....	Eskimos	FABRICIUS HANSEN 1940	377	137 36.33	206 54.64	20 5.30	14 3.71	35.48	4.62	60.27	
Nanortalik	Eskimos	–	419	205 48.92	186 44.39	18 4.29	10 2.38	27.06	3.40	69.94	
Julianehåb	Eskimos	–	267	147 55.05	98 36.70	14 5.26	8 2.99	22.34	4.21	74.20	
Julianehåb	Eskimo-Whites	BAY-SCHMITH 1930	607	329 54.20	234 38.55	29 4.78	15 2.47	23.14	3.68	73.18	−1.66
–		–	101	47 46.53	28 27.72	24 23.76	2 1.98	16.31	13.95	69.74	+1.44
South-West.....	Greenlanders	AHRENGOT and ELDON 1952	186	77 41.40	92 49.46	12 6.45	5 2.69	30.85	4.68	64.47	+ .20
Jakobshavn	Greenlanders (Eskimos and Danish settlers)	FREUCHEN 1932	340	148 43.53	160 47.06	25 7.35	7 2.06	28.74	4.83	66.43	+ .97
Godhavn Prøven	Eskimo-Whites	HEINBECKER and PAULI 1927	97	40 41.24	39 40.21	8 8.25	10 10.31				

Table I (cont.)

Place	Population	Authors	Numbers	O	A	B	AB	p	q	r	D/σ
North Greenland											
Kap York	Nearly all unmixed Eskimos	Heinbecker and Pauli 1927	124	100 80.65	16 12.90	3 2.42	5 4.03	8.77	3.25	87.98	−5.36
East Greenland											
Angmagssalik	Eskimos	Gessain 1937	644								
				24.	53.3	12.	10.				
–	Eskimos	Fabricius-Hansen 1939	569	136 23.90	320 56.24	64 11.25	49 8.61	40.69	10.48	48.83	− .10
–	Eskimos	Tchernia 1941	21	7 33.33	8 38.10	4 19.05	2 9.52				
Scoresbysund	Eskimos	Tcherniakofsky and Le Méhauté 1933	20	7 35.00	7 35.00	4 20.00	2 10.00				

The letters p, q, and r refer to the gene frequencies for A, B, and O.

Table II. *A_1 A_2 BO Blood Groups. Greenland*

Place	Population	Authors	Numbers	O	A_1	A_2	B	A_1B	p_1	q	r	D/σ
West Greenland												
Holsteinsborg	Mixed Eskimos	Laughlin 1957	29	18 62.07	9 31.03	0	1 3.45	1 3.45				
East Greenland												
Angmagssalik	Pure Eskimos	Skeller 1954	180	45 25.00	108 60.00	0	15 8.33	12 6.67	42.26	7.80	49.94	− .05

course give rise to doubts concerning its reliability, but even if later determinations may modify the actual values it seems clear that the frequency of the O gene is exceptionally high and the frequency of the A gene correspondingly low, the figures being very different from those observed in all related population groups.

The extensive investigations from the east coast show the Eskimo population of this region to be distinctly different from that of other regions in Greenland, being lowest in O and highest in A and B. The only study available of an acceptable size in which the subdivisions of A have been included showed A_2 to be absent in this region.

The samples from the west coast which, as mentioned, give a much more extensive representation of its southern part, show this region to be conspicuously heterogeneous, with no uniform trend from south to north. On considering the samples stated to be taken from pure population groups it is found that, for instance, the O gene shows a relatively low frequency in the south, rising very clearly in the Nanortalik district and even more so in Julianehåb, whereas it seems to go down again further north, approaching the values observed in the most southern part of the west coast. Thus Julianehåb and to some extent the Nanortalik region seem to stand out with an ABO blood group distribution clearly different from that of their immediate neighbours as well as those of other population groups in Greenland. The samples from the most northern part of the west coast, which are, however, quite small, show no clear tendency to approach the distribution found in the Thule region.

The MN blood groups

The distribution within the MN system has been investigated to only a very limited extent, as shown in Table V. On the basis of these results it can only be said that there are pronounced differences between the Eskimos on the east coast and those on the west coast, corresponding to what was found in the ABO system. No information is available from the Thule district.

The Rh blood groups

Until now only two investigations of the Rh blood groups have been published, namely from Angmagssalik (SKELLER 1954) and from the southernmost districts of West Greenland (AHRENGOT and ELDON 1942). The most important finding seems to be that D-negative individuals were not encountered in any of these populations.

Other blood groups

The remaining blood groups have with one exception not been studied in Greenland until now. Only one investigation of the P system

has been reported from Angmagssalik (SKELLER 1954), where the frequency of the P_1 gene was found to be 0.13, which is definitely lower than the values found in Northern Europe.

II. Related Ethnic Groups

The distribution of blood groups has also been investigated in Eskimos in North America. Tables showing these are to be found in MOURANT (1954) and MOURANT, KOPÉC and DOMANIEWSKA-SOBCZAK (1958). The results of the blood group determinations in Eskimos in North America, especially Canada and Alaska, can be seen from Tables III–V. Only the results for blood groups also investigated in Greenlanders have been cited, and as far as the ABO blood groups (given in Table III) are concerned, only those investigations which comprised a reasonable number of individuals. For each population is given the observed number within each group and underneath both the percentages and the calculated gene frequencies and the D/σ values (after MOURANT, KOPEĆ and DOMANIEWSKA-SOBCZAK 1958).

The pure Eskimos in Canada, Alaska, and on the Aleutian Islands possess appreciable frequencies of the three ABO blood group genes. The A gene shows relatively small variations with no clear trend. The O gene has its highest value in the Eskimos of Labrador, and there seems to be a rather general increase from the West to the East. The B gene, on the other hand, is high in Eskimos of Alaska and falls gradually towards the East, being almost absent in Eskimos of the Baffin Island and Labrador. The relatively small studies in which the subgroups of A have been taken into account show the A_2 gene to be almost absent in these populations. The total range of variation of the A and O genes is much smaller in North American than in Greenland Eskimos.

The most remarkable characteristic of the North American Eskimos seems to be the high B frequency observed in Alaska; the only Eskimos in Greenland with a similar frequency of this gene are these living on the east coast, but the values of the A and O genes, on the other hand, are quite different in these two groups, although they both show the same tendency to be low in O and high in A when compared with the other groups in the two regions. The average frequencies of the more eastern Eskimos of North America generally come closer to the West Greenland Eskimos.

A comparison between Greenland Eskimos and other ethnic groups from which it is known or has been postulated that they are descended reveals that compared with the Eskimos there is a lower frequency of the A gene among the Indians of Canada. The majority of the Indians in both North and South America have in by far the majority of cases

Table III. *The ABO Blood Groups. North America, Alaska, Eskimos*

Place	Population	Authors	Numbers	O	A	B	AB	p	q	r	D/σ
Alaska	Eskimos	MATSON and ROBERTS 1949	341	126	153	40	22				
				36.95	44.87	11.73	6.45	30.15	9.52	60.33	− .70
–		PAULS 1952	655	217	284	105	49				
				33.13	43.36	16.03	7.48	29.89	12.54	57.57	+ .01
Alaska Western	Eskimos	PAULS et al. 1953	2954	1125	1302	386	141				
				38.08	44.08	13.07	4.77	28.54	9.38	62.08	+1.70
–	Eskimo-Whites	–	258	108	105	34	11				
				41.86	40.70	13.18	4.26	25.85	9.16	64.99	+ .42
Alaska Nome	Eskimos	LEVINE, V. 1944	254	110	108	30	6				
				43.31	42.52	11.81	2.36	25.90	7.40	66.70	+1.44
Alaska Point Barrow	Eskimos	LEVINE, V. 1948	329	134	155	32	8				
				40.73	47.11	9.73	2.43	29.10	6.31	64.59	+1.45
–	Mixed Eskimos	–	172	54	94	9	15				
				31.40	54.65	5.23	8.72	38.94	7.14	53.92	−2.31
Aleutian Islands	Mixed Eskimos	LAUGHLIN 1951	144	71	64	6	3				
				49.31	44.44	4.17	2.08	26.84	3.18	69.98	− .42

The ABO Blood Groups. North America, Canada, Eskimos

Place	Population	Authors	Numbers	O	A	B	AB	p	q	r	D/σ
Canada North-West Territories	Pure and Mixed Eskimos	JORDAN 1946	272	120	138	10	4				
				44.12	50.73	3.68	1.47	30.88	2.61	66.51	+ .23
Victoria Island.....	Pure Copper Eskimos	CHOWN and LEWIS 1959	320	146	153	14	7				
				45.63	47.81	4.37	2.19	29.14	3.16	67.70	
Labrador and Baffin Island	Eskimos	SEWALL 1939	146	81	64	0	1				
				55.48	43.84	.00	.68	25.47	.34	74.19	
Baffin Island	Eskimos	HEINBECKER and PAULI 1928	166	92	72	1	1				
				55.42	43.37	.60	.60	25.12	.61	74.27	

Table IV. *A_1 A_2 BO Blood Groups. North America, Eskimos*

Place	Population	Authors	Numbers	O	A_1	A_2	B	A_1B	A_2B	p_1	p_2	q	r	χ^2
Canada, Hudson Bay	Eskimos	Chown and Lewis 1952	67	36 53.7	28 41.8	1 1.5	1 1.5	1 1.5	0 .0	24.63	.99	1.50	72.88	.70
Canada, Ungava District	Eskimos	Chown and Lewis 1956	64	26 40.63	37 57.81	0	1 1.56	0 .00						
Alaska.....	Eskimos	Corcoran et al. 1959	241											
Wainwright..	Eskimos		111	33 30	58 52	1 1	13 12	6 5	0 0	35	.5	9.0	55	
Barrow	Eskimos		64	17 27	42 66	1 2	4 6	0 0	0 0	41	2.0	3.0	54	
Anaktuvuk Pass.....	Eskimos		55	9 16	29 53	0 0	12 22	5 9	0 0	39	0.0	17	44	
Beaver.....	Eskimos		11	6 55	5 45									

Table V. *MN Groups. Greenland, North America, Denmark, Iceland and Norway*

Place	Population	Authors	Number tested		Phenotypes % MM	MN	NN	Genes % M	N
East Greenland	Eskimos	FABRICIUS-HANSEN 1939	569	obs	83.48	15.64	.88	91.30	8.70
				exp	83.36	15.88	.76		
–	Eskimos	SKELLER 1954	180		85.55	13.88	.56	92.50	7.50
West Greenland	Eskimos	FABRICIUS-HANSEN 1940	733	obs	66.17	30.97	2.86	81.65	18.35
				exp	66.67	29.96	3.37		
S.W. Greenland	Eskimos	AHRENGOT and ELDON 1952	187	obs	67.38	28.34	4.28	81.55	18.45
				exp	66.51	30.09	3.40		
North America									
Aleutian Islands	Eskimos	LAUGHLIN 1950	142	obs	71.83	25.35	2.82	84.51	15.49
				exp	71.41	26.19	2.40		
Alaska	Eskimos	MATSON and ROBERTS 1949	341	obs	47.80	41.64	10.56	68.62	31.38
				exp	47.09	43.06	9.85		
Alaska	Eskimos	PAULS et al. 1953	604	obs	63.91	30.46	5.63	79.14	20.86
				exp	62.63	33.02	4.35		
Canada Victoria Island	Pure copper Eskimos	CHOWN and LEWIS 1959	320	obs	69.06	30.31	0.63	84.22	15.78
				exp	70.92	26.59	2.49		
Alaska	Eskimos	CORCORAN et al. 1959	241						
Wainwright	Eskimos		111		66	33	1	82	18
Barrow	Eskimos		64		61	38	1	80	20
Anaktuvuk Pass	Eskimos		55		78	22	0	89	11
Beaver	Eskimos		11		54	36	9		
Denmark	Danes	HENNINGSEN 1952	2345		29.8	48.5	21.7	54.1	46.0
Iceland	Icelanders	DONEGANI et al. 1950	747	obs	31.19	51.54	17.27	56.96	43.04
				exp	32.44	49.03	18.52		
Norway	Norwegians	HARTMANN and LUNDEVALL 1944	3430	obs	30.18	49.03	20.79	54.70	45.30
				exp	29.92	49.56	20.52		

group O, whilst this phenotype appears in only one-third of the North Asian tribe, the Tungus Oroks.

Investigations of Eskimos in Canada and Alaska have, with a single exception, shown almost the same frequencies for the M gene, from 0.80 to 0.85, as the West Greenland Eskimos. A relatively high incidence of the M gene as found in East Greenland Eskimos is seen in many Indians.

For hundreds of years there has in many places been mixing between Eskimos in Greenland and Europeans, in the last centuries mainly Danes and Norwegians. The blood groups of these populations are therefore of interest. A survey of the results is to be found in MOURANT (1954) and MOURANT, KOPEĆ and DOMANIEWSKA-SOBCZAK (1958). The average frequencies of the A, B and O genes of the Scandinavians are very different from those found in the Thule and East Coast Eskimos, whereas they are closer to the values generally found on the west coast of Greenland, but the heterogeneity of this latter region calls for more detailed analyses, as will be discussed later.

To summarize, the results obtained in the investigations of the ABO and MN blood groups in Eskimos in Greenland show significant differences between East and West Greenlanders and Polar Eskimos. The gene frequencies for the Eskimos in East Greenland and Thule deviate more from the Eskimos in North America than is the case for the West Greenlanders. However, it must be stressed that the total range of variation of the genes for the ABO blood groups is much more extensive in Greenlanders than in the Eskimos investigated in North America.

B. Genetically determined variations in the Serum Proteins

The Gm system

In 1956 GRUBB demonstrated some inherited variations in the gamma-globulins which were given the name the Gm system. It was based on the finding that sera from some patients with chronic polyarthritis, together with sera from a few patients with other diseases and a few normal persons, could agglutinate O Rh positive blood corpuscles which had previously been sensitized with selected incomplete anti-D sera. On closer study, GRUBB found that some sera from normal subjects contained a substance which inhibited agglutination with some of these rheumatic and normal sera. Sera causing inhibition were called Gm(a+), whilst sera which lacked this inhibitor were termed Gm(a−). Those agglutinins which are found in patients with primary polyarthritis are now often called "Raggs", whilst those found exceptionally in nor-

mal subjects have been called "Snaggs" (ROPARTZ et al. 1960). Raggs are usually polyvalent, that is, can be used to test for several Gm factors, whilst Snaggs are monovalent. The Gm factors seem to be stable and can tolerate storage at $-10°$ for up to several years (PODLIACHOUK et al. 1958). On the other hand it is known that the Gm types are not stable in incorrectly stored or infected sera (personal experience and LINNET-JEPSEN (1965)).

It has been proved that the Gm system is far more complicated than was originally supposed, several new factors having been demonstrated: first Gm(b) (HARBOE 1959), and Gm(x) (HARBOE and LUNDEVALL 1959), later many more additional types (for a review, see NATVIG and KUNKEL 1968).

The inhibitors seem to be inherited, presumably determined from one single but very complex locus. The most common gene complexes usually found in Caucasian populations are Gm^a, Gm^{ax}, and Gm^b. STEINBERG et al. (1961) were the first to launch the hypothesis that other gene complexes can appear in other populations, such as the gene Gm^{ab} in Indians and Eskimos.

The presence of close linkage between the Gm(a) locus and the loci for blood groups (although the relationship to the Kidd system has not been elucidated) and other serum protein variants has been excluded (SINISCALCO 1959, HAUGE 1962). A number of investigations into the Gm system in various ethnic groups have been carried out, and from the anthropological viewpoint it seems in some cases to be a valuable aid (STEINBERG 1962).

Previously, investigations into the Gm system in Greenlanders have been performed only on a very small scale (GRUBB and LAURELL 1956). The methods used in the investigations by the present author (GILBERG and PERSSON 1967, PERSSON and TINGSGAARD 1968, PERSSON 1968) are described in the appendix. The results of the investigations of the Gm frequencies in Greenlanders are shown in Table VI. In this connection it may be reasonable to stress that greater care has been taken in obtaining samples from pure Eskimos in the Godthåb district than in other parts of the west coast. In the Julianehåb district especially, a Norwegian family settled in 1774, but their descendents were not included in the study of the serum groups. The possible importance of this will appear in the discussion.

The results of the investigations were the demonstration of considerable variations in the Gm gene frequencies. The maximum value of Gm^a was found in Eskimos in North Greenland, whilst the lowest value in Greenland has been found in West Greenlanders. The gene Gm^{ax} is lacking in pure Polar Eskimos and occurs only rarely in East Greenland Eskimos.

Table VI. *The Gm system, Greenland*

Place	Population	Authors	Number	Gene frequencies Gm^a	Gm^{ax}	Gm^b
West Greenland						
Holsteinsborg...	Mixed West Greenlanders	Grubb and Laurell 1956	74	0.767		0.233
Godthåb	Mixed West Greenlanders	Persson 1968	301	0.641	0.083	0.276
North Greenland						
Thule.....	Mixed Thule Eskimos	Gilberg and Persson 1967	301	0.825	0.005	0.170
Thule.....	Pure Polar Eskimos	Gilberg and Persson 1967	153	1.000	0	0
East Greenland						
Angmagssalik...	Pure Angmagssalik Eskimos	Persson and Tingsgård 1966, 1968	451	0.998	0.002	0

Significant differences in the distribution of the Gm types were demonstrated between the west coast Greenlanders on one side and Eskimos in North and East Greenland on the other, whereas the Thule and the Angmagssalik Eskimos are very similar in this respect (Table VII).

Table VII.

The distribution of the Gm groups in original unrelated Polar Eskimos and west coast Greenlanders

	Thule obs.	Thule exp.	Thule χ^2	West obs.	West exp.	West χ^2	Total
a+x+	0	7.0	7.000	48	41.0	1.195	48
a+x−	51	40.7	2.607	230	240.3	0.441	281
a−x−	0	3.3	3.300	23	19.7	0.553	23
	51		12.907	301		2.189	352
	$\chi^2 = 15.096$ (for 2 d.f., $p < 0.001$)						

The distribution of the Gm groups in original unrelated Angmagssalik Eskimos and west coast Greenlanders

	Angmagssalik obs.	Angmagssalik exp.	Angmagssalik χ^2	West obs.	West exp.	West χ^2	Total
a+x+	0	16.8	16.800	48	31.2	9.046	48
a+x−	163	138.1	4.490	230	254.9	2.432	393
a−x−	0	8.1	8.100	23	14.9	4.403	23
	163		29.390	301		15.881	464
	$\chi^2 = 45.271$ (for 2 d.f., $p < 0.001$)						

Table VIII. *The Gm system, North America, Denmark, Iceland and Norway*

Place	Population	Authors	Number	Gene frequencies		
				Gm^a	Gm^{ax}	Gm^b
Alaska.....	Eskimos	STEINBERG et al. 1961	50	0.970	0.030	0
Denmark	Danes	NIELSEN 1961	1000	0.212	0.124	0.664
Iceland	Icelanders	WALTER and PÁLSSON 1962	95	0.195	0.198	0.607
Norway.....	Norwegians	HARBOE and LUNDEVALL 1961	1000	0.236	0.147	0.618

The investigations of the Gm gene frequencies in Eskimos in North America (Table VIII) are so limited that no detailed conclusions can be drawn.

The frequencies for Danes, Icelanders and Norwegians (Table VIII) show a value for the Gm^a gene between 0.20 and 0.24. These frequencies are much lower than those found in the Eskimos in any part of Greenland.

The Haptoglobins

In 1955 SMITHIES described a new method of electrophoresis using a starch gel. By means of this he was able to demonstrate that certain of the alpha-2-globulins could be divided up into a number of individually different types. In 1956 SMITHIES and WALKER stated that the haemoglobin-binding alpha-2-globulin must be considered to be identical with the Haptoglobin described by POLONOVSKI and JAYLE (1939). The amount of Haptoglobin varies in different individuals and can diminish during illness (NYMAN 1959). Otherwise, it is applicable to the Haptoglobins that storage for long periods in a deep-frozen condition has no effect on the determination of the Haptoglobin types (GALATIUS-JENSEN 1960).

The three main patterns originally demonstrated were labelled Haptoglobins 1-1, 2-1 and 2-2. In addition, a number of different variants have since been discovered. Ahaptoglobinaemia can occur on genetic basis in normal individuals, as first described by ALLISON et al. (1958), GALATIUS-JENSEN (1958b) and HARRIS, ROBSON and SINISCALCO (1959).

Extensive family, twin, and mother-child studies have confirmed that the three usual types are produced by a single pair of allelomorphic genes called Hp^1 and Hp^2 (GALATIUS-JENSEN 1956, 1958a, 1960, FLEISCHER and LUNDEVALL 1957, MÄKELÄ, ERIKSSON and LEHTOVAARA 1959, HARRIS, ROBSON and SINISCALCO 1958, 1959, FALK and PROKOP 1961,

Fleischer and Mohr 1962). Only in a very few cases has any deviation from this mode of inheritance been found. Simultaneous determination of the erythrocyte types has in the majority of these cases confirmed the suspicion of illegitimacy.

Hauge (1962) has shown by analysis of the genetic relationships between the Haptoglobin system and the blood group systems (with the exception of Kidd) that there could be no close linkage to these; with regard to the Lutheran and Kell loci the information was, however, inadequate. In recent years extensive investigations into the distribution of the Haptoglobin types in populations throughout the world have been undertaken. Reviews of the results of these have been published by Sutton et al. (1960), Kirk and Lai (1961) and Kirk (1968), among others.

Table IX. *The Haptoglobins. Greenland*

Place		Population	Authors	Number	Gene frequencies	
					Hp^1	Hp^2
Greenland.....		Greenlanders	Persson 1962 b	444	0.346	0.654
West Greenland						
	Holsteinsborg	Mixed West Greenlanders	Galatius-Jensen 1960	74	0.297	0.703
1	Nanortalik ..	Mixed West Greenlanders	Persson 1968	53	0.422	0.578
2	Julianehåb ..			132	0.361	0.640
3 + 4	Narssaq and Frederikshåb			96	0.330	0.670
5	Godthåb			456	0.332	0.668
6	Sukkertoppen			114	0.300	0.700
7	Holsteinsborg			90	0.274	0.726
8	Egedesminde			91	0.278	0.722
9 + 10 + 11	Godhavn, Jakobshavn and Qutdligssat..			114	0.358	0.642
12	Umanak			69	0.412	0.588
13	Upernavik ..			62	0.364	0.636
Total	West Greenland			1277	0.336	0.664
North Greenland						
	Thule.....	Mixed Thule Eskimos	Gilberg and Persson 1967	301	0.335	0.665
	Thule.....	Pure Polar Eskimos	Gilberg and Persson 1967	153	0.372	0.628
East Greenland						
	Angmagssalik	Pure Angmagssalik Eskimos	Persson and Tingsgård 1966, 1968	737	0.482	0.518

Table X.

The distribution of the Haptoglobins in original unrelated Polar Eskimos and original Angmagssalik Eskimos

	Thule			Angmagssalik			Total
	obs.	exp.	χ^2	obs.	exp.	χ^2	
Hp 1 – 1	8	9.3	0.182	31	29.7	0.057	39
2 – 1	20	27.4	1.999	95	87.6	0.625	115
2 – 2	23	14.3	5.293	37	45.7	1.656	60
	51		7.474	163		2.338	214
$\chi^2 = 9.812$ (for 2 d.f., p = 0.01 – 0.001)							

The distribution of the Haptoglobins in original unrelated Polar Eskimos and west coast Greenlanders

	Thule			West			Total
	obs.	exp.	χ^2	obs.	exp.	χ^2	
Hp 1 – 1	8	5.3	1.373	126	128.7	0.057	134
2 – 1	20	23.8	0.607	582	578.2	0.025	602
2 – 2	23	21.9	0.055	533	534.1	0.002	556
	51		2.037	1241		0.084	1292
$\chi^2 = 2.121$ (for 2 d.f., p = 0.5 – 0.3)							

The distribution of the Haptoglobins in original unrelated Angmagssalik Eskimos and west coast Greenlanders

	Angmagssalik			West			Total
	obs.	exp.	χ^2	obs.	exp.	χ^2	
Hp 1 – 1	31	18.2	9.002	126	138.8	1.180	157
	95	78.6	3.422	582	598.4	0.449	677
	37	66.2	12.880	533	503.8	1.692	570
	163		25.304	1241		3.321	1404
$\chi^2 = 28.625$ (for 2 d.f., p < 0.001)							

The methods used in the determinations of the Hp types, carried out by the present author, are as mentioned given in the appendix. No comprehensive investigation of the Greenlanders has been undertaken previously; only a very small sample having been studied (GALATIUS-JENSEN 1960). Table IX shows the gene frequencies in the Haptoglobin system in Eskimos in Greenland as found by the present author. The cases in which no Haptoglobin pattern could be demonstrated are included in the given total number. In those cases where new samples could be obtained distinct pattern always appeared with none of the three common types being in excess. No attempt has therefore been made to calculate the frequency of Hp°.

Table XI. *The Haptoglobins. North America, Denmark, Iceland, and Norway*

Place	Population	Authors	Number	Gene frequencies	
				Hp^1	Hp^2
Canada, Baffin Island, District of Franklin, Northwest Territory....	Eskimos	Parker and Bearn 1961	67	0.231	0.769
Alaska.....	Eskimos	Blumberg et al. 1958–59	418	0.30	0.70
Alaska.....	Anaktuvuk Eskimos	Blumberg et al. 1958–59	57	0.50	0.50
Alaska.....	Eskimos	Scott et al. 1966	220	0.32	0.68
Denmark	Danes	Galatius-Jensen 1960	2046	0.397	0.603
Iceland	Icelanders	Walter and Palsson 1962	188	0.387	0.614
Iceland	Icelanders	Beckman and Johannsson 1967	402	0.416	0.584
Norway.....	Norwegians	Fleischer and Lundevall 1957	1000	0.363	0.637

Investigations of the Haptoglobin types in the different public health districts in West Greenland showed, when all districts were compared, that the total variation did not exceed that which could be ascribed to chance. The frequency for the Hp^1 gene in Angmagssalik Eskimos differed significantly from that in the present mixed West coast Eskimos (Table X), but the frequency of the Hp^1 gene in Polar Eskimos did not deviate significantly from the West Greenland Eskimos (Table X). It may be noted that especially the Nanortalik and also the Julianehåb districts show differences from their neighbours, as was the case with the ABO system.

Results of investigations into the Haptoglobins in Eskimos outside Greenland are given in Table XI. The frequencies for the Hp^1 gene vary from 0.23 to 0.50, which are in the same range as the values found in the Greenland Eskimos.

The results for Danes, Icelanders and Norwegians are also given in Table XI. The frequencies for the Hp^1 gene lie between 0.36 to 0.40, below the frequency for the Angmagssalik Eskimos but above the frequency for the mixed west coast Eskimos.

The Gc system

During studies of the immuno-electrophoretic technique HIRSCHFELD in 1958 demonstrated group-specific alpha-2-globulins, which he called the Gc system (HIRSCHFELD 1959). The physiological importance of these proteins is as yet completely unknown. In contrast to the Transferrins, the Gc proteins are not broken down by neuraminidase, and storage in a deep-frozen condition for longer periods does not affect the Gc types (CLEVE and BEARN 1962).

It is possible to distinguish between three different phenotypes, depending on the presence of a rapidly moving component (Gc 1-1) and a slowly moving component (Gc 2-2), or the simultaneous occurrence of both components (Gc 2-1).

The ordinary Gc types are probably determined by two autosomal alleles without dominance; Gc 1-1 and Gc 2-2 are the homozygotes and Gc 2-1 the heterozygote (HIRSCHFELD, JONSSON and RASMUSON 1960, CLEVE and BEARN 1961a, 1961b, HESS and BÜTLER 1962, JENSSEN 1962, REINSKOU and MOHR 1962, NERSTRØM 1963a, 1963b, 1965). In addition, there are special rarer variants of the Gc system. Further studies on the inheritability and constancy of these atypical Gc patterns are highly desirable, but have not yet been carried out to any greater extent.

There seems to be neither association nor linkage between the Gc system and the blood groups ABO, Rh, MNSs, P, K, Le(a), Lu(a), Fy(a), Jk(a), the Haptoglobins, the Gm system, the Transferrins, the Ag and Lp systems, or the cholinesterase types (HIRSCHFELD and BECKMAN 1960, CLEVE and BEARN 1962, MOHR and REINSKOU 1963, NERSTRØM 1965). During the past few years research has been carried out into the distribution of Gc types in various ethnic groups (CLEVE and BEARN 1961 a, 1961 b, 1962, HIRSCHFELD 1962).

In 1963 CLEVE et al. described two genetic variants within the Gc system, based on genes called Gc Chippeva and Gc Ab origine, the latter leading to the phenotypes Gc Ab-Ab, Gc Ab-1 and Gc Ab-2. The first variant was first observed in the Chippewa Indians in North America, the second in the natives in the Cape York area of North-East Australia. Familial occurrence of the variants is described, and the gene frequencies have been calculated (CLEVE et al. 1967).

Among 748 samples from the Angmagssalik Eskimos there were five with a deviant Gc pattern (PERSSON and TINGSGAARD 1965). The precipitation line found on immunoelectrophoresis was bimodal and showed an arc corresponding to Gc 2 and an arc anodal to Gc 1. The results obtained in three members of one family showing the abnormality were technically reproducible in three separate samples of serum and also

Table XII. *The Gc system. Greenland*

Place		Population	Authors	Number	Gene frequencies Gc¹	Gc²
Greenland.....		Greenlanders	Persson 1963	581	0.624	0.376
West Greenland						
1	Nanortalik ..	Mixed West Greenlanders	Persson 1968	53	0.630	0.370
2	Julianehåb ..			132	0.724	0.276
3 + 4	Narssaq and Frederikshåb			96	0.695	0.305
5	Godthåb			456	0.682	0.318
6	Sukkertoppen			114	0.757	0.243
7	Holsteinsborg			90	0.662	0.338
8	Egedesminde			91	0.675	0.325
9 + 10 + 11	Godhavn, Jakobshavn and Qutdligssat..			114	0.700	0.300
12	Umanak			69	0.669	0.331
13	Upernavik ..			62	0.746	0.254
Total	West Greenland			1277	0.694	0.306
North Greenland						
	Thule.....	Mixed Thule Eskimos	Gilberg and Persson 1967	301	0.707	0.293
	Thule.....	Pure Polar Eskimos	Gilberg and Persson 1967	153	0.670	0.330
East Greenland						
	Angmagssalik	Pure Angmagssalik Eskimos	Persson and Tingsgård 1966, 1968	583	0.610	0.390

in samples taken as whole blood in venules. Two of the sera have since been examined by Kitchin and Bearn (1966), and in each case a pattern indistinguishable from Gc Ab-2 was seen.

In 1963 Nerstrøm and Skafte Jensen demonstrated that after freezing and thawing of whole blood the Gc component can gradually move into immunologically identical alpha-1-globulin. The Gc-2 component is more rapidly weakened than the Gc-1 component; however, the configuration and localization of the new alpha-1-precipitate is independent of the original Gc types of the samples. The changes do not occur during the investigation of serum. Later Nerstrøm (1963c) showed that the change may be produced by a factor found in leucocytes and thrombocytes. Probably it is a proteolytic enzyme. The addition of certain bacteria can distort the Gc system until it is unreadable (Nerstrøm, Mansa and Frederiksen 1964).

Table XIII.

The distribution of the Gc types in original unrelated Polar Eskimos and original Angmagssalik Eskimos

	Thule			Angmagssalik			Total
	obs.	exp.	χ^2	obs.	exp.	χ^2	
Gc 1 – 1	22	20.0	0.200	61	63.0	0.063	83
2 – 1	25	22.8	0.212	70	72.2	0.067	95
2 – 2	4	8.2	2.151	30	25.8	0.684	34
	51		2.563	161		0.814	212

$\chi^2 = 3.377$ (for 2 d.f., $p = 0.2 - 0.1$)

The distribution of the Gc types in original unrelated Polar Eskimos and west coast Greenlanders

	Thule			West			Total
	obs.	exp.	χ^2	obs.	exp.	χ^2	
Gc 1 – 1	22	24.2	0.200	562	559.8	0.009	584
2 – 1	25	22.3	0.327	514	516.7	0.014	539
2 – 2	4	4.5	0.056	104	103.5	0.002	108
	51		0.583	1180		0.025	1231

$\chi^2 = 0.608$ (for 2 d.f., $p = 0.8 - 0.7$)

The distribution of the Gc types in original unrelated Angmagssalik Eskimos and west coast Greenlanders

	Angmagssalik			West			Total
	obs.	exp.	χ^2	obs.	exp.	χ^2	
Gc 1 – 1	61	74.8	2.546	562	548.2	0.347	623
2 – 1	70	70.1	0.000	514	513.9	0.000	584
2 – 2	30	16.1	12.001	104	117.9	1.639	134
	161		14.547	1180		1.986	1341

$\chi^2 = 16.533$ (for 2 d.f., $p < 0.001$)

Table XII gives the distribution of the Gc gene frequencies in Greenlanders, as found by the present author. Hitherto there have been no investigations into the Gc system in Eskimos in Greenland. The main results of the Gc determinations were that the gene frequencies in the Eskimos in the various districts in West Greenland show no statistically significant differences from each other. In contrast, the Angmagssalik Eskimos deviated significantly from the present west coast Eskimos (Table XIII). The frequencies for this group lie close to the values found for the Polar Eskimos. It may be noted that differences are again observed between the Nanortalik and Julianehåb districts and their neigh-

Table XIV. *The Gc system*
North America, Denmark, Iceland, and Norway

Place	Population	Authors	Number	Gene frequencies	
				Gc^1	Gc^2
Canada	Eskimos	Cleve and Bearn 1961 b	67	0.702	0.298
Alaska	Eskimos	Scott et al. 1966	214	0.70	0.30
Denmark	Danes	Nerstrøm 1965	1312	0.725	0.275
Iceland	Icelanders	Walter and Pálsson 1962	93	0.759	0.241
Norway	Norwegians	Reinskou and Mohr 1962	383	0.722	0.278

bours, but with respect to this system the two districts deviate in opposite directions.

There have been very few investigations into the Gc system in Eskimos outside Greenland (Table XIV). The frequencies for the Gc^1 gene in the Northerners lie between 0.72 to 0.76, highest for the Icelanders, which is also a little above the frequencies for the population of West Greenland.

The Transferrins

Smithies was also the first (in 1957) to demonstrate that there are different types of beta-globulins, which were later identified as Transferrins, the iron binding proteins. The most common type is called Transferrin C, whilst those types which in electrophoresis move more slowly than C are called D, and those which move more rapidly are called B. However, the terminology is somewhat confused, as new variants are constantly being described.

Investigations of the genetic background have been carried out for the common type C (Smithies and Hiller 1959), and the variants B_1 (Harris et al. 1958), B_2 (Smithies 1958, Harris et al. 1960a, de Grouchy and Lamy 1960), D_1 (Horsfall and Smithies 1958), and D_{0-1} also called D_4 (Harris et al. 1960b). The fact that no human serum containing three Transferrin bands has been found also seems to give indirect support for the supposition that the 14 different bands of Transferrin observed so far represent 14 alternative alleles on a single locus.

As yet there have been no more thorough investigations into the linkage between the Transferrins and other serum and blood types. However, investigations carried out by Smithies and Hiller (1959) suggest that it is improbable that there is linkage between the loci for

Table XV. *The Transferrins. Greenland*

Place	Population	Authors	Number	Transferrin phenotypes		
				CC	CD_1	B_2C
Greenland.....	Greenlanders	PERSSON 1962a	274	273	1	0
West Greenland .	Mixed West Greenlanders	PERSSON 1968	1277	1273	3	1

the Transferrins and the genes for ABO, MNSs, P, and Rh blood groups, or the Haptoglobins.

There are difficulties in the investigations of Transferrin types which are not met with in other serum types. Firstly, the variant types are so relatively rare that a large material is necessary in order to calculate exact gene frequencies. Secondly, the difficulties in aquiring sera with known types make it hard to make an exact classification of the variants which are found. Thirdly, in old and poorly preserved blood neuraminidase may alter the Transferrin phenotypes (BLUMBERG and WARREN 1961). Such samples usually show three Transferrin bands, but there may be two or four, depending on the break-down of the Transferrins. They always appear as slowly-moving bands behind the usual Transferrin C. In order to investigate whether the bands observed are true variants or merely break-down products it can in doubtful cases be of value to add neuraminidase.

The difficulties mentioned have meant that in comparison with the numerous investigations into the Haptoglobin types, research into the gene frequency of the Transferrins in the various populations has as yet been very restricted. The slow moving Transferrin types seem meanwhile

Table XVI. *The Transferrins. North America and Scandinavia*

Place	Population	Authors	Number	Transferrin phenotypes		
				CC	B_1C	B_2C
Canada, Baffin Island, District of Franklin, Northwest Territory ...	Canadian Eskimos	PARKER and BEARN 1961	67	67	0	0
Alaska.....	Alaskan Eskimos	GIBLETT and MOTULSKY 1962	167	167	0	0
Scandinavia	Scandinavians	BECKMAN and HOLMGREN 1961	450	445	1	4

to occur with a very varied distribution in Central and South America, and also in the Mongols (GIBLETT 1962).

The results of the investigations concerning the Transferrins in Eskimos in Greenland are shown in Table XV. Nearly all had the ordinary type CC, and therefore no subdivision has been undertaken. Table XVI contains a review of the Transferrin types in Eskimos in North America and Scandinavians. The results from the Eskimos in Canada show, corresponding to the results from Eskimos in Greenland, that the ordinary type Transferrin CC is dominant.

Other serological characteristics

Other inherited haematological variations have also been included in the investigations of Eskimos, for instance hereditary methaemoglobinaemia (SCOTT and HOSKINS 1958), abnormal haemoglobins, which have not been observed so far (SCOTT et al. 1959) and polymorphic types of red cell enzymes (SCOTT et al. 1966).

MELARTIN (1967) has studied different populations for albumin variants. A new variant, albumin Naskapi, was demonstrated in Indians in North America and in Eskimos from Quebec, Alaska and in Aleuts, but not in any other populations so far studied. The albumin locus appears to be linked to the Gc locus.

The results of the seroanthropological investigations of the population of Greenland have been the demonstration of many significant variations between the three main regions of Greenland. The studies have also confirmed the classification of the present population of South-East and South-West Greenland as two separate groups. As the first detailed and comprehensive investigation of the Polar Eskimos the seroanthropological investigations have demonstrated that these too in many respects form a special group with their own characteristics.

More extensive comparisons with Eskimos and related groups outside Greenland are not possible. This is partly because the numbers included in the materials collected so far have been small, and partly because only the inhabitants of a few places have been investigated.

Chapter 5
DISCUSSION AND CONCLUSIONS

The very comprehensive and reliable anthropometrical investigations carried out by Jørgensen (1953) have provided a good picture of the population situation in Greenland in the period before the Danish colonization. At least two different groups of Eskimos could be clearly distinguished: one living in the north-east region and another living on the west coast and southern part of the east coast. Information about the inhabitants of the Thule district is less complete, as the skeletal material from this region has been too sparse to permit of any definite conclusions. However, modern investigations within the ABO system seem to support the assumption that the Polar Eskimos differed from the other groups. Extension of the anthropometric investigations to the Eskimos of North America has given a substantial basis to the supposition that the north-eastern group of Greenland Eskimos came from the region round Hudson Bay, whereas the Inugsuk group found on the west coast and southern part of the east coast was mainly derived from the Eskimos living in Alaska.

The earliest invasion of Europeans into Greenland was, according to the historical information available, by the Norsemen, who mainly settled in the Julianehåb and Godthåb regions after the year 1000. Judging from the skeletal material derived from west coast Eskimos living in the following centuries there was no extensive mixing of Inugsuk elements and Norsemen.

The characteristics of developments since 1500 are the total disappearance of the north-eastern group of Eskimos, the continued flow of Eskimos from North America to the Thule region, which on the other hand remained untouched by Europeans until about 70 years ago, and the almost continuous immigration from Europe, mainly from its northern parts, to certain regions on the west coast, whereas the Eskimos living on the east coast have until very recently lived in almost complete isolation.

When considering the available seroanthropological results it should first of all be stressed that the extent of the investigations varies very greatly from one region to another. This applies specifically to the ery-

throcyte types, whereas the present author has tried to collect information on the distribution of the serum groups from all regions of Greenland. It is a deplorable fact that the north-eastern group of Eskimos disappeared before the discovery of the blood groups so that no additional information can now be obtained concerning this part of the Eskimo population.

One of the most conspicuous features of the whole amount of the blood and serum group data presented here is the great range of variation observed within nearly all the systems studied. When discussing these results in more detail, it seems reasonable to accept the evidence brought forward by the earlier studies of different types which point towards a subdivision into at least three main areas which will, therefore, be considered separately in the following.

When it is attempted to analyse and compare different human population groups, some general types of influence known to be of high although varying importance should be kept in mind. In the present connection, continuous migration has undoubtedly constituted a major source of changes in many of the areas, whereas prolonged isolation has been a prominent characteristic of other districts. The evalution of these factors may often receive valuable support from historical evidence.

Another important factor, selection, is much more difficult to evaluate, as the present knowledge about the relative advantage or disadvantage of the different serological characters under specific environmental circumstances is extremely limited. As mentioned before, it has only recently been possible to demonstrate that blood groups cannot be considered resistant to selection, and whether this applies to all blood and serum groups, and if so to what extent, is still unknown. The picture is probably even more complicated in regions where living conditions change relatively rapidly, as has been the case in Greenland.

Still another factor, the effect of which is impossible to predict in any given case, is genetic drift, the variations due to chance which in small populations may lead to very prominent differences between two closely related population groups. This factor is undoubtedly of relevance in Greenland where the population to a great extent has been formed by small groups.

At all events it seems unreasonable to expect that the factors mentioned should have been of equal importance in the different regions in Greenland.

The Thule region

The seroanthropological observations on the Eskimos in this region are unfortunately very incomplete. The data on the ABO blood group distribution show some evidence of not being fully reliable, but it may

with some reservations be stated that the Polar Eskimos show unique features in that the frequency of the O gene seems to be much higher, and the frequency of the A gene much lower here than in any other Eskimo population studied so far, so in this respect the Polar Eskimos take a position of their own as compared with all other population groups in Greenland. With the material at present available, no definite explanation of this striking finding can be given, but as no relevant population group is known which could, by mixture with the Polar Eskimos, have given rise to this high frequency of the O gene, genetic drift must naturally be taken into consideration among the possible causes.

Apart from the ABO system, the Polar Eskimos differ from the population of the west coast with regard to the Gm(a) factor, whereas they are in this respect quite similar to the east coast Eskimos. When the two other serum group systems studied here are considered, there are no significant differences between the Polar Eskimos and the total west coast population.

Differences between Polar and east coast Eskimos with respect to the serum group systems are found to be significant only as regards the Hp types.

Finally, when the results of the serum group determinations on Polar Eskimos are compared with the limited data available on Eskimos in North America, it appears that no striking differences can be demonstrated here.

Thus, due to the limited extent of the material, it seems at the present time impossible to draw any definite conclusions as regards the relationship between the Polar Eskimos and other Eskimo populations in Greenland and North America. They occupy a unique position with respect to the ABO groups, whereas the gene frequencies of the serum groups are in general closer to those of the North American Eskimos than to those of the east coast Eskimos, who show a much higher frequency of the Hp^1 gene. The differences between the Thule Eskimos and the persons born in West Greenland are characterized by the fact that the latter group generally speaking comes closer to the blood group gene frequencies prevailing in Northern Europe.

South East Greenland

As mentioned above, the Eskimos living in East Greenland show highly significant differences from the Polar Eskimos both within the ABO system and with respect to the Hp system. Some difference is also found in the Gc system, although it does not reach the level of statistical significance. The Gm(a) factor shows very similar frequencies in the two groups.

When compared with persons born in West Greenland it appears that the Angmagssalik Eskimos are different with respect to all the systems studied. This is in agreement with the known historical facts which reveal that the people on the east coast have until recently lived in almost complete isolation and have never experienced an inflow of genes from abroad to the same extent as that in many parts of the west coast. The differences between these two groups which are considered to originate from the same source, the Inugsuk group, should thus find their main explanation in the great admixture by Danes and Norwegians and other Europeans which has taken place on the west coast during the last centuries, as will be discussed below. When the East Greenland and the North American Eskimos are compared, differences are observed in all systems studied with the exception of Gm.

The finding of a deviant Gc phenotype in the Angmagssalik Eskimos (the only report to date of this variant in Eskimos) does not seem to throw any additional light upon the derivation of this population group. This variant has only rarely been observed, and that in widely scattered populations such as in U.S.A., Africa, Australia, and a few places in Asia (Kitchin and Bearn 1966).

The West Coast

The seroanthropological results from the population living in this area present quite conspicuous internal variations with respect to most of the factors studied. Not all of the differences reach statistical significance, but it should be kept in mind that the number of individuals investigated in many of the districts is quite small and it should also be noted that the same pattern of variation is sometimes repeated in more than one system. Generally speaking, the population of the west coast shows a blood group distribution which can largely be explained as a mixture of elements resembling on one hand the present Angmagssalik Eskimos, and on the other Danes and Norwegians, the results being, however, in the majority of cases closer to the latter group than to the former.

The Hp system forms, however, an exception to this general tendency. The frequency of the Hp^1 gene is, as mentioned, high among the Angmagssalik Eskimos and lower on the west coast, but in many of the districts here it is even lower than in Scandinavia and most other European countries. Thus in this respect the east coast Eskimos of today are presumably different from the Inugsuk elements which constituted the original population of both this area and the west coast, although this is not completely certain. Considering the present day Eskimo populations in the regions from which the Inugsuk elements, according

to the archaelogical information available, it appears that the largest Eskimo sample from Alaska shows a frequency of the Hp^1 gene which is lower than most of the values found on the west coast of Greenland, and on the whole no relevant population possesses an Hp^1 gene frequency which is as high as that of the Angmagssalik Eskimos. Therefore, the east coast Eskimos may perhaps to-day have an unusually high frequency of this gene as a result of genetic drift, but this does not, of course, exclude the possibility that other factors such as selection could also have been at work. At present it seems impossible to find any evidence which may lead to a solution of this puzzling phenomenon. The pattern of the B gene distribution is similarly not quite clear. The frequency is high in east coast Eskimos, as is the case in Alaska Eskimos, but the values found in the west coast population are lower than those of the Scandinavians. It seems even more difficult to find a reasonable explanation of this complicated picture.

Going into greater detail, it is interesting to note that the inhabitants of the southern part of the west coast, especially those of the Nanortalik district, and also in most respects those of the Julianehåb district, seem to stand out as population groups of their own. They have higher frequencies of the O gene and the Hp^1 gene and a lower frequency of the A gene than their immediate neighbours. The results of the Gc serum group determinations also show them to be different, but whereas the Julianehåb district shows higher values of the Gc^1 gene, the few observations from Nanortalik lead to a frequency which is lower than that found in the remainder of the west coast population.

On comparing the results obtained in the Julianehåb district (where the number of observations is higher and information therefore probably more reliable than that from Nanortalik) with the gene frequencies of the Danes, Norwegians and Icelanders, it is evident that the values found in this population group come much closer to those found in the Icelandic population with respect to the systems in which the Icelanders differ clearly from Danes and Norwegians. Thus the frequency of the A gene is lower, and that of the O gene is higher in the Julianehåb district than in Danes and Norwegians, as it is in Icelanders. According to historical evidence, however, no special immigration of Icelanders to the Julianehåb district has taken place since the Middle Ages. Meanwhile, the Basques are known to have taken a considerable part in whaling expeditions and maybe they had the last European contact with the Norsemen in this district. The most striking characteristic of the Basque population, the extraordinarily high frequency of the d gene of the Rh system (GUASCH 1950) has, however, not been traced in the Julianehåb district (AHRENGOT and ELDON 1952 and personal communication) where no Rh-negative individuals were found.

From the historical accounts we know that Vesterbygden was given up in about 1350 A.D. but that the Norsemen still remained in Østerbygden in the Julianehåb district. Archaeological investigations in the Julianehåb district (MATHIASSEN 1936) have led to the conclusion that it is improbable that there had been any real settlement in this district before the Norse settlement. A great number of Norse ruins in this district show signs of having being abandoned for no obvious reasons, without any signs of Eskimo culture. In contrast, the Eskimo ruins in Julianehåb from the Inugsuk Culture are characterized by a remarkable number of Norse objects, including such objects as do not otherwise occur in the Inugsuk Culture.

As mentioned the Danish colonization was begun in 1721 by HANS EGEDE. In 1723 he undertook a voyage of discovery from Godthåb, travelling south along the west coast of Greenland, searching for the Norsemen. By the 20th of August 1723 he had reached the 68°48′ degree of latitude off the coast of Julianehåb district and described the Greenlanders there as follows: "Disse Folch der boe, ere temmelig smuche og hvide" (The people living there are rather beautiful and white) (EGEDE 1724). Thus these fairskinned Greenlanders in Julianehåb, in contrast to the Eskimos he usually described, were possibly the descendants of the Norsemen. However, HANS EGEDE was obsessed by the idea that the Norsemen must be found on the east coast of Greenland where he thought Østerbygden was situated.

In contrast to the serological determinations the anthropometrical investigations of the population in the Julianehåb district are incomplete and no conclusions can be based on them. The results of the serological investigations may point towards a mixture of Norse and Eskimo components. The descendants of these mixings may have lived in isolation for centuries in this relatively inaccessible southern part of Greenland. Supplementary, detailed and more extensive studies, including especially the many factors in the Gm system, may be expected to throw more light upon this important problem.

Other indications, albeit slighter and less uniform, of the differential evolution of the population groups in the various parts of the west coast population have been mentioned in the preceeding chapters. In addition a stepwise comparison of the regions, taking two neighbouring regions at a time, has for instance shown that in the Hp system Holsteinsborg and Egedesminde deviate from their immediate neighbours and they are thus in this respect more different from the Scandinavians than the rest of the west coast population. This may, of course, be due to chance but as the same tendency, which does not, however, reach significance, was found in the Gc system, this should call for further studies. Also, as the present author has previously pointed out. the

internal consistency within the Hp and Gc system was closest to statistical significance in both cases in the districts of Godhavn, Jakobshavn and Qutdligssat; this should be kept in mind in future investigations. The ABO blood group determinations from these districts are too few to throw any additional light on these problems.

In conclusion it may be stated that persons born in West Greenland can scarcely be considered genetically homogeneous. The difficulties of the contact between the many regions has undoubtedly prevented a free exchange of genes, and access from the sea over the centuries has not been equally easy to all places, which has caused differences in the rate of immigration. Furthermore, the evidence obtained with regard to the region of Julianehåb gives some support to the assumption that the population living on the west coast before the Danish colonization started in 1721 also showed heterogeneity. It is in any case quite clear that future investigations of the west coast population should be directed towards a detailed examination of each of the regions separately.

The heterogeneity which has been demonstrated here and the small materials available, as well as the lack of precise knowledge about the origin of the immigrants, would make any attempts at an estimation of the amount of genetic admixture on the west coast of very doubtful value at the present moment. It seems, however, to be permissible to state that the present knowledge points towards a very considerable but probably varying admixture of Danish and Norwegian elements in the present day population of the west coast, where the gene pool seems to be more similar to that of the Danish and Norwegian populations than to that found in the East Greenland Eskimos, who are supposed in many respects to give a good reflection of the original inhabitants of the major part of the west coast.

The questions concerning the relation between the Greenland Eskimos and the North American Eskimos seem to be even more difficult to solve at present. Seroanthropological data on this latter group are still very scanty, and until more extensive investigations have been carried out it seems impossible to attempt any analyses. Detailed information about North American Eskimos is so far only available with respect to the ABO system. Among these groups the Alaska Eskimos are closest to the East Greenland Eskimos, but in general these two populations present pronounced differences.

Our present knowledge of the anthropology of the population living in Greenland today shows quite clearly that it may be divided into three main groups: the inhabitants of the Thule region, still investigated only to a limited extent, the east coast inhabitants who are probably the group which most closely resembles the Greenland Eskimos of the Middle Ages, and the west coast population which is certainly hetero-

geneous, as has been clearly demonstrated for the first time by the investigations of the present author. This is probably due to the fact that they have lived in smaller groups with little mutual contact and have experienced an immigration from Europe which has differed with respect to both extent and origin of the immigrants. Finally, the west coast population may also have shown heterogeneity in the Middle Ages, as has been suggested by some of the observations described here, especially where the Julianehåb district is concerned.

It has been pointed out repeatedly in the preceding chapters that continued serological studies of both the Greenland population and the Eskimos in North America are highly desirable. The very considerable extensions of the serum groups which have taken place since the present author completed his investigations give very good promise of valuable additional information. It is a well-known fact, which has also been illustrated by the serological findings discussed here, that it may be misleading to base conclusions about ethnic relations on the results obtained from the study of a single blood group system, but that as many serological factors as possible should be included in all future investigations.

SUMMARY

Chapter 1

Introduction

During the last approximately 700 years the Eskimos who formed the original population of Greenland have had a steadily increasing contact with Europeans, but there are still a few places in Greenland where it is possible to find almost "pure" Eskimos. Because of the great changes which are taking place in the conditions in Greenland it is predictable that the serological characteristics of the Eskimos will change within the next few decades. The determination of blood groups, which usually plays an important part in population-genetic investigations, has for purely practical reasons been of far less value in the investigation of the Eskimos. Genetically determined variations of different serum proteins in man, first described in 1955, have great advantages in the seroanthropological investigations of the Eskimos, as long transportation times have little or no effect on the possibility of determining the serum types, in contrast to what is the case with the blood group determinations.

The Purpose of the Present Investigations

The aim of the present work has been to bring together all the information collected so far concerning the anthropology of both the present and the past population of Greenland. The additional and detailed evidence brought forward through the studies of the present author seemed to open new possibilities of more penetrating analyses of the genetic relations between the various populations in Greenland as well as between these and those groups in North America and Europe which are known to have contributed to the gene pool of the present Greenland population. The results of the serological studies performed by the present author seem for the first time to have created a more comprehensive basis for a comparison and combination of the results of anthropometric and seroanthropological observations.

Chapter 2

Review of the Origin and History of the Population of Greenland

Several waves of settlers have come in over North-eastern Greenland and wandered further south along the coasts since the first men reached Greenland about 4,000 years ago. The extent of the various cultures is briefly mentioned. The Dorset Culture, which reached Greenland at about the time of the birth of Christ, was gradually driven away from the coasts, remaining longest in East Greenland.

Whilst Eskimos with the Dorset Culture were being replaced by the Eskimos with the Thule Culture, after the year 982 A.D. Icelandic peasants settled along the fjords of West Greenland. The Norsemen lived here for about 500 years, but their fate is up to the present unknown.

The Thule Culture, which probably came from North-eastern Asia, spread from Thule down the west coast. In the course of this migration it changed in form, so that a completely new culture arose, called the Inugsuk Culture. By retrograde spread northwards the Inugsuk Culture reached Thule. By mixture with later elements of the Thule Culture a special form of culture arose in North-East Greenland. Throughout the centuries there was a continual immigration from North America into the area of Thule itself, so that an independent strain, called Polar Eskimos, arose in Thule.

From about 1600 A.D. the Eskimos had increasing contact with Europeans, particularly whalers of many nations. The Danish colonization of Greenland began in 1721. In the beginning there was a very large proportion of Danes and Norwegians, but only few Icelanders, among the colonists. The result of the mixing of the Eskimos and the foreigners has been that the population of the west coast of Greenland consists of a mixture of Eskimos and Europeans.

Chapter 3

Anthropometrical Investigations of Greenlanders and Related Ethnic Groups

Anthropometrical investigations of the Greenlanders are comprehensive. In 1953 JØRGENSEN, through his comprehensive investigations of Eskimo skeletal material, demonstrated that in the period before the Danish colonization two different types existed in Greenland, a North-East type in North-East Greenland and the Inugsuk type in South-West and South-East Greenland. Comparisons between Greenland Eski-

mos and different Eskimo peoples in Canada and Alaska have shown close concordance between the Inugsuk type and the Birnirk Eskimos in Alaska, while the North-East Greenland type corresponds to the Eskimos of Hudson Bay.

Chapter 4

The Seroanthropology of the Greenlanders and Related Ethnic Groups

A. Erythrocyte groups

Investigations in the Greenland population of the ABO system have not yet been carried out in sufficient detail; this applies especially to the northern part of the west coast and to the Thule region. The observations from the latter place show an exceptionally high frequency of the O gene, strikingly different from the rest of the Greenland population. The extensive investigations from the east coast show the Eskimos population of this region to be distinctly different from that of other regions in Greenland. The samples from the west coast show this region to be conspicuously heterogeneous. Julianehåb and to some extent the Nanortalik region seem to stand out with an ABO blood group distribution clearly different from that of other population groups in Greenland. The other blood groups have been investigated only to a very limited extent. The most remarkable characteristic of the North American Eskimos seems to be the high B frequency observed in Alaska; the only Eskimos in Greenland with a similar frequency of this gene are those living on the east coast. The average frequencies in the eastern Eskimos of North America generally come closer to the West Greenland Eskimos.

B. Genetically determined variations in the serum proteins

In 1956 GRUBB demonstrated some inherited variations in the gamma-globulins called the Gm system. It was later found that this system is far more complicated than was originally assumed, as further Gm factors have been demonstrated. These seem to be determined by one single, but very complex locus. The results of the investigations into the Gm system in Greenlanders were the demonstration of significant differences in the distribution of the Gm types between the west coast Greenlanders on one hand and Eskimos in North and East Greenland on the other, whereas the Thule and the Angmagssalik Eskimos are very similar in this respect.

In 1955 SMITHIES described a new method of electrophoresis using starch gel. By means of this he was able to demonstrate three types of the haemoglobin-binding alpha-2-globulins called Haptoglobins. The three

usual types are produced by a single pair of allelomorphic genes called Hp^1 and Hp^2. Investigations of the Haptoglobin types in the different public health districts in West Greenland showed, when all districts were compared, that the total variation did not exceed what could be ascribed to chance. The frequency for the Hp^1 gene in the present mixed west coast Eskimos differed signifucantly from the Angmagssalik Eskimos but not from the Polar Eskimos.

By means of immuno-electrophoresis HIRSCHFELD (1959) demonstrated the group specific alpha-2-globulins called the Gc system. The ordinary three types are probably determined by two autosomal alleles without dominance. In addition there are special rarer variants, but NERSTRØM's (1963c) investigations have demonstrated that similar changes can also occur due to the influence of various extraneous factors. The results of the Gc determinations in West Greenlanders were that the gene frequencies in the single districts showed no statistically significant differences from one another. In contrast, the Angmagssalik Eskimos deviated significantly from the present west coast Eskimos. The frequencies for this group lie close to the values found for the Polar Eskimos.

Several types of iron binding beta-globulins called the Transferrins have been described, but the majority are rare. The genetic conditions would suggest that the Transferrins are inherited as an autosomal, two allele system without dominance. Difficulties can arise in the investigations of the Transferrin types due to decomposition by neuraminidase. Investigations of the Transferrins in Eskimos in West Greenland showed that the ordinary type Transferrin CC is predominant.

Investigations of the distribution of the serum groups in Eskimos outside Greenland are still very deficient. This is partly because the numbers included in the materials collected so far have been small, and partly because the inhabitants of only a few places have been investigated.

Chapter 5

Discussions and Conclusions

Anthropometrical investigations have given the result that in the period before the Danish colonization at least two different groups of Eskimos could be clearly distinguished: one living in the north-east region and another living on the west coast and southern part of the east coast.

The earliest invasion of Europeans into Greenland was, according to the historical information available, the Norsemen, who settled mainly in the Julianehåb and Godthåb regions after the year 1000 A.D. Judging from the skeletal material derived from west coast Eskimos living in the following centuries no extensive mixing of Inugsuk elements and Norsemen took place.

One of the most conspicuous features of the whole of the blood and serum group data from Greenland is the great range of variation observed within nearly all the systems studied. When discussing these results in more detail, it seems reasonable to accept the evidence brought forward by the previous studies of different types which point towards a subdivision into at least three main areas which will, therefore, be considered separately in the following.

When it is attempted to analyse and compare different human population groups, some general types of influence known to be of high, though varying importance should be kept in mind. In the present connection, continuous migration has undoubtedly constituted a major source of changes in many of the areas. However, selection, genetic drift and isolation are also factors to be taken into consideration.

The data on the ABO blood group distribution in the Thule region show some evidence of being not fully reliable, but the frequency of the O gene is higher here than in any other of the Eskimo populations studied so far, with a correspondingly low frequency of the A gene. The determination of the Gm(a) factor has also shown this group of Eskimos to be decisively different from the Eskimos born further south, whereas the few data available from Eskimos living in North America indicate similar frequencies. In contrast, the Gc system does not show significant differences from the west coast population or from the Eskimos of North America, whereas the distribution of Haptoglobin types in the Polar Eskimos is significantly different from that found in the people living on the east coast of Greenland. The Angmagssalik and Polar Eskimos are also different with regard to the ABO blood group system. In conclusion it may be stated that due to the sparseness of the material it seems at present time impossible to draw any definite conclusions as regards the relationship between the Polar Eskimos and other Eskimo populations in Greenland and North America.

The Eskimos living in East Greenland show significant differences from the persons born in West Greenland with respect to all the serological systems studied. The differences between these two groups, which are supposed to have their origin from the same source, the Inugsuk group, find their main explanation in the great admixture of Danes and Norwegians and other Europeans which has taken place on the west coast during the last centuries. Generally speaking, the population of the west coast shows a blood group distribution in more cases closer to the latter group than to the Inugsuk Eskimo group. The Hp system presents, however, an exception to this general tendency. The frequency of the Hp^1 gene is high among the Angmagssalik Eskimos and lower on the west coast, but in many of the districts here it is even lower than in Scandinavia and most other European countries.

The inhabitants of the southern part of the west coast, especially those of the Nanortalik district and also in most respects those of the Julianehåb district, seem to stand out as a group of their own. When comparing the results obtained in the Julianehåb district with the gene frequencies of the Danes, Norwegians and Icelanders, it is evident that the values found in this population group come much closer to those found in the Icelandic population with respect to the systems in which the Icelanders differ clearly from Danes and Norwegians. According to historical evidence, however, no special immigration of Icelanders to the Julianehåb district has taken place since the Middle Ages. The serological investigations may point towards a mixture of Norse and Eskimo components. The descendents of these mixings may have lived in isolation for centuries in this relatively inaccessible southern part of Greenland.

A stepwise comparison of the regions on the west coast, taking two neighbouring regions at a time, showed in the Hp system that Holsteinsborg and Egedesminde deviated from their immediate neighbours. Where the internal consistency within the Hp and Gc system is concerned, this was closest to statistical significance in both cases in the districts of Godhavn, Jakobshavn and Qutdligssat.

The questions concerning the relation between the Greenland Eskimos and the North American Eskimos seem to be difficult to resolve at present. Seroanthropological data on this latter group are still very sparse, and until more extensive investigations have been carried out it seems impossible to attempt any analysis.

Our present knowledge of the anthropology of the population living in Greenland today shows quite clearly that it may be divided into three main groups: the inhabitants of the Thule region, still investigated only to a limited extent, the east coast inhabitants, who are probably the group which most closely resembles the Greenland Eskimos of the Middle Ages, and the west coast population which is certainly heterogeneous, as has been clearly demonstrated for the first time by the present investigations. This is probably due to the fact that the west coast population has lived in smaller groups with little mutual contact and has experienced an immigration from Europe which has differed with respect to both extent and to the origin of the immigrants. Finally, the west coast population may also have shown heterogeneity in the Middle Ages, as has been suggested by some of the observations related here, especially where the Julianehåb district is concerned.

Continued serological studies of both the Greenland population and the Eskimos in North America are highly desirable. The very considerable extensions of the serum groups which have taken place during the last few years also give great promise of valuable additional information.

RESUME

Kapitel 1.

Indledning

Eskimoerne, som udgør Grønlands oprindelige befolkning, har i de sidste ca. 700 år haft en stadig tiltagende kontakt med europæerne; men endnu findes der enkelte steder på Grønland, hvor man har næsten "rene" eskimoer. På grund af de stærkt ændrede forhold i Grønland kan det forudses, at eskimoernes serologiske særpræg vil være forandrede om få årtier. Blodtypebestemmelser, som ved populationsgenetiske undersøgelser ellers har haft den største betydning, har for eskimoernes vedkommende på grund af rent praktiske vanskeligheder ved undersøgelserne ikke haft samme betydning. Genetisk bestemte variationer i menneskets serumproteiner, der først blev beskrevet i 1955, frembyder store fordele ved seroanthropologiske undersøgelser af eskimoer, idet langvarig transport har ringe eller ingen indflydelse på muligheden af at bestemme serumtyperne modsat de tidligere anvendte erytrocyttypebestemmelser.

Undersøgelsernes formål

Bogens formål har været at samle alle foreliggende oplysninger om Grønlændernes antropologi, ikke kun hos de nuværende beboere, men også hos den tidligere befolkning. De nye og detaljerede oplysninger, som er tilvejebragt ved forfatterens undersøgelser, synes at åbne nye muligheder for en mere tilbundsgående analyse af de genetiske relationer mellem de forskellige populationer i Grønland ligesom mellem disse og de grupper i Nordamerika og Europa, som vides at have bidraget til den nuværende genfordeling i Grønland. Resultaterne af forfatterens serologiske undersøgelser synes for første gang at have skabt et mere omfattende grundlag for en sammenligning og kombination af resultaterne af anthropometriske og seroanthropologiske undersøgelser.

Kapitel 2

Oversigt over den grønlandske befolknings oprindelse og historie

Siden de første mennesker kom til Grønland for ca. 4.000 år siden, er flere bølger af folk kommet indover det nordøstlige Grønland og er

derfra vandret videre langs kysterne. De forskellige kulturers udbredelse omtales kort. Dorsetkulturen, som kom til Grønland omkring Kristi fødsel, blev efterhånden fortrængt fra kysterne, sidst i Østgrønland.

Samtidig med at Dorsetkulturen blev fortrængt af Thulekulturen, drog efter år 982 islandske bønder over og bosatte sig langs de vestgrønlandske fjorde. Her boede nordboer i omkring 500 år, men deres endelige skæbne har hidtil været ukendt.

Thulekulturen, som sandsynligvis kom fra det nord-østlige Asien, bredte sig fra Thule ned langs vestkysten. Herunder ændrede den form, så der opstod en helt ny kultur, kaldet Inugsukkulturen. Ved tilbagespredning nordover nåede denne kultur til Thule og videre nord om Grønland ned langs østkysten. Ved tilblanding af sene Thuleelementer opstod herved en særlig kulturform i Nordøstgrønland. I selve Thuleområdet skete der igennem århundreder stadig indvandring af nye grupper, således at en selvstændig stamme kaldet Polareskimoerne opstod i Thule.

Fra omkring år 1600 fik eskimoerne tiltagende kontakt med europæerne, især hvalfangere fra mange nationer. I 1721 indledtes den danske kolonisation af Grønland. Af de udsendte var i begyndelsen en meget stor del danskere og nordmænd og kun få islændinge. Resultatet af eskimoernes opblanding med fremmede er blevet, at befolkningen på Grønlands vestkyst består af en blanding af eskimoer og europæere.

Kapitel 3

Anthropometriske undersøgelser af grønlændere og beslægtede etniske grupper

Anthropometriske undersøgelser af grønlændere er omfattende. I 1953 har JØRGENSEN ved sine store undersøgelser af eskimoiske skeletter vist, at der i tiden før den danske kolonisering fandt sted har eksisteret to forskellige typer i Grønland, en nordøstgrønlandsk og Inugsuktypen i Sydvest- og Sydøstgrønland. Sammenligning mellem eskimoer i Grønland og eskimoer i Canada og Alaska har vist stor overensstemmelse mellem Inugsuktypen og Birnirk eskimoerne i Alaska, medens den nordøstgrønlandske type svarer til eskimoerne ved Hudsonbugten.

Kapitel 4

Grønlændernes og beslægtede etniske gruppers seroanthropologi

A. Erytrocyttyper

Undersøgelser over ABO systemet hos Grønlands befolkning er i detaljer endnu utilstrækkelige; dette gælder især den nordlige del af vestkysten og Thuleregionen. Undersøgelser fra sidstnævnte sted har vist

en usædvanlig høj frekvens af O genet, stærkt afvigende fra resten af Grønlands befolkning. De omfattende undersøgelser på Østkysten har vist, at eskimoerne herfra er afgjort forskellige fra eskimoerne andre steder i Grønland. Undersøgelserne på vestkysten har vist, at denne region er klart heterogen. Julianehåb og i nogen grad Nanortalik synes at fremtræde med en ABO blodtypefordeling tydelig forskellig fra resten af Grønland. De øvrige blodtyper er kun undersøgt i ringe grad. Det mest bemærkelsesværdige ved Nordamerikas eskimoer synes at være den høje B frekvens i Alaska; de eneste eskimoer i Grønland med en lignende frekvens af dette gen er østkystens beboere. De gennemsnitlige frekvenser hos de mere østlige eskimoer i Nordamerika ligger i almindelighed nærmere ved beboerne på Grønlands vestkyst.

B. Arvelige variationer i serumproteinerne

I 1956 påviste GRUBB nogle arvelige variationer i gamma-globulinerne kaldet Gm systemet. Senere viste det sig, at dette system var langt mere kompliceret, end man antog i begyndelsen, idet der er påvist flere Gm faktorer. Disse synes bestemte af et enkelt, men meget komplekst locus. Undersøgelserne over Gm systemet hos grønlænderne viste signifikante forskelle i fordelingen af Gm typerne mellem på den ene side beboere på vestkysten og på den anden side eskimoerne i Nord- og Østgrønland, medens Thule- og Angmagssalikeskimoerne i denne henseende ligner hinanden meget.

I 1955 beskrev SMITHIES en ny elektroforesemetode med stivelsesgel. Ved anvendelse heraf var han i stand til at påvise 3 typer af det hæmoglobinbindende alfa-2-globulin kaldet Haptoglobinet. Foruden de 3 oprindelige typer er der senere beskrevet flere modifikationer. De 3 almindelige typer frembringes af et enkelt par allelomorfe gener kaldet Hp^1 og Hp^2. Undersøgelserne af Haptoglobintyperne i de forskellige lægedistrikter på vestkysten viste, når alle distrikter blev sammenlignet, at den totale variation ikke overskred, hvad der kunne tilskrives en tilfældighed. Fordelingen af Haptoglobintyperne hos de nuværende blandede eskimoer på vestkysten afveg signifikant fra Angmagssalikeskimoernes, men ikke fra Polareskimoernes.

Ved immunelektroforese påviste HIRSCHFELD (1959) gruppespecifikke alfa-2-globuliner kalder Gc systemet. De almindelige tre typer er sandsynligvis bestemt af to autosomale alleler uden dominans. Desuden er der specielle sjældne varianter, men undersøgelser, især af NERSTRØM (1963c), har vist, at lignende forandringer kan opstå ved forskellige ydre faktorers indflydelse. Resultatet af Gc undersøgelserne i Vestgrønland var, at genfrekvenserne i de enkelte distrikter ikke viste statistisk signifikante forskelle fra hverandre. Derimod afveg Angmagssalikeskimoerne signifikant fra de nuværende vestkysteskimoer. Frekvenserne for denne

sidste gruppe ligger tæt ved de værdier, som er fundet hos Polareskimoerne.

Forskellige typer jernbindende beta-globuliner kaldet Transferriner er beskrevet, men de fleste er sjældne. De genetiske forhold tyder på, at Transferrinerne arves som et autosomalt, 2 allelt system uden dominans. Det omtales, hvordan undersøgelser over Transferrintyperne kan vanskeliggøres på grund af nedbrydning ved neuraminidase. Undersøgelserne af Transferrintyperne hos vestgrønlændere viser, at den almindelige Transferrintype CC er dominerende.

Undersøgelser over serumtypefordelingen hos eskimoer udenfor Grønland har hidtil været mangelfulde. Dels har materialerne næsten alle været små, dels har undersøgelserne kun omfattet befolkningen på enkelte bopladser.

Kapitel 5

Diskussion og konklusioner

Ved anthropometriske undersøgelser er det vist, at i perioden før den danske kolonisation fandtes mindst to forskellige eskimotyper: en der levede i det nordøstlige Grønland og en anden, der levede på vestkysten og den sydlige del af østkysten.

Fra historiske kilder vides det, at den første europæiske invasion til Grønland bestod af nordboer, som især bosatte sig i Julianehåb- og Godthåbdistriktet efter år 1000. Skeletmateriale fra vestkysteskimoer, der levede i de følgende århundreder, giver ikke grundlag for den antagelse, at der fandt nogen udstrakt blanding sted mellem Inugsukeskimoerne og nordboerne.

Et af de mest iøjenfaldende træk ved alle blod- og serumundersøgelserne i Grønland er den store variationsbredde, der findes i næsten alle undersøgte systemer. Ved en detaljeret diskussion synes det, bedømt ud fra tidligere undersøgelser, rationelt at dele materialerne i 4 grupper efter landsdelene i Grønland.

Ved en analyse og sammenligning af forskellige humane populationsgrupper, må flere faktorer af stor, men varierende betydning tages i betragtning. På Grønland har tilblanding utvivlsomt været en vigtig årsag til forandringer i genfrekvenser. Desuden må dog også selektion, genetisk drift og isolation tages i betragtning.

Den foretagne undersøgelse af ABO typerne i Thule har givet et resultat, der ikke synes helt pålideligt. Frekvensen af O genet fandtes større her end i nogen anden eskimogruppe. Desuden fandtes en tilsvarende lav frekvens af A genet. Undersøgelser over Gm(a) faktoren har også vist, at denne eskimogruppe er helt forskellig fra de eskimoer, der lever længere mod syd på vestkysten, hvorimod de få undersøgelser over eskimoer i Nordamerika viser lignende frekvenser. Gc systemet

derimod viser ikke signifikante forskelle fra beboerne på vestkysten eller overfor eskimoerne i Nordamerika. Derimod er fordelingen af Haptoglobintyperne hos Polareskimoerne signifikant forskellig fra den, der findes hos eskimoerne på Østkysten. Dette samme gælder ABO systemet. Som konklusion kan det fastslås, at på det foreliggende, utilstrækkelige grundlag er det umuligt at drage sikre konklusioner angående slægtskab mellem Polareskimoerne og andre eskimogrupper i Grønland og Nordamerika.

Eskimoer i Østgrønland viser signifikante forskelle fra vestkystens beboere med hensyn til alle undersøgte serologiske systemer. Forskellene mellem disse to grupper, som antages at stamme fra samme eskimogruppe, Inugsukeskimoerne, forklares især ved den store tilblanding af danskere og nordmænd og andre europæere, som har fundet sted på vestkysten gennem de sidste århundreder. I det store og hele er fordelingen af erytrocyttyper i befolkningen på vestkysten i flere tilfælde nærmere den sidstnævnte gruppes end den, der findes hos eskimoerne. Haptoglobinerne er dog en undtagelse fra denne almindelige tendens. Frekvensen af Hp^1 genet er høj blandt Angmagssalikeskimoerne og lavere på vestkysten, men i mange distrikter her endog lavere end i Skandinavien og de fleste andre europæiske lande.

Beboerne på den sydlige del af vestkysten, især i Nanortalik distriktet og i det væsentlige også Julianehåb distriktet synes at fremtræde som en særlig gruppe. Ved sammenligning af resultaterne fra Julianehåb med genfrekvenserne hos danskere, nordmænd og islændinge er det tydeligt, at denne gruppe grønlændere har værdier, der er nærmere dem, som findes hos islændinge med hensyn til de systemer, hvor islændinge klart afviger fra danskere og nordmænd. Siden middelalderen har der imidlertid ikke været nogen speciel immigration af islændinge til Julianehåb. De serologiske undersøgelser kan derfor tolkes som et resultat af, at befolkningen i Julianehåbdistriktet i middelalderen havde elementer af både nordboer og eskimoer. Efterkommerne heraf har så levet isoleret gennem århundreder i denne relativt utilgængelige sydlige del af Grønland.

En trinvis sammenligning af lægedistrikterne på vestkysten, to nabodistrikter ad gangen, viser, at i Hp systemet afviger Holsteinsborg og Egedesminde fra naboerne. Godhavn, Jakobshavn og Qutdligssat distrikterne viste både i Hp og Gc systemerne de største afvigelser ved "internal consistency".

Spørgsmålet om slægtskabet mellem eskimoerne i Grønland og Nordamerika synes for nærværende vanskeligt at løse. Seroanthropologiske undersøgelser af den sidste gruppe er meget sparsomme, og førend mere omfattende undersøgelser er blevet udført, synes forsøg på en analyse af spørgsmålet umuligt.

Den nuværende viden om de nulevende grønlænderes anthropologi viser tydeligt, at de kan deles i tre hovedgrupper: beboerne i Thuleregionen, stadig kun undersøgt i begrænset omfang; østkystens beboere som sandsynligvis er den gruppe, der kommer nærmest Grønlands eskimoer i middelalderen; vestkystens befolkning, som er heterogen, således som det for første gang tydeligt er vist ved de her omtalte serologiske undersøgelser. Årsagen hertil er sandsynligvis, at de har levet i mindre grupper med ringe gensidig kontakt, og hvortil immigrationen fra Europa har varieret både med hensyn til grad og oprindelse. Endelig kan vestkystens beboere også have vist heterogenitet i middelalderen, således som nogle af resultaterne, specielt i Julianehåb tyder på.

Fortsatte serologiske undersøgelser af både den grønlandske befolkning og eskimoerne i Nordamerika er ønskelig. De sidste års udvikling indenfor forskningen af serumtyperne giver løfte om værdifuld ny viden.

APPENDIX

Methods of Investigation

In the following an account will be given of the various methods of investigation used by the present author in the determinations of the genetically determined variations in the serum proteins in man. The reliability of the determinations has been confirmed by investigations of repeated samples, by duplicate determinations and by mother-child and other family investigations. In order to facilitate reading and to avoid repetition, a list of reagents has been included.

a) Investigation of the Gm types

The technique described by GRUBB and LAURELL (1956) was used for the investigation of the Gm system, the slightly modified form used at the Institute of Forensic Medicine, Copenhagen, being followed in most details.

Freshly obtained blood corpuscles were always used. These were obtained from three donors in turn, these donors having proved to be suitable, in contrast to other donors whose erythrocytes did not give such clear agglutination. The blood corpuscles were sensitized with selected incomplete anti-D supplied by Statens Seruminstitut; no. 475714 diluted 1:1 was used for determinations of Gm(a), and undiluted no. 367507 (later no. 790639) for the determinations of Gm(x). In order to find sera containing an agglutinator, that is Gm antibody, sera from patients with primary polyarthritis were investigated. Suitable agglutinators were found in 9 of the 143 sera tested. The specificity of these sera was checked at the Institute of Forensic Medicine. If the investigation were to be repeated to-day I would prefer to use the monovalent Snaggs, which gives a greater distinction between Gm(a+) and Gm(a−) sera than did the Raggs sera which were used (ROPARTZ, ROUSSEAU and RIVAT 1961).

Anti-Gm sera were used in dilutions found appropriate from titrating experiments. Each day the anti-Gm sera were checked to ensure that they gave a strong agglutination; in addition a check was made to ensure that the sensitized erythrocytes did not agglutinate in saline. Serum

from the subjects to be Gm typed was diluted 1:7 with physiological saline. The hollow plates used contain 3 rows of 10 holes in each. For the first run anti-Gm(a) (Klara), anti-Gm(x) (Anna), and also physiological saline (included as a check to reveal the presence of any possible agglutinators in the sera under investigation) were used. The second run was carried out in a similar way, though with the use of other anti-Gm sera: anti-Gm(a) (Karla) and anti-Gm(x) (Elin), together with, as before, a horizontal row with physiological saline. However, in no case was any serum from Greenland with anti-Gm properties found. Checks with sera of known Gm type were made daily.

There was occasionally doubt about the Gm type in the sera under investigation. In these cases the serum was further titrated, beginning with one part serum and one part physiological saline, and the titration was continued in 8 tubes. Sera of known type were titrated in a manner similar to the unknown serum against the anti-Gm serum. Difficulties in typing the sera could occur in cases in which there was agglutination between the serum, physiological saline and the sensitized erythrocytes. In these cases it was possible to dilute the serum under investigation with 4 and 8 parts of physiological saline and warm the diluted serum in a water bath at 63° for 10 minutes. Hereafter the diluted serum was typed as described above, and a check made to discover whether the agglutination in the control row containing the serum, 0.9 % NaCl solution and the erythrocyte suspension had disappeared.

Production of starch for electrophoresis

The methods used in the production of the starch are as follows: Starch electrophoresis which, as stated, was first described by SMITHIES in 1955, has been used for the determination of the Haptoglobin types and the positions of the various Transferrin bands. Danish potato flour, when suitably treated, was found to give results in the Haptoglobin investigations which corresponded to those obtained using the original Canadian starch.

1) Production of starch for Haptoglobin investigations.

1,200 ml acetone p.a. (analytical quality) and an empirically established amount of 12 N HCl were added to 600 g Danish potato flour. The first supply of starch required 28 ml HCl, the second 34 ml HCl. Otherwise the method described by GALATIUS-JENSEN (1960) was followed.

2) Production of starch for Transferrin investigations.

The hydrolyzed starch used for Haptoglobin investigations was unsuitable for the determination of Transferrins as, among other things, the Haptoglobin pattern was so prominent that it was difficult to read the Transferrins.

The method described by SMITHIES (1955) has therefore been used to produce starch for the Transferrin investigations. In order to obtain good, clear results it was found most convenient to use a mixture of 50 % of the starch which I had made, and 50 % of Smithies' original starch (Connaught).

b) Investigation of the Haptoglobin types

The technique described by SMITHIES (1955) was used for the determination of the Haptoglobins. The method is the same as that used at the Institute of Forensic Medicine, Copenhagen.

The detailed procedure was as follows: 47 g hydrolized starch was dissolved in 335 ml borated buffer I, which had to be less than one week old. 50 μl of each serum sample was used, and sufficient of a standard haemoglobin sample was added to give a final concentration of 300 mg% (GALATIUS-JENSEN 1960). A total of 64 tests could be carried out at a time. In those cases in which there was haemolysis only 48 tests were occasionally included, so that they could move further, and reading was easier. Borate buffer II (at most one week old), was placed in the inner chamber of the electrode vessel. In the outer chamber was placed 10 % sodium sulphate. A current of 350 volt, approx. 10 v/cm, was passed for 2 hours. The samples were then stained with benzidine solution. On all occasions readings were made twice, and several sera with known Haptoglobin types were always included. The tests were photographed in colour for later use.

c) Investigation of the Gc types

GRABER and WILLIAMS, in 1953, described an immuno-electrophoretic method of investigating serum proteins. The first stage of this method is an electrophoretic separation of the proteins in agar gel. The second stage comprises the addition of antibodies. When these diffuse against the electrophoretically separated antigens, which at the same time diffuse against the antibodies, there is a reaction between antigen and antibody which leads to the formation of a visible precipitate.

For the investigations the technique described by SCHEIDEGGER (1955), which HIRSCHFELD (1959) has modified by, among other things, using a longer separation time, has been used. For details of the method reference is made to those articles. The anti-human immune sera used were rabbit sera supplied by the department of physical chemistry, Statens Seruminstitut. Selection of those of the sera which were most suitable for the determination of Gc was regularly carried out among the immunized rabbits, as it became apparent that only about 10 % of the rabbits were suitable, and less than 2 % gave really good results. In

particular numbers 1413 and 1592 were used and it was only for lack of these that numbers 1580, 1584, and 1607 were used. LKB immunoelectrophoresis apparatus nr. 6800 A was used for the investigations. The agar gel was produced from Difco Special Agar-Noble, which was dissolved in distilled water and to which barbitol buffer I was added. If the sera were cloudy they were filtered before use. It was possible to place 18 slides at a time in the electrophoresis apparatus, so that 36 sera could be investigated together. Barbitol buffer II was used in the electrode vessels. Apart from this the standard method was used, except that the samples were allowed to stand for 180 mins at 240 volts, equivalent to 7–8 v/cm. The albumin migrated about 40 mm.

With the sera used the localization of the Gc stripes was so obvious that it was unnecessary to stain them with amido black. Sera of known type were included in every series, and all readings were made twice. The slides were preserved and at a later date all results were checked.

d) Investigation of Transferrin types

The serum samples were investigated by starch electrophoresis using a discontinuous puffer system, as described by POULIK (1957). A modification of this system, originally described by ASHTON, was used (see BECKMAN and HOLMGREN 1961). The advantage of this method is that it gives a particularly good separation in the region between the beta-globulins and the albumins. 12.8 g of the starch made as described above, and 12.8 g of SMITHIES' original Canadian starch (Connaught) were dissolved in the two puffers described in the article. Following advice from BECKMAN I used amounts slightly different from those given by BECKMAN and HOLMGREN (1961), as these gave better results. 8 ml of lithium-borate buffer and 192 ml citrate-tris buffer were used. 20 samples were investigated at a time. The citrate-tris buffer was used in the electrode chambers. 3 mm thick platinum wire wound round glass rods was used as electrode. The starch and the electrode vessel were connected with Wettex (cellulose) cloths, which were known from experience to give good results. In order to prevent the starch from melting during the course of the electrophoresis an ice tray was placed on the starch. After this the current was switched on and maintained at 90 mA by means of a stabilizer (stavolt), as higher voltage led to melting of the starch.

The current was connected for about two hours, a sample stained with methylene blue being used to indicate how far the tests had reached. After this the starch was stained with amido black. The Transferrin bands showed up very clearly with this staining method, and by means of sera of known Transferrin type it was possible to check the correct

positions of the bands. Colour photographs of the samples were taken for later use.

If Transferrin bands other than the normal type C were demonstrated by the method described the samples were subjected to more detailed investigation to determine which types were involved. The vertical starch electrophoresis described by SMITHIES (1959) was used in the modification used for the determination of serum Transferrins (GIBLETT, HICKMAN and SMITHIES 1959).

Statistical methods

The material was primarily divided into smaller groups, which were afterwards assembled to form three main groups corresponding to the main regions of Greenland. In the statistical analysis a test was first made of whether the distribution of serum types in each main region corresponded to what was to be expected from the mode of inheritance, and then each subgroup was tested for "internal consistency" (ROSIN 1956). Finally, a comparison of the distribution of serum types between the main groups was made.

The following formulas were used in the calculation of gene frequencies:

a) The Gm system.

The genes which have been taken in account here are Gm^a, Gm^{ax}, and Gm^b. In the investigations tests were made with anti-Gm(a) and anti-Gm(x), but it was unfortunately impossible to obtain an anti-Gm(b) which would have been important in the calculation of the gene frequencies and for assessment of the presence of the gene Gm^{ab}, which STEINBERG et al. (1961) think is to be found in Eskimos. The method used here was described by HARBOE and LUNDEVALL (1961). The use of this method acknowledges that testing with anti-Gm(b) could give other values for the gene frequencies. If the gene Gm^{ab} is to be found it was included in the following calculations under Gm^a.

Gene frequencies

$$Gm^b = \sqrt{Gm(a-)}$$

$$Gm^{ax} = 1 - \sqrt{Gm(x-)}$$

$$Gm^a = 1 - (Gm^b + Gm^{ax}).$$

b) The Haptoglobin system.

Hp 1 – 1, Hp 2 – 2, and Hp 2 – 1 indicate the number of genotypes found, and n the total number of observations.

$$Hp^1 = \frac{2\,Hp\,1-1+Hp\,2-1}{2\,n} = p$$

$$Hp^2 = \frac{2\,Hp\,2-2+Hp\,2-1}{2\,n} = q$$

The expected genotype frequencies were calculated according to the HARDY-WEINBERG law.

The agreement between the expected and actual frequencies has been tested by the following formula:

$$\chi^2 = \frac{n\,(Hp\,2-1^2-4\,Hp\,1-1\,x\,Hp\,2-2)^2}{(2\,Hp\,1-1+Hp\,2-1)^2\,x\,(Hp\,2-1+2\,Hp\,2-2)^2}$$

(with one degree of freedom), which is given by FISHER (see RACE and SANGER 1962, p. 78).

c) The Gc system.

The frequency of the genes Gc^1 and Gc^2, the expected genotype frequency, and the χ^2 test were calculated from formulas similar to those given for the Haptoglobins.

A statistical complication arose in the investigations of the gene frequencies in Thule and Angmagssalik, as the individuals investigated were related. COTTERMAN (1947) has published "weighting systems" for the assessment of gene frequencies in materials where related individuals are included. The tables for genes with and without dominance and for families of different size in which none, one or both parents were investigated have been used in the calculation of the gene frequencies in Thule and Angmagssalik. In the case of families in which one of the parents is unknown Cotterman gives no tables for the calculation of the gene frequencies. In these cases the "weight" was calculated from the values given for use in cases where only one of the parents was investigated. The "weight" was determined by the number of children, but in this case, the number of individuals included in the calculation comprised only the children, as the unknown parent was excluded.

For all comparisons between observed and expected frequencies

$$\frac{(\text{actual no. observations} - \text{expected no. observations})^2}{\text{expected no. observations}}$$

was calculated for each class, and χ^2 was then equal to the sum of all these results.

The requirement, that for use of the χ^2 test there must be no theoretical class frequency of less than 5, was not strictly upheld in those cases in which there was no significant difference.

Where there was a small number of observations in a group and it was desired to compare two frequencies the following formula was used (KEMP and NIELSEN 1961, p. 78):

$$\chi^2 = \frac{(n_1 + n_2)\left(x_1(n_2 - x_2) - x_2(n_1 - x_1) - \frac{n_1 + n_2}{2}\right)^2}{n_1 n_2 (x_1 + x_2)(n_1 + n_2 - x_1 - x_2)}$$

where n_1 and n_2 are the total numbers in group 1 and group 2, respectively, and x_1 and x_2 are the numbers with a definite property in each of the groups, with $f = 1$.

List of Reagents

Abbreviations: p.a. = pro analysi (analytical grade).
Ph.Dan. = Pharmacopea Danica (Danish Pharmacopeia, IX. Ed. 1948).

Acetone p.a. (Merck)

Agar gel

Special Agar (Noble), Difco, B 142	6 mg
Purified water	300 ml

Amidoblack stain

Amidoschwartz 10 B (Merck)	6 g
Concentrated acetic acid p.a. (Merck)	100 ml
Methanol, Ph.Dan.	250 ml
Purified water	250 ml

Benzidine reagent

Benzidine	25 mg
Barium penoxide	200 mg
dissolved in a mixture of concentrated acetic acid, Ph.Dan.	2.5 g
Purified water	2.5 g

(This reagent should be freshly prepared).

Borax buffer I

Boric acid p.a. (Merck)		1.898 g
Sodium hydroxide 1 N		29.5 ml
Bidistilled water	sufficient to produce	4,500 ml

Borax buffer II

Boric acid p.a. (Merck)		46.37 g
Sodium hydroxide 1 N		150.0 ml
Bidistilled water	sufficient to produce	5,000 ml

Borax buffer III

Boric acid p.a. (Merck)		9.275 g
Sodium hydroxide 1 N		60.0 ml
Bidistilled water	sufficient to produce	5,000 ml

Borax buffer IV

Boric acid p.a. (Merck)		92.75 g
Sodium hydroxide 1 N		300.0 ml
Bidistilled water	sufficient to produce	5,000 ml

Barbitol buffer I

Barbitol, Ph.Dan.		1.66 g
Barbitol sodium, Ph.Dan.		10.51 g
Calcium lactate, Ph.Dan.		1.536 g
Bidistilled water	sufficient to produce	1,000 ml

Barbitol buffer II

Barbitol, Ph.Dan.		1.38 g
Barbitol, sodium, Ph.Dan.		8.76 g
Calcium lactate, Ph.Dan.		0.384 g
Bidistilled water	sufficient to produce	1,000 ml

Citrate/Tris buffer

Citric acid p.a. (Merck)		1.60 g
Tris (hydroximethyl) aminomethane (Trizma ® Base, Sigma)		6.29 g
Bidistilled water	sufficient to produce	1,000 ml

Liquid paraffin, Ph.Dan.

Lithium/Borax buffer

Lithium hydroxide purissimum (Merck)		1.20 g
Boric acid p.a. (Merck)		11.89 g
Bidistilled water	sufficient to produce	1,000 ml

Merthiolate 0.1% (*Eli Lilly & Co., USA*)

Paraffin, mp. 40–42° (Merck)

Sodium acetate 1 M

Sodium acetate (trihydrate, p.a. Merck)		136 g
Purified water	sufficient to produce	1,000 ml

Sodium chloride solution 0.9%

Sodium chloride, Ph.Dan.		9 g
Purified water		1,000 ml

Sodium citrate solution 3%

Sodium citrate, Ph.Dan.		30 g
Purified water	sufficient to produce	1,000 ml

Sodium sulphate solution 10%

Sodium sulphate, Ph.Dan.	100 g
Purified water	sufficient to produce 1,000 ml

Starch gel for haptoglobin

Potato starch, Ph.Dan.	600 g
Acetone p.a. (Merck)	1,200 ml
Concentrated hydrochloric acid p.a. (Merck)	sufficient quantity
Sodium acetate 1 M	300 ml

Starch gel for transferrin

Potato starch, Ph.Dan.	300 g
Acetone p.a. (Merck)	600 ml
Concentrated hydrochloric acid p.a. (Merck)	6 ml
Sodium acetate 1 M	150 ml

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Erratum:

p. 64 line 21 in Acta genet. (Basel). 1968, 61–69: 1968. In 8 out of these, read: in 7 out of these.

P. 266 in Acta genet. (Basel). 1968: Tabel III line 3 0.001 read: 0.01 and line 9 3.850 read 1.604.

P. 267 in Acta genet. (Basel). 1968: Tabel IV line 2 0.001 read: 0.032 and line 3 0.110 read 1.110.

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