GEOGRAPHICAL
HANDBOOK
SERIES

ICELAND

NAVAL INTELLIGENCE DIVISION

B.R. 504

GEOGRAPHICAL HANDBOOK SERIES

ICELAND

July 1942

NAVAL INTELLIGENCE DIVISION

preparation, and this list will be substantially extended by the end of 1942.

The purpose of the books is primarily naval. They are designed first to provide, for the use of Commanding Officers, information in a comprehensive and convenient form about countries which they may be called upon to visit, not only in war but in peace-time; secondly, to maintain the high standard of education in the Navy and, by supplying officers with material for lectures to naval personnel ashore and afloat, to ensure for all ranks that visits to a new country shall be both interesting and profitable.

Their contents are, however, by no means confined to matters of purely naval interest. For many purposes (e.g. history, administration, resources, communications, etc.) countries must necessarily be treated as a whole, and no attempt is made to limit their treatment exclusively to coastal zones. It is hoped therefore that the Army, the Royal Air Force, and other Government Departments (many of whom have given great assistance in the production of the series) will find these Handbooks even more valuable than their predecessors proved to be both during and after the war of 1914–18.

This volume has been prepared for the Naval Intelligence Division at the Cambridge sub-centre (Director, Mr J. M. Wordie; General Editor, Dr H. C. Darby). It has been written mainly by Dr L. Hawkes, Mr J. R. James, Dr B. B. Roberts, Mrs S. Ross and Mrs Dorothy Wright, with further contributions by Dr H. Carmichael, Rev. R. J. C. Hambrook, Mr T. C. Lethbridge, Mr W. V. Lewis, Mr G. Manley, Lieut. E. E. Thomas, R.N.V.R. and Mr G. Turville Petre. The maps and diagrams have been executed by Miss Margaret Alexander, Mr D. Baldwin, Mr D. J. Bennett, Mr A. O. Cole and Mrs Gwen Raverat. The book has been edited by Dr B. B. Roberts.

J. H. GODFREY
Director of Naval Intelligence

July 1942.

CONTENTS

LIST OF MAPS AND DIAGRAMS

LIST OF PLATES

For notes on the form and pronounciation of place names the reader is referred to pp. 419–424

Chapter I

GEOLOGY AND PHYSICAL GEOGRAPHY

Introduction: The Rocks: Volcanoes: Hot Springs: Earthquakes: Glaciers and Glacial Lakes: The Great Ice Age: Former Shore Levels: The Land Surface: Mineral Deposits

INTRODUCTION

Iceland lies between the parallels 63° 23′ and 66° 33′ N, and the meridians 13° 28′ and 24° 32′ W. The shortest distances to the neighbouring countries are as follows: East Greenland 300 km., Faroe Islands 420 km., Shetland Islands and Scotland 800 km., Norway 970 km., and Denmark 1,500 km.

Flóki Vilgerðarson, the third Norwegian viking to visit Iceland, landed on Barðaströnd on the north side of Breiðifjörður about A.D. 865 and wintered there. After a hard spring Flóki climbed a mountain, and, seeing to the north a fjord full of pack ice, he called the country Iceland. Thus a name which would be more appropriate for Greenland, with six-sevenths of its area ice, was given to a land of which only one-eighth is ice covered. 'Volcanoland' would have been a more suitable name, for all its rocks are directly or indirectly derived from hot rock liquid, of which the greater part has been poured out from volcanoes. Geologically, Iceland is an unfinished country, for it is being periodically added to by outpourings of lava and volcanic ashes, and the greatest fissure eruption of historic times (Laki, 1783) occurred there. The processes by which it was built up are still in operation, and no other country illustrates so completely within its own borders the geological dictum that 'the present is the key to the past'. The glaciers include the largest one in Europe; volcanoes are sometimes active beneath them, and this 'land of frost and fire' presents phenomena which, unknown or little studied elsewhere, have attracted the attention of scientists the world over. The literature relating to the natural history of Iceland is scattered in the journals of many countries and in many languages. Apart from the pioneer explorations of the Icelander Þorvaldur Thoroddsen (1855–1921), which were of necessity in many respects little more than a reconnaissance, no systematic survey of the rocks has yet been attempted and a host of problems awaits solution.

The length of the island from east to west is 490 km., its breadth from north to south is 312 km., and its area is about 103,000 sq. km., being greater than that of Ireland by about one-fifth. It is not an arctic country; the most northerly point lies just south of the Arctic Circle. In the most northerly districts the sun is seen above the horizon for 2½ weeks in June (for further details of the duration of daylight see Appendix III). The shape of the island is a rough oval to which is attached in the north-west a peninsula diversified by a great number of fjords. Iceland is largely a tableland with an average height of 700–1,000 m. above sea level; there are narrow borders of coastal land, valleys which cut into the tableland from all sides, and a few small areas of low-level land towards the south and west. About one-fourteenth of the country can be reckoned as lowland. The rigorous climate of the highlands, their deserts, lava fields and glaciers render them uninhabitable.

THE ROCKS

The rocks of Iceland may be divided into two groups—a younger series and an older series; their distribution is indicated in Fig. 1. In the present state of our knowledge there are many rocks which cannot with confidence be placed in either group. It may be that some of them are intermediate in age, so it must be recognized that in many places the boundary between the older and younger series is only tentatively drawn. In broad outline the map is correct, but it must be noted that in some parts, notably Snæfellsnes and districts to the south-east of it, the younger rocks are seen to overlie the older ones. With few exceptions the rocks were formed on land; there is no evidence that the sea has ever covered more than parts of the lowlands. Some of the commonest rocks in the world, limestones and quartz sandstones, do not enter into the make-up of the land, and the pebbles of quartz sandstone occasionally found by the shore have been brought from afar entangled in the roots of drift-wood.

The Older Rocks

These belong to a late period of geological time, viz. the Eocene (early Tertiary) period, which began perhaps some 60 million years ago. The rocks are mainly dark or grey basalts, in sheets averaging about 10 m. in thickness, commonly separated by thin beds of softer brown

Fig. 1. North Atlantic Tertiary Volcanic Regions. Tertiary igneous rocks are shown black. The central zone in Iceland is occupied by younger igneous rocks. Adapted from J. E. Richey, *Scotland, the Tertiary Volcanic Districts*, p. 41 (London, 1935).

or red rock. The total thickness of the series runs into thousands of metres, the base is nowhere seen, and the succession of sheets piled one above another in coastal cliffs and valley sides is one of the most characteristic features (trap-featuring) of the Icelandic landscape. Similar rocks of the same age are found in Greenland, the Faroes, Scotland and Ireland. It is obvious that formerly these basalts extended far beyond the present coasts of these countries, and it is possible that at the time when these lavas were being poured out there was a land bridge from Greenland to Europe. Individual basalt sheets can be traced for many kilometres; they were perhaps poured out from fissure volcanoes (see p. 12). The basalts show all the features exhibited by the present-day lava flows (see p. 8) except that the holes (vesicles) commonly present in the upper and lower parts of the sheets are filled with white chalcedony, zeolites, calcite and other minerals. In the interior of some sheets fractures may be present, normal to their surfaces, which produce a rough columnar structure. The thin beds of brown and red rock so commonly seen between the basalts are weathered volcanic ash or lava or both. They are laterites—rocks containing a high proportion of the oxides of aluminium and iron—and the climate under which they were formed was probably a warmer one than that of Iceland to-day. Beds of brown and dark sandstone and shale up to 50 m. thick also occur, and these contain leaf impressions, fossil wood (*surturbrandur*) and occasionally thin beds of poor-quality coal (see p. 68).

In places, particularly in the east, lavas of acid composition are found between the basalts. These lavas (and ashes), though of small amount in comparison with the basic rocks, are conspicuous by reason of their nature and colour. The lavas commonly have an outer skin of black or green glass (obsidian), whilst their main mass is a fine-grained stone, white, light grey, or pink in colour (rhyolite). Both the glass and the stony rock often show a colour banding, and rounded bodies made up of radiating crystals (spherulites) may be present in such numbers as to form pea or ball-like aggregates.

Originally the older rocks formed one great tableland built up of horizontal sheets of rock, but it has been broken up into blocks which have been tilted up to 10° in various directions (Plate 2). Quite commonly the tilt is directed towards the interior of the country, as may be well seen when sailing in many of the fjords. Erosion has been at work carving deep valleys and eating into the boundaries of the country so that the way in which the rocks were piled up can be studied in the faces of the cliffs. In these cliffs it can be seen that some of the rock masses must have been formed by the cooling of rock liquid beneath the surface. This cooling was slow compared with that of a surface lava and the crystals were able to grow to a larger size, sometimes a centimetre across. The rocks, which are called 'intrusive' in contradistinction to the 'extrusive' lavas, may be classified into dykes, sills, laccoliths, and stocks.

Dykes. These are vertical or nearly vertical sheets of rock which cut across the lava layers (Fig. 34). They are seen in gullies in the mountain sides or they may stand out as walls; parallel dyke walls often form sheltered harbours for small boats. They are commonly dark basalt but they may be light-coloured or glassy acid rock; some dykes contain sheets of both acid and basic rock. A columnar structure, in which the columns lie at right angles to the sides of the dyke, is common.

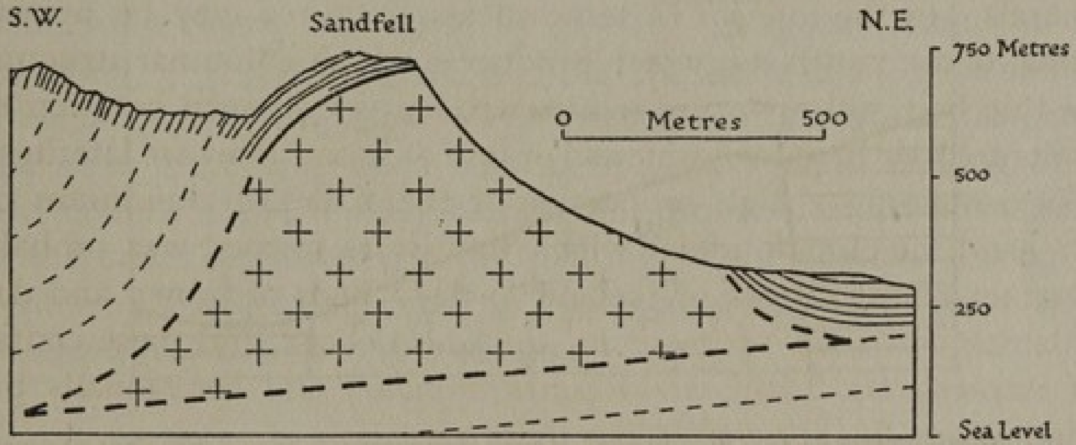


Fig. 2. Section across the Sandfell laccolith, Fáskrúðsfjörður.

Sills. These are rock sheets lying between the lavas, and they were formed from rock liquid which penetrated between the lava sheets and cooled there. It is often difficult to distinguish them from the lavas; they appear to be comparatively uncommon. Dykes and sills are usually a few metres thick.

Laccoliths. One fine example is seen at Sandfell on the southern side of Fáskrúðsfjörður in east Iceland. Here the dark lavas bend over a hill of light-coloured acid rock (Fig. 2). The lava series was originally horizontal, but has been pushed up at a point by the uprise of rock liquid which cooled below to form a kind of subterranean volcano. In places the lavas can be seen tilted almost vertically, and the intrusion at the time of its growth must have given rise to a blister about 700 m. high on the earth's surface.

Stocks. These are steep-sided masses of rock with a flattish roof (Fig. 3). Nearly all the larger intrusions of Iceland are of this type;

they are best shown in the south-east. Stocks differ from laccoliths in that the lavas adjoining and overlying them have suffered little if any disturbance, and the problem as to how they grew is a much debated one. It seems likely that the block of lavas which these masses replace moved down whilst the rock liquid rose to occupy its place. The best exposed stock is that of Slaufrudal, south-east Iceland. This is composed of light-coloured rock, and its relations to the dark-layered basalts are finely exposed (Fig. 3). The stock is 7·5 km. long and 2 km. broad; the base is not seen; its volume is at least 10 cu. km. The impressive mountain bastions of Austurhorn and Vesturhorn on either side of Lónsfjörður are carved out of stocks. The rocks of these intrusions are dominantly either light-coloured acid (granite and

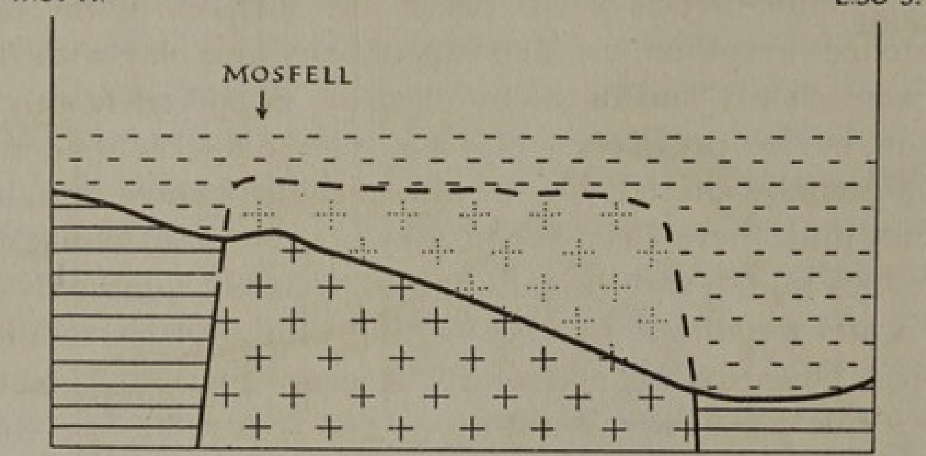


Fig. 3. Section across the Slaufrudal stock. Horizontal lines—basalts; crosses—granite and granophyre; continuous lines—rocks now seen; broken lines—conjectural, now eroded away. Length of section 3 km. No vertical exaggeration.

granophyre) or dark-coloured basic (gabbro). The gabbro of Vesturhorn is a handsome coarse-grained rock, and it would provide the finest building stone in Iceland. The appearance of thin slices of the granophyres when seen under the microscope is most striking.

The older rocks of Iceland can be matched with those of the same age in Greenland, the Faroes, west Scotland and north Ireland. In these districts there are no younger volcanic rocks; only in Iceland and Jan Mayen are they to be found. This later volcanic activity continued from Pliocene times down to the present day, but it is not yet known whether there was a period of rest between the older and the younger activity. Before Pliocene times the rocks were disturbed by earth movements and they also suffered prolonged erosion. Had the later volcanic activity not broken out, Iceland to-day would have been a group of islands like the Faroes.

The Younger Rocks

Pliocene. These rocks (which are perhaps about 2 million years old) are only known at one place, the western side of the Tjörnes peninsula. In the cliffs north of Húsavík is a series of sands and ashes with many marine shells, overlain by lavas, and these deposits were probably laid down in a bay of an island which was larger than the present one.

The Palagonite Formation. This is the name given to the post-Pliocene rocks of the median zone. These rocks were formed during Pleistocene times, when for considerable periods the country was occupied by glaciers. The conditions were similar to those which obtain at the present day in the western part of Vatnajökull (see p. 39). The rocks include lavas with ash beds, often crowded with lava blocks (the 'palagonite breccia'). In places the surfaces of the lavas are ice scratched, and there are deposits of sand and clay with boulders which were clearly laid down by glaciers. A special feature of this formation is the prevalence of basic volcanic glass (sideromelan) which is partially altered to a brown substance known as palagonite. The glass must have been formed by a very rapid chilling of the volcanic rock liquid, and the chilling was probably commonly effected by the water produced by the melting of the glaciers during the eruptions. Towards the end of Pleistocene times the great shield volcanoes (see p. 16) were built up.

VOLCANOES

The central zone of Iceland is built of younger accumulations of volcanic products (Figs. 4 and 21). Here volcanic activity has lasted from the Pliocene period through the Ice Age to the present day. Outside the zone marked on Fig. 21, glacial and post-glacial volcanoes have been active in the Snæfellsnes region also. Under vulcanicity are included all phenomena associated with the rise of hot rock liquid (about 1,000° C.) to and near the surface. The liquid stiffens into stone on cooling, and the emission of gases from it in shallow depth results in hot spring activity. The term lava is applied both to the liquid and the solid rock.

In Iceland, for the most part, this liquid has been basic (about 48% silica), and the solid lava or basalt is dark to light grey in colour and commonly composed of the minerals olivine (green), felspar (white), augite and iron ore (black). The crystals are small but can usually be distinguished with a hand lens. The lava solidifies rapidly at its surface, and the gases within it expand to form bubbles so that the resulting rock is full of holes (vesicles); within, the flow becomes a homogeneous rock with larger crystals than those of the upper and lower surfaces. A lava field is known in Iceland as a *hraun*, and the surfaces are of two contrasted types: *apalhraun*, very irregular, blocky and cavernous, and *helluhraun*, partly glassy, comparatively smooth with swelling and rope-like forms. *Apalhraun* is very difficult to traverse and is impossible for horses; *helluhraun* is better, although it is broken into slabs lying at various angles. One and the same flow may be an *apalhraun* in one part and a *helluhraun* in another. The

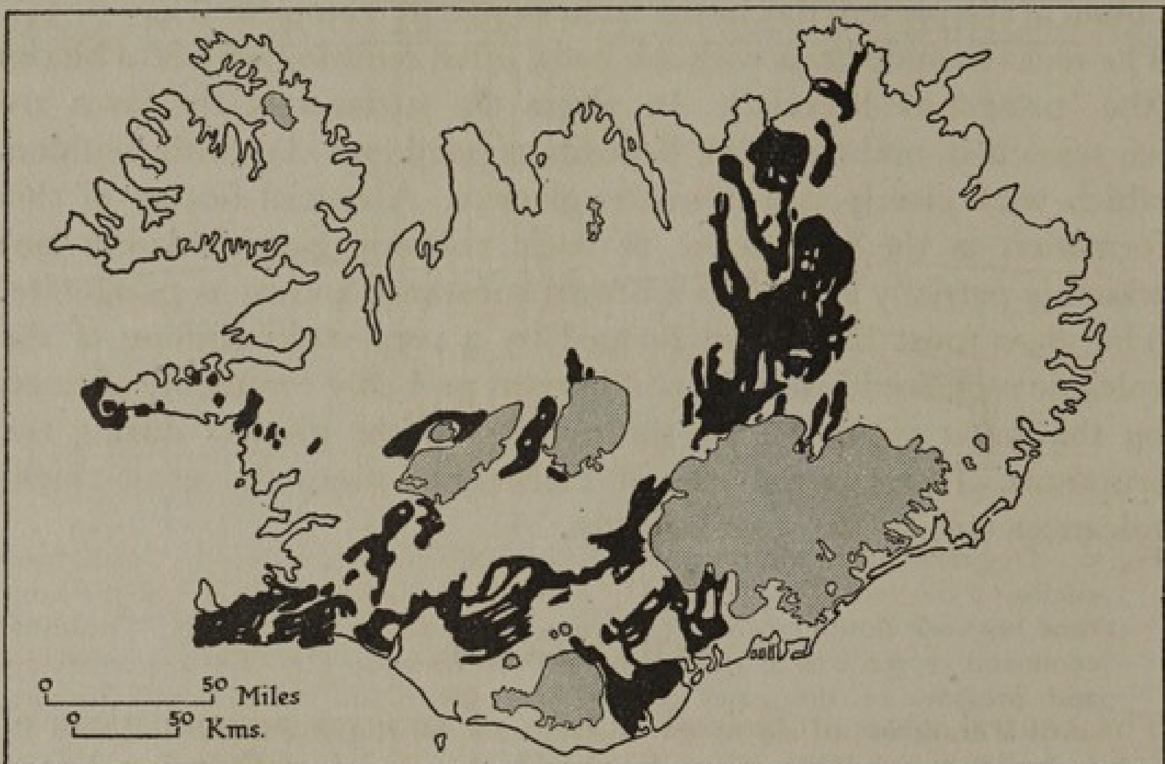


Fig. 4. Post-glacial basaltic lava (black areas). Stippled areas are glaciers. Source: Þ. Thoroddsen, *Geological Map of Iceland* (Copenhagen, 1901).

general level surface of a lava field may carry scattered small cones of slaggy lava (hornitos) up to a few metres high at points where gas pressure has been concentrated within the lava flood. In the final stages of the spread of a lava the inner liquid may drain away, the overlying crust remaining to form the roof of a tunnel. Surtshellir, a tunnel in the Hallmundarhraun west of Eyriksjökull, is about 1·5 km. long, 11 m. high and 16 m. broad, and it contains remarkable ice formations.

With explosive action at the place of emission of lava, the liquid is blown skywards and fragmented. The finest material is known as ash, the larger as lapilli, and compact masses more than a few centimetres across are called bombs. During an ash eruption, daylight may be completely excluded. The ash lying about the desert is caught up by strong winds and can be extremely troublesome for travellers.

The consolidated layers of fragmental products are of great thickness in the younger volcanic zone, and are known as palagonite tuffs. These tuffs often contain angular basalt fragments and are then known as tuff-breccias. The chief constituent of such rocks is black basaltic

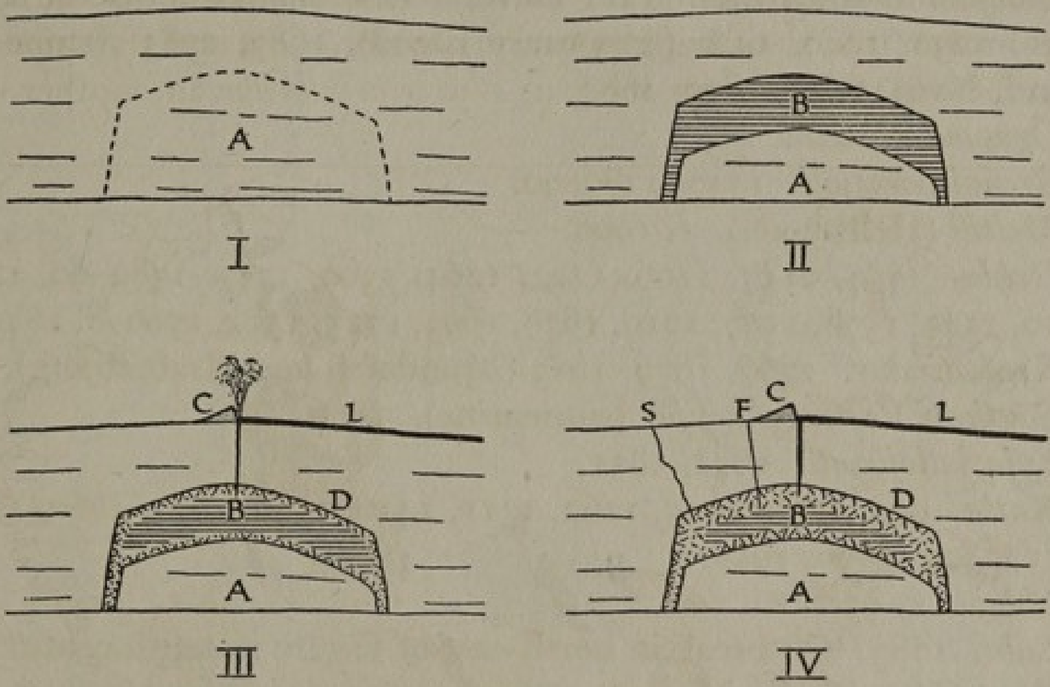


Fig. 5. Diagrams illustrating successive stages of volcanic activity. I. Cracks form enclosing the rock mass (*A*). II. The rock mass (*A*) sinks, and at the same time hot rock liquid (*B*) rises to form a subsurface reservoir. III. The liquid cools and crystallizes at the borders of the reservoir (*D*). The concentration and pressure of the gases dissolved in the liquid consequently increase until a crack is opened to the surface and the frothing liquid is forced up to build an ash cone (*C*) and overflow as a lava (*L*). The effect may be compared with that shown on releasing the pressure in a soda-water bottle. IV. A later stage. Most of the subterranean liquid has crystallized, and the gases which are continuously being forced off give rise to fumaroles (*F*) and hot springs (*S*). With complete crystallization and cooling down of the rock, the hot-spring activity gradually dies down.

glass (sideromelan). The yellowish brown colour of the rocks is due to the substance palagonite, which is formed by the weathering of the glass. The bulk of the palagonite tuff and breccia was probably formed during the Ice Age, an age which may be regarded as still in being in the glacier-covered districts.

It is impossible to state with confidence how a volcano works, and the conditions vary greatly. The above series of hypothetical sections through the outer part of the earth's crust illustrate one possible volcanic mechanism and history (Fig. 5).

The historic period goes back 1,000 years and the recorded eruptions are listed below. The exact time and place of the earlier outbreaks is naturally somewhat uncertain. Many of them occurred in deserts far from human habitation, and the localities of eleven eruptions between 1105 and 1510 cannot be determined.

List of Volcanoes active in Historic Times. (For localities see Fig. 6)

Eldeyjar (submarine). 1211 (several new islands formed), 1226, 1231, 1238, 1240, 1422 (temporary island), 1583, 1783 (temporary island, Nyö), 1830, 1879, 1884.

Ögmundarhraun. 1340.

Brennisteinsfjöll. 1340, 1389–90.

Meitill (Hellisheiði). *c.* 1000.

Hekla. 1104, 1157, 1206, 1222, 1294, 1300, 1341, 1389–90, 1436, 1510, 1544, 1578, 1597, 1619, 1636, 1693, 1725, 1755, 1766–8, 1845–6.

Krakatindur. 1766, 1879, 1913 (Mundafell and Hrafnabjörg).

South of Vestmannaeyjar (submarine). 1896.

Eyjafjallajökull. 1612, 1821.

Katla. 900, 1179, 1245, 1262, 1311, 1416, 1580, 1625, 1660, 1721, 1755, 1823, 1860, 1918.

Eldgjá. *c.* 950.

Laki. 1783. Outbreak in north-east of fissure in tenth century.

West Vatnajökull. Many from Grímsvötn; localities of others uncertain. About forty eruptions between 1332 and 1934.

Öræfajökull. 1341, 1362, 1598, 1727.

Kverkfjöll. 1717, 1929 (?).

Askja. 1875, 1921, 1922, 1923 or 1924, 1926.

Sveinagjá. 1875.

Krafla (Viti). 1724.

Leirhnúkur. 1725, 1727, 1728, 1729, 1746.

Hrossadalur. 1728.

Bjarnarflag. 1725, 1728.

Dalfjall. 1728.

Leirhafnarskörð. 1823.

North-east of Grímsey (submarine, temporary island). 1372.

North of Siglufjörður (submarine). 1838.

Near Mánareyjar (submarine). 1868.

North-west of Eyjafjörður (submarine). 1873.

Between Iceland and Greenland (submarine, temporary islands?). 1332, 1456, 1783.

For descriptive purposes the volcanoes may be grouped into several

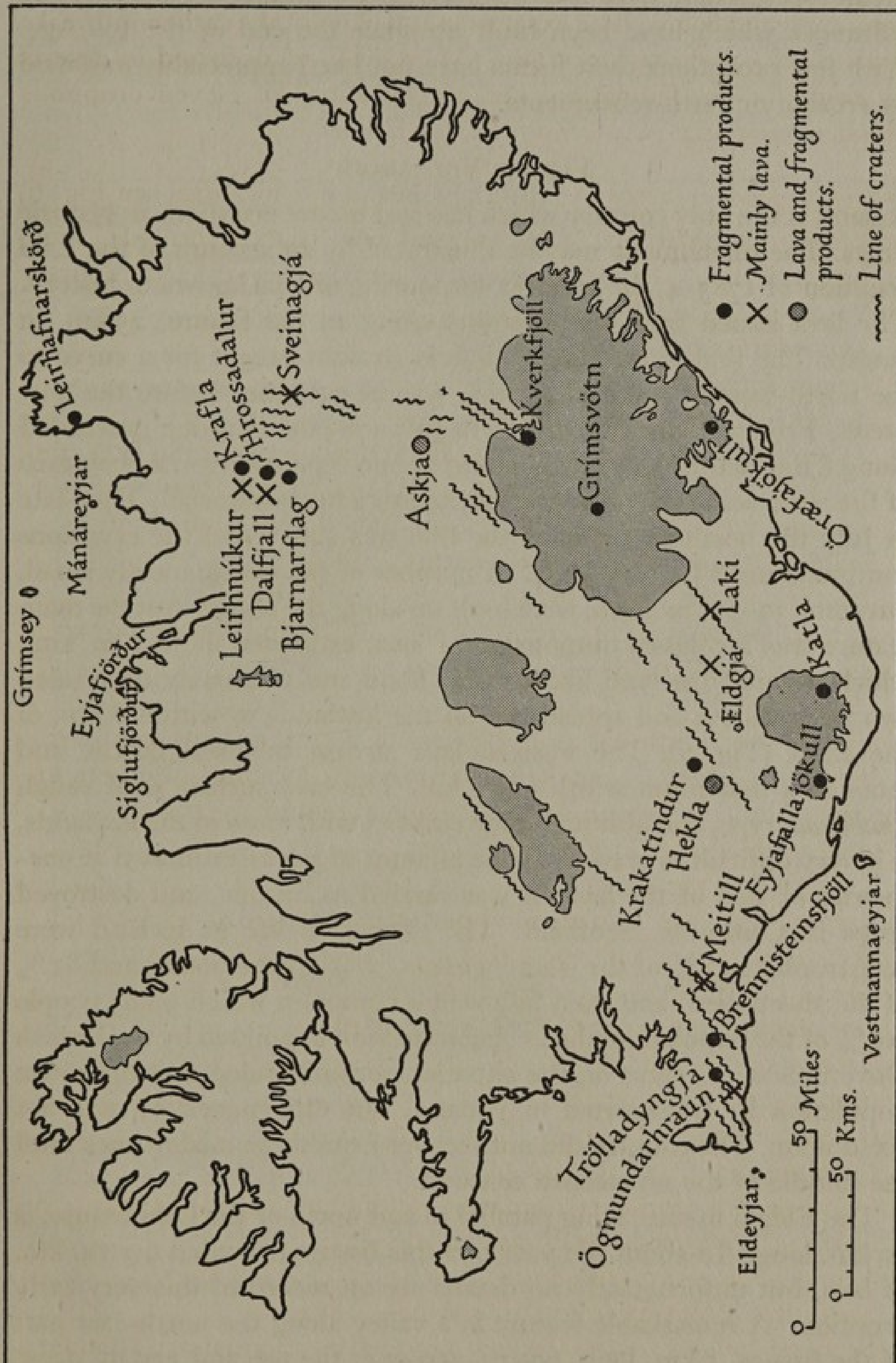


Fig. 6. Volcanoes active in historic times.

broad types, and in what follows illustrative examples are chosen from volcanoes which have been built up since the end of the Ice Age. With few exceptions their forms have not been appreciably modified by erosion or earth movements.

Fissure Volcanoes

Iceland is the only country which has had fissure eruptions in historic times. The phenomena may be illustrated by an account of the Laki eruption of 1783–4, the greatest outpouring of lava known in history. The lava issued from many points along an old fissure, 25 km. in length. The line of eruption points is straight except for a curve to the north-west at Laki hill, which was in existence before the outbreak. From early in June to late in July 1783 the eruption proceeded along a line south-west of Laki, and at one time twenty-two columns of fire were seen; the noise was likened to a huge waterfall. Then late in July the north-east part of the line was active and the eruptions continued until January 1784. A number of ash cones, mostly small, but some 30–100 m. high, were built up along the fissure, but the main feature was a colossal outpouring of lava, estimated at 12·3 cu. km., which covered the land like a water flood and ultimately descended two river valleys and spread out on the lowlands to within 8 km. of the shore (Fig. 7). The western lava stream travelled 80 km. and attained a maximum width of 20 km. The lava surface is of rough *apalhraun* type, and although now covered with moss in the lowlands, it is very difficult to traverse. The amount of ash is estimated at one-quarter of that of the lava; it was carried to Europe, and destroyed crops in Caithness, Scotland. The effects on life in Iceland were catastrophic: 53% of the island's cattle, 77% of the ponies and 82% of the sheep died, and then followed a famine in which 9,283 people (19% of the population) died. A commission appointed by the Danish Government to report on the situation recommended that the entire population be transported to Jutland, but this suggestion was not acted upon. The country did not recover from these misfortunes until the middle of the nineteenth century.

The Eldgjá fissure, lying parallel to and north of the Laki fissure, is 30 km. long. In about the year 950 this fissure extruded 9·3 cu. km. of lava, but unfortunately no details are on record of this very early eruption. A remarkable feature is a valley along the north-east part of the fissure, 5 km. long, 600 m. across at the top and 270 m. deep. It is thought that this valley was formed by explosions which blew away the old rocks.

A fissure eruption field may be composed entirely of lava with no line of ash cones, and the Illahraun south of Hofsjökull may be cited in illustration. Here the lava appears to have issued without explosive activity from a fissure 1 km. in length and covered an area of 50 sq. km.

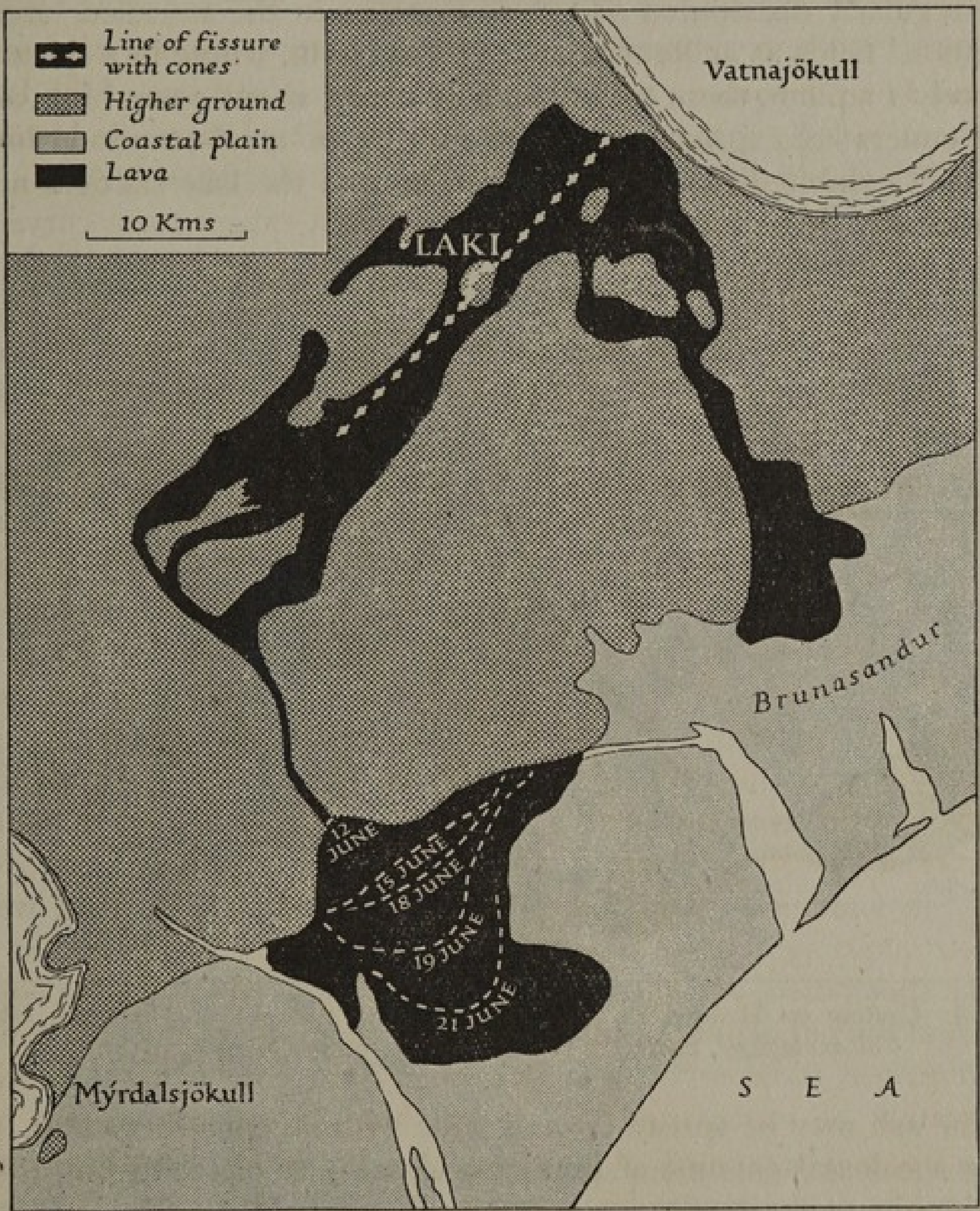


Fig. 7. The lava stream from the eruption of Laki in 1783. Adapted from Þ. Thoroddsen, *D. Kgl. Danske Vidensk. Selsk. Skrifter, Naturvidensk. og Mathem.*, Afd. 8, Række IX (Copenhagen, 1925).

Ash Volcanoes

With explosive activity ash, lapilli, and bombs collecting round a vent may build comparatively small cones, up to 150 m. high, with wide funnel-shaped craters. The silhouettes of these accumulations are one of the most striking features of the landscape of the young volcanic zone. Such cones form rapidly during a single eruptive period with or without lava outpouring at their base. They may be isolated as Hverfjall on the east of Mývatn (Fig. 15) or in linear series as Laki, or irregularly distributed and close together in the so-called 'areal-eruption' fields as at Rauðholar near Reykjavík, where in a space of scarcely 1 sq. km. there are over ninety cones, about 40 m. high, and with craters from 10 to 90 m. across. At Mývatn 'areal-eruption' fields are well exhibited in the islands and around the lake borders near Skútustaðir (Figs. 8 and 9).

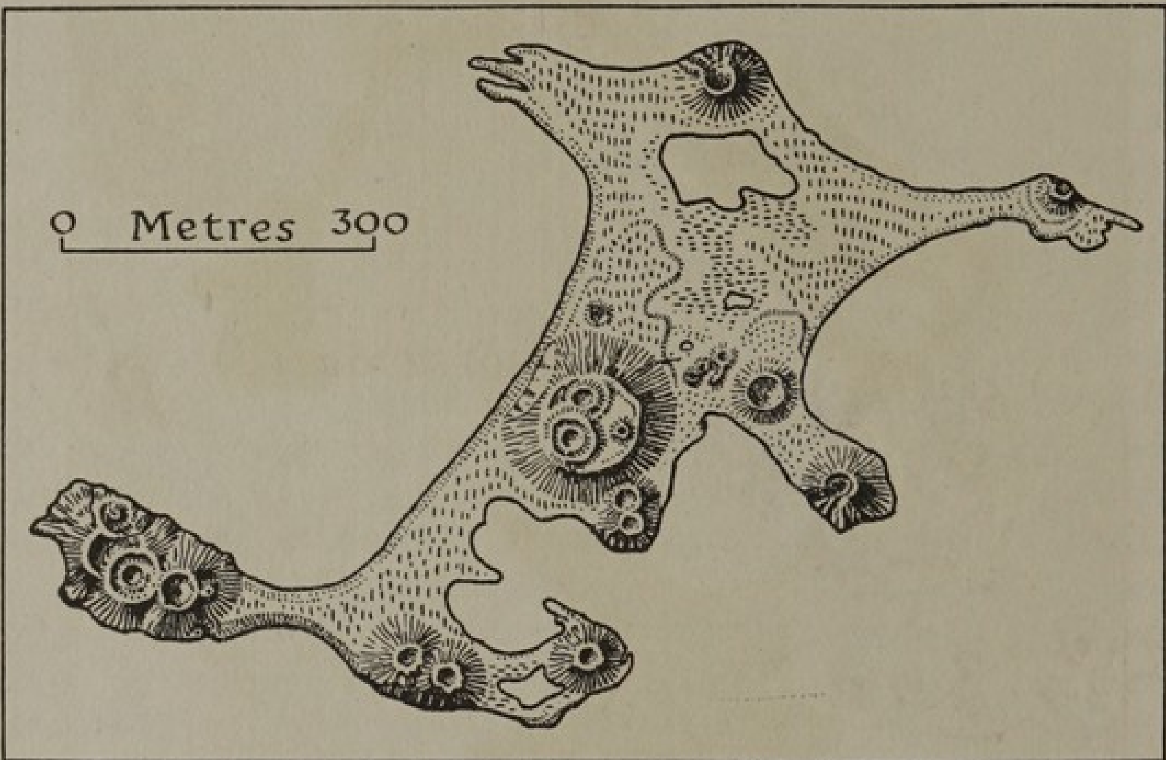


Fig. 8. Craters on Hrútey, an island in Mývatn. Source: A. Rittmann, *Bull. Volcanologique*, Serie II, Tome 4, Bd. 5, p. 13 (Naples, 1938).

The ash may be spread far and wide with no cone formation. In 1875 a colossal amount of pumice and ash was ejected from a pit, Öskjuviti, 90 m. in diameter, in the floor of Askja. The ash was distributed to the east where in Jökuldal seventeen farms were laid waste, whilst ash was falling in Stockholm 24 hr. after the eruption. The outbreak at Krafla in 1724 provides another example of the absence of cone formation. With a series of explosions and the expulsion of ash and stones lasting for several hours an oval-shaped hollow known as Helvíti (= hell), 350 m. across, was formed, and this was for 100 years the site of a boiling lake. In 1839 it was thus described:

'The border is not raised, the sides go steep down, and at the bottom is a boiling lake of bluish black mud emitting a suffocating steam. The walls are glowing with smoking sulphur. The whole is a complete devil's cauldron from which all living things fly; horses quake with mortal fear and can hardly stand when taken to the brink.' By 1846

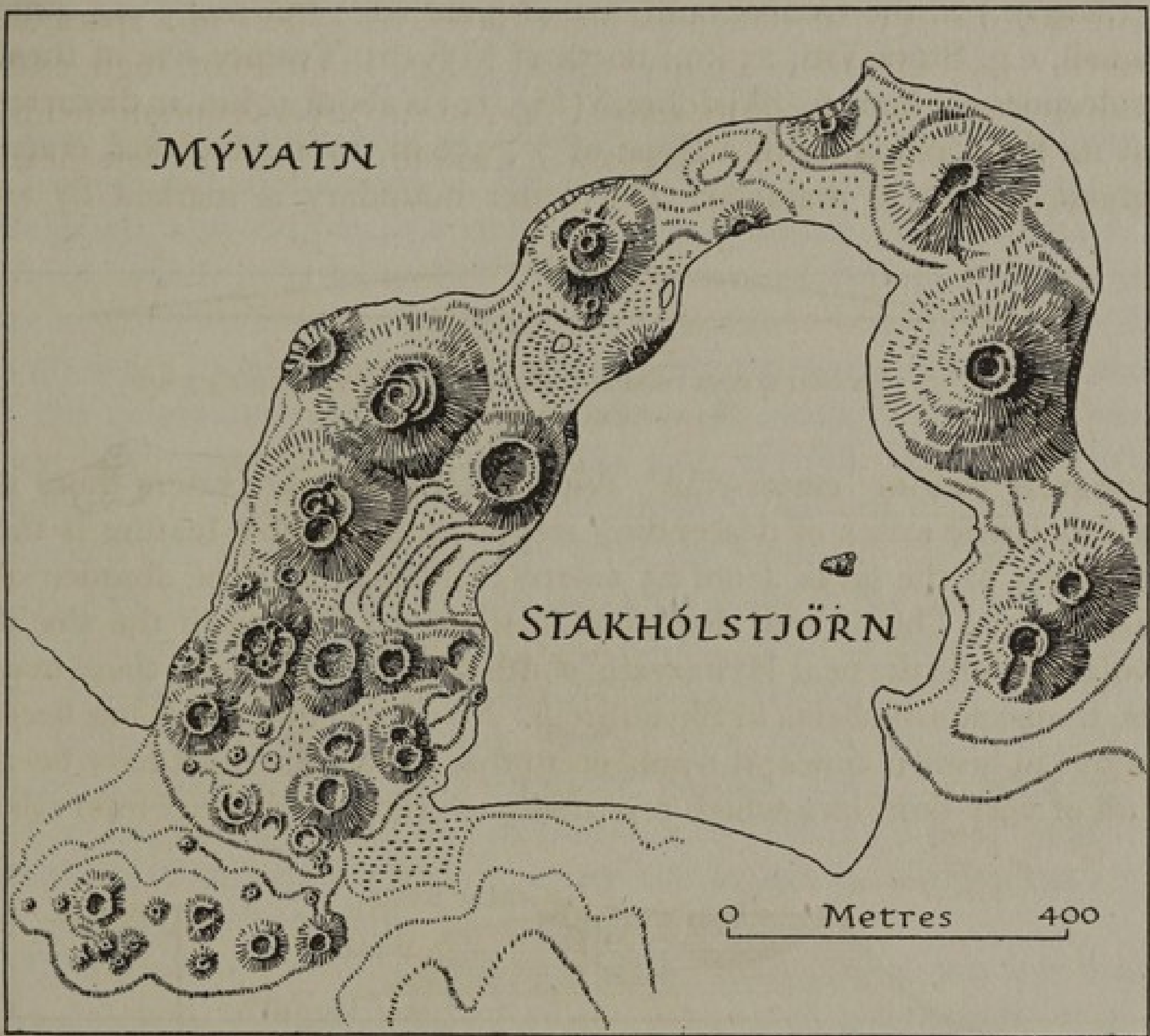


Fig. 9. Craters near Skútustaðir, on the southern side of Mývatn. Source: A. Rittmann, *Bull. Volcanologique*, Serie II, Tome 4, Bd. 5, p. 10 (Naples, 1938).

the water was clear and tepid, and at the present day it is at atmospheric temperature and neutral in reaction, showing that all volcanic action has ceased in Helvíti although many hot springs are found in the neighbourhood.

Many crater pits of the Krafla type are probably 'explosion craters' or 'maar' formed by the emission of gas only, with a blowing away of a funnel-shaped mass of pre-existing solid rock.

Shield Volcanoes (*Dyngjur*)

Dyngjur (= domes) are entirely composed of lava which has been extruded from central vents to build low shield-shaped domes with gentle slopes of from 2° to 8°. Skjaldbreið (1,060 m.), north-north-east of Þingvallavatn, Trölladyngja (1,491 m.), and Kollotta Dyngja (1,209 m.) in the Ódáðahraun, are of great size; but many are quite small, e.g. Stóra Viti, 25 km. north of Mývatn. Twenty-five of these volcanoes are known. Skjaldbreið (Fig. 10) is about 10 km. in diameter at its base, rising, with a slope of 7°, 550 m. to a cylindrical crater about 300 m. in diameter. The crater boundary is marked by an

Fig. 10. Section across Skjaldbreið. Length of section 13·5 km. No vertical exaggeration.

irregular wall or 'crater-ring'. Within some *dyngjur* craters there is a concentric series of descending steps. A remarkable feature is the thinness of the lavas, from 25 to 100 cm. thick, and the absence of ash layers. This is well displayed in the deep fissures in the shield volcano Solkatla, near Hvítárvatn, south of Langjökull, and there may be thousands of sheets in Skjaldbreið. No *dyngja* in Iceland has been active in historic times; it would seem that the craters must have been full of very fluid lava which repeatedly overflowed at short intervals.

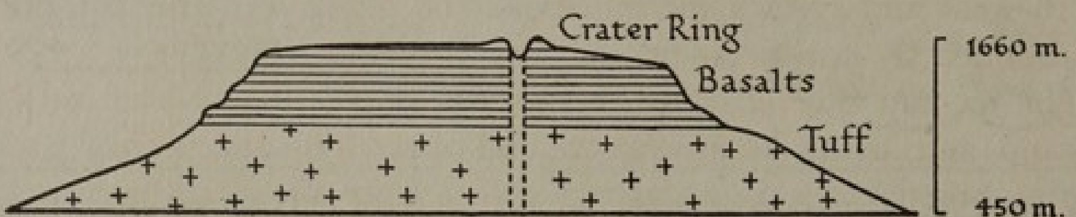


Fig. 11. Section across Herðubreið. Length of section 9 km. No vertical exaggeration.

Herðubreið (= broad-shouldered), a square block, steep-sided above with scree slopes below, rises 1,200 m. above the lava desert of Ódáðahraun and is the most remarkable mountain in the interior of Iceland (Fig. 11; Plate 20). Formerly it had an ice-cap; it was first climbed in 1907. The lower half is palagonite tuff and breccia, the upper a succession of basalts with thicknesses up to 2 m. There are no ash layers. Towards the south-east corner of the summit plateau is an elliptical crater measuring 200 × 150 m., with a crater ring the highest part of which is 100 m. above the crater floor. Herðubreið is thus a typical *dyngja*, but its lavas must originally have extended far beyond the present walls of the mountain and opinion is divided regarding its origin. Some consider that the outer part of the volcano has been eroded away, others that the block is bounded by fractures—hence its angular plan—and that it is a 'horst' or mass which stands up because it has been pushed up, or the surrounding country has gone down.

Ash and Lava Cones

These volcanoes are built of layers of lava and fragmental products. They are not so common in Iceland as in other parts of the world. Helgafell, now extinct, is a striking example in the Vestmannaeyjar. Hekla, which belongs to this type, is the most famous volcano in Iceland. It was active on twenty-one occasions between 1100 and 1846, when its latest eruption occurred, although there were outbreaks in the neighbourhood in 1878 and 1913. In olden times Hekla was generally regarded in Europe as the gate of Hell. In the twelfth century it was reported that 'the wailing and gnashing of teeth of the damned can be heard miles away from the mountain and shepherds have seen great vultures driving the fallen souls in the form of black ravens into the opening to hell'. An Italian Jesuit in the seventeenth century wrote that 'God willed that such openings should be found on earth in order that people should have hell's and purgatory's torments before them and therefore become more God-fearing'. There are two craters in the Hekla ridge, which trends north-east to south-west and rises 1,300 m. above the lowlands. The volcano is surrounded by lava fields 700 sq. km. in extent.

The ice-cap Snæfellsjökull rests on a dome-shaped ash and lava volcano, and, being situated at the end of the long and narrow peninsula of Snæfellsnes, is a striking object from the sea. The summit crater reaches 1,446 m., and there are a number of subsidiary craters on the southern and western flanks of the mountain from which lavas have poured down on to the coastlands; the volcano became extinct before the historic period.

Acid Eruptions

Acid rock liquid (silica percentage about 70) has appeared only once in historic times (Askja, 1875, 3–4 cu. km. of pumice), but several post-glacial lava flows of this composition are known, the most extensive being those east of Hekla in the Torfajökull district, i.e. the Hrafntinnuhraun to the south and three other flows to the east of the glacier. Acid rock liquid is more viscous than basic and readily chills to a black glass or obsidian (Icel. *hrafntinnu* = raven flint). The Hrafntinnuhraun covers an area of 25 sq. km., is 20 m. thick, and the bulk of the flow is a light-grey banded rock (rhyolite) which is encased in a 2–3 m. thick shell of obsidian with in places an outermost covering

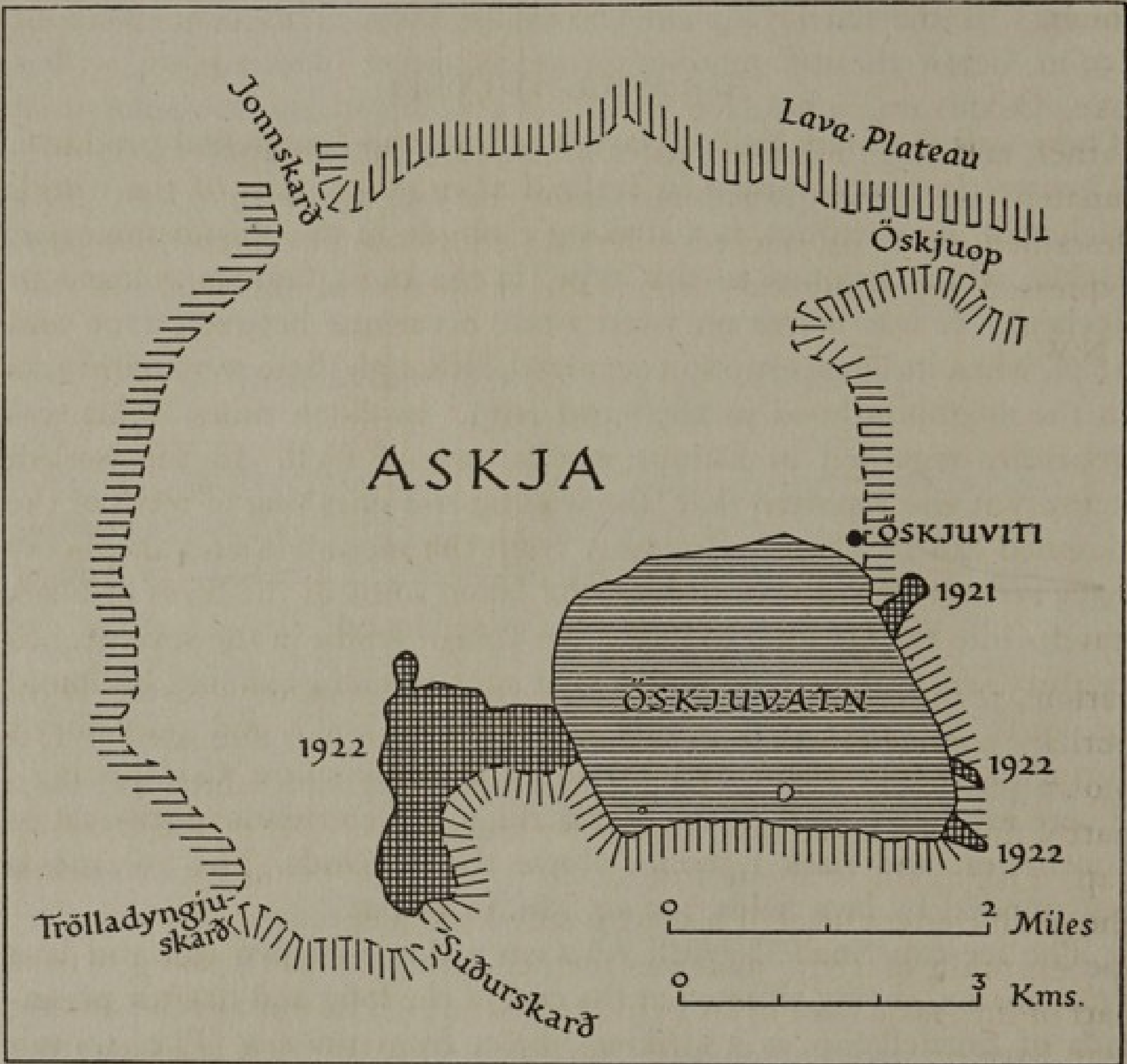


Fig. 12. Sketch plan of Dyngjufjöll and the Askja caldera. Dashed lines—border of the tuff mountain ring; cross hatching—latest lavas with dates of eruptions. Adapted from N. H. van Doorninck, *Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap*, Diel 51, p. 227 (Amsterdam, 1934).

of pumice. These rocks are attractive stones; the colours are varied, and the black lustrous obsidian often contains white crystalline balls or spherulites. Other well-known occurrences are in the neighbourhood of Mývatn, where north of the lake is the rhyolite and obsidian hill Hliðarfjall, and on the east side of Krafla the obsidian ridge of Hrafntinnuhryggur.

Dyngjufjöll and Askja

This remarkable volcanic complex, lying 30 km. north of Vatnajökull, is the finest example in Europe of a caldera or volcano with an abnormally large crater. Within a roughly rectangular enclosure of tuff mountains, the Dyngjufjöll, rising 700 m. above the surrounding country, is the flat lava plain known as Askja. This plain is about 350 m. below the tuff mountains and is about 8 km. square, with a lake, Öskjuvatn, 4 km. long and 2·5 km. broad, in the south-east corner, and also the crater pit of Öskjuviti (Figs. 12 and 13). Unfortunately the region was unexplored before the eruption of 1875 described on p. 14, and considerable difference of opinion has been expressed regarding the origin and sequence of formation of the

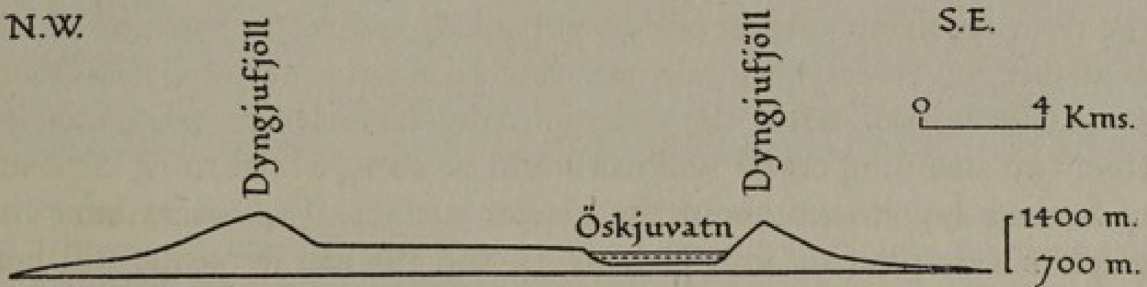


Fig. 13. Section across Askja. Vertical scale ×2·5.

various features. Originally a large volcano probably existed here, perhaps a *dyngja* resting on tuff, and the central part subsided or was blown piecemeal away to form the Askja depression which was then partly filled by lava flows, some of which poured out of the Öskjuop gap. Öskjuvatn is about 170 m. deep, its floor being 230 m. below the main caldera level. This steep-sided lake depression was dry after the eruption of 1875, and was formed either by the sinking of this part of the Askja floor or by being blown out—if the former the sinking may have occurred along with the eruption of 1875, if the latter the depression must have been in existence before that. The pumice ejected on 29 March 1875 was acidic in composition. Six weeks before and 6 days after this, great outpourings of basic lava took place from the Sveinagjá fissure, 60 km. to the north.

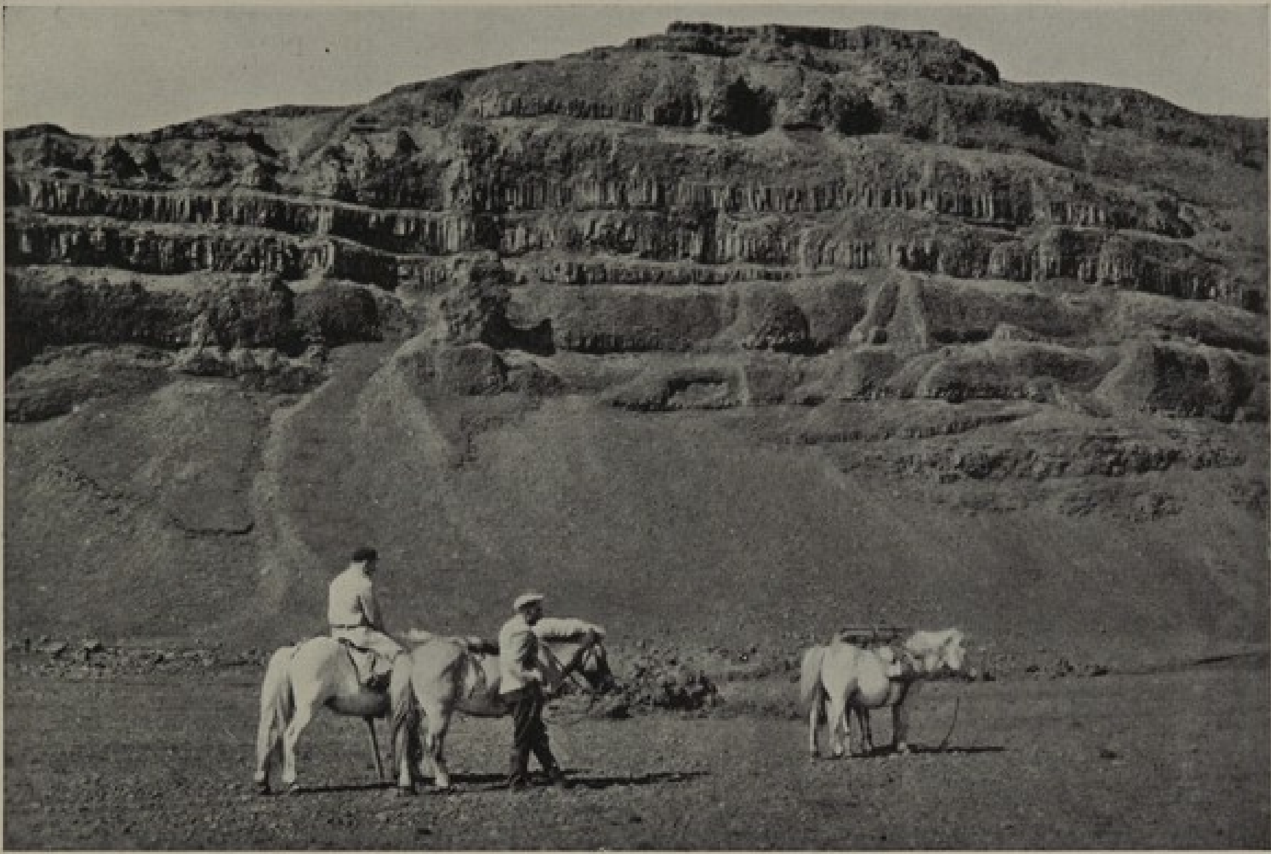
Sub-glacier Eruptions

Volcanoes beneath the ice in southern Iceland have been repeatedly active with remarkable results. The western third part of Vatnajökull rests on strongly volcanic ground, and over forty sub-glacier eruptions are on record. An account of the 1934 outbreak at Grímsvötn will serve to illustrate the phenomena.

Grímsvötn is, in its resting period, an ice-filled valley, 10 km. long, 6 km. broad and 400 m. deep, situated in the heart of Vatnajökull some 55 km. north of the front of Skeiðarárjökull (Fig. 26). From 30 March to 7 April, from all over the country, a cloud could be seen by day 10–15 km. in height, and fire by night, and ash was scattered to the south-east. Previous to this, on 23 March, the volume of the Skeiðará river, which emerges from beneath the glacier at its eastern end, began to increase, and this continued until 30 March, when the flood reached its greatest volume. The water issued from thirteen tunnels in the glacier front to cover a large part of the outwash plains or *sandar*, and tore from the glacier a great number of icebergs which were stranded on the *sandar*, some reaching the sea (Fig. 14; Plates 3 and 4). At its maximum the flood was comparable in delivery with the river Amazon; it then rapidly subsided, and by the evening of the next day the rivers were normal. Such a flood is called a *jökulhlaup* (= glacier burst). After the eruption, the Grímsvötn valley was ice free, two steaming crater hollows could be seen, whilst thick deposits of hot ash lay strewn about the glacier surface. Two years later the glaciers were pouring into Grímsvötn and the ash deposits, still hot, were covered with snow, whilst the ice blocks on Skeiðarársandur had melted away leaving a countless number of shallow pits, the so-called 'kettle holes', and the tunnels in the glacier front from which the main flood waters had issued had collapsed. From the facts that the *jökulhlaup* preceded the visible eruption and that the volume of water delivered was approximately that of the ice in Grímsvötn (10 cu. km.), it may be deduced that the earlier phase of the eruption was completely subglacier, the heat energy being absorbed in melting the ice in the valley. The melt waters drained off through 55 km. long tunnels at the bottom of the glacier, thus allowing the gases and ash to be subsequently delivered into the air during the period of the visible eruption. The amount of ice melted indicates a heat output of 8×10^{14} cal.

Öræfajökull has witnessed four sub-glacier eruptions in historic times, the last in 1727. In about 1362, a *jökulhlaup* destroyed forty farms and was followed by an eruption and fall of ash which completely destroyed the vegetation.

Katla, a volcano beneath Mýrdalsjökull, has been active on fourteen occasions, the last in 1918 (Plate 5). On 12 October 1918 there was an earthquake followed 2 hr. later by an ash eruption, and simultaneously a *jökulhlaup* which was over in 2 hr.; later, these happenings were repeated. The sudden onset of the Katla *jökulhlaups*, so different from the Skeiðará ones which develop gradually for days, renders them

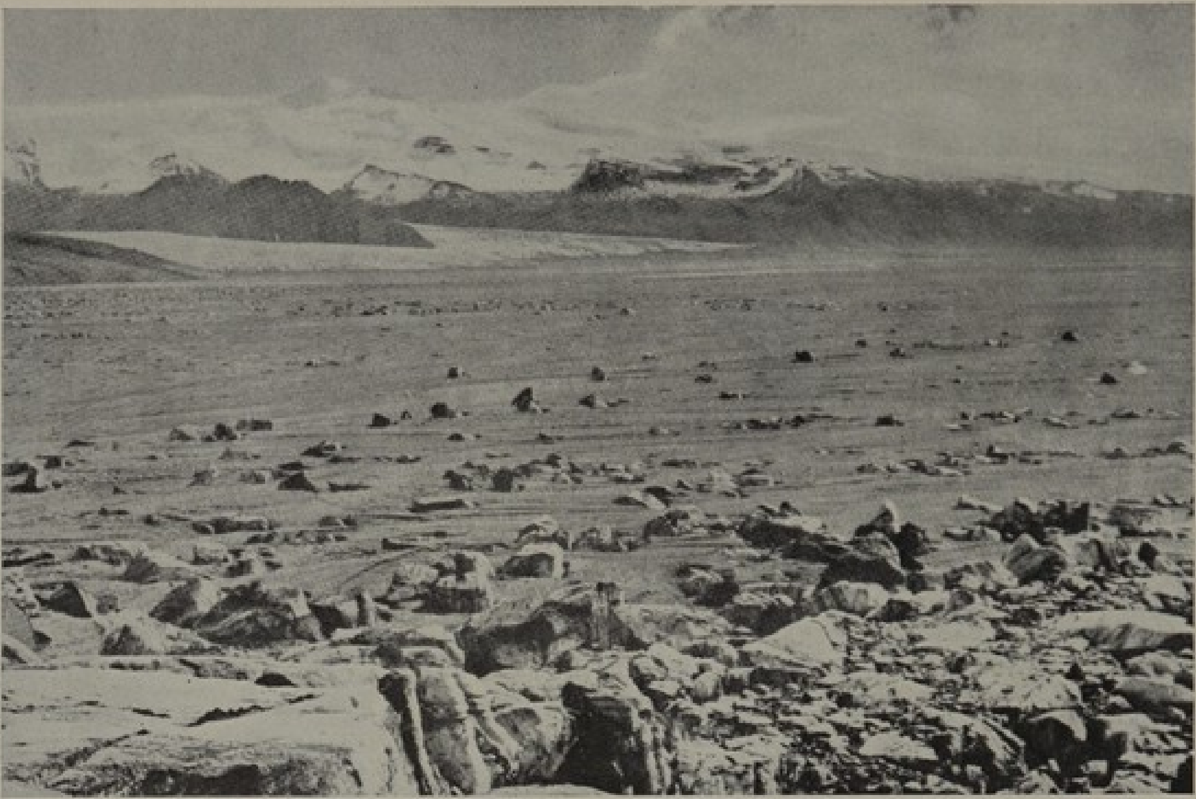


M. H. Donald

Plate 1. Columnar basalts near Núpstaður. The individual 'flows' give rise to the characteristic step-like 'trap-featuring' above; below they are smothered in scree.

L. Hawkes

Plate 2. Tilted Tertiary basalts near Hoffellsjökull. The tilt is towards the interior of Iceland.



N. Nielsen

Plate 3. Ice blocks on Skeiðarársandur transported and deposited by the flood (*jökulhlaup*) from Skeiðarárjökull in 1934.

N. Nielsen

Plate 4. Skeiðarársandur after the *jökulhlaup* of 1934. The ice blocks in the background are about 10 m. high and have been transported 1 km. from the broken glacier front.

particularly dangerous for travellers on Mýrdalssandur. In 1918, thirty-seven horses and several hundred sheep were drowned.

Hitherto the observed sub-glacier eruptions have all been of the explosive ash-producing type, but there were indications of a sub-

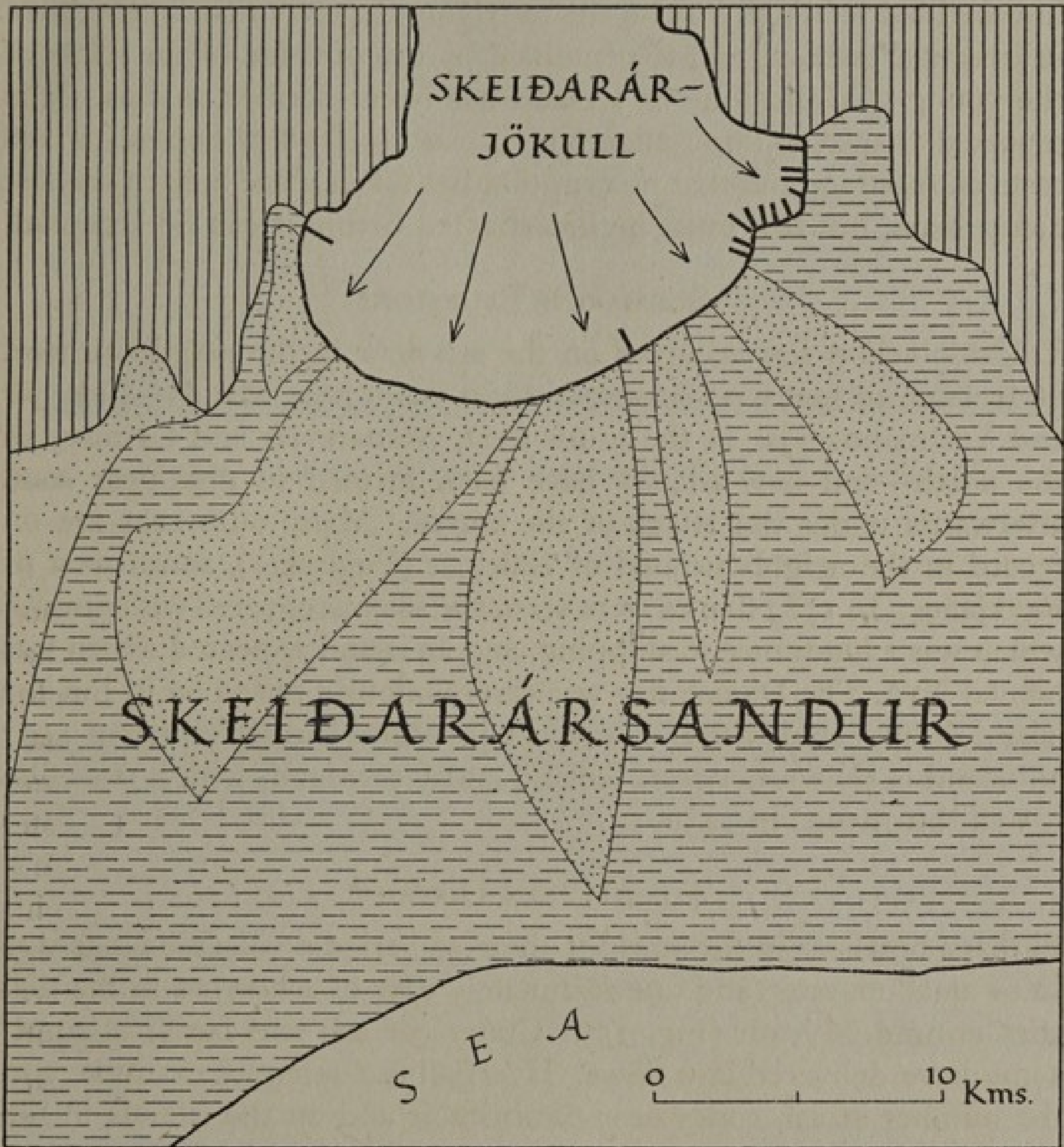


Fig. 14. The *jökulhlaup* from Skeiðarárjökull to the sea in 1934. Broken horizontal lines indicate the area covered by the flood. Dotted areas remained dry. Thick lines in the glacier front mark tunnels delivering the water. Vertical lines represent higher ground. Adapted from N. Nielsen, *Vatnajökull; Kampen Mellem Ild og Is*, p. 61 (Copenhagen, 1937).

glacier outpouring of lava in western Vatnajökull in 1934. For two months in the summer of that year the Djúpá, which emerges from the glacier, was in abnormal flood, and a zone of the ice 10 km. long and 2 km. broad sank 100 m. and was so riven as to be untraversible.

A curiosity sometimes observed in Iceland is the occurrence of beds of ice in volcanic deposits. The Askja volcano was snow covered at the time of the eruption in 1875, and 35 years later the snow was still present as a layer of ice beneath the overlying pumice beds. When interbedded ice finally melts the overlying deposits may settle down in irregular fashion, and the tumbled nature of some of the rocks of the young volcanic zone of Iceland has been ascribed to this. It is reported that at Djinmifjallgarður, in east Iceland at 800 m., a lava rests on fossil ice and that no eruption has taken place here in the last 1,000 years, but this must be investigated before it can be accepted.

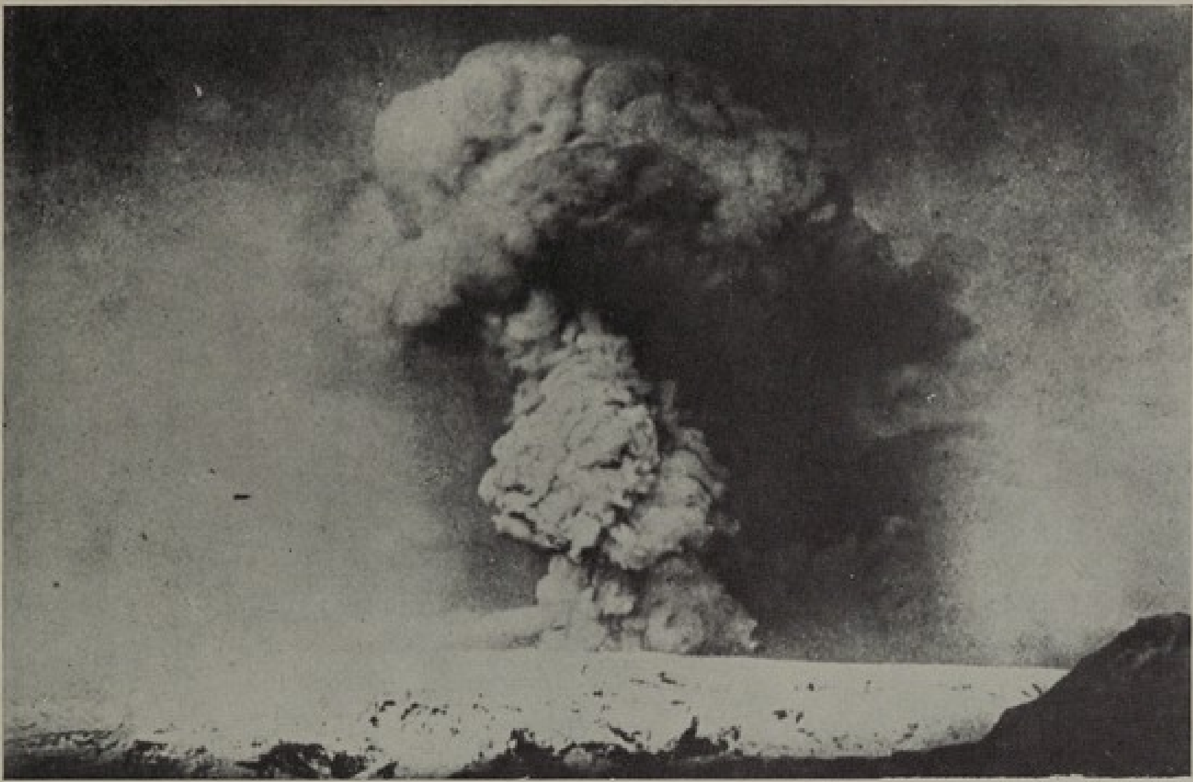
Submarine Eruptions

Volcanic action has occurred on the sea floor in the neighbourhood of Iceland on many occasions, in most cases near islands—Eldeyjar and Vestmannaeyjar in the south-west, Mánareyjar and Grímsey in the north—and new islands have been formed to disappear soon afterwards under the attack of the waves. Many outbreaks are on record in the neighbourhood of Eldeyjar (Fuglasker), south-west of Reykjanes. In 1783 flames were seen, the sea was covered with pumice which was a hindrance to shipping, and an island appeared which was named Nyö. The Danish flag was ceremoniously raised on it, but the island disappeared within a year. In Johannes Ruysch's map of 1507 an island is shown between Iceland and Greenland, with a note that it was 'burnt up' in 1456.

The Mývatn District

Perhaps nowhere in the world is there so varied a volcanic landscape in so small an area (and one fortunately easy of access) as in the district around Mývatn (Fig. 15). Craters of ash and lapilli abound; some have delivered lava flows. Hverfjall is a splendid example, and the number of ash cones near Skútustaðir and on the islands in the lake is very great (Figs. 8 and 9). Some of these islands have been eroded by the waves, revealing the inner volcanic structures. The central plug of fused rock within a cone on the west of Hrútey is particularly noteworthy.

Lava surfaces of all kinds may be studied east of the lake. Volcanoes were repeatedly active in the district from 1724 to 1729. In 1729 lava flowed over Reykjahlið farm and poured into the lake. The church, being situated on a rise, was surrounded but unharmed. Fissure-volcano phenomena are well displayed along the line of the Þrengslaborgir. Dimmuborgir is a remarkable area of fantastic lava pinnacles

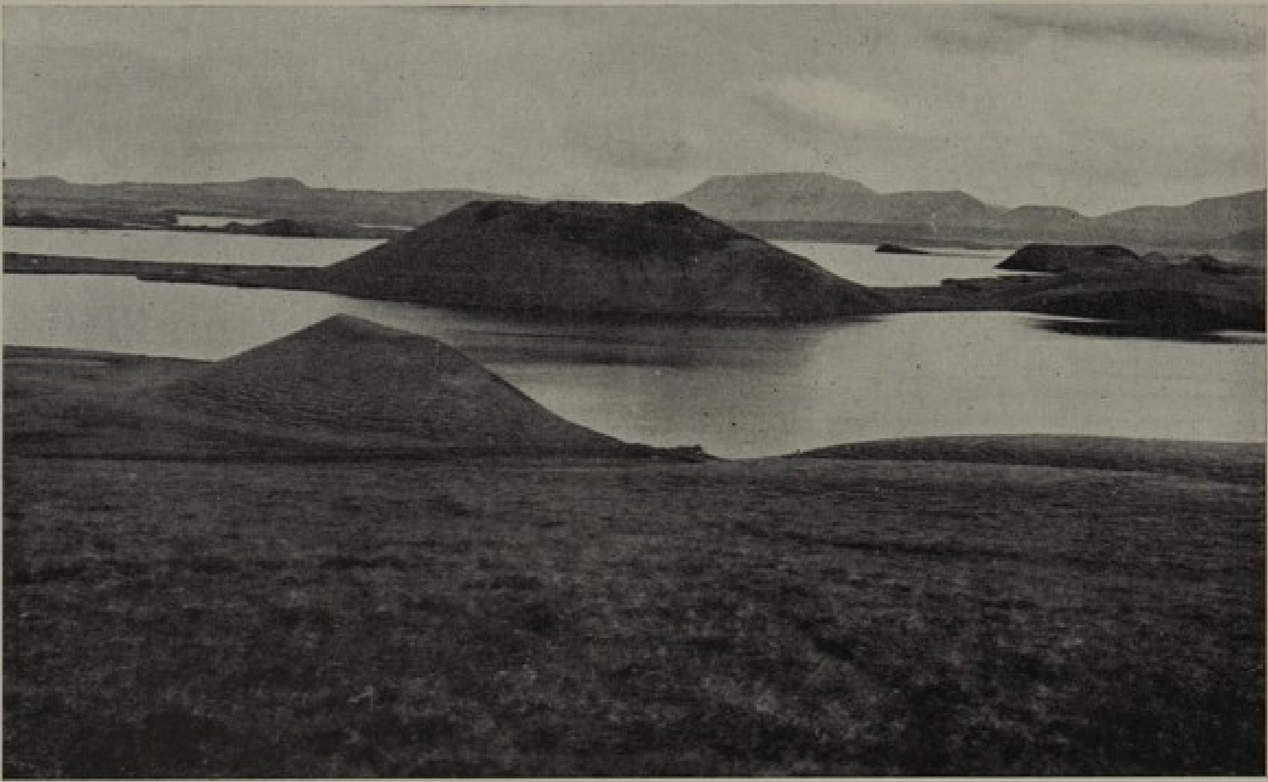


K. Guðmundsson

Plate 5. Eruption of Katla in Mýrdalsjökull, seen from Vík, 1918.

M. H. Donald

Plate 6. Hot springs near Stóri Geysir in Haukadalur. Note the basin of siliceous sinter formed by deposition from the hot water.



M. H. Donald

Plate 7. Volcanic cones, Mývatn. Irregularly distributed cones of volcanic ash are a characteristic feature of the lake scenery.

L. Hawkes

Plate 8. Almannagjá. One of the widest of the *gjár*. The left-hand block is tilted towards the plain of Þingvellir. Þingvallavatn is seen in the distance.

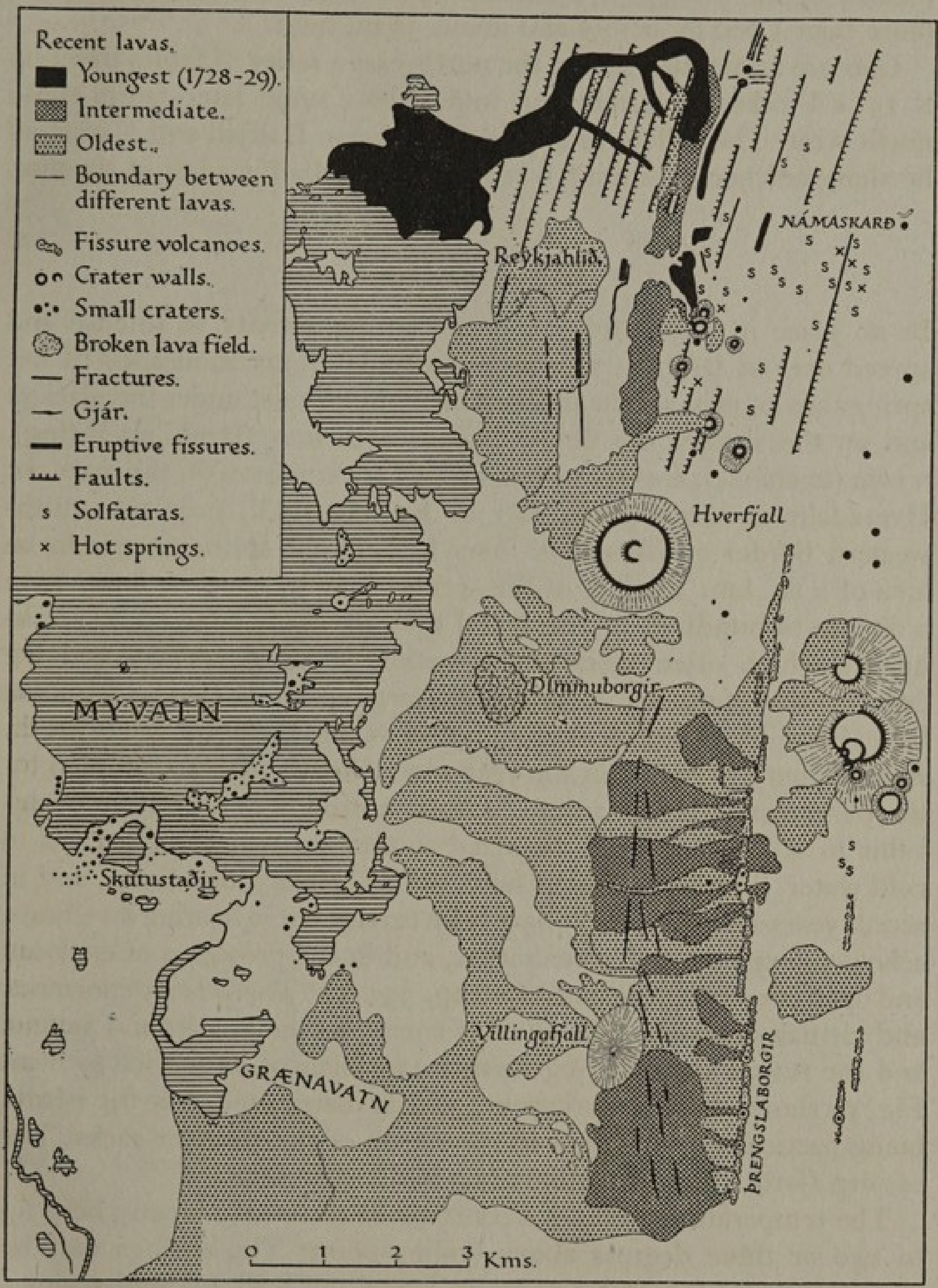


Fig. 15. Geologically recent lavas, faults, fissures and craters in the Mývatn district. Adapted from A. Rittmann, *Bull. Volcanologique*, Serie II, Tome 4, Taf. IX (Naples, 1938).

formed by the collapse into tunnels of the surface of a flat lava dome more than 1,000 m. across and about 30 m. high.

Gjár are numerous, and in the north-east a series of faults trending N 15° E breaks the surface up into strips; some later faults trend north-west. The solfataras and hot springs on Dalfjall and Námafjall lie along northerly trending fractures. Hliðarfjall is a hill of rhyolite.

HOT SPRINGS

In no place in the world is thermal spring activity so intense and spread over so large an area as in Iceland. Many thousands of hot springs are known, and in addition many more exist under the glaciers and on the shallow sea floor. Names with *hver* (steaming spring), *reykja* (to smoke), *laug* (clear hot spring) are common on the map. In Hveradalir in the western part of Kerlingarfjöll, near the south-western border of Hofsjökull, over a thousand springs occur in an area of 2 sq. km. The life of the springs may be short or long, from a day up to hundreds of years, and they are easily affected by earthquakes which often mark the cessation of some springs and the development of others. Reykjalaug, a large spring in Laugardal, must have been in existence for over 900 years, for it is recorded in *Kristni saga* that, when in the year 1000 Christianity was adopted by the parliament, the remaining heathen northerners rode from Þingvellir to Reykjalaug to be baptized as they refused to suffer this in cold water. The springs have been utilized since olden times, and in recent years extensive works have been carried out in heating dwellings, schools, hospitals, and greenhouses, and in the provision of enclosed and open-air swimming baths (see pp. 333–5). There is an enormous and virtually inexhaustible store of energy in the hot ground waters, and the future should bring further extension of its service to man. Fig. 16 shows that the springs are widely distributed over the island, being particularly abundant in the region of the younger rocks. The eastern fjord region is the only one without springs.

The temperature of the waters at the surface may be anything up to two or three degrees above boiling-point. The springs may be classified as (1) fumaroles or steam vents—all acid, (2) acid springs, and (3) alkaline springs. In the fumaroles the steam, forcing its way up with great power and noise, can form columns over 100 m. high. The distinction between acid and alkaline springs is an important one. The acid springs are found in volcanic districts after the actual eruptions; they are restricted to dry high land, their temperatures

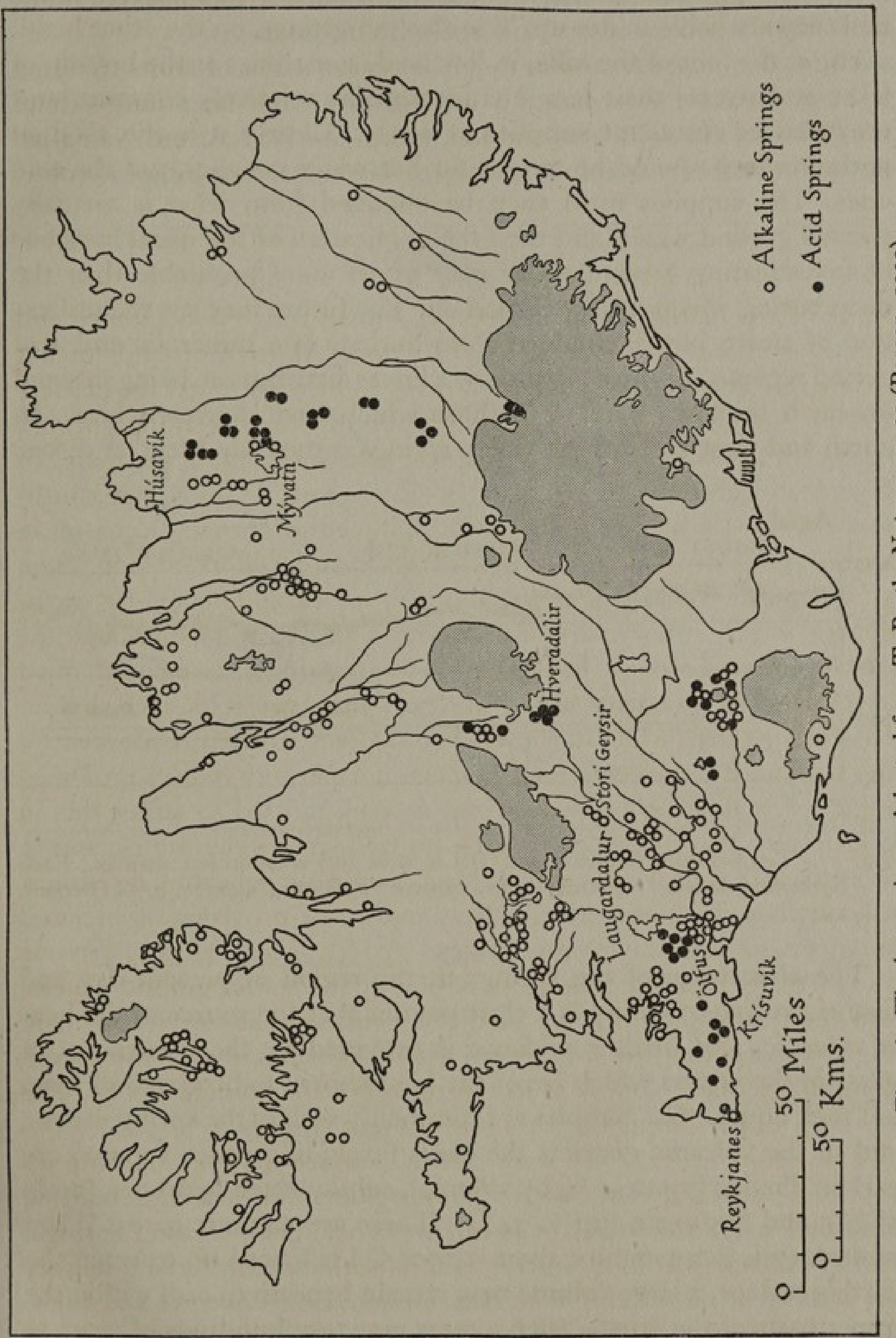


Fig. 16. The hot springs. Adapted from T. Barth, *Naturen*, p. 21 (Bergen, 1939).

fluctuate rapidly (Fig. 17), the water delivery is comparatively small, and they are liable to dry up. The alkaline springs, on the other hand, occur at the foot of the hills, in low land, sometimes at the bottom of lakes and rivers; their temperature remains relatively constant, and they deliver abundant supplies of water. Clearly it is the alkaline springs which should be tapped for hot-water supplies, not the acid ones. The supplies must then be obtained from what is virtually normal ground water, and then the application of the usual methods of investigating ground water may prove more profitable than the deep boring which is now carried on. The future may see the utilization of steam power obtained from borings into fumarolic and acid spring regions. Springs often show a linear distribution, being situated on earth fractures parallel to those which have delivered lava. In north and west Iceland the valley springs commonly occur at dykes.

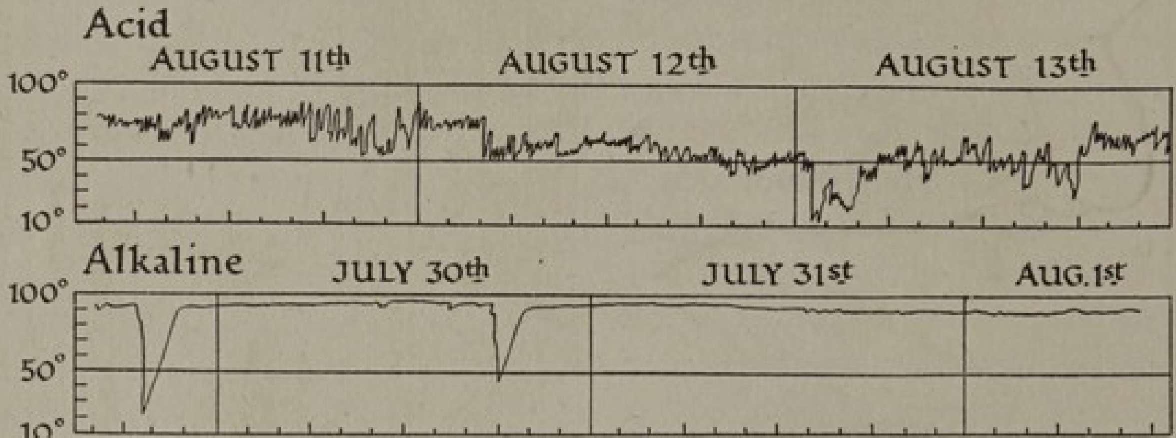


Fig. 17. Temperature fluctuations (°C.) in acid and alkaline hot springs. Each horizontal division represents 2 hr. Source: T. Barth, *Naturen*, p. 24 (Bergen, 1939).

The abundance of the springs in the region of present-day and historic volcanic activity is a clear pointer that the source of the heat is volcanic, and further evidence is provided by the occurrence of gases in the waters which are of the kind known to be given off from hot rock liquid. Gas bubbles are commonly seen in the spring waters, and in the volcanic districts the gases (excluding water vapour) are carbon dioxide (up to 96% by volume), sulphuretted hydrogen (up to 18%), and hydrogen (up to 54%). These are volcanic gases. When molten rock (temperature about 1,000° C.) is forced up to reach the earth's surface, a large volume may remain beneath to cool within the upper parts of the crust. Such a mass may take hundreds of years to cool down (rocks are poor conductors of heat), and the source of the colossal thermal energy released in the hot springs must be sought in these subterranean reservoirs (see Fig. 5). The rock liquid contains steam and other gases in solution, and as crystallization proceeds there comes a point when the accumulated gases in the remaining liquid attain such a concentration that they boil off. If the overlying rocks are dry, the gases reach the surface through fissures and blow off as fumaroles. If a relatively small amount of ground water is encountered, the gases

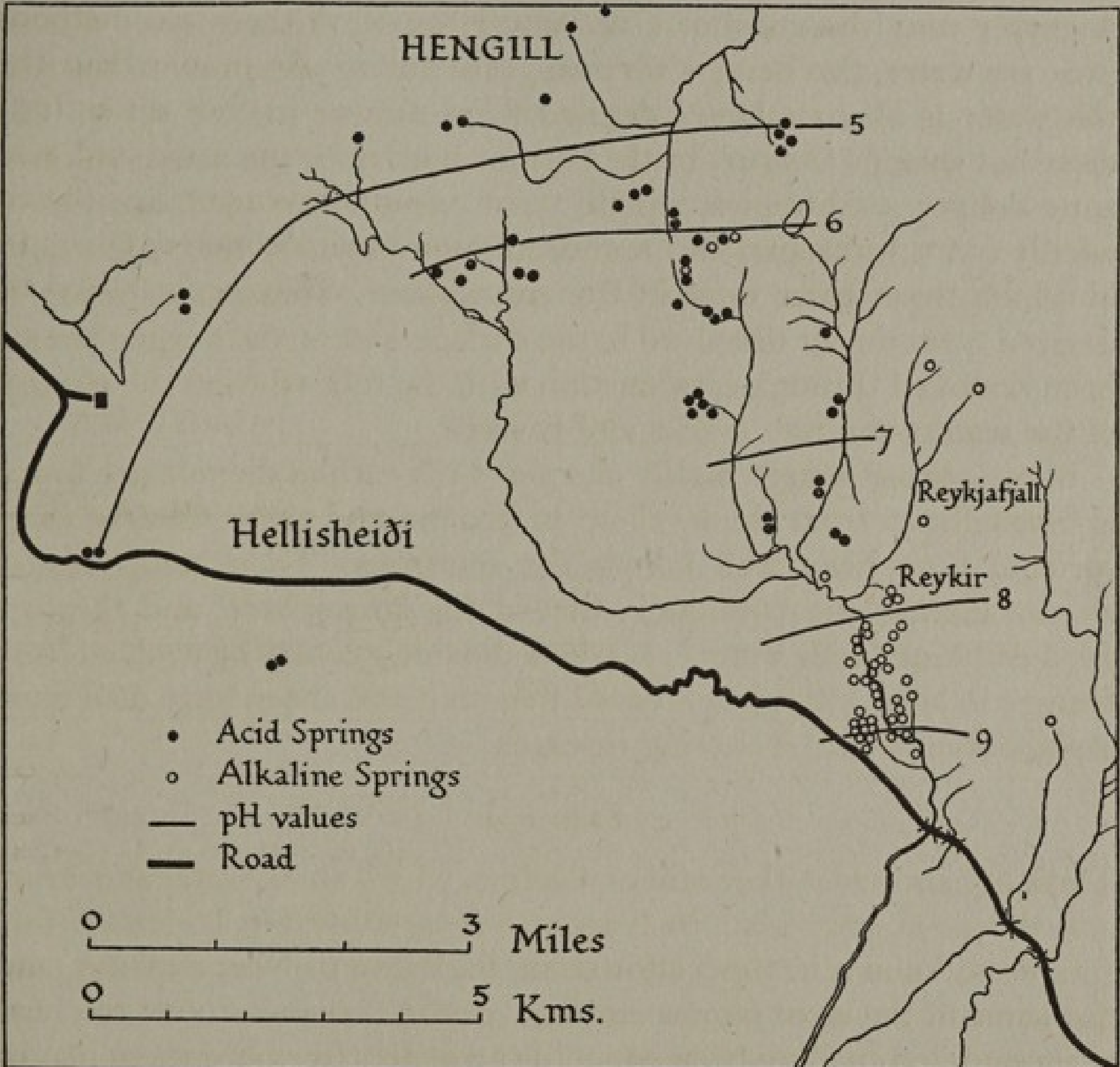


Fig. 18. Hot springs in the Ölfus district. *p*H values show decreasing soil acidity (5–7·1) and increasing alkalinity (7·1–9). 7·1 is neutral. Source: T. Barth, *Naturen*, p. 25 (Bergen, 1939).

are dissolved and acid springs result. If the source is deep and there is much ground water, the acidity of the exhalations and solutions is gradually lost by reaction with the rocks, and alkaline springs result. Thus the location and characteristics of the various springs are explained. In the Ölfus region (Fig. 18) lava was poured out near Hengill in the year 1000, and to-day with decreasing distance from Hengill, where a subterranean cooling mass may be expected to lie, the springs show decreasing acidity to become neutral and then alkaline.

A small part of the spring waters may be condensed steam from volcanic sources, but the bulk of it—and often perhaps the whole of it—is surface water which has sunk into the earth and become heated. The very wet climate of Iceland is a contributory factor to the pre-eminence of its springs as deliverers of copious quantities of water. A geyser near the coast at Gunnuhver, on Reykjanes, gives almost pure sea water, this being a very rare case due to proximity to the sea; the water is almost always derived from rain or melted snow. The clear hot springs (*laugar*) of the regions bordering the active volcanic zone deliver gas bubbles, which, water vapour excluded, are almost wholly (98 %) nitrogen and argon, in approximately the proportions in which these gases exist in the atmosphere. These gases must be derived from the air dissolved in the surface waters, the oxygen having been removed through combination with the rocks during the passage of the waters through cracks and fissures.

Many spring waters highly charged with carbon dioxide are found in Snæfellsnes from sea level up to 300 m., and these *ölkeldur* (beer springs) have been well known for centuries. Their temperatures are not high, being commonly that of the atmosphere, and they are good drinking 'soda water'. Carbon-dioxide gas may be evolved from fissures in lava, and it is on record that men and sheep have died from asphyxiation when sheltering in caves.

Geysers

These are springs, either acid or alkaline, which spout water and steam into the air at intervals. Such springs were studied in Iceland before they were known in the Yellowstone Park and in New Zealand, and the name of the most famous spring, 'geysir', meaning 'spouter', has with modified spelling been adopted as a general term for them. Some geysers erupt periodically at such regular intervals as to be useful as time recorders of inferior accuracy. These are not as a rule very powerful geysers, and their eruptions seldom attain an altitude of 20 m.; others, including most of the best known and most vigorous, erupt irregularly. Only a very small proportion of the springs are geysers, and geyser activity may be lost or acquired after earthquakes, or with time, or by artificial means. Fig. 19 illustrates the situation at one of the springs near Reykir in Ölfus, a quiet spring which had never been known to erupt. A pipe was bored from *C* to *B*, and the original irregular channel was made vertical from *A* to *B*. When *C* is

M. H. Donald

Plate 9. Stóri Geysir, the largest and most famous of the geysers, erupting in 1936. The vent is in the middle of a broad low dome of sinter.

J. W. Wright

Plate 10. The margin of Langjökull in summer. The surface is studded with boulders, some of which stand on ice pedestals.

B. B. Roberts

Plate 11. The central part of Vatnajökull is an unbroken expanse of snow.

closed, boiling goes on steadily in the basin; but on opening *C* and lowering the water level by 2·5 m. geyser activity is induced, eruptions lasting 2–3 min. being separated by quiet intervals of about 10 min. When the water is allowed to rise, the temperature at the surface is 103° C. When the level is lowered, it is only 100° C. The activity in this case is controlled by water pressure. Spouting is affected by the resistance offered in the subterranean channels to the free passage of water. In olden times when such activity was annoying or dangerous it was stopped by putting stones into the pipe, and activity has been induced by removing obstructions from hot spring conduits.

Geysers are first mentioned early in the seventeenth century, but they must have existed long before then. The best known group of hot springs with geysers, including Stóri Geysir and Strokkur (Fig. 20),

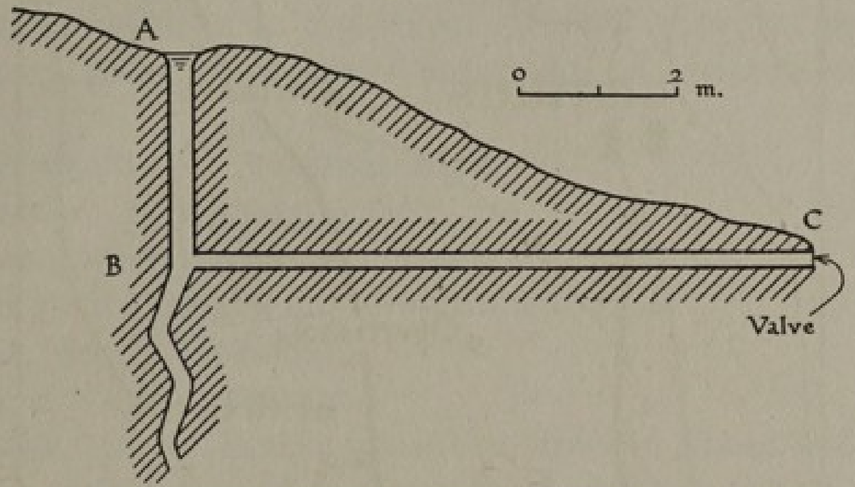


Fig. 19. Section through artificial geyser near Reykir.

lies between Laugarfjall and the river Almenningsá, south-west of the farm Haukadalur, some 38 km. east-north-east of Þingvallavatn. Other geysers occur near Reykir in Ölfus, in the Reykjanes peninsula, and in Hveravellir between Langjökull and Hofsjökull. It is not known for certain when Stóri Geysir began to erupt, but before 1800 eruptions occurred every 3–6 hr. Later, activity diminished, and in 1875 weeks could pass without an outburst. With this decline the nearby Strokkur increased its activity, sending up compact water columns 60 m. high and often spouting for over 2 hr. at a time. The earthquake in 1896 resulted in a greatly diminished activity of Strokkur, but in the reawakening of Stóri Geysir which erupted twice a day. Later, this activity died down to cease in 1907, when, stimulated by a generous dose of soap, an eruption was effected in the presence of the King of Denmark. In 1935 the spring was made to erupt again by digging a draining ditch through the side of the basin

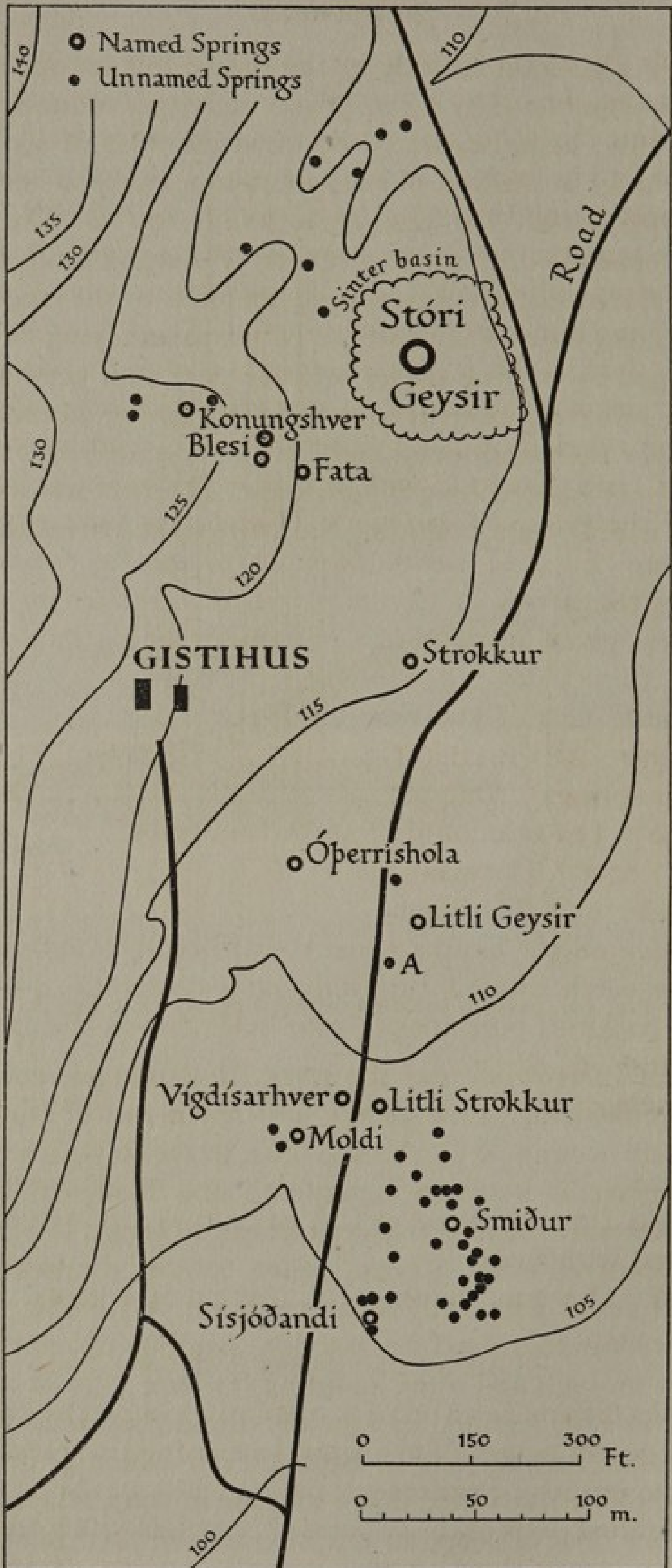


Fig. 20. The hot spring area in Haukadalur (Stóri Geysir). Contours in metres. Source: Th. Thorkelsson, *Visindafélag Íslandinga*, Vol. xxv, p. 14 (Reykjavík, 1940).

and lowering the level of the water. Stóri Geysir is a vertical cylindrical pipe 22 m. deep and 2 m. wide. At the surface, silica has been deposited from the water to form a basin of yellowish white sinter (*hverahrudur*) 18 m. across and 6 m. high. The loss of heat in this basin was preventing the water from coming to the boil. Before an eruption the temperature in the basin is near to boiling-point; at the bottom of the pipe it is about 124° C. Loud detonations are then heard from below, and the water becomes agitated and flows over the rim of the basin. Unless this is a false alarm, as is often the case, a column of water and steam is suddenly shot vertically skywards, to be followed by others for a period of many minutes. These attain varying heights up to 65 m., and conclude with a roaring emission of steam. The activities of the group of springs in Haukadalur varies from year to year; the map (Fig. 20) was made in 1930, and the following notes refer to the conditions at that time. Unless otherwise stated, the temperatures, given in degrees Centigrade, are surface-water temperatures:

Stóri Geysir. 62·4°. At 20 m. depth 112°.

Konungshver. At 1 m. depth 86°.

Blesi (two springs). One 70°.

Fata. 100°. Great amount of steam and gases.

Strokkur. 80·5°. Dormant.

Litli Geysir. 65°. Dormant.

Óþerrishola. 98·5°. Erupts when the orifice is closed with turf.

(*A*). The earth around this unnamed cluster of springs is hot enough for cooking; pots are put into holes dug in the ground.

Vígdísarhver. 64·8°.

Litli Strokkur. 99·5°. At 3 m. depth 101°. Violently agitated by gases.

Moldi. 100°.

Smiður. At 1 m. depth 101·2°. A geyser; as a rule does not erupt unless treated with soap.

Sísjóðandi. At 1·2 m. depth 99·5°. Agitated by gases.

Theory of Geyser Action

Considerable difference of expert opinion exists regarding the mechanism of geyser action. This is not surprising since, except for the very variable eruptive phenomena themselves and the exploration of only those limited parts of the systems of channels which are accessible, nothing is known of the situation in depth, and the conditions must vary from geyser to geyser. The following general statement can, however, be made. The source of the energy is the superheated steam which, rising from the depths, condenses in and raises the temperature of the ground waters. While normally the heat is continuously transferred by the water to the earth's surface and there dissipated, in the geyser it is not removed as fast as it is added and it accumulates until the system becomes unstable and the water is violently emitted. Cooler water then flows in to occupy the cracks and channels of the system, and the heating-up process begins all over again; the periodicity is thus accounted for.

The greatest difference of opinion centres around the cause of the start of the eruption. Measurements made in the upper parts of geysers show that the temperature increases in depth and is often only a few degrees below the boiling-point corresponding to the depth (the boiling-point is raised by the pressure of the water column). The temperatures have never been observed to reach boiling-point in the accessible channels, but this may perhaps happen at greater depths, with the result that steam is formed and the water is forced out at the surface. This would reduce the pressure, and more steam would be formed to blow out the contents of the system. Some scientists deny that this superheating is a common cause of the start of the eruptions and think that the formation of gas bubbles is usually responsible. The gases dissolved in the water may separate out as swarms of bubbles as the water rises in the channels, with the result that the hydrostatic pressure of the water column is reduced (the 'air-lift pump' principle). This promotes the upward movement until it attains eruptive proportions—in most cases steam would then come to play its part. In support of this theory it may be mentioned that eruptions have occurred when the temperature of the water has been below boiling-point.

In the large geysers with irregular times of eruption, activity may be started by various trigger actions such as the reduction of atmospheric pressure. The effects of clearance of channel obstructions and the lowering of water level have already been mentioned; other artificial stimulants are the closing of the pipe (when a narrow one) with turf, and also the addition of soap. The soap reduces the surface tension of the water and thus promotes the formation of gas bubbles. The diminution of the force acting to restrain bubble formation is, however, minute compared with that expended in the eruption, and it can only serve as a trigger action when other conditions are ripe.

EARTHQUAKES

Earthquakes are frequent in Iceland; ninety considerable ones are on record between the years 1500 and 1900. In a thinly populated country the loss of life and property has not been great, although serious enough for so small a nation. Disastrous earthquakes have never been recorded from Reykjavík, but between 1901 and 1934, sixty-one slight shocks were felt there. Six seismic areas may be recognized (Fig. 21). Areas I–V occur partly or wholly in the area of younger rocks; only one, VI, is in the old basaltic area. About 65 % of the population live in these regions. Earthquakes may accompany volcanic eruptions and often immediately precede them, but most of them are independent of eruptions and are due to differential movements of the earth's crust. The effects include the opening of earth fissures, changes in surface level, disturbance of drainage, modification of hot spring and geyser activity, falls of rock, and collapse of screes.

In the earthquake of 1789 in the Þingvallavatn area, fissures 4 m. wide were formed; the lava tract between Almannagjá and Hrafnagjá (see Fig. 42) sank more than half a metre; the northern shores of Þingvallavatn were submerged, whilst the floor of the lake near the south-west shore was raised to form dry land. In 1896 a particularly violent earthquake shook south Iceland (Area II), and many fissures, one of them 15 km. long, were formed.

The only earthquake hitherto studied in any detail is that which was centered on Dalvík, Eyjafjörður, on 2 June 1934 (Area VI). Damage was considerable within an area about 1 km. in diameter. In general, timber houses stood the shock better than concrete ones, but the latter behaved variously according to their construction. Solid structures with concrete floors and partitions stood well, but concrete houses with floors and partitions of wood proved vulnerable. Ships at sea in the neighbourhood experienced a powerful blow as if they had suddenly grounded, and unusual wave disturbance was noted. For a shock of considerable intensity (VIII–IX, M.C.S. scale), the earthquake was felt over rather a small area (Fig. 21), as compared with European earthquakes of the same intensity. This indicates that the origin of the disturbance was situated at a shallow depth, a feature which appears to be characteristic of Icelandic earthquakes, for no shock has been felt over the whole island. In 1913 and 1919 earthquakes originated beneath the sea floor 100 and 200 km. respectively to the north of Eyjafjörður in the submarine hollow marking the continuation of the fjord valley.

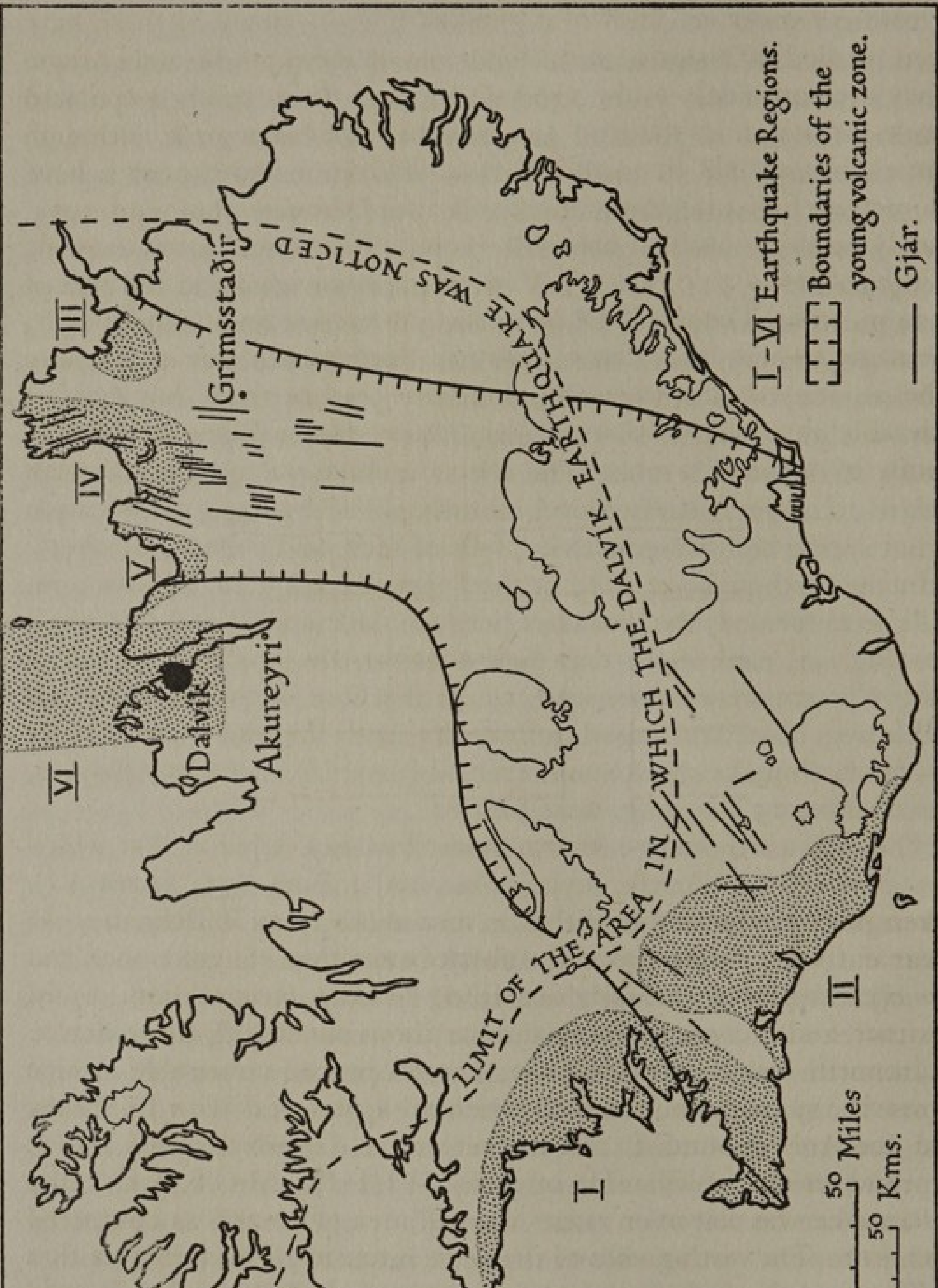


Fig. 21. Earthquake regions. Sources: (1) S. Thorarinsson, *Geog. Annaler*, pp. 233, 261 (Stockholm, 1937). (2) Þ. Thoroddsen, *Petermanns Mitteilungen*, Ergänzungsheft Nr. 153 (Gotha, 1906).

The gaping fissures which are such a striking feature in the zone of younger rocks are known as *gjár* (sing. *gjá*). Some of these have been formed in historic times, but most of them are of earlier date. They are commonly a few metres wide and up to 50 m. deep, with blocks or standing water at the bottom. They can be followed in remarkably straight lines, roughly parallel to one another for tens of kilometres (Fig. 21). In the north of Iceland the direction is approximately north to south, in the south-west it is north-east to south-west. Widths of up to 50 m. are reported; the Almannagjá, near Þingvellir, is 24 m. wide. The levels of the surface on both sides of a *gjá* may be the same or they may show a vertical displacement of up to 50 m. The amount of displacement along one fissure may change considerably in a short distance. Very rarely *gjár* may be bridged at points by a basalt layer; in this case the break in the top layer has

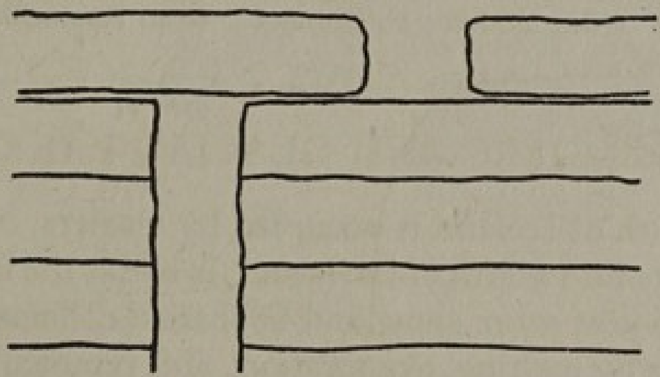


Fig. 22. Section across a bridged *gjá*.

taken place to the side of the main fissure (Fig. 22). The fissures are clear cut where they traverse compact smooth-surfaced lava (*helluhraun*). In blocky and rough-surfaced lava (*apalhraun*) they are less distinct, and in loose fragmental rocks they may be difficult to detect.

In north Iceland measurements have been made from east to west across the *gjá* regions. The total width of the fissures formed since the last Ice Age amounts to 1–3 m. per 100 m., which is estimated to represent a rate of widening of from 2–6 mm. per km. a year. Little reliance can be placed on these figures, but extension is undoubtedly going on. The young volcanic zone appears to be widening with a drifting apart of the blocks of older rocks which bound it. An investigation into the matter has been started. The exact relative positions of eighty points between Akureyri and beyond Grímsstaðir (i.e. across the northern fissure zone) were determined by theodolite triangulation in 1938, and a repetition of these observations is planned for 1948 to find out what movements, if any, horizontal and vertical have taken place in that time. The section (Fig. 23) indicates the nature of the ground which is being studied. An extension of the triangulation net is also planned, and the results should throw light on the much discussed idea that parts of the earth's crust are slowly changing their relative positions.

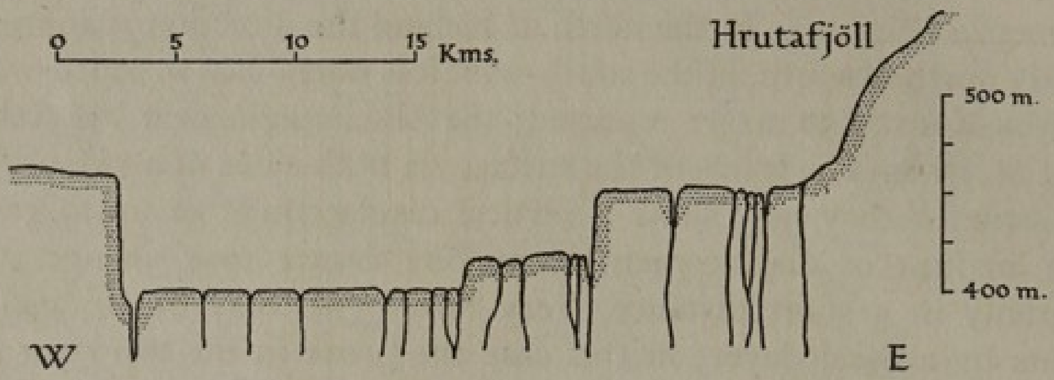


Fig. 23. Section across part of the fissure zone east of Mývatn. Vertical scale approximately ×80. Source: F. Bernauer, *Geol. Rundschau*, Bd. 30, p. 313 (Leipzig, 1939).

GLACIERS AND GLACIAL LAKES

About one-eighth of Iceland is occupied by glaciers, of which Vatnajökull, covering one-twelfth of the island, is by far the largest (Fig. 24).

Where in the year more snow and hoar frost collects on the ground than disappears by melting, evaporation, and removal by wind, some of the deposit remains. If these conditions persist from year to year, the accumulated deposits become a mass of compact ice, i.e. a glacier or *jökull* (plur. *jöklar*). The snow, which is originally a felt of skeleton ice crystals with much enclosed air, is gradually transformed into glacier ice. This is brought about by melting and refreezing, by sublimation, and by pressure of subsequently deposited snow.

At an intermediate stage the snow becomes granular while still containing a considerable proportion of air spaces, and it is then known as 'névé' or 'firn'. Perennial firn areas are classed as glaciers, and compact ice must commonly be present beneath them. Leaving out of account surfaces so steep that snow cannot accumulate on them, the altitude at which the amount of snow deposited is equal to the amount melted is known as the snow-line: above it snow accumulates, below it any snow disappears before the end of summer. The main controls of the altitude of the snow-line are temperature and precipitation. The temperature must be low enough for snow to fall, and the amount of snow must be great enough for part of it to survive the summer melting. The result is that glaciers occupy the higher and consequently colder parts of Iceland, but some high regions are not ice covered because the snow precipitation is insufficient to persist.

In the north-west peninsula the snow-line is low (about 600 m.) because of low temperatures and considerable precipitation from the

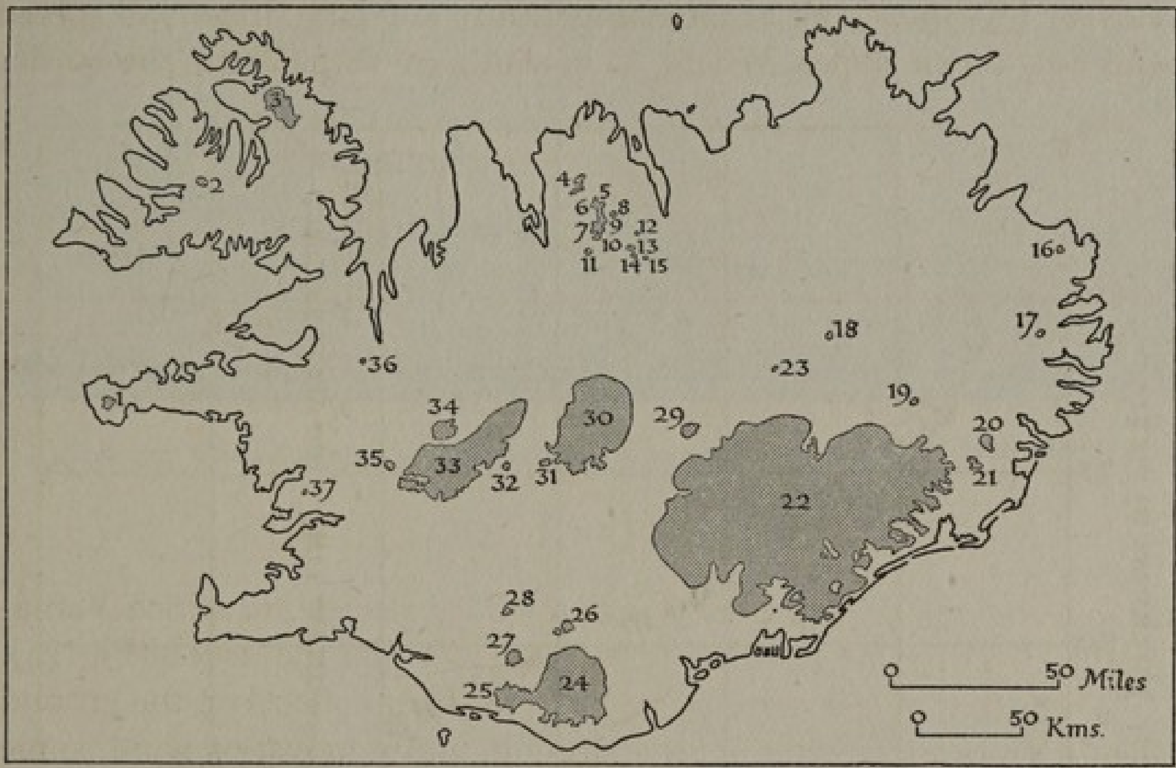


Fig. 24. Glaciers.

1. Snæfellsjökull
2. Glámajökull
3. Drangajökull
4. Hákambar
5. Þverárjökull
6. Skiðadalsjökull
7. Tungnahryggsjökull
8. Gljúforárjökull
9. Barkárdalsjökull
10. Myrkárjökull
11. Hjaltádalsjökull
12. Vindheimajökull
13. Bægisárjökull
14. Glerárdalshnúkur
15. Kerling
16. Dyrfjöll
17. Fonn
18. Herðubreið
19. Snæfell
20. Þrándarjökull
21. Hofsjökull
22. Vatnajökull
23. Dyngjufjöll
24. Mýrdalsjökull
25. Eyjafjallajökull
26. Torfajökull
27. Tindafjallajökull
28. Hekla
29. Tungnafellsjökull
30. Hofsjökull
31. Kerlingarfjöll
32. Hrútafell
33. Langjökull
34. Eiríksjökull
35. Ok
36. Trollakirkja
37. Skarðsheiði

winds from Greenland. In the central highlands of Ódáðahraun it is high (above 1,400 m.), for although temperatures are low, precipitation is small as the winds have dropped most of their moisture on the surrounding highlands. In the south, where both temperature and precipitation are high, the snow-line on the southern part of Vatnajökull is at 1,100 m.

Glacier ice can only be formed above the snow-line, yet glaciers are found far below it. Thus Breiðamerkurjökull descends to 20 m. above sea-level, which is about 1,100 m. below the snow-line. All such glaciers are continuous with the ice above and are made of ice which has moved down into the melt zone. The ice of Icelandic glaciers is at melting-point throughout, except temporarily at the surface in winter, and at this temperature any large mass will spread and flow down slopes. Where, as in southern Vatnajökull, the border

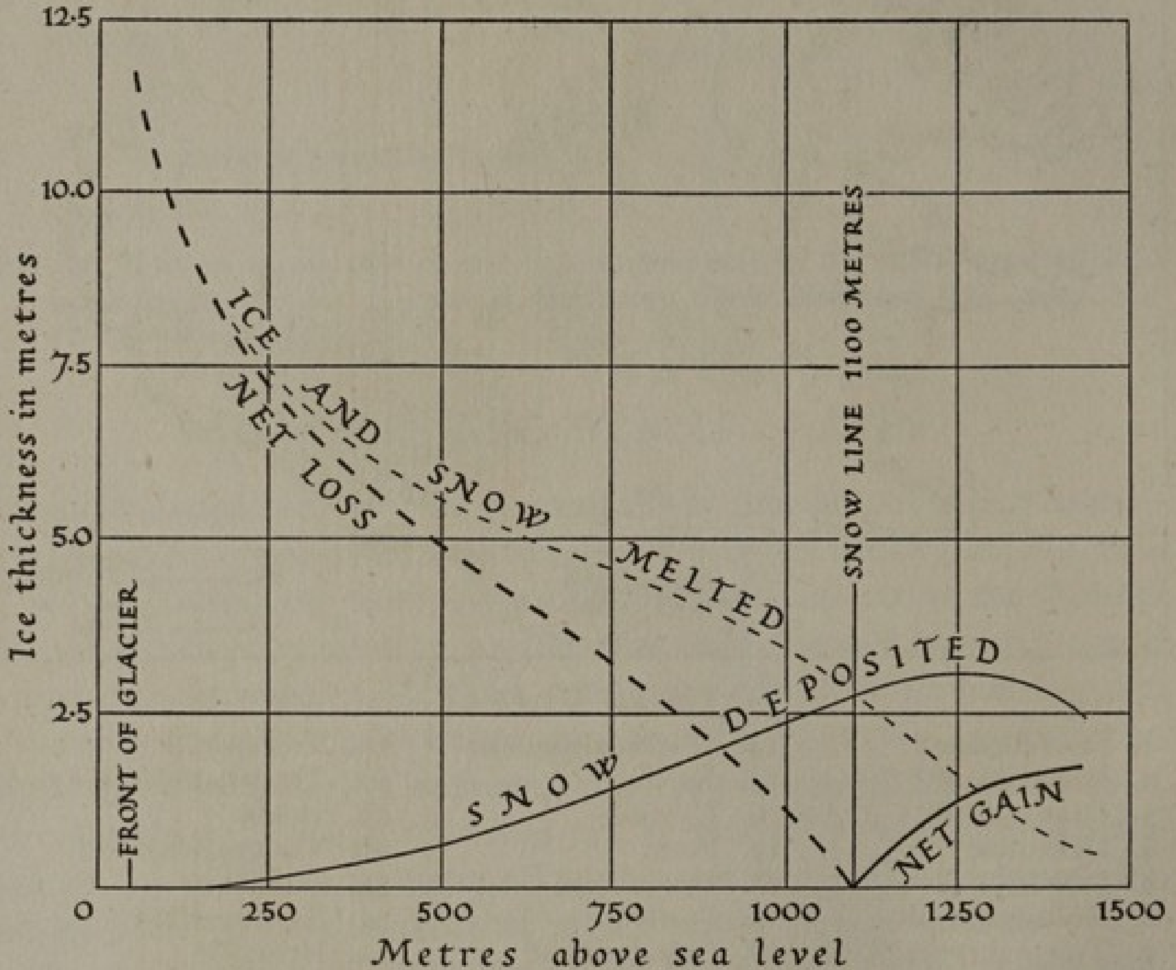


Fig. 25. Annual deposition and melting of snow at different altitudes on the south-eastern part of Vatnajökull. Based on data collected by H. W. Ahlmann, *Geog. Annaler* (Stockholm, 1938–9).

of an ice sheet is situated in mountainous country, the spread is effected by tongues of ice descending the valleys, and the movement is accelerated where the valleys narrow and where the gradient is steep. Thus the surface layers of the middle of Hoffellsjökull, where it is narrowly confined at 500 m., moves at the rate of 750 m. (over half a mile) a year. A moving ice tongue is known as a *skriðjökull* (= creeping glacier). If a valley glacier reaches flat lowlands beyond confining rock walls, it spreads out as an 'expanded foot'. Skeiðarárjökull (Fig. 14) provides a fine example of this.

L. Hawkes

Plate 12. Gjánúpsvatn, an ice-dammed lake on the east side of Hoffellsjökull.

L. Hawkes

Plate 13. Stranded icebergs in the upper end of Gjánúpsvatn, after partial draining. Trap-featuring is distinct in the mountain slopes behind.

W. L. S. Fleming

Plate 14. Þorbergsvatn, an ice-dammed lake at the northern edge of Vatnajökull. The overflow from the lake passes beneath the glacier in the centre of the picture.

W. L. S. Fleming

Plate 15. A terrace above Þorbergsvatn, formed at a time when the lake level was higher.

A study of the way in which a glacier is nourished above the snow-line and melted below it was made in the south-eastern part of Vatnajökull during the years 1935–8. The results, in average annual figures, which must be regarded as approximate only, are given in Fig. 25. At the snow-line, accumulation is equal to the melting which is equal to 2·6 m. (thickness of compact ice). The total precipitation (snow and rain) at this level is 3·5 m. of water. The maximum total precipitation, which occurs at an elevation of about 1,260 m., reaches the remarkable figure of 4·3 m. (170 in.) of water, this being twice the precipitation recorded from any land station in Iceland. No less remarkable is the ice melting: at the front of the glacier an ice layer 12 m. thick disappears annually. The high values for precipitation and melting are due to the proximity of the Gulf Stream waters which render the winds from the sea humid and warm. Warm air blowing over the glacier is the chief agent of melting; in the lower part of the glacier it is estimated that 85% of the wastage is due to this. The region is a cloudy one and the direct heat of the sun's rays is of minor importance, though it becomes greater towards the high ice-cap regions.

Vatnajökull

With an area of 8,800 sq. km. this is the largest ice mass in Europe (Fig. 26). It is not dome-shaped, but has a gently rolling surface through which rocks appear at points, and it forms a sheet-like cover to the ground beneath and to some extent reflects its relief (Fig. 27). Above 1,000 m. is the glacier sheet proper, the thickness of which probably lies between 150 and 250 m., whilst at the borders are the outlet glaciers, narrowly confined as valley tongues or broad spreading lobe extensions. In olden times it was crossed by people travelling from north to south, probably by way of the Norðlingalægð depression, and in recent times many exploration journeys have been made, but the weather on the glacier is commonly very bad and considerable 'polar equipment' is desirable (Plate 11). Expeditions which have spent any length of time on the ice-cap have used sledges drawn by horses, dogs or men. Special tents and clothing are required to give adequate protection from the weather, and travellers must expect blizzards lasting for as long as 5 days.

The marginal regions of the ice-cap are riven with innumerable deep crevasses which make access to the higher regions extremely difficult in summer. Where sections are visible in crevasses, bands of dirt are usually seen in the ice. These dirt layers are deposits either

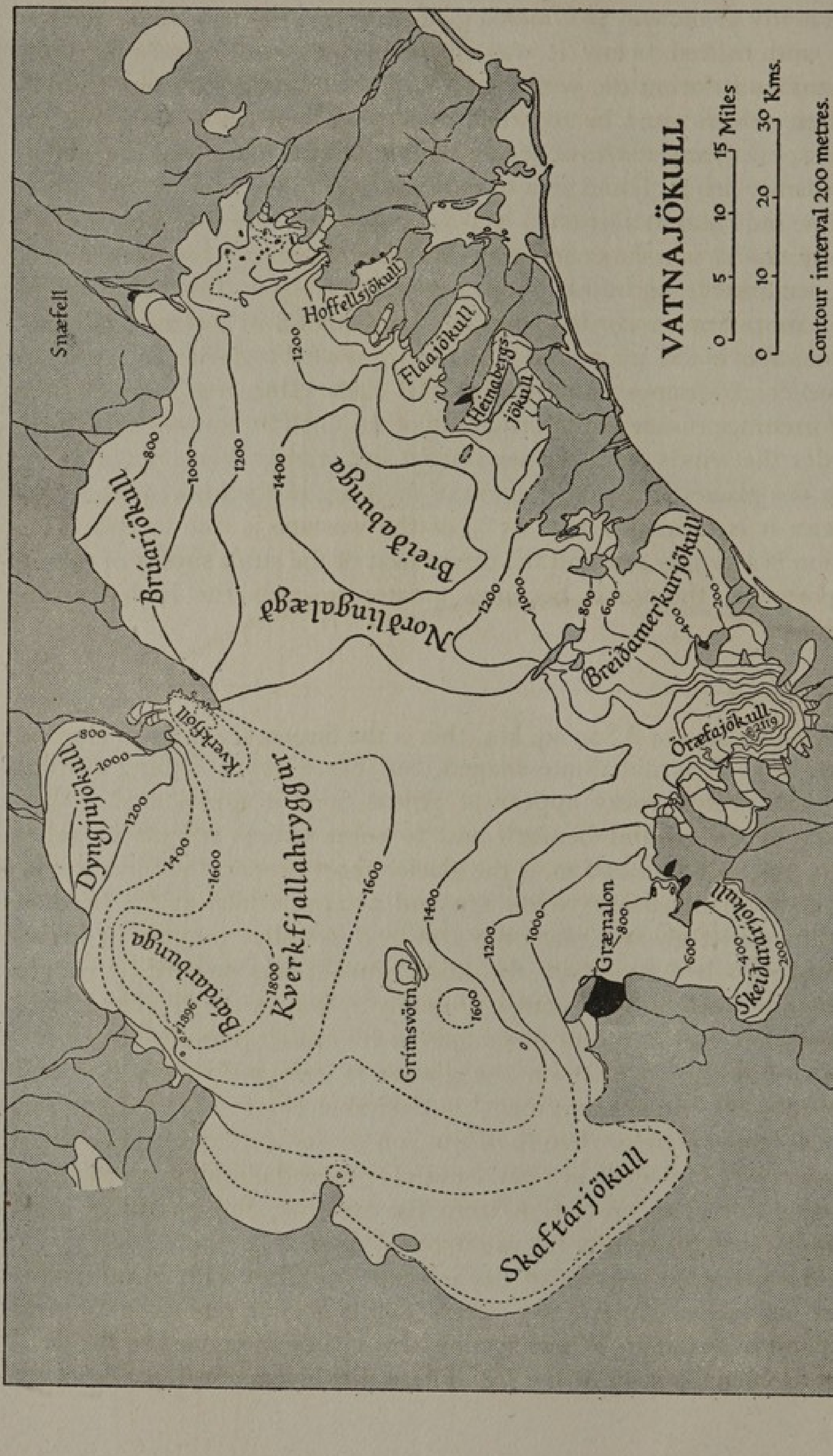


Fig. 26. Vatnajökull. Glacial lakes shown in solid black. Source: H. W. Ahlmann, *Geog. Annaler*, Pl. iii (Stockholm, 1937).

of ash from volcanic eruptions or of dust blown from the northern and western deserts on to the glacier. Dirt bands often mark a former ice surface at the end of a summer melting period. Öræfajökull, with the highest summit in Iceland (2,119 m.), has an independent centre of ice dispersal, and to the north it merges with the main ice-cap to feed Breiðamerkurjökull and Skaftafellsjökull.

The rock material brought down by the glaciers is dropped at their fronts, and when these remain in the same position for many years the accumulations build considerable ridges, or terminal moraines. The moraines of Kvíarjökull are particularly striking; they rise 90 m. above the plain and hide the glacier from the view of the traveller. Moraines in advance of the glacier fronts mark stillstands of former ice fronts, and the ridges, though apparently made of pebbles

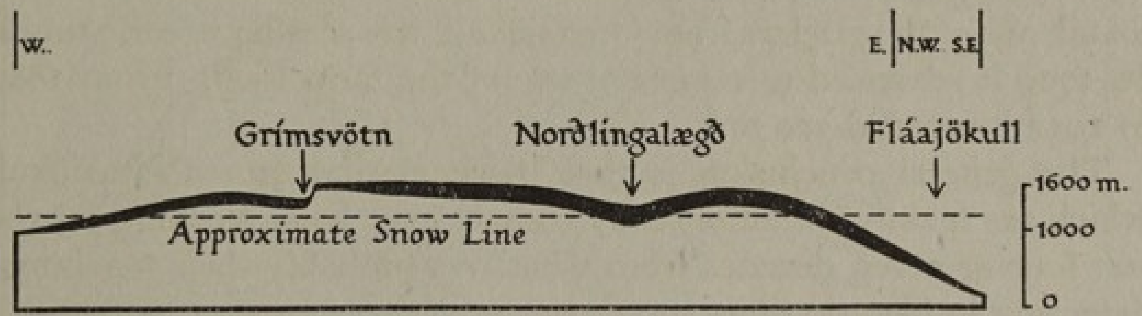


Fig. 27. Section across Vatnajökull. Length 130 km. Vertical scale × 10. Probable thickness of ice shown in black.

and sand, often have a core of ice which is melting extremely slowly owing to the insulating cover of deposits. The Háalda moraine, in 1904 500 m. from the front of Skeiðarárjökull and rising 40 m. above the sands, was in that year broken through by a *jökulhlaup* (see p. 20), and it was shown to consist of an ice core covered by a thick layer of gravel. The frontal parts of the lobe-shaped glaciers Brúarjökull and Dyngjujökull on the north of Vatnajökull are covered with rock debris. Some observers maintain that these glaciers are dead, that is to say, they are sheets of ice which no longer receive accessions from the main glacier and are slowly melting away, but this is disputed.

Changes in Vatnajökull in historic times. Glaciers are rarely mentioned in the ancient literature, but it appears probable that 1,000 years ago Vatnajökull had approximately the same appearance and size as it has now. There is more information relating to the last few decades, and at the present time all the outlet glaciers are thinning and in retreat. In the western region considerable changes in the positions of the fronts—sometimes advance, sometimes retreat—have been brought about by the *jökulhlaups* due to volcanic eruptions, but in the east this disturbing influence is absent and the changes in the condition of the glaciers are a direct consequence of climatological changes. Recent modifications of Heinabergsjökull and Hoffellsjökull are typical. It can be seen from the map (Fig. 28) that the front of Heinabergsjökull has receded 1·25 km. since about 1880. The front of Hoffellsjökull has receded 1·3 km. since 1890, and its thickness, at a distance of 1·5 km. from the present front, has diminished by 100 m., a rate of loss of 2 m. a year. It is estimated that this glacier has lost one-third of its volume since 1890.

Breiðamerkurjökull was much smaller 1,000 years ago. Big advances took place in 1794 and 1820, and in 1875 there was a fear that it would reach the sea and cut off communications along the coast. The many oscillations of this glacier are probably, in part at any rate, due to *jökulhlaups* occasioned by the draining of glacial lakes. Hrútarjökull, one of the glaciers from Öræfajökull, was smaller in early times. In 1709 it advanced to cover the site of the farm Fjall. From 1880 to 1932 it receded 300 m.

The general conclusion is that those glaciers from Vatnajökull which are mainly conditioned by climate have been receding for the last four or seven decades from what was probably their maximum extension in historic times.

Glacial (*ice-dammed*) *Lakes of Vatnajökull.* The main valleys on the southern and eastern borders of Vatnajökull are occupied by the outlet glaciers, but tributary valleys are ice-free and their rivers have their exits blocked by the glaciers, with the result that the water accumulates in front of the ice dams to form lakes. The lake level may rise until the water overflows over some col at the side of the tributary valley or at its head, or the lake may suddenly be drained by the water finding its way under the dam and down channels beneath the glacier to the lowlands at its foot. The resulting flood often carries ice blocks from the glacier front, and is known as a glacial *jökulhlaup*. Such a *hlaup* is similar to a *jökulhlaup* of volcanic origin (see p. 20), but is generally of smaller dimensions although if often does serious damage to farmland.

An account of the glacial lakes of Heinabergsjökull (Fig. 28) will serve to illustrate the general character and behaviour of such lakes. In 1870 the glacier was larger; its front was 2 km. in advance of its present position; it was thicker, and two lakes, Vatnsdalur and Dalvatn, were dammed up on its northern side. Vatnsdalur was full and its water overflowed over the col at 464 m. at the head of Heinabergsdalur to Dalvatn, which attained a level of 133 m. and then

Fig. 28. Glacial lakes of Heinabergsjökull. Black—present lake. Vertical shading—former lakes. Dotted line—glacier front in 1890; continuous line in 1903; dot and dash in 1939. Source: S. Thorarinsson, *Geog. Annaler*, p. 219 (Stockholm, 1939).

emptied beneath the frontal ice of the glacier. After 1877 the glacier front began to recede and grow thinner; Dalvatn shrank and finally disappeared in the 1920's. In November 1898 the Vatnsdalur lake emptied for the first time known to the inhabitants with a violent *hlaup*, and since then it has drained every year, the time of draining gradually becoming earlier; in 1938 it occurred on 5 July. The *hlaups* commonly lasted 10 days, beginning slowly and culminating on the 6th or 8th day to die down rapidly. The 1898 *hlaup* did relatively little damage in spite of its violence, probably because the ground was frozen so that the soil was not washed away, but in the following years several farms were destroyed and at present only four inhabited farms remain between the Kolgrimá and Holmsá rivers. With the thinning of the ice dam the *hlaups* are getting smaller every year. In 1938 the lake emptied for a second time in October, as the dam is now so thin that it cannot hold up the water received by the lake in one year, and the inhabitants are looking forward to the end of this menace.

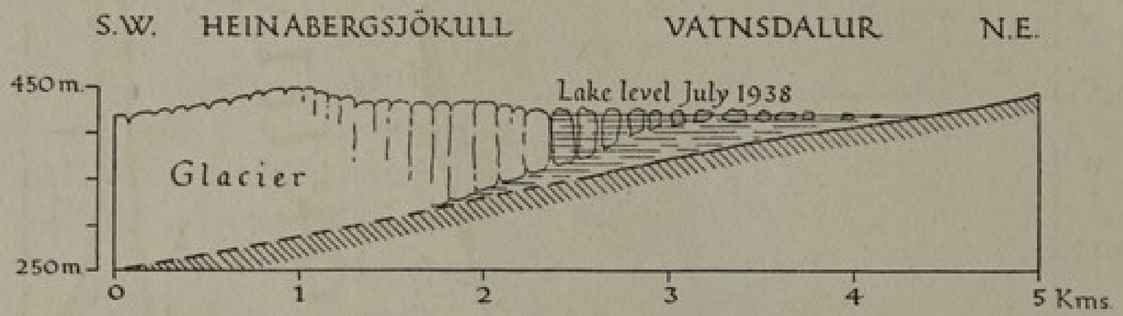


Fig. 29. Longitudinal section of Vatnsdalur glacial lake. Vertical scale × 5. Adapted from S. Thorarinsson, *Geog. Annaler*, p. 222 (Stockholm, 1939).

The section (Fig. 29) illustrates the present situation of Vatnsdalur lake and its dam. The regular emptying of the lake indicates that the cause of its commencement is the lifting of the ice dam when the water at its front is deep enough. This valve would of course cease to function with a reduction of the lake level, but *all* the water drains away. The initial buoying up of the dam must serve to allow the water to force a channel through it, and this channel remains open when the ice settles down again. Vatnsdalur lake must have overflowed over the 464 m. col for a long time before 1898, as interesting evidence of its existence is given by the beach which can be clearly seen round the sides of the valley at 464 m. Similar beaches mark the former levels of Dalvatn. The overflow channel at the col is 8 m. wide and 1·5 m. deep.

Grænalón, on the western side of Skeiðarárjökull, with an area of 18 sq. km. and a depth of 200 m., is the largest glacial lake in Iceland.

It drained in 1898, 1935 and 1939, the water passing beneath Skeiðarárjökull. In the 1939 *hlaup* large stretches of the western front of the *jökull* were broken and huge ice blocks were strewn over the sands; pastures were destroyed, and telephone lines swept away. Fig. 30 gives the course of the water delivery for the 1935 and 1939 *hlaups* and illustrates the normal history of glacial lake emptyings.

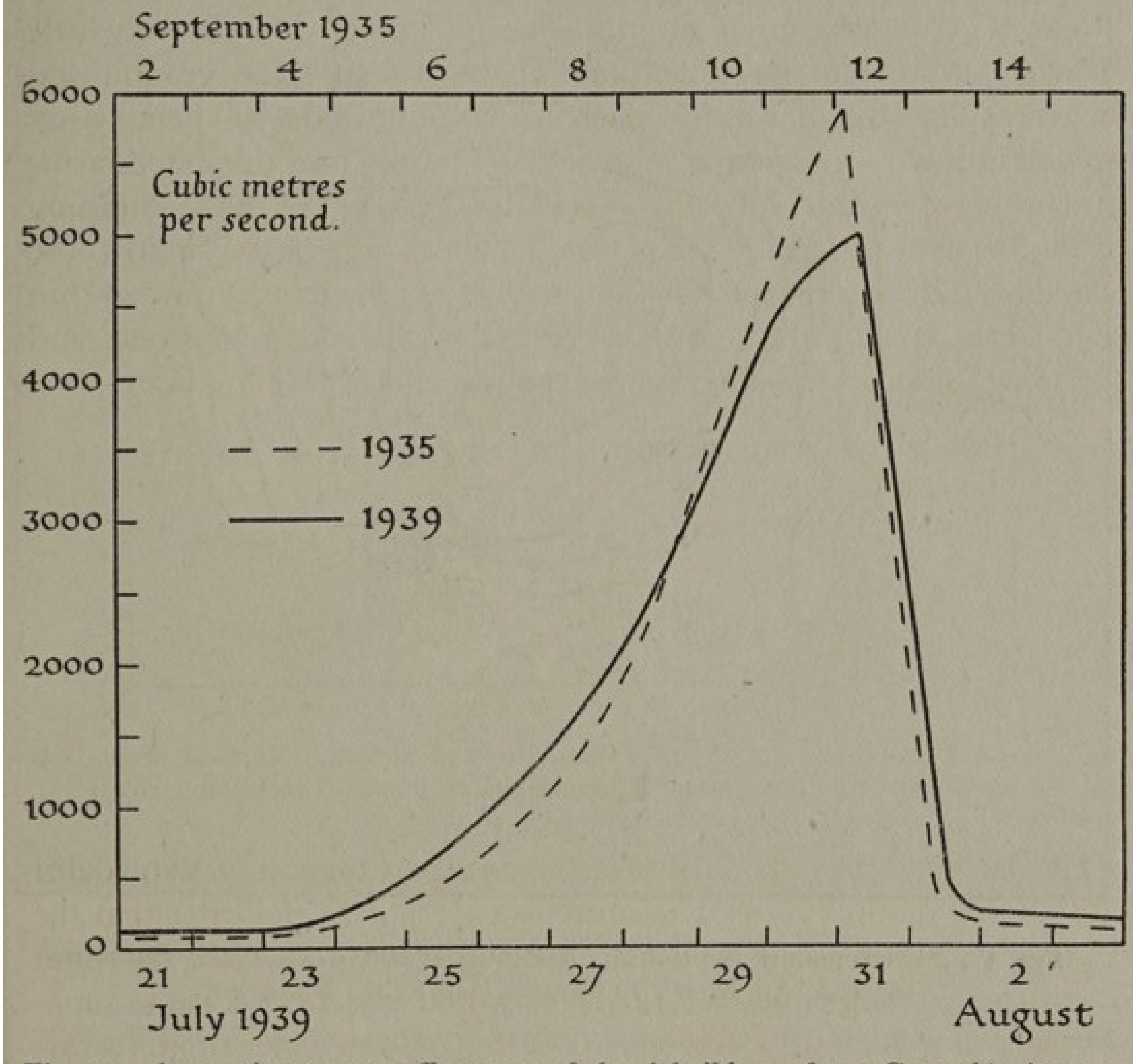


Fig. 30. Approximate run-off curves of the *jökulhlaups* from Grænalón in 1935 and 1939. Adapted from S. Thorarinsson, *Geog. Annaler*, p. 227 (Stockholm, 1939).

Hofsjökull

This ice sheet has not been accurately surveyed. It is comparable in size with Langjökull, but estimates of its area vary. The sketch map and section (Figs. 31 and 32) show its general character. The central area is an almost level plateau; the remainder is in part terrace-like, and the ice, especially in the west, cascades over a series of steep cliffs in which at places rock is exposed. A number of outlet *skriðjökulls* are

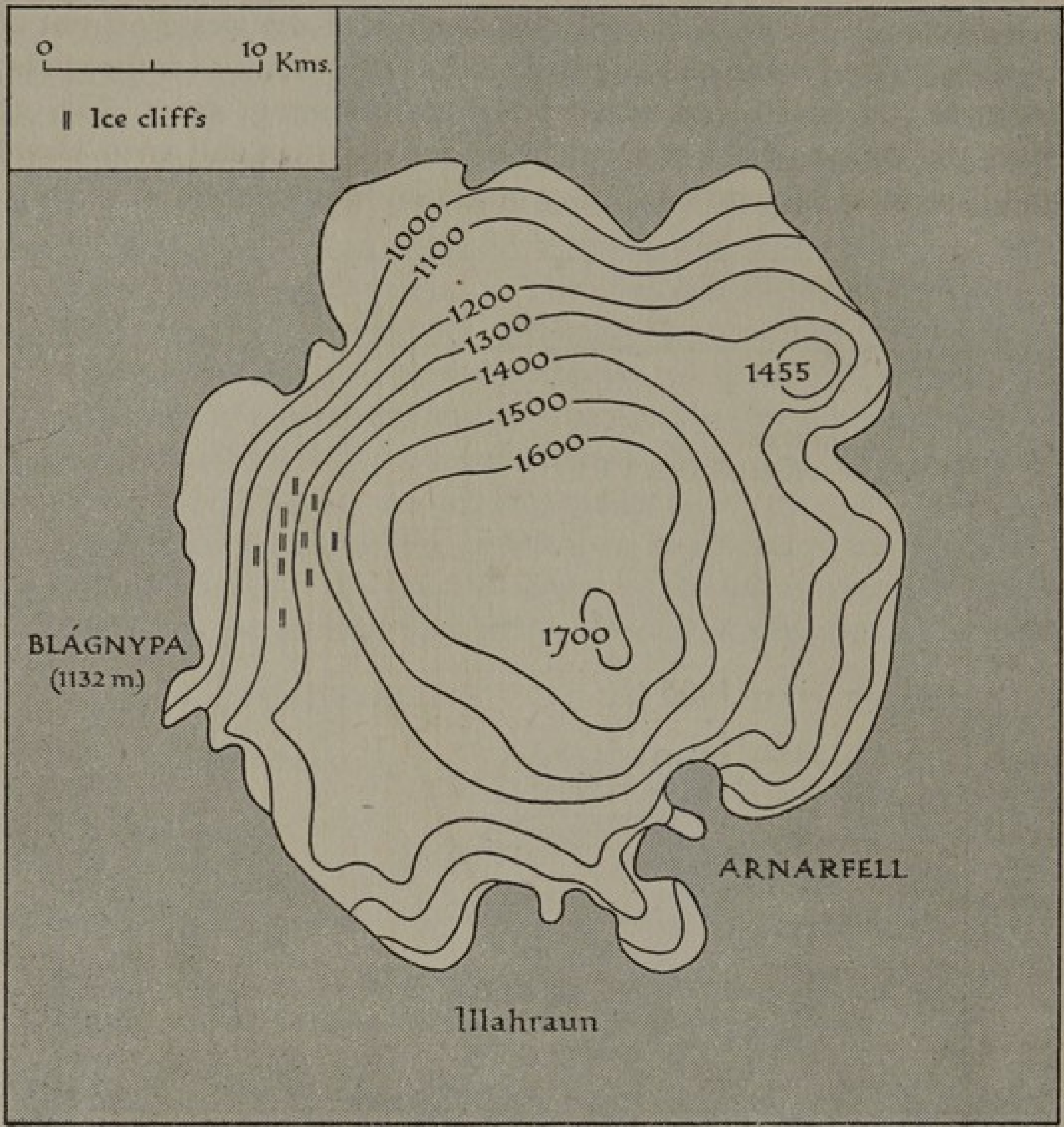


Fig. 31. Sketch map of Hofsjökull. Contours at 100 m. intervals. Based on Iceland 'Air Map', 1 : 600,000 (G.S.G.S., No. 4140).

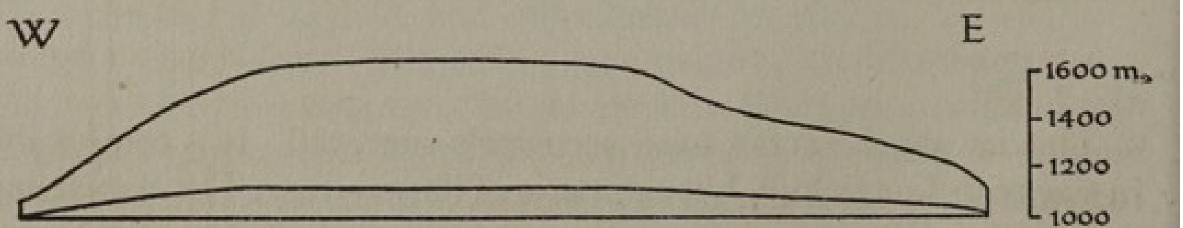


Fig. 32. Section across Hofsjökull. Lower line—true scale. Upper line—vertical scale × 10. Length of section 30 km.

found round the margin, and these have probably been in retreat for many years.

Langjökull

This glacier has an estimated area of 1,100 sq. km. and a gently rolling surface with three elevated regions.

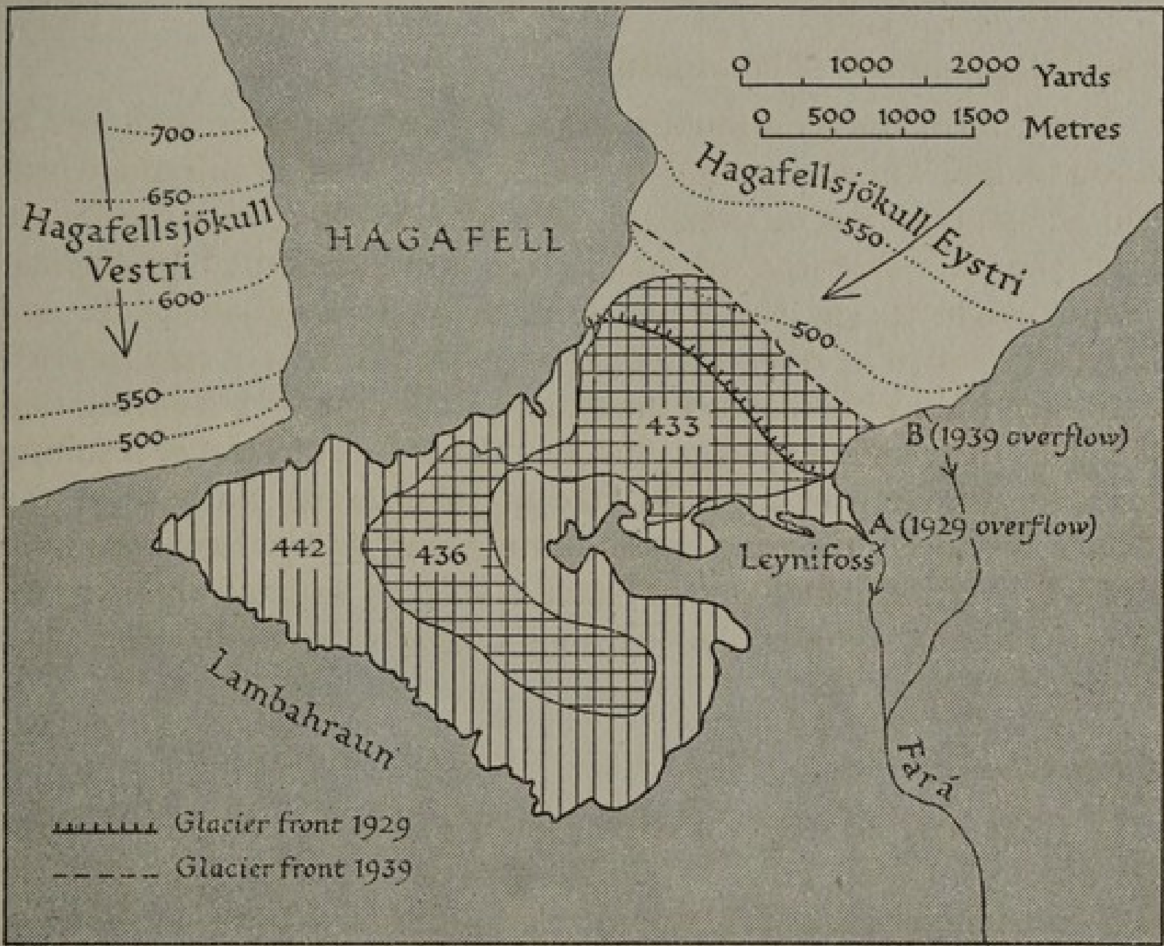


Fig. 33. Hagavatn. Vertical lines alone represent the lake after the 1929 *hlaup* over the col A. Vertical and horizontal lines represent the two lakes after the 1939 *hlaup* over col B. In 1939 the glacier front had retreated to the position of the dashed line. Lake levels in metres. Sources: J. W. Wright, *Geog. Journ.* vol. 86, Sept. 1935 (2). S. Thorarinsson, *Geog. Annaler*, p. 238 (Stockholm, 1939).

A number of lakes are dammed by the glacier ice along the south-west margin of the glacier. Hagavatn had in 1929 an area of 11 sq. km. Sudden lowerings of its level with *jökulhlaups* occurred in 1884, 1902, 1929 and 1939. The lake differs from the general type of glacial lakes already described in that it is dammed at one end by a prehistoric lava flow and at the other by the front of the glacier (Fig. 33). In 1929 the glacier front occupied the Leynifoss col (A in Fig. 33). The water then forced out the ice lying in the col; the lake level fell about 3 m.;

its area was reduced by 10%, and the *hlaup* caused much damage in the lowlands by the destruction of pastures and of the bridge over the Tungufljót at Haukadalur. With retreat of the glacier the water in 1939 forced its way under the ice to escape over another col (B in Fig. 33), 9·5 m. lower than the one used in 1929, and the fine Leynifoss no longer exists. There are now two lakes, the northern and ice-dammed one being 3 m. below the southern one which drains into it.

Eyjafjallajökull and Mýrdalsjökull

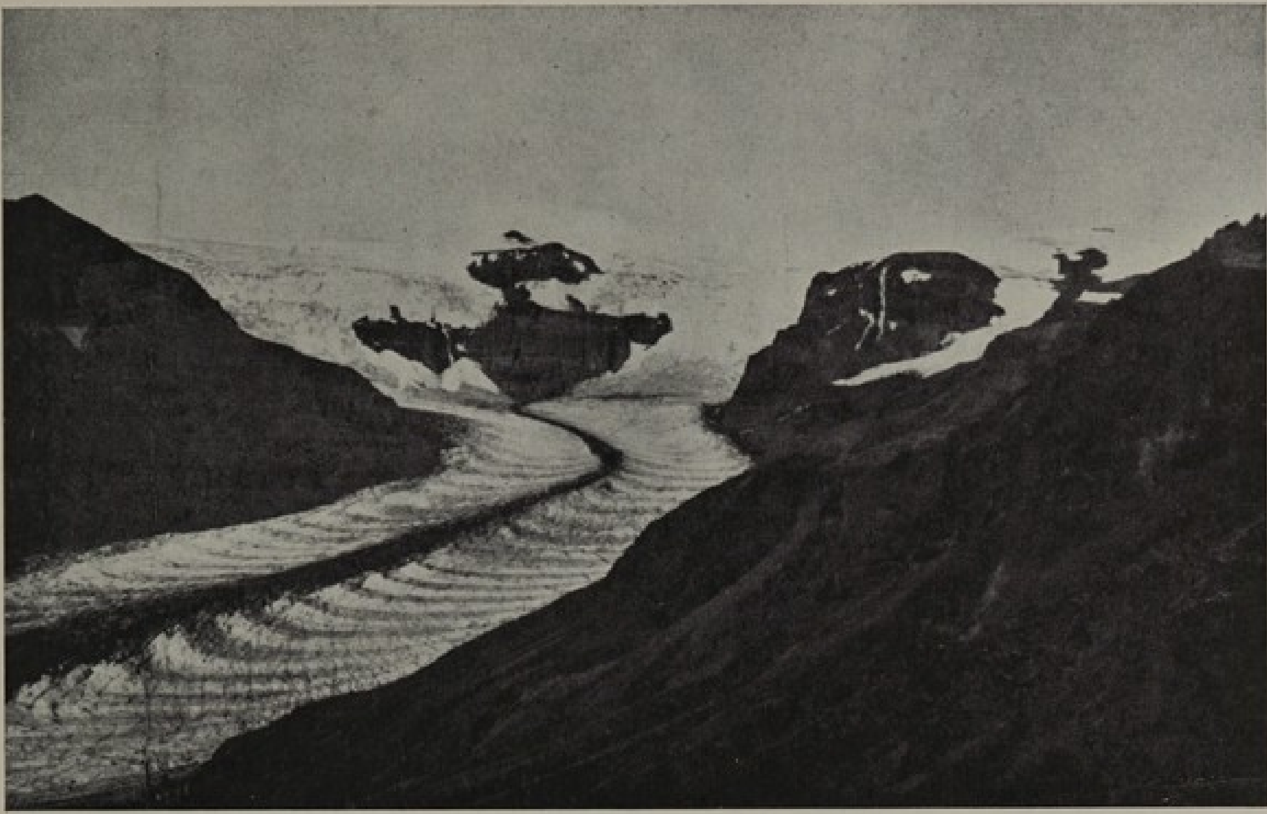
These form one continuous ice sheet with an estimated area of 1,000 sq. km. The former largely covers a cone-shaped volcano, which had an ash eruption in 1821, and a large *skriðjökull* flows northward from the horseshoe-shaped crater. The southern outlet, Sólheimajökull, originates in the depression between Eyjafjallajökull and Mýrdalsjökull. The river from the glacier front smells of sulphuretted hydrogen (hence the name Fulilækur = stinking river), showing that the glacier covers hot springs, and it is also subject to *hlaups* resulting from the draining of a glacial lake in Jökulsárgíl. Since 1930 the glacier has been receding and thinning and *hlaups* are becoming smaller. Mýrdalsjökull covers Katla, a volcano situated about 7 km. from its eastern border, famous for its many catastrophic eruptions in historic times.

Other Glaciers

Of these may be mentioned Drangajökull (about 200 sq. km.) and Glámajökull (4 sq. km.) in the north-west peninsula; Torfajökull (a group of eight separate glaciers); Kerlingarfjöll (five small glaciers); Hofsjökull, to the east of Vatnajökull (eight valley glaciers), Þrándarjökull (an ice-cap); Snæfell, an extinct volcano with four glaciers; and Hekla, with three glaciers on its northern side. There are many other small glaciers in cirque hollows and on mountain tops. About twelve small ones in the highlands west of Eyjafjörður are sufficiently prominent to have received names.

Past and Present conditions of the Glaciers

The Icelandic glaciers of to-day may be the remnants of those of the last Ice Age or they may represent a new glaciation. The streams issuing from Vatnajökull deliver birch trunks and marine shells showing that the glacier was formerly much smaller at a time when the sea level was higher. It is known from Scandinavian evidence that between the last Ice Age and recent times there was a warm



M. H. Donald

Plate 16. Morsárjökull, a valley glacier flowing from the southern margin of Vatnajökull. Note the prominent median moraine. The curious transverse corrugations of the glacier have not yet been explained.

O. Magnússon

Plate 17. One of the glaciers descending from Langjökull into Hvítárvatn.

Plate 18. Desert country north of Vatnajökull. An expanse of gravel with wind-etched boulders in the foreground. Vatnajökull in the distance.

period (before about 500 B.C.), and it was probably at this time that the Icelandic glaciers were smaller, and possibly non-existent. There is no evidence that they have changed materially in size during the last 1,000 years. At the present day all, with two exceptions, are in recession, and, in common with the great majority of the world's glaciers, have been receding for some decades. Two outlet glaciers of Drangajökull in Kaldalón and Reykjarfjörður have shown advances in recent years. Some of the small ice masses are below the snow-line and are slowly disappearing. It has been suggested that some of the larger glaciers owe their existence to their own surface elevation, and that if the ice could be removed they would not form again because the land they cover is beneath the snow-line. This can only be the case if the ice-caps are much thicker than they are believed to be (see Fig. 27).

THE GREAT ICE AGE

As already noted, there is abundant evidence of the existence of glaciers at the time the younger rocks of the median zone were laid down. In the regions of the older rocks also glaciers have left their mark on the surface in the form of loose deposits (moraines) and in the grooving of the floors of the valleys. Whether Iceland was ever completely covered by ice will probably never be known, but it would seem unlikely.

It is certain that in many localities there was more than one glaciation—perhaps there were several—and that between them, in what are called inter-glacial periods, the glaciers shrunk very considerably and perhaps disappeared from the country for a time. The best evidence for this is to be seen in the Víðidalsá valley near Lækjamot, south of Húnafjörður. Here the partly buried floor of an old valley is ice scratched, proving the presence of ice. On this floor is a series of clays, sandstones, and gravels—in all 70 m. thick—with fossil plants indicating the presence of a bush or forest-like vegetation of a climate slightly warmer than the present one, and also proving the extensive recession of the glaciers. These deposits are overlain by lavas which are in turn covered by moraines, proving the reoccupation of the valley by ice.

Glaciated lava surfaces, covered by marine deposits, plant beds and lavas, which latter are overlain by other glacial deposits, are found at many places. The following are the localities which have been examined: Búlandshöfði and Brimlarhöfði (on the north side of

Snæfellsnes), Fossvogur and Elliðaárvogur (near Reykjavík), Breiðavík (Tjörnes), and Röndin (south of Kópasker in Axarfjörður). These all bear witness to inter-glacial conditions, but much investigation remains to be carried out before the full story can be told. Probably nowhere is the record of the Ice Age so complete as in Iceland, but its study is only in its infancy.

FORMER SHORE LEVELS

These can be proved in Iceland both above and below present sea level. How far their present positions are due to movements of the land and how far to changes in sea level cannot be determined.

All the older rocks were laid down on a land surface. The earliest marine deposits are of Pliocene age. Since their formation they have been tilted downwards in a northerly direction to disappear beneath the sea. Erosion has removed some of the deposits; they are now found only up to about 200 m. above sea level in western Tjörnes.

The next marine deposits in order of age occur in the lower Palagonite Formation; they belong to the earlier part of the Ice Age. Clays, sands and gravels with marine shells, covered by lavas and other volcanic deposits, are found in the west and north. At Búlandshöfði on Snæfellsnes the deposits occur at an elevation of 180 m. The shells of some layers indicate colder seas, while the shells of other layers indicate seas of temperatures comparable to those of to-day. These deposits are considered to indicate glacial and inter-glacial conditions respectively.

The most striking evidences of higher shores are the flat-topped terraces of sands and gravels round the coasts. They are conspicuous along the sheltered shores of the fjords, especially at river mouths. Splendid examples are seen at Akureyri and at Sauðárkrókur. In places cliffs facing the open sea have a low foreland which was formed by wave erosion when the shore level was higher (see Fig. 34). On the west coast, in Borgarfjörður, marine deposits are found up to 80 m., in Eyjafjörður up to 70 m. At the time of their formation the sea must have covered considerable areas of the present lowland. The highest level was probably attained at the time of the last glaciation, perhaps some 10,000 years ago. According to one theory the country was pressed down to this extent by the weight of the ice.

The most prominent terrace which is well developed on the west, north and east, has a height of 40–50 m. In sheltered places, e.g. near Syðri-Firði, south-west Lóni, a whole series of terraces occurs below

R.A.F.

Plate 19. Bíldudalur, a small inlet on the south side of Arnarfjörður in the north-west peninsula. Curious scollop-shaped hollows have been eroded in the steep fjord wall. Note the horizontal trap-featuring and the regularity of the plateau surface (see also Plate 41).

E. Sigurgeirsson

Plate 20. Herðubreið, an extinct volcano of unique type in central Iceland. The lower part is palagonite tuff, the terraced upper part is built of lavas (see p. 16).

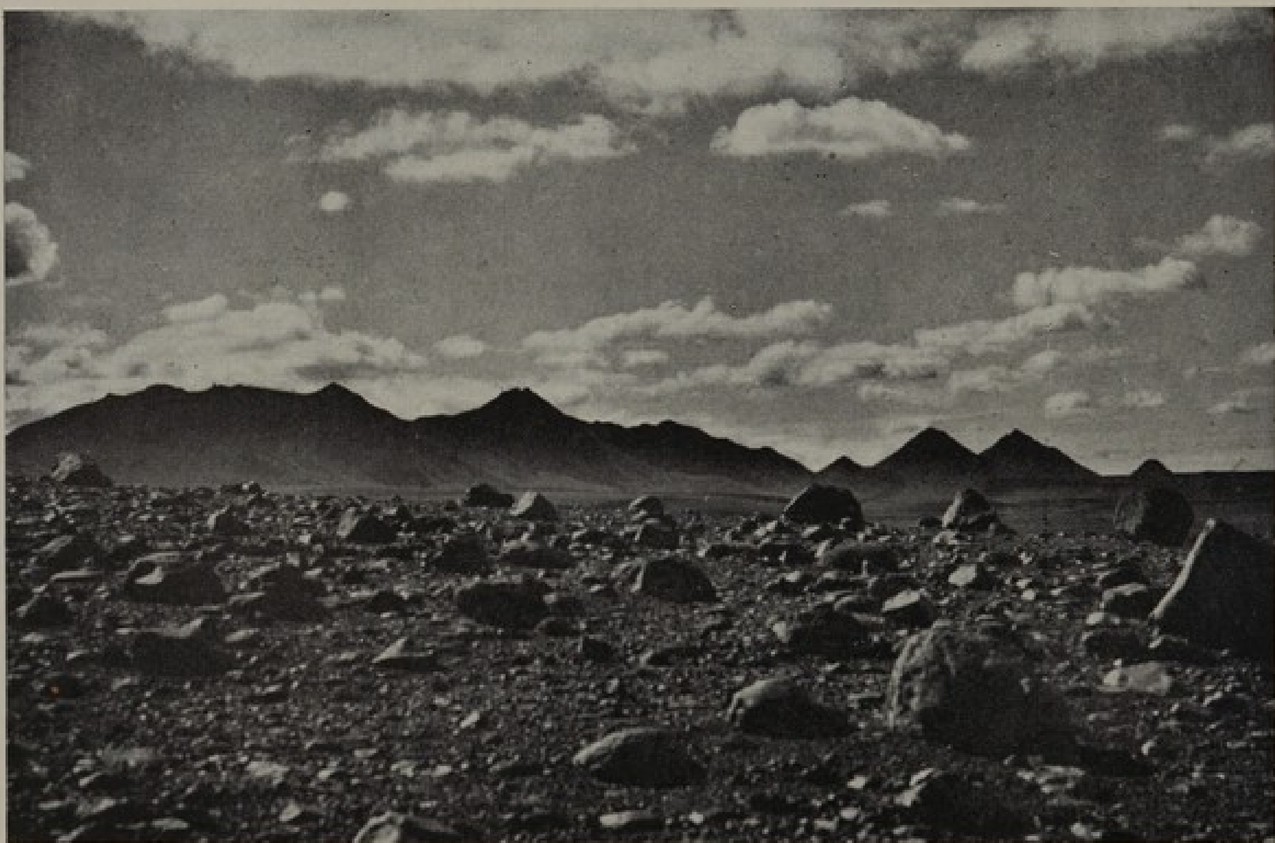


Plate 21. Stony desert near Moðrudalur. The sharply defined irregular skyline is characteristic of the palagonite hills in the central desert.

the 40 m. one. Some of the areas formerly occupied by the sea are now covered by lava or ice. Breiðamerkurjökull rests on a marine foundation formed during a post-glacial warm period when the shore was 50–60 m. higher than at present. It is claimed that pieces of wood delivered by streams emerging from beneath Skeiðarárjökull belong to trees which occur in the southern part of North America. If this is so, they must be driftwood stranded long ago on land now covered by the glacier.

With regard to lower shore levels than the present one, two evidences may be cited. A layer of peat with roots of birch and willow is visible at low tide on the shores of Faxaflói at Akranes, Borgarnes, Seltjarnarnes, Álftanes and Garðskagi. This indicates a shore level at 4 m. lower than the present one. The other evidence concerns possible

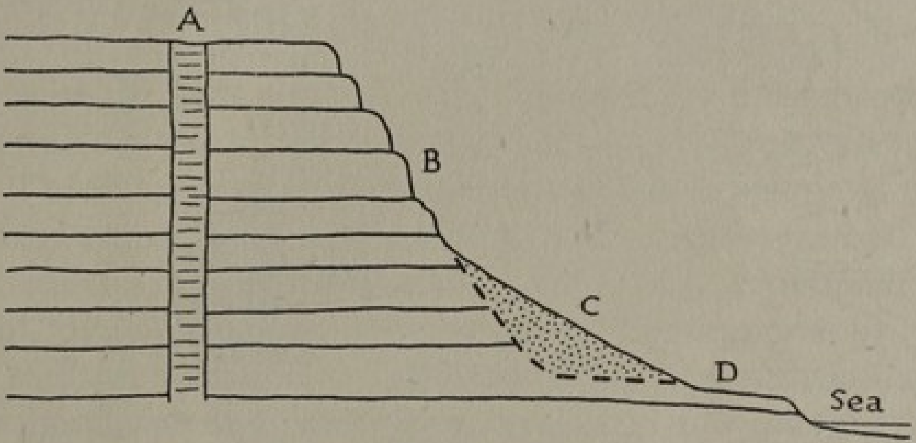


Fig. 34. Generalized section of basalts, with a dyke (*A*), a stepped cliff (*B*), and scree accumulation (*C*) on a raised coastal platform (*D*).

changes of level of a larger order. It can be seen from the map of submarine contours (Fig. 35) that there are many grooves in the sea floor round Iceland. Some of them are obvious continuations of the fjord valleys; the 200 m. depth contour shows this clearly. The Eyjafjörður groove can be traced down to −600 m. Some geologists consider that these grooves have been cut in solid rock by rivers or glaciers when the sea level was lower: that they are 'drowned valleys'. If we imagine the sea surface to be lowered 600 m., there would be a land bridge from Greenland to Europe. Whether the irregularities in the submarine shelf around Iceland are to be interpreted in this way, and if so the date of their formation, are very debatable questions. That some amount of 'drowning' is indicated is generally conceded.

According to the information given in the sagas, it seems that no noteworthy change in the position of the shore level has occurred in the last 1,000 years. With regard to present-day changes, it is a

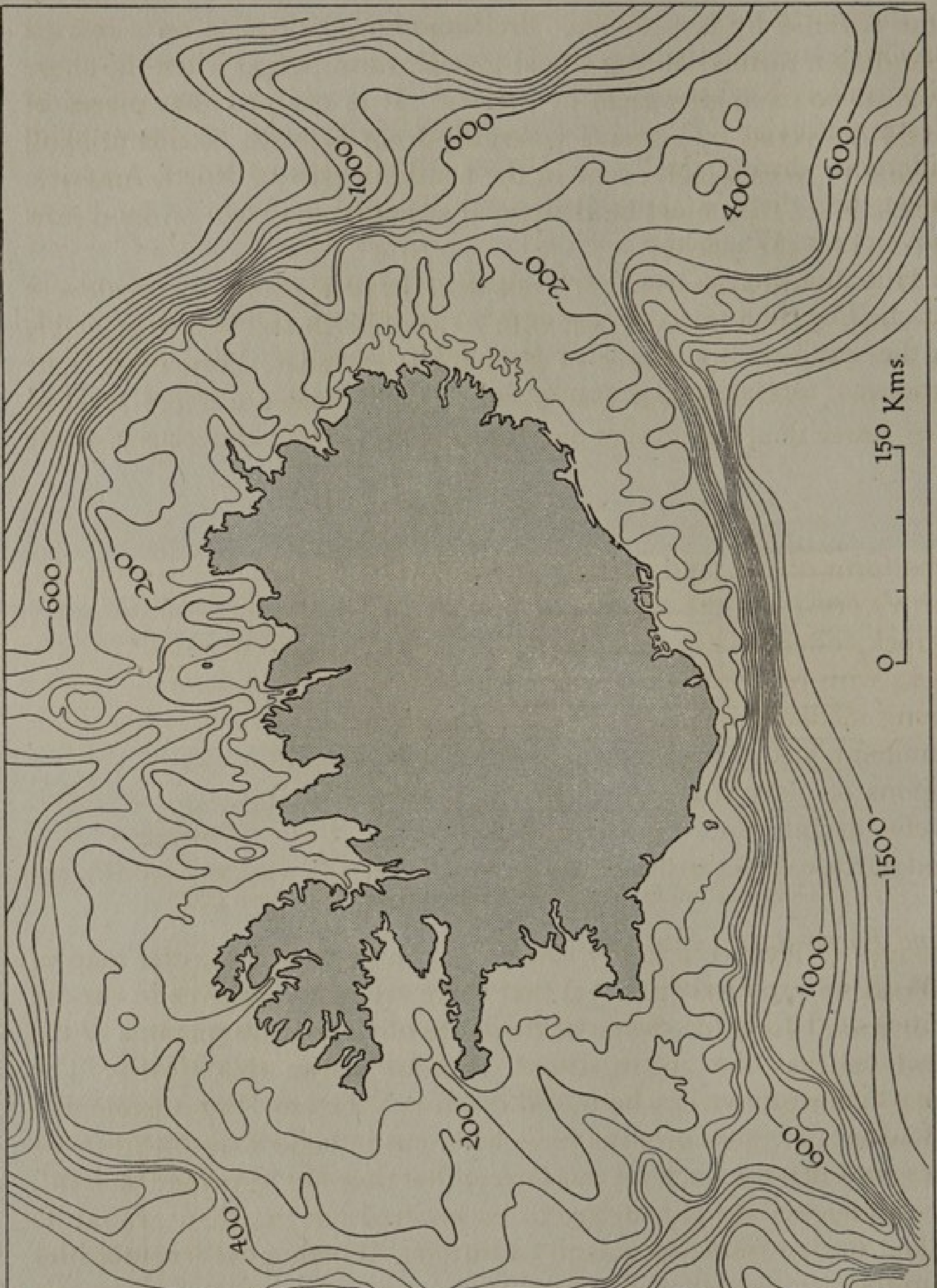


Fig. 35. Submarine contours round Iceland. Contours at 100 m. intervals. Source: W. Iwan, *Berliner Geog. Arbeiten*, Bd. VII, p. 18, 1935.

common opinion that the land is rising on the north coast in Húnaflói, in the north-west peninsula, in the northern and inner part of Breiðifjörður, and that it is sinking on the south coast of Breiðifjörður, in Faxaflói, Reykjanes, and on the south coast in Arnessýsla and Vestmannaeyjar. People say that they have noted an appreciable difference during the last 40 years. No measurements have been made, but there is some evidence in favour of the reality of these movements. Where the coast is low on the north of Breiðifjörður and in Húnaflói the sea has thrown up a series of gravel ridges along the beach. The ridges become lower nearer the shore. On the other hand, in the south-west of the island the ridge nearest the sea and now in process of formation is generally higher than the ridges farther inland.

THE LAND SURFACE

The form of the land surface is the result of (1) movements of the earth's crust, (2) the accumulation of rock, (3) the removal (erosion) of rock. There is a contrast between the regions of older and younger rocks with regard to the relative importance of these factors. In the young median zone, earth movements are active, accumulation is the dominant factor, and erosion is as yet of less importance. In the regions of older rocks, earth movements and accumulation are relatively insignificant compared with erosion in the moulding of the land surface.

Land Forms due to Earth Movements

With differential vertical movements of the earth's crust, irregularities of the land surface result. Parts of the land are raised above others so that there is an abrupt drop from one to another along a line which is known as a fault. Differences of surface level, due wholly to faulting, are unknown in most parts of the world, e.g. in the British Isles and France, and Iceland is of special interest in that fault relief is so well developed there.

The most striking case is the abrupt fall along a north-south line from the high land east of Akureyri to the lower country to the south of Skjálfandi. This fault marks the western boundary of the northern part of the median zone (Fig. 21). Originally the older rocks continued across the site of the median zone, but they have sunk on the east side of the fault. The whole of the median zone may be regarded as a 'graben', that is, a sunken area.

Fig. 36. Relief.

Within the median zone sudden small changes of level along fault-lines are common; changes have occurred with earthquakes in historic times (pp. 33–6). Some lakes, such as Þingvallavatn and Langisjór, are situated in graben strips. The fault-lines of south-west Iceland trend from north-east to south-west, and the parallelism of the strips of high and low land in the neighbourhood of Skálholt is controlled by earth movements. Whether any of the large fjords are the sites of graben is a debatable question.

Mountain masses, with steep sides rising like islands from the general level surface, are prominent features of the landscape of the median zone. Herðubreið has already been noted (p. 16), and the following are conspicuous examples: Hrútafell (south-east of Langjökull), Hrafnabjorg (north-east of Þingvellir), Ingólfsfjall (Ölfus) in the south-west, and Bláfjall and Selandarfjall in the north. Hofsjökull covers such a block. On one view these blocks are 'horsts' (the reverse of graben); that is, they are bounded by faults and have either been pushed up above the surrounding country, or the latter has sunk around them. Some geologists do not accept this and consider the so-called horsts to be remnants of plateaux which have been eroded—the cliffs of Ingólfsfjall, for example, may be old sea cliffs. Further investigation is required to clear up this question; one explanation may not fit all cases.

Frost Action

Rocks at the surface are broken up by mechanical forces and for the most part the products are transported by winds, rivers and glaciers, and are deposited at lower levels.

The most important factor in the disintegration of the rocks is frost. Water freezes in crevices; the growing ice crystals prize them open and fragments are broken off. In Iceland the temperature is constantly changing about the freezing-point, and the rocks are easily fractured. Below a cliff the fragments collect and build up a deposit with a surface inclination of about 30°. Such deposits are known as screes (*skriður*), and huge scree aprons, bare of vegetation, are a special feature of south-east Iceland. Such deposits do not form at sea cliffs because the fragments are removed by the waves. The spectacular screes around the Austurhorn and Vesturhorn mountains are banked against the old sea cliffs and have grown on beach platforms which are now high and dry owing to the fall of the shore level (Fig. 34; Plates 48 and 49). Houses are often of necessity built in front of the screes; and the sites have to be carefully chosen, as in the spring large blocks loosened from above may travel beyond the foot of the scree. The climber chooses a slope of large blocks for ascent, and descends the fine screes, riding down on the sliding mass. With time mud may be washed into the deposits so that they become unstable, and suddenly, often due to a slight earthquake, they may collapse and travel for a kilometre or more as a 'rock stream' (*skriðu-hlaup*), perhaps engulfing sheep and covering grazing land.

Another phenomenon due to frost, and one which is commonly seen in higher regions, is the arrangement of stones in rings enclosing mud. Also the stones of a pebbly flat may be sorted into a pattern of rings of larger stones enclosing smaller ones. Related to this in origin is the humpiness of much grassland—the small close-set mounds are known as *þúfur* (Plate 80). Agricultural machines cannot be used on such ground, and if it is levelled the humps come up again in a few decades. Frozen ground is essential for the growth of all these formations, but the exact mechanism is obscure. In many high-lying regions the ground is permanently frozen in depth. Even on very gentle slopes the loose superficial material creeps imperceptibly downwards with alternating frost and thaw.

Wind Action

Iceland is a stormy region and the winds readily pick up fine material from the dry desert surface; much of it is carried to the Atlantic. The dust may be raised 2,000 m. and the storms are a serious inconvenience to travellers. The dust is volcanic ash or glacial mud and sand. The erosive power of the sand blast is great; it is on record that sheep have been stripped of wool and skin. The rocks are abraded and polished, and where, as in the palagonite formation, these are composed of lava blocks and ash with very variable resistance to erosion, fantastic forms are developed. The fine material is eroded from volcanic breccias and boulder clays, leaving a desert surface of polished stones.

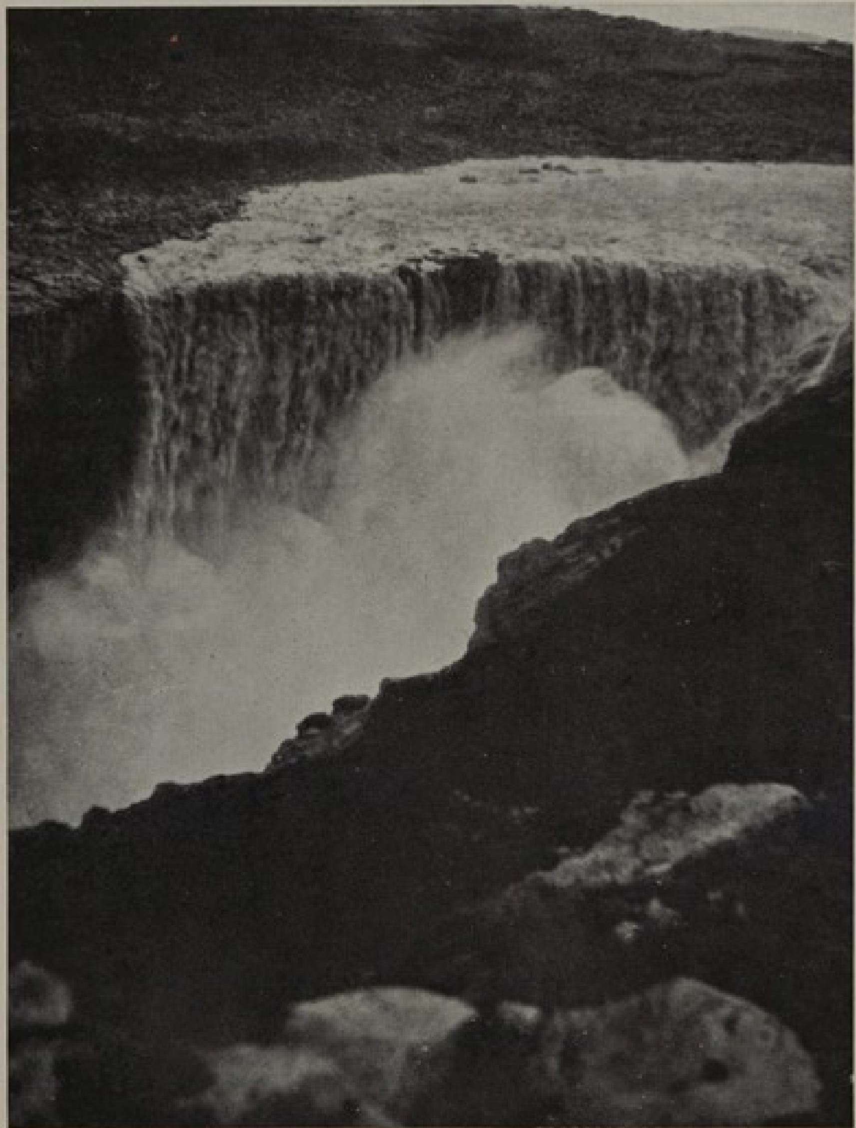
Wind-deposited sand and dust may temporarily lie about anywhere and may under favourable circumstances become protected with a cover of vegetation; the deposits are known as loess. These deposits differ from normal loess in mineral composition; calcium carbonate is wanting, and the deposits are generally impervious to water. There is no dune formation comparable with that of the sub-tropical deserts. Sand storms attack covered loess and remove it, and farms on the desert borders have been laid waste. Stone walls have been built to protect threatened land. Sea-lyme grass (*Elymus arenarius*) thrives in

W. L. S. Fleming

Plate 22. Typical desert in palagonite tuff region north of Vatnajökull. The rocks are porous; there is no surface water, and vegetation is scanty.

L. Hawkes

Plate 23. Mosfell, a frost-shattered ridge of granite in the Lón district of south-east Iceland.



B. B. Roberts

Plate 24. Dettifoss. The largest fall in Iceland (60 m. high). The Jökulsá á Fjöllum plunges into a deep and narrow gorge after flowing for 130 km. through the desert.

V. Sigurgeirsson

Plate 25. Skógarfoss. The river falls over an old sea cliff (about 60 m. high) to the coastal plain below. The men and horses show the scale.

these conditions, and has been planted to prevent the sand from burying arable land. It has been suggested that the loess deposits were laid down in a period in which the climate was cold but drier and less windy than it is now, and that present-day conditions favour erosion.

The Effects of Former Glaciers

The glaciers of the Ice Age largely if not wholly covered the country, and they have left their mark on the relief, particularly in the regions of the older rocks. Bare rock on the floors of the great fjord valleys is scratched and grooved, and the wide flat floors and steepened sides of these valleys have been moulded by the erosive action of the moving ice. On the higher mountains and ridges evidence of glacial erosion is absent; it has been removed by the destructive action of frost.

Fig. 37. Section across Ísafjörður, immediately south of the town. No vertical exaggeration. Deposits now fill the fjord, leaving only shallow water. The curve of the rock base below the deposits is conjectural. Note the sand spit rising above the water in the middle of the fjord.

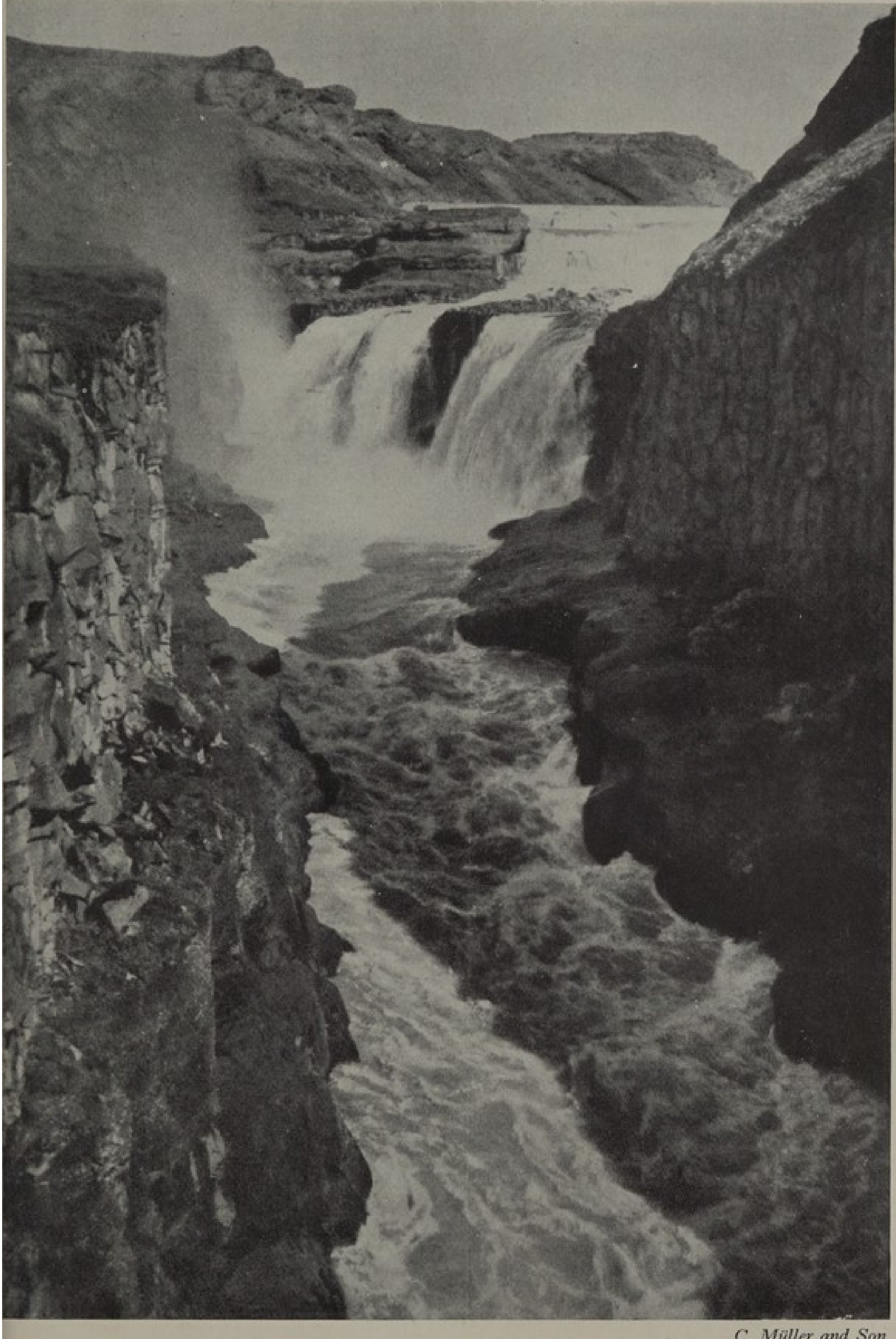
Rapidly moving glaciers are able to excavate hollows in solid rock, and these 'rock basins' are prominent features in many countries which have been glaciated. In Iceland, however, there is very slight development of them either as fjord or as lake basins. The best example of the latter is the Lagarfljót in east Iceland. This lake is 30 km. long and up to 2·5 km. broad, and it occupies a rock basin 110 m. deep. Most of the fjords are deeper inside than at their mouths, but the difference is never more than 60 m. It is difficult to understand why fjord hollows which are so widely developed in Norway and Scotland should be so insignificant in Iceland. The fjord sides are steep, but from the water it is easy to get an exaggerated idea of this. Fig. 37, illustrating Ísafjörður, is a typical cross-section. The flat submarine floor is doubtless formed of recent deposits, but these are not likely to be of great thickness, and the solid rock profile is probably that of a blunt-based V. Such a profile may well be that of a valley which is wholly due to erosion by rivers and glaciers. It has been suggested that these valleys are strips of country which have sunk between parallel faults; these faults, however, have not been proved in the rocks. The general trend of the fjords may well have been determined by fractures in the first place, but, with few exceptions, their forms are probably due to erosion which took place at a time when the shore level was much lower than it is at present.

The deep valleys, particularly those of the north-west peninsula and in the country between Skagafjörður and Eyjafjörður, commonly have steep rocky slopes at their heads. Also along the valley sides large hollows with flat floors considerably above the bottoms of the main valleys are common. These 'arm-chair' hollows are known as corries (*hvilftar* or *botnar*). Large-scale maps of the regions mentioned above show many examples. The Nantahvilft in Ísafjörður, south of the town and on the opposite side of the fjord, is a particularly fine corrie. These corrie valley heads and side hollows have been occupied by glaciers, and their forms are due to the erosive and transporting action of the ice. The floor is smoothed by abrasive action at the base of the ice, whilst the debris from the bare crumbling rock walls is carried away by the glacier. These steep walls may be likened to sea cliffs in origin, only in the *botnar* and *hvilftar* it is ice instead of the sea which grinds out the platform and removes the scree.

Boulder-clay deposits which are left after the melting of glaciers are common; they are usually thin and impersistent. The old moraine deposits commonly form irregular 'moundy' surface. Morainic mounds of acid rocks at Vatnsdalshólar, Húnafjörður, and the inner Löðmundarfjörður region have been mistaken for recent lava flows.

Rivers

Iceland has a high rainfall and the glaciers are constantly melting. The run-off is consequently great and the rivers numerous, as may be seen from Fig. 38. Only in the deserts is surface water wanting over considerable areas. This is because the lavas and other volcanic deposits are fractured and porous; the water readily sinks into the ground, and the drainage is sub-surface. This water eventually appears as springs at the desert borders; the streams issuing from the edge of the Brunahraun (Fig. 40) illustrate the general phenomena. A spectacular example is seen at Barnafoss, in the Borgarfjörður district, where water pours out from beneath a lava flow at the side of the Hvítá (Plate 30). The river from a glacier (*jökulsá*) contains fine mud in suspension and is characteristically white (*hvítá* = white river) as



C. Müller and Son

Plate 26. Gullfoss, on the Hvítá, is one of the most beautiful waterfalls in Iceland. The two cascades are 30 and 20 m. high.

Graf Zeppelin

Plate 27. Braided streams from Fláajökull, a valley glacier from Vatnajökull.

L. Hawkes

Plate 28. Silt-laden streams from Hoffellsjökull. Braided streams of this type are characteristic of the plains which border the rapidly melting glaciers. They form a serious obstacle to transport.

compared with the clear non-glacial river (*svarta* = black river). In dry summers the clear rivers are small whilst the glacial rivers carry from two to three times their usual volume of water. Even the largest rivers are for the most part unnavigable because of their steep fall, torrential current, and tendency to spread out in a series of shallow distributaries on the lowland. The Hvítá, flowing into Borgarfjörður, is navigable for small vessels in its lower reaches.

Waterfalls (*fossar*) are very common (Fig. 39). The best known are Dettifoss (60 m.) on the Jökulsá á Fjöllum, Goðafoss (12 m.) on the Skjálfandafljót, Gullfoss (two cascades 30 m. and 20 m.) on the Hvítá, Háifoss (130 m.) in Þórsárdalur, and Skógafoss (60 m.) near the coast south of Mýrdalsjökull. Skógafoss falls over an old sea cliff; the other falls tumble over the lips of massive basalts. The softer rocks beneath the massive layer are worn away at the fall, the top layer of rock is undermined and breaks off piecemeal. In this way the position of the fall gradually moves upstream, leaving a gorge (*gljúfur*) below (Plate 29). The long almost vertical-sided deep canyons, with raging torrents, form impassable barriers. The great potentialities for water power are being increasingly utilized to provide electricity for light, heat and power all over the country, larger undertakings for the towns and many small plants for individual farms. Reykjavík obtains its power from falls on the river Sog below Þingvallavatn. This large lake provides an efficient regulator for the river flow, which is very constant throughout the year (see p. 329).

Where the rivers reach lakes or the sea, their heavy load is dropped and delta flats are built up. The flat at the head of the Lagarfljót lake is 10 m. long and 1–2 km. broad, and good examples are to be seen at the heads of most fjords. The triangular flat facing Héraðsflói, north-east Iceland, has a sea front of 23 km.

The rivers coming from glacier fronts on lowlands deserve special mention. Welling up from beneath the southern front of Vatnajökull, and heavily charged with mud, sand and pebbles, they have built up gently sloping outwash plains from the glacier to the sea. These plains are called *sandar* (sing. *sandur*). Near the glacier their slope is about 1 in 60; farther away it is 1 in 140. The rivers split into a great number of distributaries known as braided streams, constantly dividing and rejoining and changing their courses (Fig. 40). There are often tens of such streams in a group, and it may take hours to cross them on ponies, the only means of travel. The crossing of these streams requires skill and experience. There are no fixed fords, and depth of water, strength of current, and presence of quicksands have all to be carefully

Fig. 38. Lakes and rivers, showing main drainage pattern.

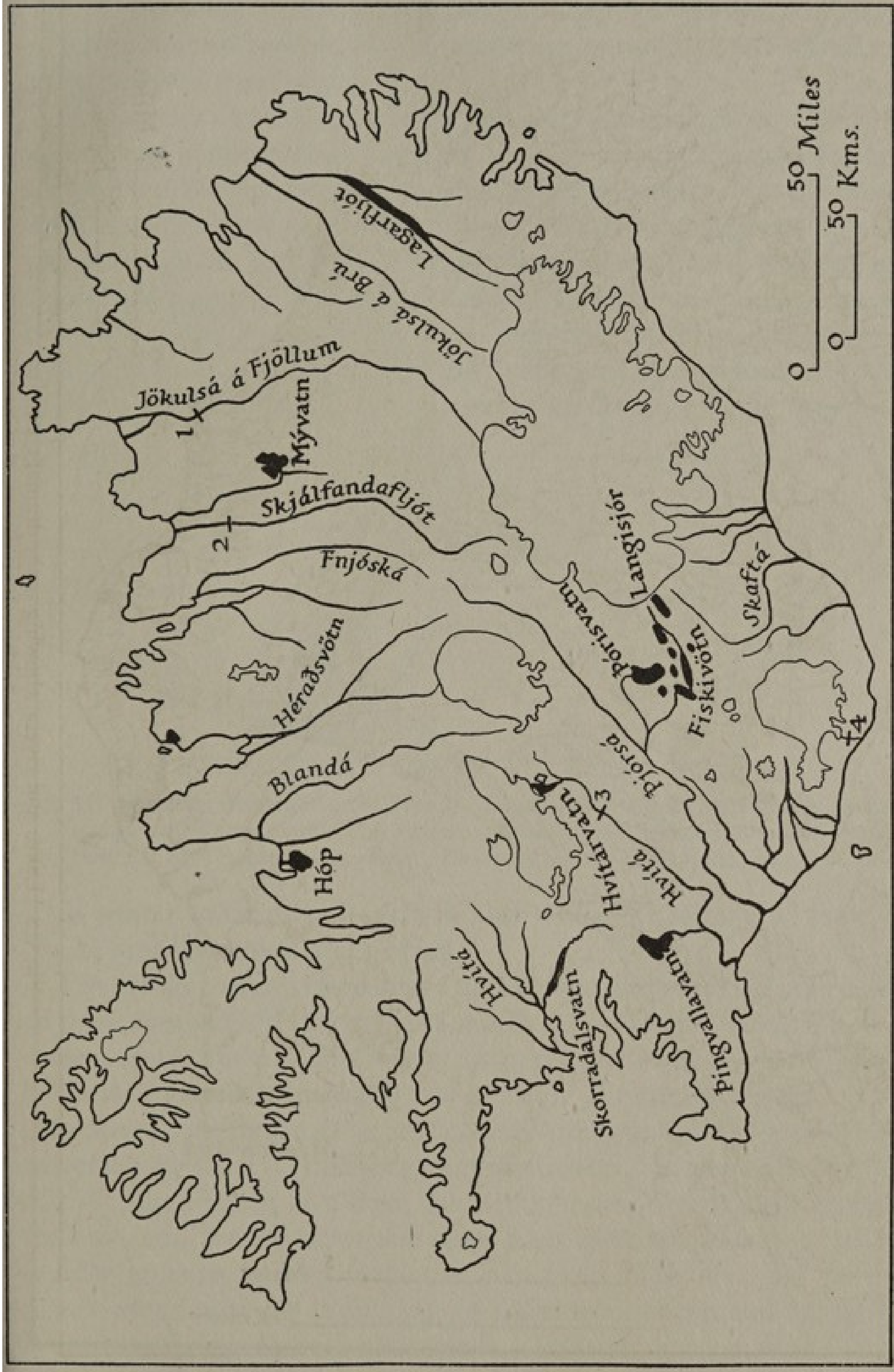


Fig. 39. Main rivers, waterfalls and lakes. The waterfalls are numbered as follows: (1) Dettifoss, (2) Goðafoss, (3) Gullfoss, (4) Skógafoss.

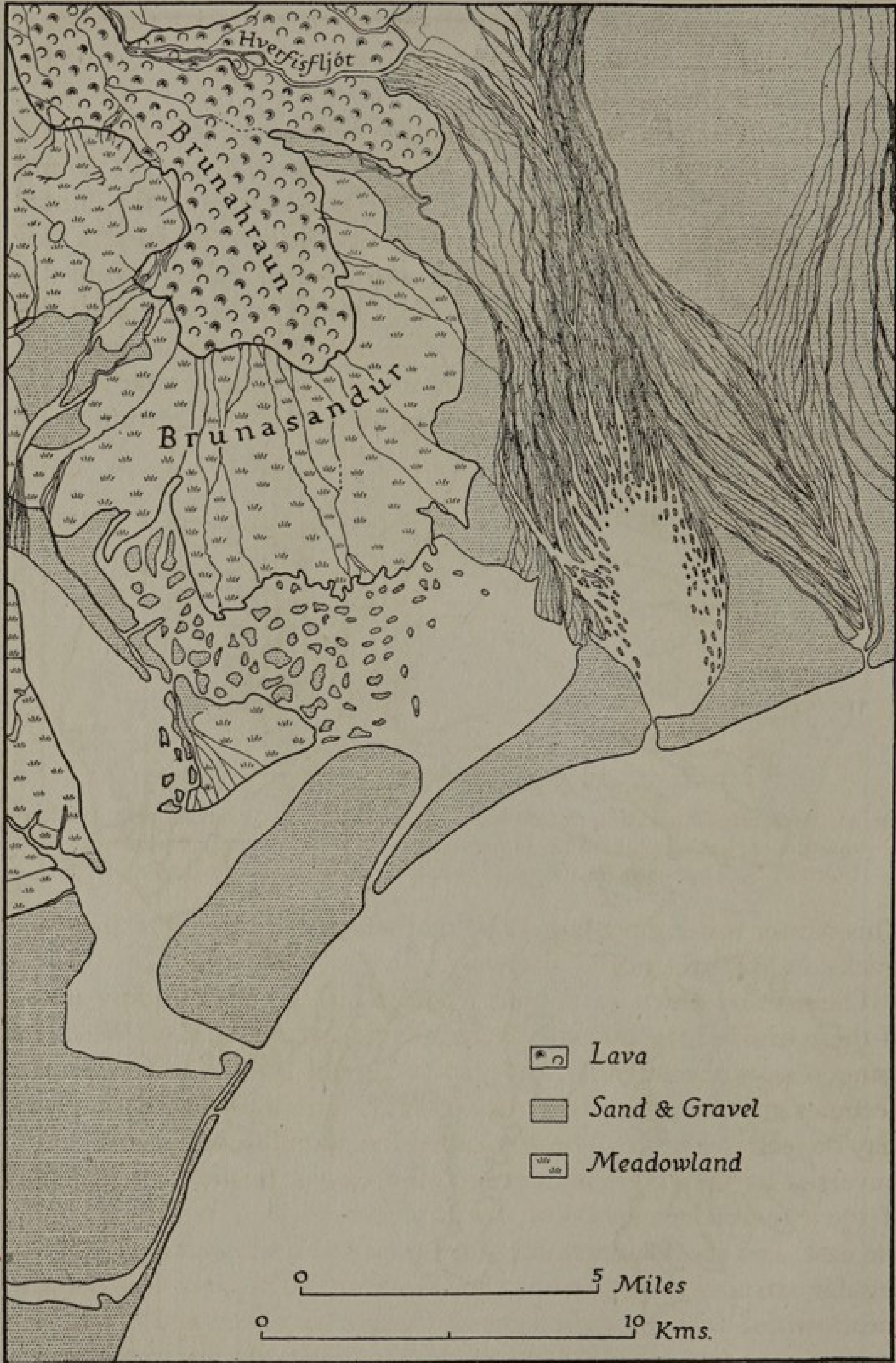


Fig. 40. Western border of Skeiðarársandur showing its braided streams, the Brunahraun lava flow from Laki, and the Brunasandur meadowland irrigated by streams emerging from the lava front. Source: Danish 1 : 100,000 map, Bl. 78 (Copenhagen, 1936).

watched. In times of *jökulhlaups* (see p. 20) the *sandar* are impassable. Near the coast a number of streams join together to reach the sea, for only a powerful river is able to maintain its mouth open against the strong coastal current drift.

On a sunny day the streams are smallest between 0500 and 0800 hr., and largest between 2000 and 2400 hr. The average change of volume throughout the year is shown in Fig. 41. It is governed by the rainfall on Vatnajökull and the melting there. The melting is greatest in July and the run-off is then at its maximum. The rainfall is greatest in September, and in that month, and in October and November, the run-off is largely due to rain. Little rain falls on the glacier in winter and melting is insignificant, yet the rivers carry a considerable amount of water up to February, and the minimum does not occur until April.

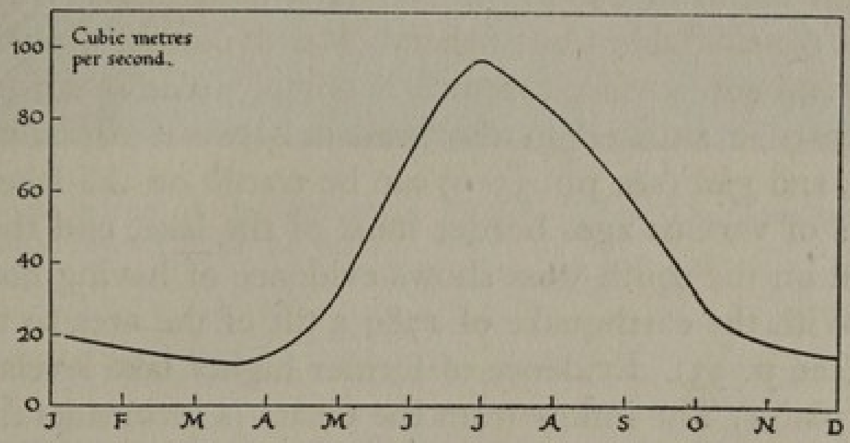


Fig. 41. Diagram illustrating the average monthly run-off of rivers on the southern margin of Vatnajökull. The figures relate to the Hornafjarðarfljót, 1936–8. Source: S. Thorarinsson, *Geog. Annaler*, p. 208 (Stockholm, 1939).

This winter water must largely be that which is draining off from the cracks and fissures in the glacier.

The *sandar*, which are subject to the depositing and eroding action of these braided streams, are practically bare of vegetation. When for some reason the streams leave an area, the level country quickly becomes covered with plants (see p. 117). An interesting case of this may be seen in Fig. 40. The area called Brunasandur was once a desert traversed by the Hverfisfljót group of streams. In the Laki eruption of 1783, the eastern lava flow, the Brunahraun, diverted the rivers to the east, and the Brunasandur since then has been watered by a few regular streams issuing from the lava front. The area has become meadowland with an abundance of pasture for sheep and cattle, and it now supports several farmsteads. In itself glacier water is not inimical to vegetation, it is only the torrential current, the inconstancy of the watercourses, and the low temperature of the water which have a destructive effect on plant growth. In the neighbourhood of the mouths of the largest glacier rivers, where there is only a slight current and the water has become warm on the way, fertile tracts are often found where the water is utilized for irrigation.

Lakes

Lakes are innumerable: mostly small and of diverse origin. The glacial lakes have already been described (pp. 36–49). Hvítárvatn has two glaciers from Langjökull flowing into it, but it does not owe its existence to an ice dam and is not therefore a true glacial lake.

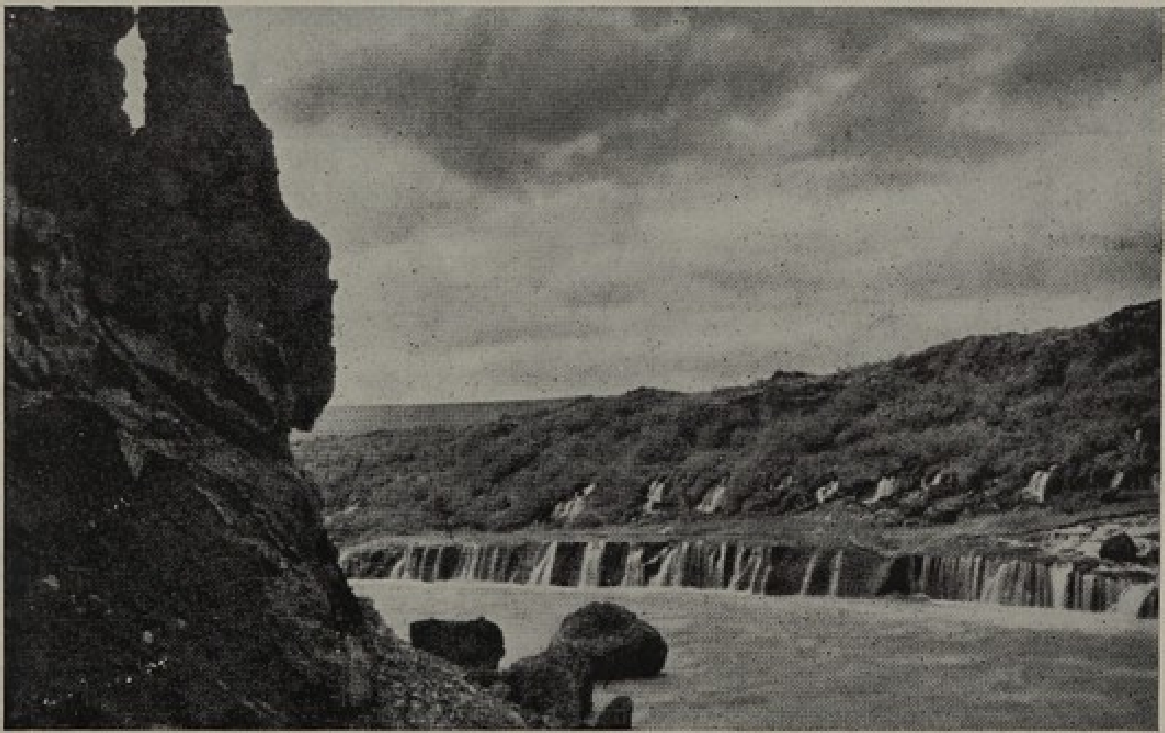
Of lakes occupying graben or down-faulted parts of the earth's crust, Þingvallavatn, Þórisvatn and Langisjór are the most important. Þingvallavatn, 103 m. above sea level, 115 sq. km. in area, and with a maximum depth of 109 m., is Iceland's largest lake (Fig. 42): it supports a considerable trout fishery. The dominant direction of its shorelines and sub-surface contours is north-east to south-west. The northern part is situated in the graben between Almannagjá and Hrafnagjá, and *gjár* (see pp. 35–6) can be traced on the lake bottom. Lava flows of various ages border most of the lake, and the Hagarvíkurhraun on the south-west shows evidence of having flowed into the lake. With the earthquake of 1789 a tilt of the area to the north occurred (see p. 33). Evidence of former higher lake levels is found at several places. The inflow from the Öxará is inconsiderable; most of the water enters from fissures in the surrounding lavas. Strongly flowing deep streams have been observed in the surrounding *gjár*: they keep a low and constant temperature (about 3·5° C.) throughout the year. The lake freezes over in winter, but never completely until the end of December.

Þórisvatn, north-east of Hekla and 80 sq. km. in area, is the second largest Icelandic lake, and is similar in origin to Þingvallavatn. It fills a depression due to earth movement; its longer axis trends north-east to south-west, and recent lava flows reach its shores. No visible stream enters it, but there is a considerable outflow to the Kaldakvísl River, and the lake must be fed by subterranean drainage from the lava fields.

Mývatn is flat-floored and shallow, with a maximum depth of 4 m. Its outline is very irregular and there are many islands (Fig. 43). It occupies a depression in a region of recent lava fields with many ash cones, and in the eighteenth century a lava flow reached its northern shores (Fig. 15). It is fed by subterranean sub-surface drainage. Weather changes result in fluctuations of the water level amounting

K. Grossman

Plate 29. The gorge of the Jökulsá á Fjöllum below Dettifoss (see Plate 24). Columnar basalts form the sides.



W. Heering

Plate 30. Ground water emerging from beneath a lava-flow falls into the Hvítá near Barnafoss.

R.A.F.

Plate 31. Þingvallavatn, the largest lake in Iceland. *Gjár* are prominent in the left foreground.

to about 40 cm. In the neighbourhood of Vógar a small area of the lake never freezes in winter owing to the presence of hot springs. In prehistoric times the lake was larger and continuous with Sandvatn to the north-west.

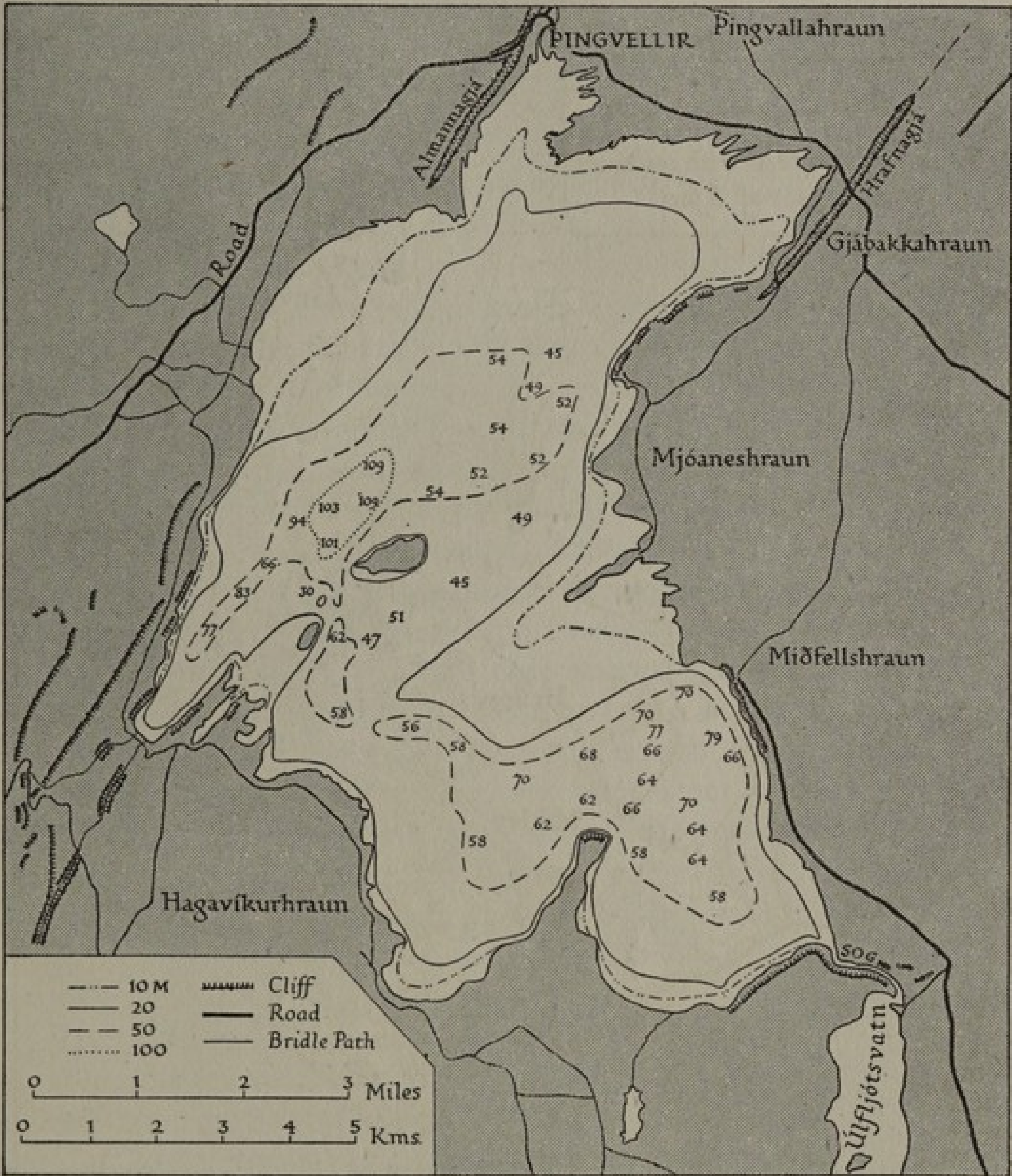


Fig. 42. Þingvallavatn. Source: B. Saemundsson, *Geog. Tidskrift*, Bd. 17, p. 176 (Copenhagen, 1904).

Many small lakes occupy old crater pits. A well-known group of them, the Veiðivötn or Fiskivötn, occurs south of Þórisvatn.

Of lakes occupying glacially eroded rock basins Lagarfljót has already been noted (p. 57). Skorradalsvatn in the Borgarfjörður district is another example. It is 15 km. long, about 1·5 km. wide and 38 m. deep. The head of the basin is filled for 5 km. with river deposits. Corrie lakes are rare. Moraine-dammed lakes and lakes occupying hollows in the irregular surface of glacial deposits are very numerous.

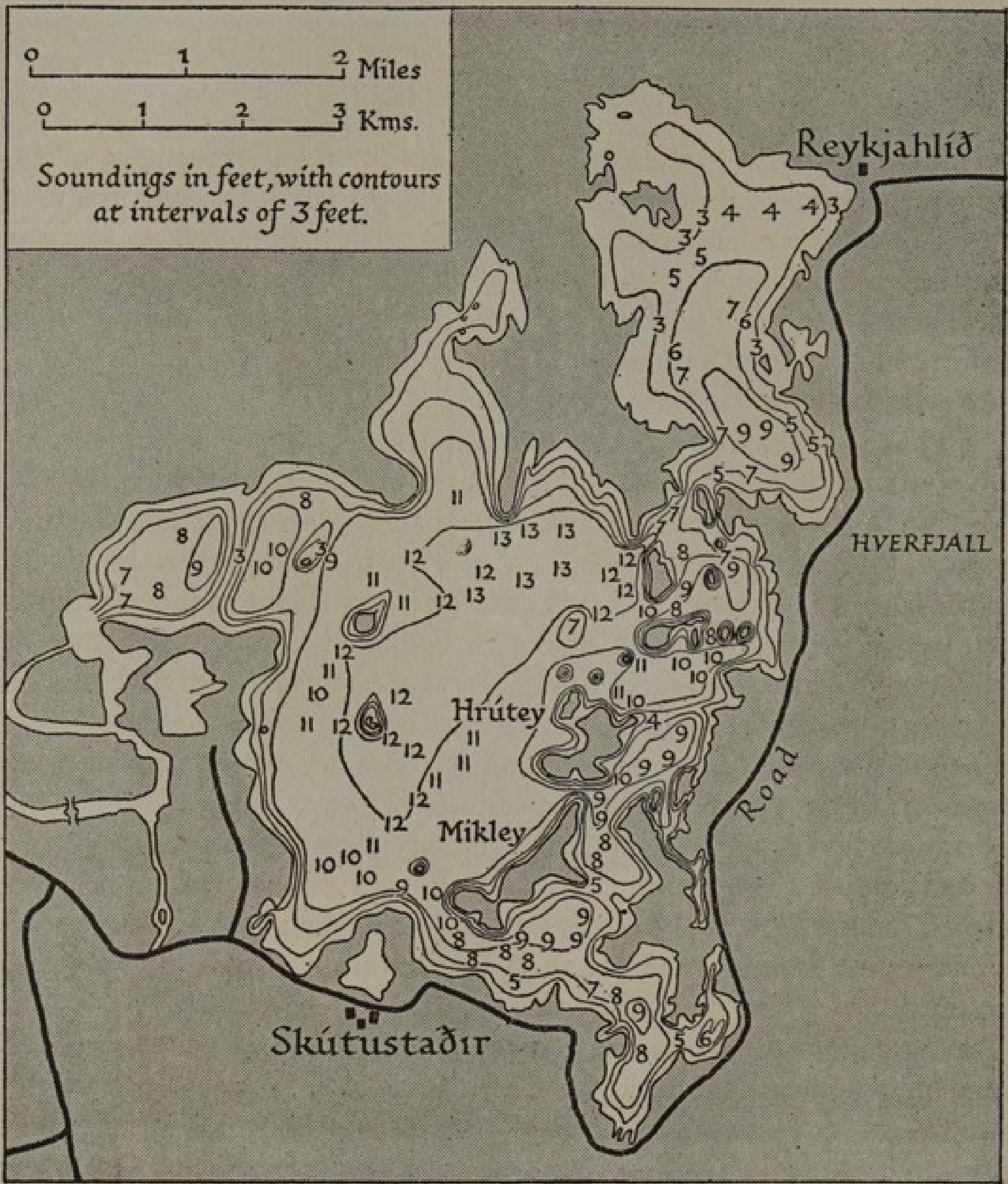


Fig. 43. Mývatn. Source: D. G. Glennie, *Geog. Journ.* June 1940, p. 444.

Lagoon lakes behind sand bars are common, particularly in the north: Hóp, in Húnafjörður, Höfðavatn and Miklavatn, in Skagafjörður, are among the larger ones. The water of these lagoons is often fresh at the surface and salt in depth. According to the condition of the bars and the outlets, the quality of the water may often change quickly; sometimes they contain fresh water, sometimes brackish water, sometimes salt water. The fauna in these lakes is subject to periodic changes. Sometimes marine animals immigrate through the outlets; at other times they disappear and a fresh-water fauna becomes dominant.

MINERAL DEPOSITS

As far as they are at present known, the commercial importance of the mineral deposits is almost negligible for export purposes; only sulphur and Iceland spar have been of overseas trade value, but in so poor and isolated a land, deposits of inferior quality are often worked for local consumption. There is the usual tale of money lost in unprofitable enterprises, e.g. the formation of a so-called Borax Company which, however, failed to find any borax.

Sulphur. Workable deposits occur on the surface, or beneath a thin cover of earth and grass, near Krísuvík in the south-west, in the Mývatn district at Fremrinámur (Ketill), Hlíðarnámur and Kraflanámur, lying south-south-east, east, and north-north-east respectively of the lake. The sulphur had a commercial importance in the thirteenth century when the sole right of export belonged to the Archbishop of Nidaros (Trondheim), and the trade was especially lucrative in the sixteenth century, as much as 400 tons being exported in one year. The main supply was obtained from the Mývatn district and shipped from Húsavík; the Krísuvík deposits have never been of much importance. In the early seventeenth century the price of sulphur began to fall; the industry gradually became unprofitable and in 1883 it closed down. Interest has recently been revived and a plant was under construction late in 1938 for the production of sulphur at Mývatn; an output of 4,000 tons a year was in view.

Iceland Spar. This is a transparent variety of calcite used in optical instruments to provide polarized light. The greater part of the world supply has come from Helgustaðir on the northern shore of Eskifjörður, east Iceland. The mine is situated 105 m. above sea level, near to the shore, and is now a hole about 25 m. in diameter at the surface and 15 m. deep. The best spar was found in the clay infillings of crevices in the basalt. Great care had to be taken in extraction as the mineral is soft and easily cleaved; it was the practice to flood the workings in winter as a protection against the injurious effects of frost. Mining began in 1850 but ceased at the beginning of the war of 1914–18, and the deposit is virtually exhausted. Calcite is a very common mineral in the older Icelandic rocks, but it was the great transparency and size of the Helgustaðir crystals which rendered them valuable; doubtless other deposits remain to be discovered.

Zeolites. Teigarhorn, near Djúpivogur in Berufjörður, south-east Iceland, is famous for zeolites, minerals of great variety and interest to the mineralogist. Specimens from this locality are found in museums all over the world.

Fuel. Beds of coal (lignite) are not uncommon in the older rocks, but the seams are thin and of inferior quality. Since 1916 sporadic attempts have been made to work them, apparently always at a loss, although they are often dug in a small way for local use. Black lustrous volcanic glass has been mistaken for coal. Coal has been worked at Stálfjall, on the northern shore of Breiðifjörður, and on the coast at Tjörnes, 10 km. north-north-east of Húsavík. At Tungunámur, Tjörnes, three seams (of Pliocene age), 10, 40 and 70 cm. thick respectively, are separated by mudstone; the coal is very sandy and gives a strong sulphurous smell when burnt; the mine has been abandoned. Lignite is being mined on a small scale in Sugandafjörður. Below are the approximate analyses of coals from five places in Iceland, together with those of a continental lignite and a Scottish non-caking coal for comparison:

Locality	Carbon %	Calories	Sulphur %	Combustible volatile matter %	Moisture %	Ash %
Jökulbotnar	21·4	2,923	3·9	22·9	11·3	40·5
Skálnes	33·0	3,444	4·5	20·4	9·0	33·0
Tjörnes	26·4	4,030	6·4	33·2	12·2	21·5
Skarðströnd	34·8	4,421	8·9	28·0	13·2	15·0
Stálfjall	—	5,100	—	—	18·0	18·0
Continental lignite	59·0	5,300	—	24·7	10·3	6·0
Scottish coal	89·0	8,000	1·0	7·5	—	4·5

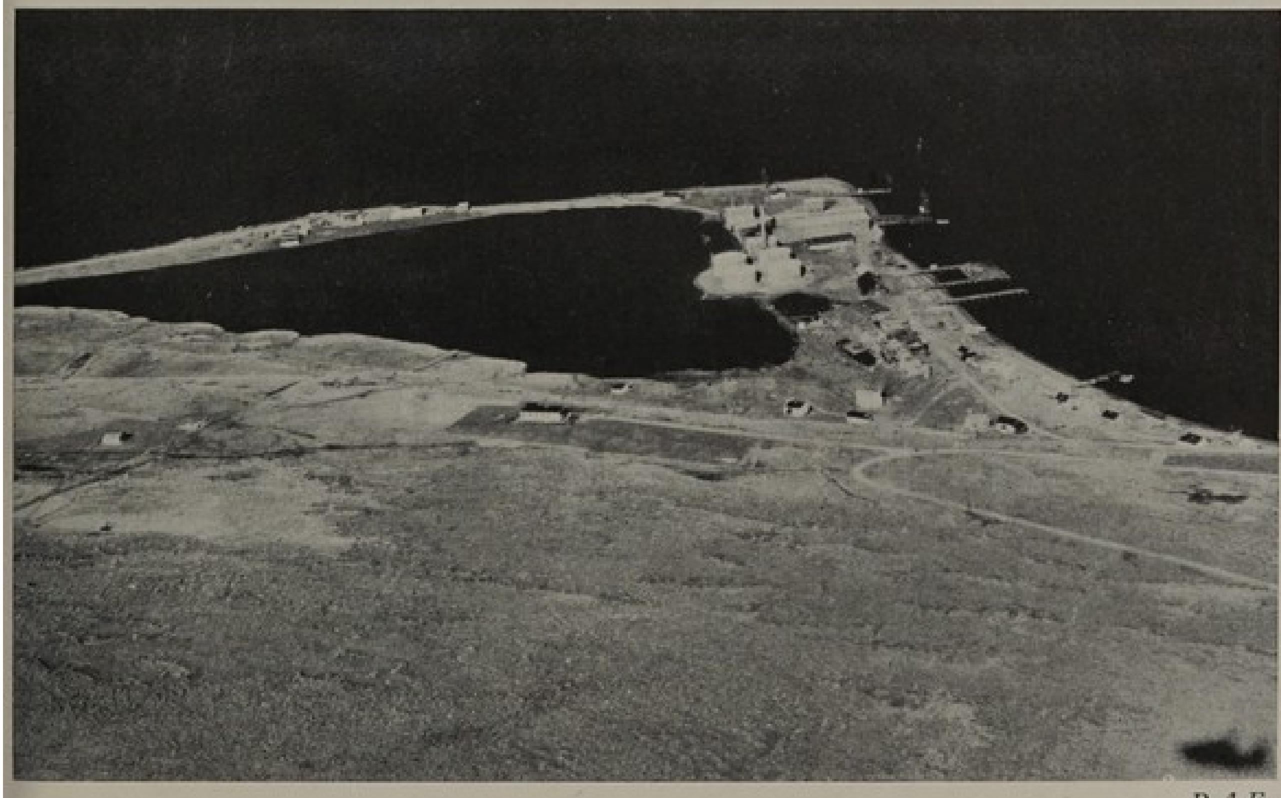
Source: H. H. Eiriksson, *Trans. Inst. Mining Engineers*, Vol. LIX, Part I, p. 4 (London, 1920).

Peat is widespread in the lowlands and valleys and has been extensively dug for fuel. Thicknesses seldom reach 4 m., and the deposits in the volcanic districts commonly contain ash and blown sand.

Metals. Bog iron ore was the sole source of the iron used in the first centuries after the colonization, and production was continued up to the early eighteenth century. The ore occurs in the valleys, and

R.A.F.

Plate 32. Akranes, a fishing and trading centre on the shores of Faxaflói, is the terminus of one of the main motor-bus routes to the north. Two parallel reefs are visible. A former shoreline can be traced along the foot of the hills in the background.



R.A.F.

Plate 33. Hjalteyri, an important herring-oil and fish-meal factory, is situated on a recurved spit enclosing a lagoon in Eyjafjörður.

R.A.F.

Plate 34. Raufarhöfn, a herring-fishing centre on the eastern side of Melrakkasljetta. The entrance to the harbour is shallow and access to the piers is only kept open by dredging during the fishing season. This lowland area is the most northerly part of Iceland.

many hearths have been found in the west and north where there were woods to provide the charcoal. Fnjóskadalur in the north and Hvammsfjörður in the west were the most important centres. The analysis of a bog iron ore from Breiðimyri yielded 65·5 % of ferrous oxide, equivalent to an iron content of 51 %. The red lateritic deposits between the basalts of older Iceland contain considerable amounts of the oxides of iron and aluminium; as far as is known, the beds are not thick and they have not been worked. Iron ore (magnetite and ilmenite) is a common constituent in the predominantly basic rocks of the island, and it has been concentrated in the sands of many shores and in shallow-water deposits. The sands off the Héraðsflói in east Iceland, for example, have been examined as a possible source of iron, but the considerable titanium content of the ore has negatived exploitation.

Gold occurs in the pyrites bearing calcite-quartz veins in much altered basalt 190 m. by the Mógilsá on the south side of the Esja plateau, north-east of Reykjavík. The veins are from 2 mm. to 2 m. in thickness, and contents of gold varying from 3 to 19 gr. a ton have been proved; the metal is present in the pyrites. The occurrence has no commercial importance.

Deposits of the sulphides of copper, lead and zinc occur in breccia near Svinhólar, Lóni, in south-east Iceland; their extent is unknown.

Limestone. Beds of limestone are unknown. Deposits of shell sand occur on some coasts, particularly on the southern shores of the north-west peninsula. Analysis of a sample showed 90% calcium carbonate. In the Esja plateau in the locality mentioned above calcite from veins in the basalts has been burnt for lime.

Salt. In old times salt extraction from sea water was carried out in many places. In 1773 a plant was started at Reykjanes in Ísafjarðarsýsla to evaporate sea water by means of hot-spring waters, but it was abandoned 13 years later.

Kaolin. Deposits of kaolin or china clay (*bleikja*) in Þruðardalur (Kollafjörður, in the north-west peninsula) attracted the attention of the Danish Royal Porcelain Fabrik in the eighteenth century. The deposits are not in beds, but occur as a great number of small hillocks. An analysis of this material gave in percentages: silica 42·01, aluminium oxide 37·26, water 13·64, with 6·72 of other substances.

MAPS OF ICELAND

The maps on the following eight pages have been reduced from the Danish 1:100,000 series. The areas not yet covered by the Danish survey have been drawn in from the latest available sources; in particular from the British series of 1:100,000 maps and G.S.G.S. No. 4140 (for details see pp. 424–8).

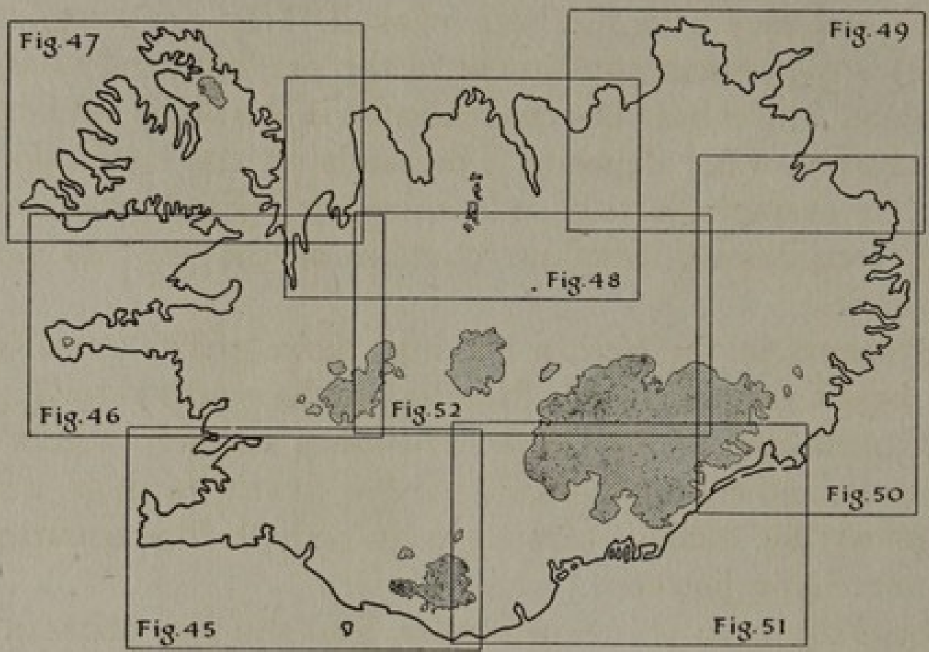
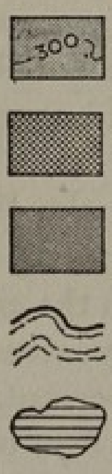


Fig. 44. Key to maps of Iceland (Figs. 45 to 52).

Towns and villages are shown in Roman lettering; physical features in italics. Contours are drawn at 300, 600 and 900 m.:



0–600 metres

600–900 metres

Above 900 metres

Glaciers

Lakes

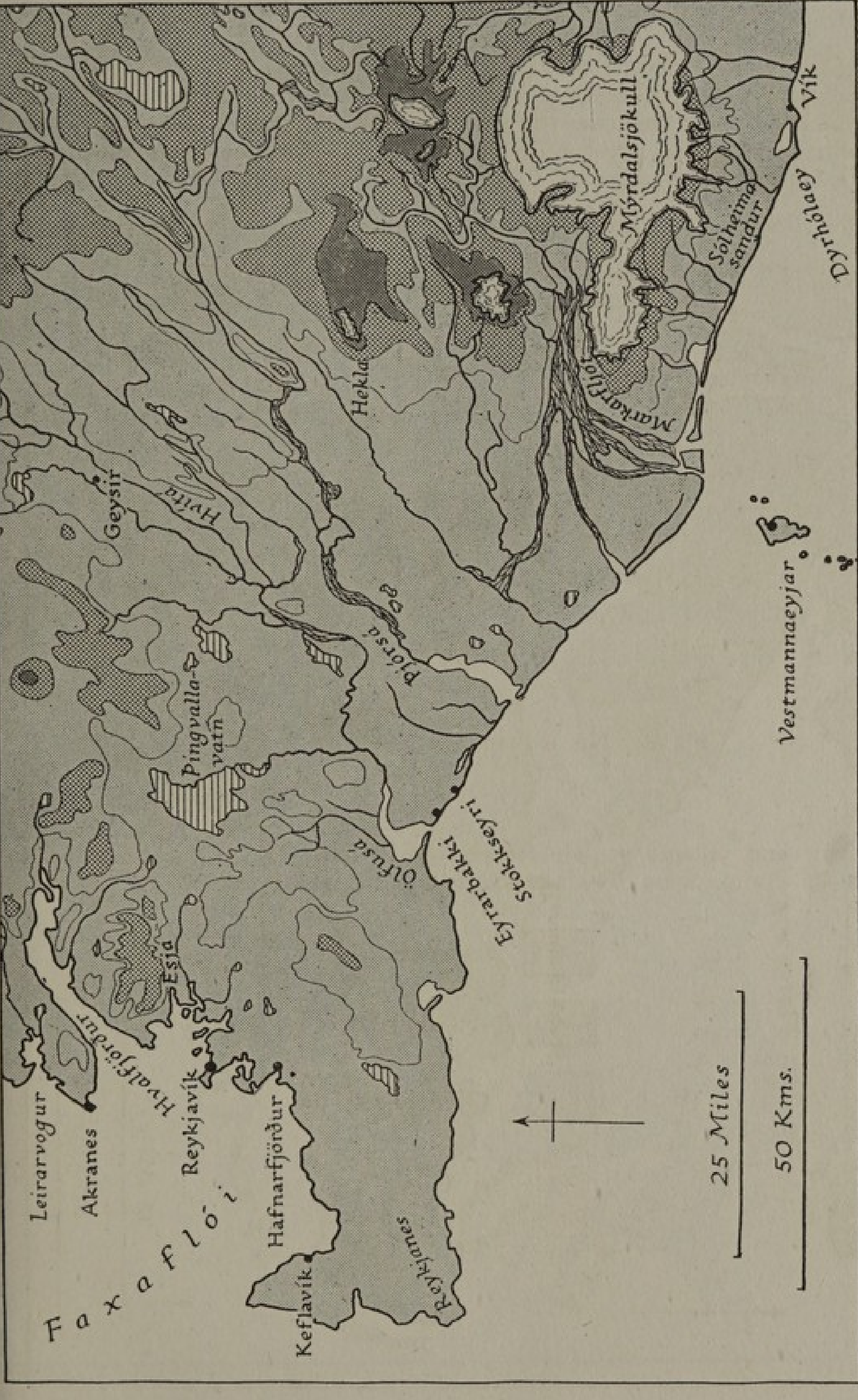


Fig. 45. Iceland: south-west.

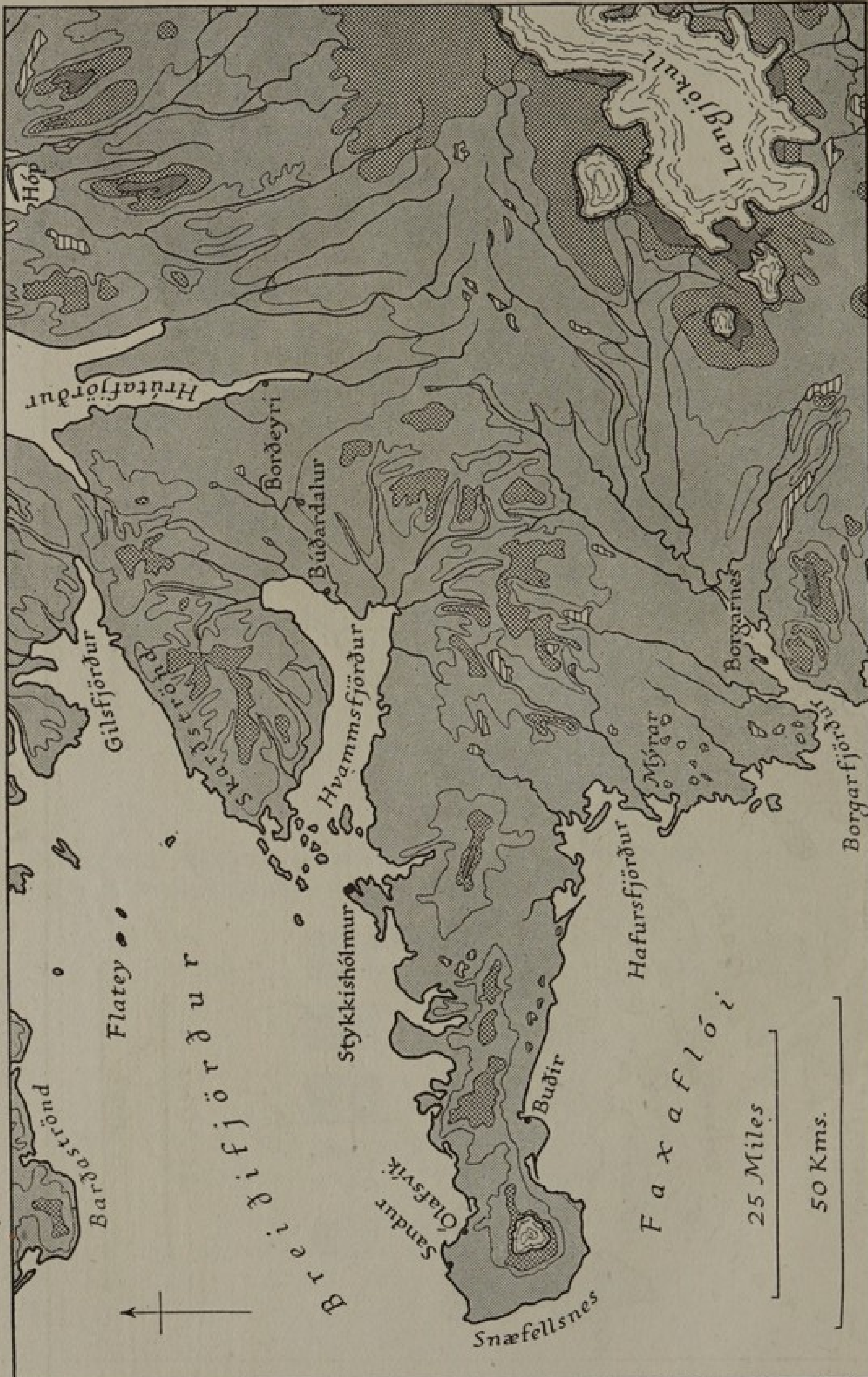


Fig. 46. Iceland: mid-west.

Fig. 47. Iceland: north-west. Va. = Vatneyri; Bí. = Bíldudalur; Þi. = Þingeyri; Fl. = Flateyri; Su. = Suðureyri; Bo. = Bolungarvík; Ís. = Ísafjörður; He. = Hesteyri; Dj. = Djúpavík; Hó. = Hólmavík; Hv. = Hvammstangi; Bl. = Blönduós; Sk. = Skagaströnd.

Fig. 48. Iceland: mid-north. Hv. = Hvammstangi; Bl. = Blönduós; Sk. = Skagaströnd; Sa. = Sauðárkrókur; Ho. = Hofsós; Si. = Siglufjörður; Ól. = Ólafsfjörður; Da. = Dalvík; Hj. = Hjalteyri; Ak. = Akureyri; Hú. = Húsavík.

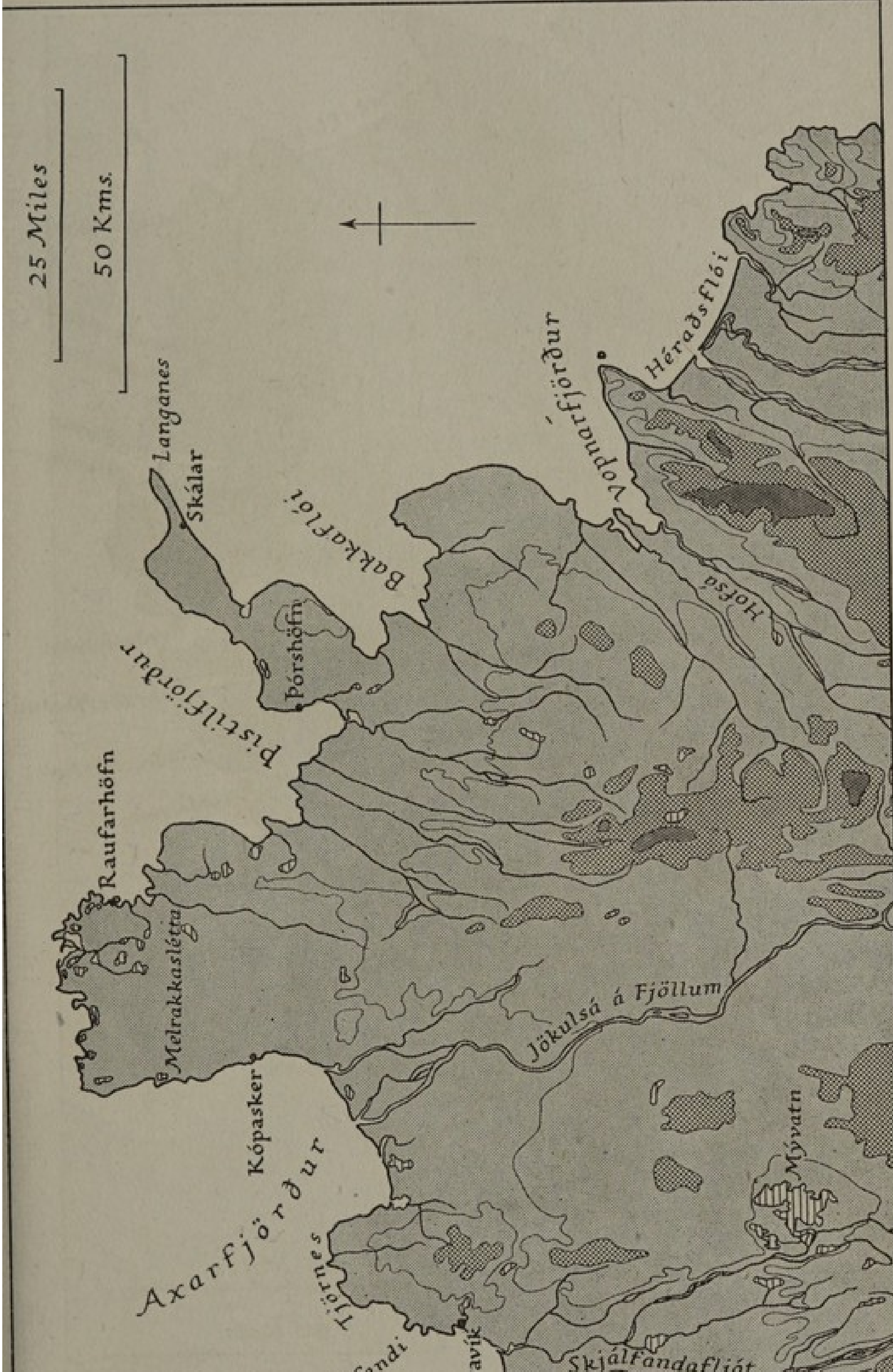


Fig. 49. Iceland: north-east.

Fig. 50. Iceland: east. Nj. = Njarðvík; Se. = Seyðisfjörður; Ne. = Neskaupstaður; Es. = Eskifjörður; Bú. = Búðir; Dj. = Djúpivogur; Hö. = Höfn.

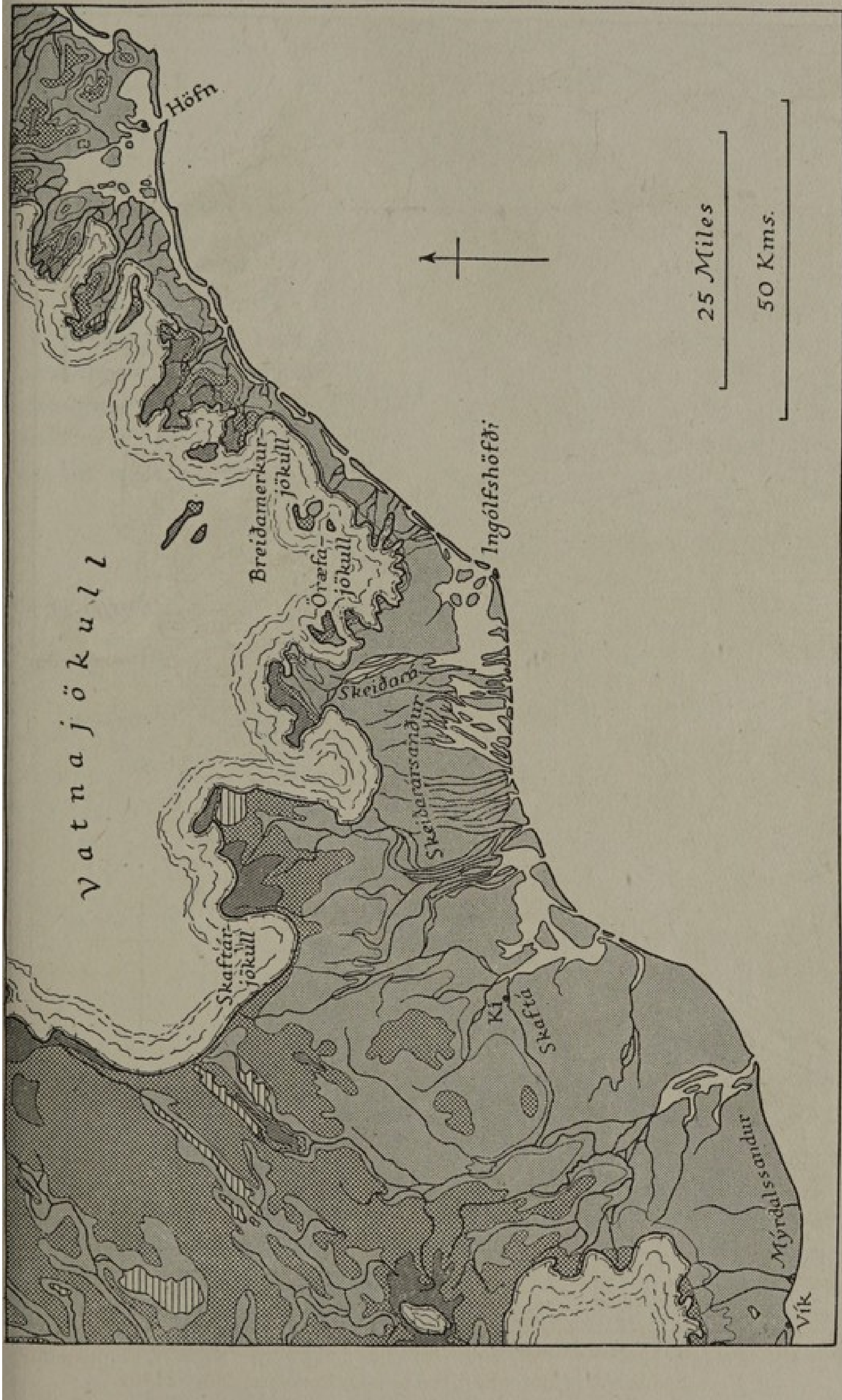


Fig. 51. Iceland: south-east. Ki. = Kirkjubæjarklaustur.

Fig. 52. Iceland: central.

Chapter II

COASTS

Introduction: The Rocky Coast: The Sandy Coast: Islands: Summary of Main Coastal Features: Note on Lighthouses

Introduction

The coastline of Iceland is about 6,000 km. in length, of which one-third is in the north-west peninsula. The coasts fall into two categories: (1) rocky, cliffed, and irregular in outline, with long fjord inlets, (2) sandy and smooth in outline. The former predominates on the west, north and east, the latter characterizes the south.

The Rocky Coast

The seaward-facing cliffs often rise to hundreds of metres and are due to marine erosion of present and raised-beach times. Commonly they plunge steeply to the sea with no possible pathway at their foot, but in places the narrow remnant of a raised-beach platform, cut when the sea level was about 50 m. higher, lies between the present minor cliffs and the old ones behind (see Fig. 34). Within the long fjord inlets the slopes are also commonly very steep, but a low fringe of land is usually more conspicuous and permits communications. The fjords do not show the intricate branching of those of Norway. They are characteristically broad, with parallel sides and blunt ends. The gently curving plan of some of the fjords of the north-west peninsula is a striking feature.

The steep fjord sides cannot be ascribed to marine erosion; they are the result either of valley glacier erosion or of faulting. A few of the wider inlets, such as Skagafjörður and Héraðsflói, are regarded by some as 'fault graben' (see p. 64). Most of the fjords are generally thought to be the drowned ends of valleys whose forms have been moulded by glacial erosion. The original valleys were probably formed by rivers guided by fracture lines. The glacial moulding was a subsequent and temporary process. The fjord hollows can be followed out to sea as grooves in the sea floor (Fig. 35), and it seems that some of the valley excavation must have taken place with a much lower shore level than the present one. With our present limited knowledge of the geology of Iceland, the general question of the origin and date of formation of the broad features of coastal and submarine relief remains a very open one.

At their heads, and also their sides where tributary valleys join, the fjords shallow to delta flats, and in the broad ones, such as Húnaflói and Skagafjörður, marine action has moulded the fronts of the deltas to gently curving sand and shingle bars with shallow lagoons behind (Plate 50). These lagoons are slowly being filled up with river deposits. Behind the recent delta deposits are areas of low flat marshy land built of deposits formed when the sea level was higher. The extensive lowland behind the Héraðsflói sand bar may be cited as an example.

The lowlands and lagoons of Lónsfjörður lie behind a narrow curving bar of shingle, 20 km. long, which joins together the Austurhorn and Vesturhorn headlands. In Skagafjörður the island of Þorðarhöfði is tied to the mainland by two shingle bars. Bars of this kind are due not to delta deposits but to wave action and longshore transport. Other sand spits, also unconnected with delta deposition, are found within the fjords. The most striking example is that on which the town of Ísafjörður is built (Fig. 37; Plate 73). This spit stretches half-way across the fjord and then turns sharply towards its head. The spit is largely occupied by buildings, and from a high point the town appears to stand in the water. The bar is clearly shaped by marine current action, but it has been suggested that its core may be a terminal moraine.

The Sandy Coast

Within the coasts just described there are many local stretches of sand and shingle shore. The south coast from Vesturhorn to Eyrarbakki is entirely of this type with the exception of the rocky headlands of Ingólfshöfði and Dýrhólaey. The coast is one of extensive offshore bars thrown up by wave action, with lagoons behind, or of sandy shelving shores composed of great stretches of fluvio-glacial deposits.

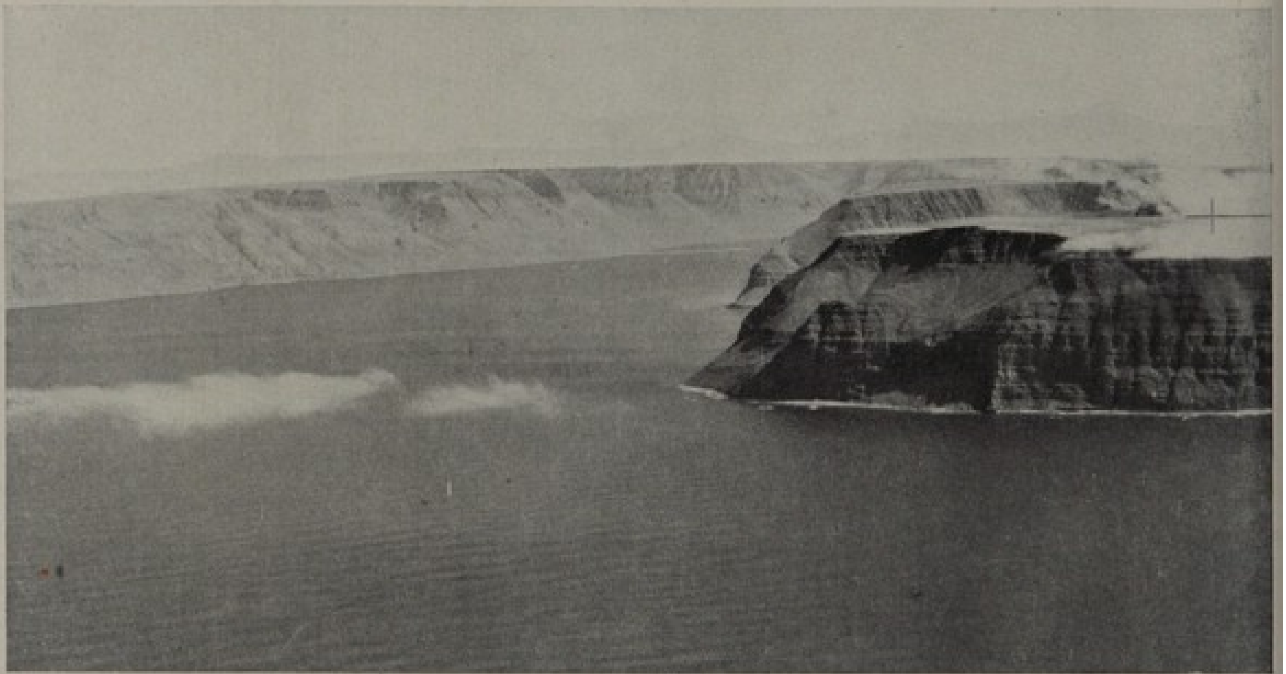
The sandy coasts mark the seaward encroachment of river deposits, the actual position of the shoreline being controlled by marine transport and redeposition. The character of the southern coast is clearly a consequence of the proximity of the glaciers with their debris-laden melt waters. There are no harbours between Höfn and Stokkseyri.

R.A.F.

Plate 35. Vatneyri, a trading and fishing centre on the north shore of Patreksfjörður. Fish-meal, fish-oil and freezing factories have been built on a sandspit. The enclosure of a lagoon on the seaward side of the spit (right) is a feature of many of these formations. Note the short and wide glacially eroded valley in the foreground.

R.A.F.

Plate 36. Flateyri, a fishing village in Önundarfjörður. A shingle spit provides the only suitable land for settlement. The flat plateau surface and the steep trap-featured fjord walls are typical of the north-west peninsula.



R.A.F.

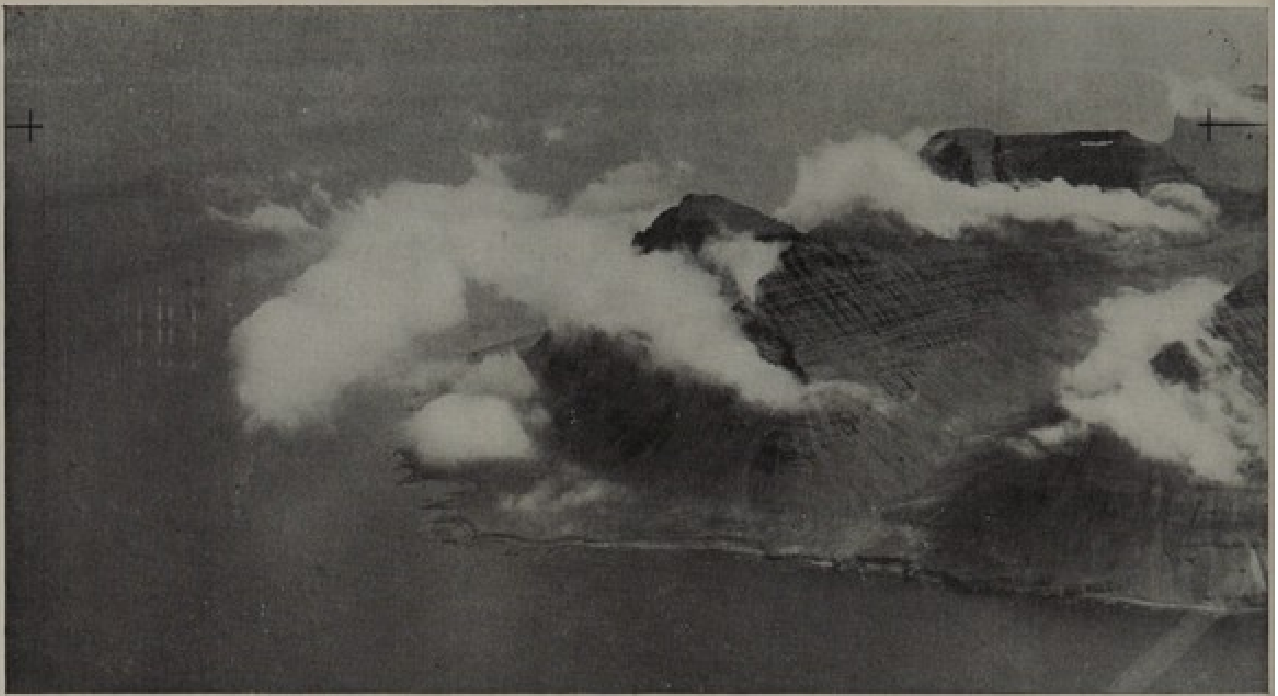
Plate 37. The entrance to Önundarfjörður. This view demonstrates the even level of the plateau surface, which here averages 500 m. above sea level.

R.A.F.

Plate 38. Dýrafjörður. Glacial erosion has played a prominent part in carving the fjord and valleys out of the plateau of basalts. Þingeyri is situated on the spit in the foreground.

R.A.F

Plate 39. Þingeyri, a fishing village on the south side of Dýrafjörður. There is an exceptionally good repair shop for trawlers.



R.A.F.

Plate 40. The entrance to Reykjafjörður on the west side of Húnaflói. The patchy distribution of clouds results from the local rise of sea breezes at the steep mountain walls.

R.A.F.

Plate 41. Bíldudalur, a village on the west shore of a small bay in Arnarfjörður. The trap-featuring of the basalt cliffs, the even surface of the plateau, and the form of the fjord valley are well shown.

Islands

Considering the indented character of the coast, islands are, with the exception of the inner Breiðifjörður archipelago, remarkably few, and all are small. Off the south-west coast the Vestmannaeyjar and Eldeyjar are built of younger rocks (see p. 7); Helgafell on Heimaey is a recent volcanic cone and volcanic outbreaks have occurred in the neighbourhood of the Eldeyjar in historic times (see p. 22). Other islands are outposts of the mainland and have been isolated as a result either of depression or erosion of the land. With the exception of Grímsey, which lies 41 km. north of the mainland, all these islands lie either within bays or fjords or close to the open coast; Drangey in Skagafjörður, Lundey in Skjálfandi, and the Mánareyjar in Axarfjörður are built of younger rocks.

Summary of Main Coastal Features

The Rocky Coasts

Eyrarbakki to Hafnarfjörður (south-west coast, Fig. 45). West of Eyrarbakki the Reykjanes peninsula presents low cliffs to the sea; along some stretches the uneven surfaces of recent lavas slope gently to the shore. Occasional green patches mark the pastures of a few farms. The interior is desert, and movement over the gnarled and jagged lavas, other than along the rough tracks, is impracticable even on foot. The triangular-shaped toe of the peninsula has a continuous fringe of settled grassland and a coastal road leads to Hafnarfjörður.

Hafnarfjörður to Hafursfjörður (west coast, Figs. 45, 46). Hafnarfjörður town, at the head of a small bay and partly sheltered by a spit, lies astride the routes from Reykjavík to the south and south-west. Rough pastures as well as numerous lakes and streams differentiate this region from the desert to the south. This coast is indented and studded with islands. The low straggling peninsula occupied by Reykjavík has a high proportion of grassland upon which the capital is steadily encroaching. The area to the north is dominated by the lofty Esja plateau, and into its northern and western sides deep valleys extend their amphitheatre-like heads. Hvalfjörður is bordered by undulating grassland backed by high mountains. There are no settlements except isolated farmsteads. A good road runs along both sides of the fjord, but at its head the country is precipitous and the road is usually impassable in winter. The twin valleys extending from the head of the fjord lead to uninhabited country and provide only poor access to the interior. North-east of Akranes, two spits almost meet across the mouth of Leirárvogur, and to the east the lowlands give way to the high cliffs on the south-east shore of Borgarfjörður. Spits extend over the southern shallows of the inner fjord and a settled marshy lowland continues inland. A road runs round the fjord from Akranes to Borgarnes, but it is closed in winter. Between Borgarfjörður and Hafursfjörður is the extensive lake-strewn plain of Mýrar, with a very irregular coastline bordered by many islands. A large sandbank lies across the head of Hafursfjörður, and inland an area of recent lavas extends far into the highlands.

Snæfellsnes and Breiðifjörður (west coast, Fig. 46). Snæfellsnes has three types of coast. On the south is a coastal plain bounded inland by a fairly continuous line of cliffs. Snæfell itself, an extinct volcano, is almost surrounded by barren wastes of recent lavas, and the sea cliffs are remarkable for caves, stacks, chimneys and columnar basalt formations. The third type occupies the northern shore east of Snæfell, and is deeply indented. A road across the peninsula leads to the important port of Stykkishólmur, and here the mouth of Hvammsfjörður is strewn with scores of low islands. Inner Breiðifjörður is studded with hundreds of low islands, many of them inhabited, and Flatey is an important centre.

The North-West Peninsula (Fig. 47). The plateau of the peninsula is deeply incised and the fjord coast is here present in its most developed form. In former days there were important whaling stations here. Sheer cliffs fall almost to the water's edge leaving only the narrowest coastal fringe; land communication is everywhere difficult, and often impossible. The west coast has a number of fjords running in a north-west to south-east direction. Some tributary inlets to the southern fjords have been enclosed by spits and largely infilled. Arnarfjörður has several branches, and Ísafjarðardjúp, the largest of the inlets in the north-west peninsula, has a series of tributary fjords along its southern side. The north-east coast of the peninsula has frequent small inlets, whilst farther to the south are large fjords. The northern part of this coast is noted for the exceptional number of offshore reefs.

Driftwood is washed ashore at many points along the north coast. Driftwood bays may be identified by such names as Rekavík (jetsam bay), Straumavík (current bay), etc.

Hrútafjörður to Skjálfandi (north coast, Fig. 48). Hrútafjörður penetrates far inland, deflecting the coastal road to the south. The

R.A.F

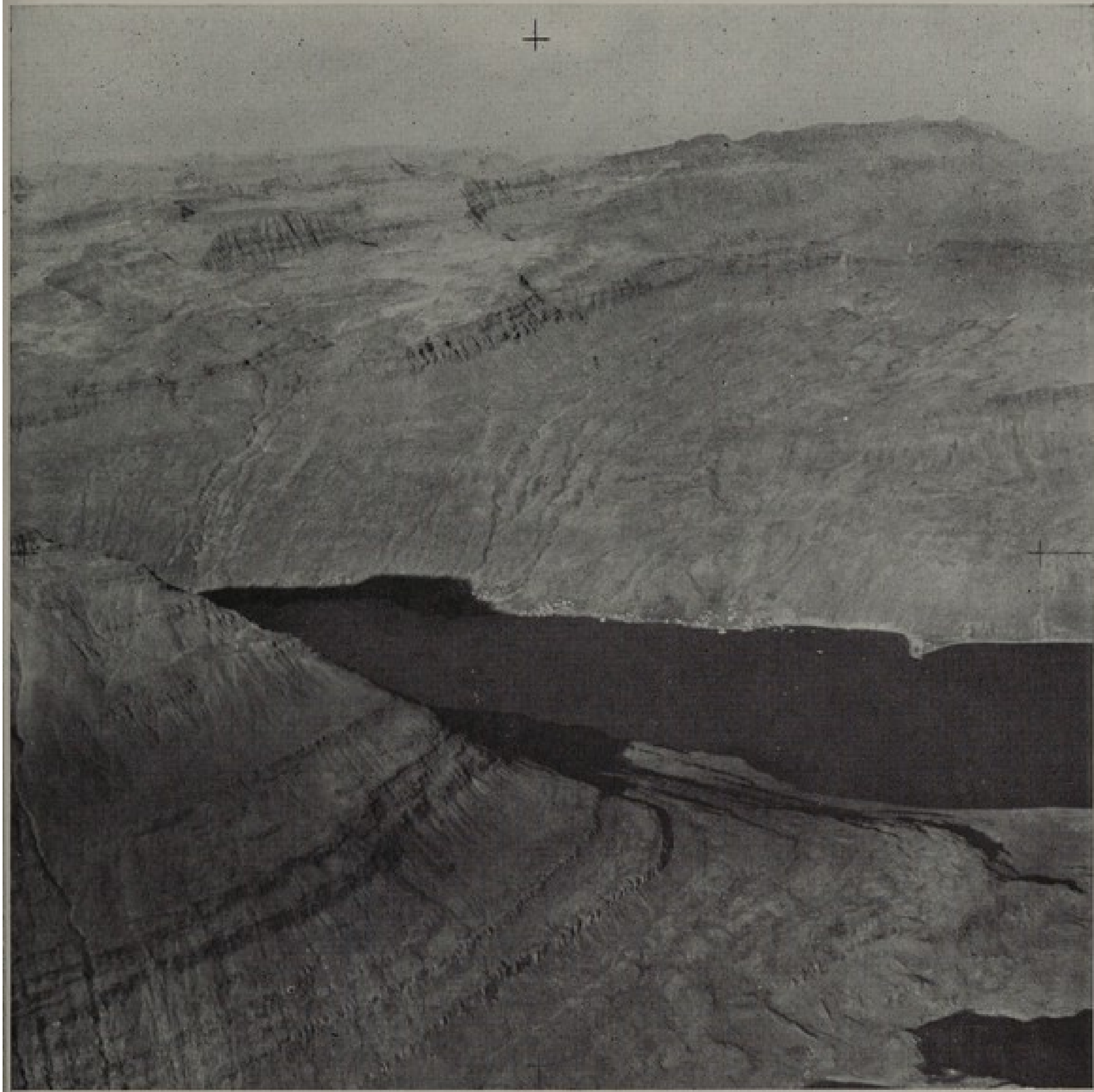
Plate 42. Húsavík, a prosperous fishing centre on the east side of Skjalfandi. The herring-oil factory can handle 700 barrels of fish a day. The irregular land surface is typical of the country built up of the younger series of rocks.

R.A.F.

Plate 43. Hörgárdalur, a valley near Akureyri. In the background is the lofty mountainous Tertiary basaltic country between Eyjafjörður and Skagafjörður, with many small glaciers.

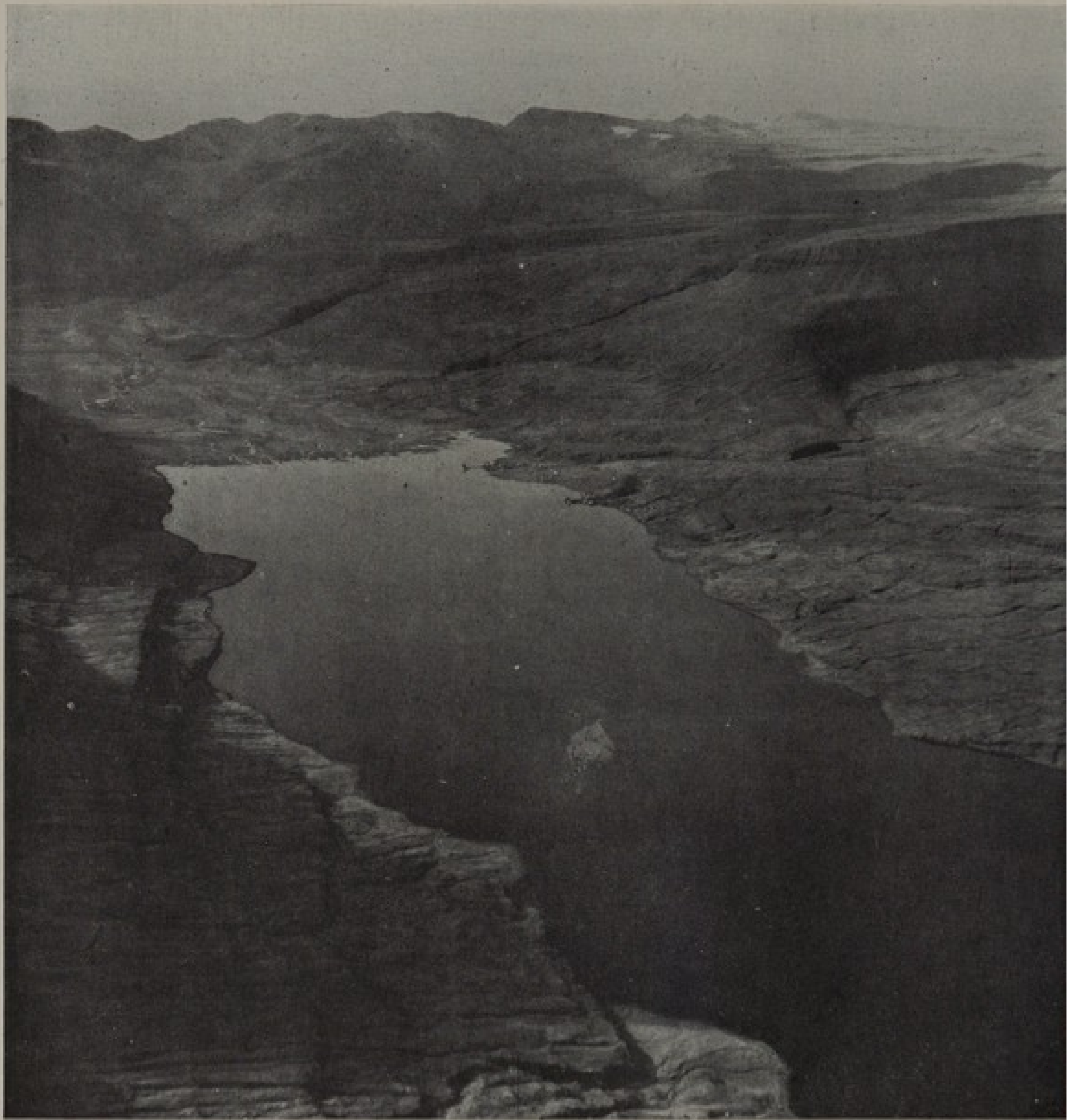
R.A.F.

Plate 44. Seyðisfjörður, a typical fjord on the east coast. The horizontal strips of snow emphasize the trap-featuring. The town is situated at the head of the fjord in the centre of the picture.



R.A.F.

Plate 45. Eskifjörður. The town is on the north side of the fjord and the famous Iceland Spar mine (see p. 67) is in Reyðarfjörður, 8 km. to the east.



R.A.F

Plate 46. The inner part of Reyðarfjörður, the longest fjord on the east coast. The farming village of Búðareyri, at the head of the fjord, is connected with the interior by a good road.

R.A.F

Plate 47. Fáskrúðsfjörður, on the east coast. The village of Búðir is scattered along the north side of the fjord.

Graf Zeppelin

Plate 48. Vesturhorn, a mountain group carved out of gabbro, granophyre and basalt. The village of Höfn is on the extreme left of the picture.

L. Hawkes

Plate 49. Austurhorn. Extensive scree aprons have collected on the low raised beach platform, and now smother the old sea cliffs.

broad bay of Húnaflói has a long sand front with large lagoons behind. Blönduos, situated at the mouth of the white glacial waters of the Blanda, is a focus of important routes which follow settled valleys. The peninsula between Húnaflói and Skagafjörður is unusual in that its northern part, being formed of younger rocks, is relatively lowlying and dotted with many lakes. On the west side of inner Skagafjörður high mountains fall to a narrow coastal strip leading to the port of Sauðárkrókur which serves the fruitful and well-settled broad valleys to the south. The eastern side is settled and is served by a road to Miklavatn, beyond which high cliffs prevent land access to the short northern fjords and the important fishing centre of Siglufjörður. The long and relatively narrow Eyjafjörður has a grassy lowland border south from Dalvík to Akureyri, the most important port on the north coast. From Akureyri the road to the west crosses the higher mountain region via the Óxnadalur valley and pass; the main road east crosses the delta flats to climb sharply and then descend into Fnjóskadalur. In former times there was a wharf at Kaupangur which is now over 1 km. inland from the delta front. Steep cliffs border the western side of Skjálfandi bay and mark the eastern boundary of the mountainous northern region of older rocks.

Skjálfandi to Héraðsflói (north-east coast, Fig. 49). A sand bar, backed by marshes, lagoons and recent lava flats, extends across the head of Skjálfandi. The port of Húsavík occupies a sheltered inlet on the east and has road connexions south and east. North of Húsavík the low marshy western part of Tjörnes peninsula is thinly populated. At the head of the next broad bay of Axarfjörður is a sandy front extending in a sweeping curve for 24 km. Behind is a triangular area of sand and marsh which the road skirts. Three km. to the west of the bridge over the Jökulsá á Fjöllum is the remarkable horseshoe valley of Ásbyrgi, a much-visited natural curiosity. The main northern road follows the coast to Kópasker and continues round to Raufarhöfn. The north and east coastline of the Melrakkasljetta peninsula is irregular with numerous spits and lagoons, whilst in the low marshy inland region are many lakes. The west shore of Þistilfjörður is high and cliffed, but at the head of the bay the land is low and undulating. Roads from the port of Þórshöfn extend along the coast in either direction for limited distances; communications with other parts of Iceland are very poor except by sea. Langanes is a peninsula of bare rock and the only settlement is at Skálar.

The coasts of Bakkaflói repeat the characteristics of those of Þistilfjörður. In Vopnafjörður the port of that name lies protected by islands on the eastern side of a projecting tongue, which continues as high ground inland and separates the two branches of the main valley. Communication across the mountainous peninsula to Héraðsflói is difficult. Here the two large rivers, Jökulsá á Brú and Lagarfljót, have their mouths and have built broad flats with a long straight sand front.

Héraðsflói to Vesturhorn (east coast, Fig. 50). This is a mountainous fjorded region and the coast is similar to that of north-west Iceland. Many small bays occur between Njarðvík and the first considerable fjord, Löðmundarfjörður. Characteristic of this district are the patches of brighter colours in the mountains where they are built of acid rocks. The long Seyðisfjörður is bounded by impressive mountain walls. Only a small valley and river enter the head of the fjord; there is little delta deposit and good wharfage at the port. A road leads inland over a high pass to the Lagarfljót district, and on to Akureyri. The narrow Mjóifjörður has little flat land or settlement, but Neskaupstaður in Norðfjörður is an important centre rivalling Seyðisfjörður.

Reyðarfjörður and its branch Eskifjörður have important settlements and a good road leading inland; Helgustaðir, on the northern shore, is the mine which has provided most of the world's supply of Iceland spar. The settlement of Buðir, in Fáskrúðsfjörður, like most of those on the east coast, is situated on the northern shore and thus receives the maximum amount of sunshine. Then follow Stöðvarfjörður and the shallow inlet of Breiðdalsvík with an irregular coastline, islands and sand bars. The long Berufjörður is unimportant except for the port of Djúpivogur at its mouth.

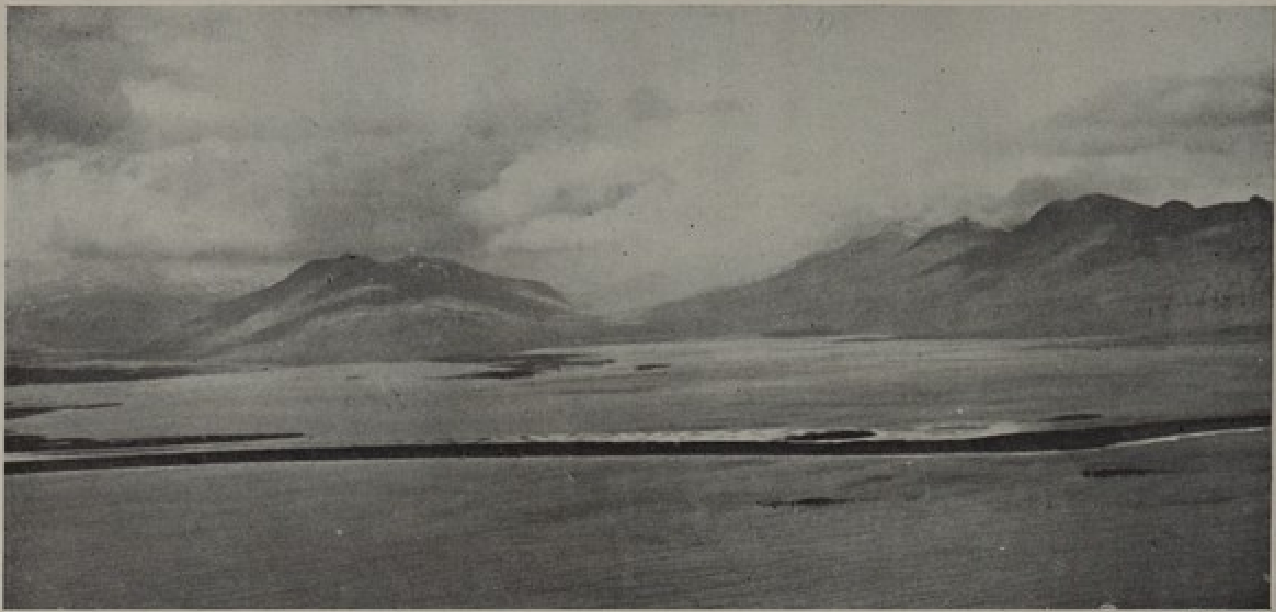
Hamarsfjörður and Álftafjörður have islands and sand bars across their mouths. Papey, the largest island on the east coast, is inhabited. The high mountain bastions of the Austurhorn and Vesturhorn are tied by a long sand and gravel bar, behind which is the shallow lagoon of Lónsfjörður and a broad region of flat settled land.

The Sandy Coast

Vesturhorn to Ingólfshöfði (south-east coast, Fig. 51). This stretch of coast has an almost continuous offshore bar, with a discontinuous line of shallow lagoons behind. The coastal plain, wide around Hornafjörður, narrows to the west as the mountains and glaciers near the shore. Breiðamerkurjökull spreads fanwise and the ice

R.A.F.

Plate 50. Djúpivogur, with Hamarsfjörður and Álftafjörður in the background (right). The entrance to these fjords is largely blocked by irregularly curving sand bars.



R.A.F.

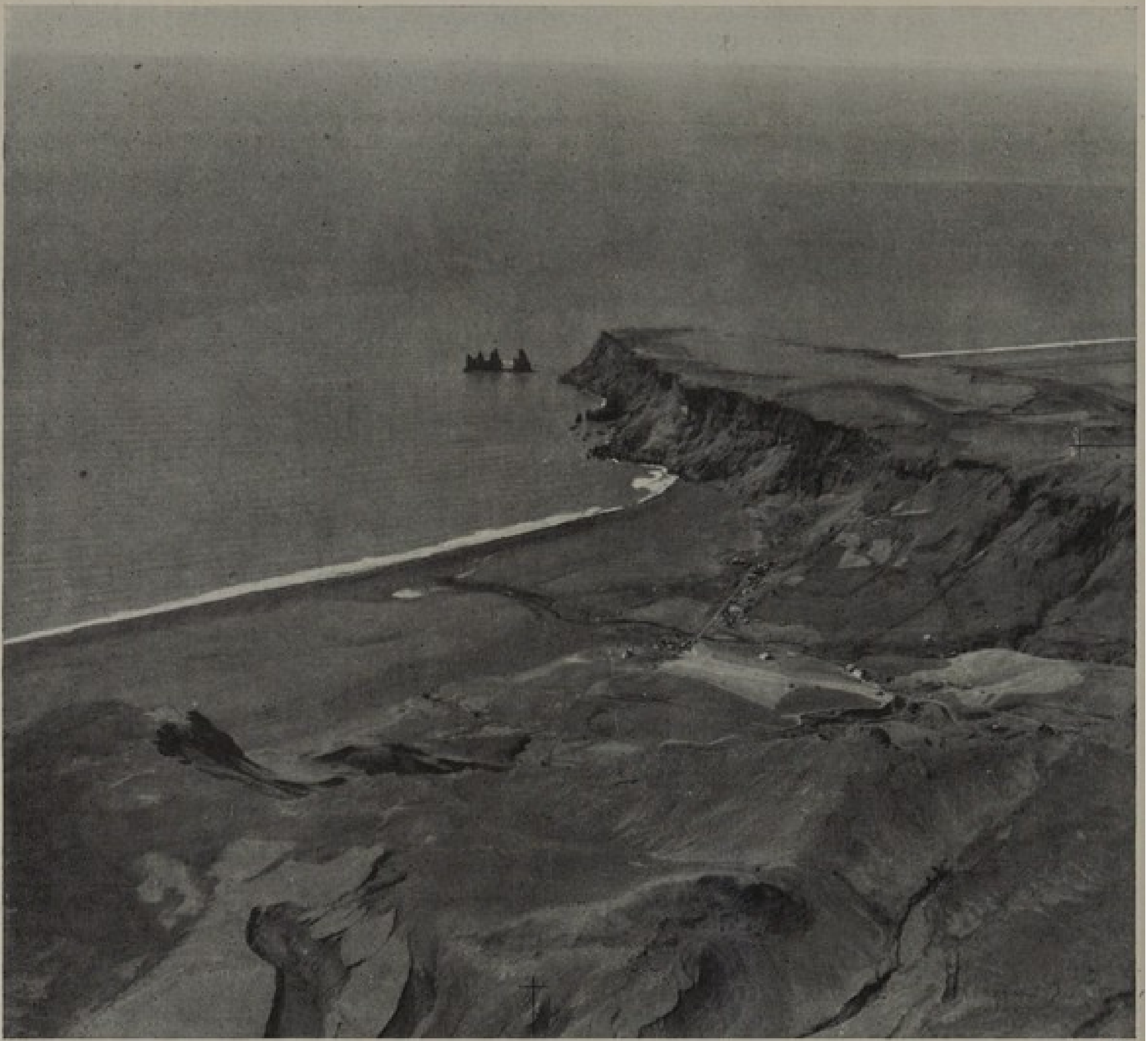
Plate 51. The sand bar blocking the entrance to Álftafjörður and Hamarsfjörður.

Graf Zeppelin

Plate 52. Beach south of Vatnajökull. The front of Breiðamerkurjökull is here only a few hundred metres from the sea.

R.A.F.

Plate 53. Hornafjörður in south-east Iceland. The village of Höfn is on the low-lying peninsula in the centre of the picture. The fjord is wide and very shallow; much of it dries out at low tide. Vatnajökull is seen in the left background with Snæfell in the extreme distance.



R.A.F.

Plate 54. Vík, the most southerly settlement on the mainland of Iceland. One of the rare rocky headlands on the sandy south coast provides some shelter.

almost reaches the shore. Öræfajökull, the highest mountain in Iceland, covers a volcano which has been active in historic times. The port of Höfn serves the Hornafjörður area. It is possible to ferry across to the offshore bar, which provides a good route westwards, or make a long pony crossing over the narrow waist of the fjord. Farms become less frequent to the west until there is a complete break in settlement at the Breiðamerkurjökull streams. The lowland fringe of Öræfajökull has fruitful pastures and is closely settled. The rocky headland of Ingólfshöfði, now difficult of access from the land, was in the seventeenth century a fishing centre with many farms in its neighbourhood, but changes in the river Skeiðará and deposition of sand and gravel have destroyed the farmland and the fishery. At Ingólfshöfði, Kálfafellsmelar, Máfabót and Alviðruhamrar there are provisioned refuges for shipwrecked seamen who must await guidance from the inhabitants before attempting to cross the sands and rivers.

Ingólfshöfði to Dyrhólaey (south coast, Fig. 51). West of Ingólfshöfði, Skeiðarárjökull and its outwash streams are a serious barrier to communications. West of Skeiðarársandur the offshore bar becomes less broken, and the main stretch to Dýrhólaey (Portland) shows no lagoons. Behind the sands are expanses of lavas with irregular surfaces. The best route westwards is a track made across a lava area and then along the inland cliff line to Kirkjubæjarklaustur, the terminus of the summer omnibus service from Reykjavík. West of the lavas is the desert lowland of Mýrdalssandur, out of which rise the isolated highlands of Hjörleifshöfði and Hafursey. This area is noted for its sudden floods associated with eruptions of the subglacial volcano Katla. The coastal plain bordering the highlands west of Mýrdalssandur narrows to the rocky promontories of Reynisfjall and Dýrhólaey. A road runs inland from Vík.

The Skeiðarársandur coast has an evil reputation amongst sailors. From the sea the high glacier-covered mountains of the interior monopolize the attention. In many lights the flat lowland sands can only with difficulty be distinguished from the sea, and the surf is the first sign of the proximity of land. Also the strong current which sets hard into the coast makes it difficult for ships to keep clear. Many wrecks can be seen.

Dýrhólaey to Eyrarbakki (south coast, Fig. 45). Westwards to Markarfljót is a strip of grassy lowland broken by the Sólheimasandur and Skógasandur wastes and the Holtsós lagoon. Sólheimajökull is the only glacier which reaches the coastal sands. Markarfljót and its innumerable distributaries drain the northern side of Eyjafjallajökull. The Þjórsá passes through a triangular area of scattered farmland, one of the largest in Iceland, with its base the coastline and its apex at Geysir. From the mouth of the Þjórsá the character of the coast changes. Isolated rocks appear offshore, and these increase in number towards Stokkseyri and Eyrarbakki, where small boats can lie in comparatively protected 'harbours'. From here, the rocky coast extends westwards. The coastal region of the south-west peninsula is lowlying throughout its length, but there are frequent stretches of low cliff.

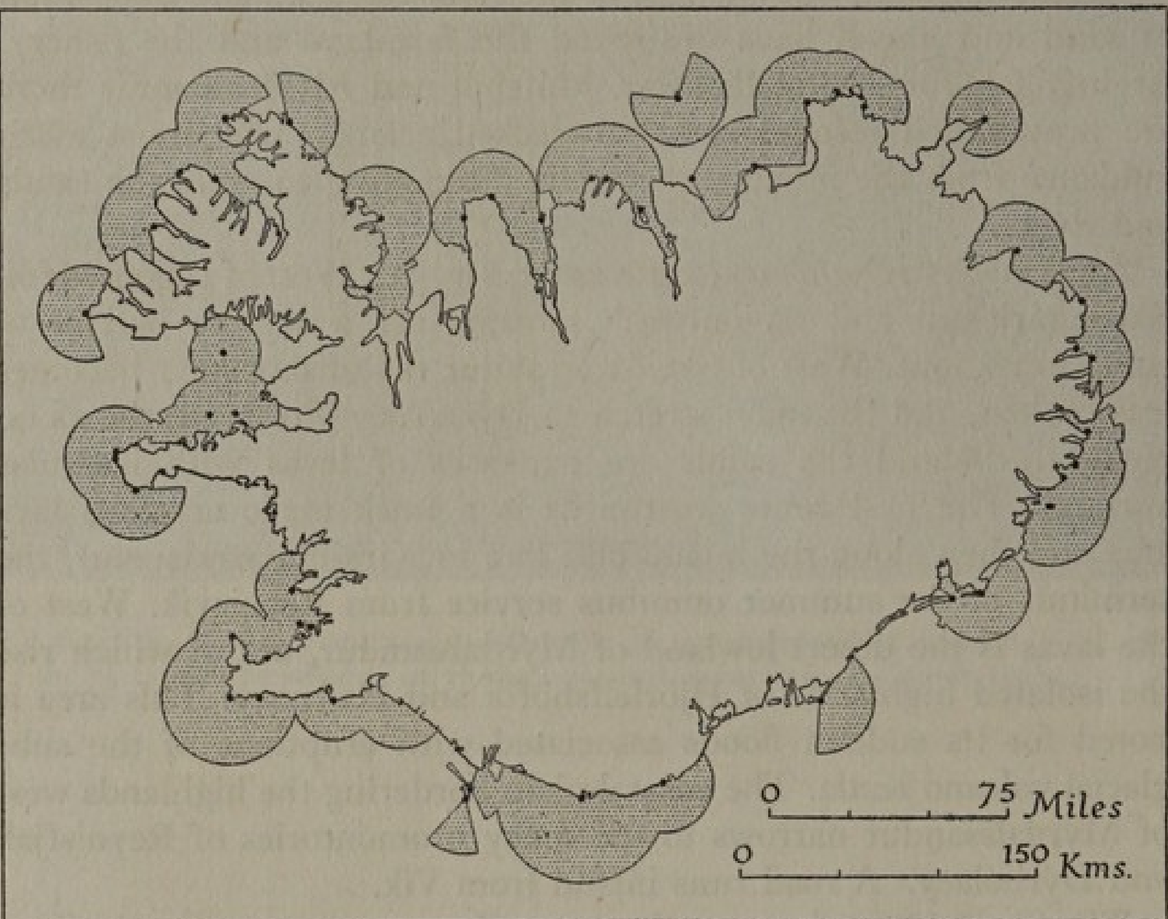


Fig. 53. Principal lighthouses, showing the sectors covered. From data in *Admiralty List of Lights*, 1938, Part II, and Supplement No. 2, 1940.

Note on Lighthouses

The first lighthouse in Iceland was erected in 1878 on the Reykjanes peninsula, a point which is passed by almost all ships on their way to Reykjavík from abroad. For 19 years this remained the only lighthouse in the country, and then three more were built at different points around Faxaflói in 1897. The absence of lighthouses was tolerated until this late date because Icelandic waters were navigated

R.A.F.

Plate 55. Keflavík, an important fishing centre in a small bay on the east side of Miðnes, the promontory marking the southern extremity of Faxaflói. The white patches show where split cod are being dried in the sun (see p. 320).

R.A.F.

Plate 56. Eyrarbakki, a fishing and farming village in the south-west. Rocks and shoals lie off this lowland shore, and the anchorage is very poor.

almost exclusively during summer, when there is so much light that artificial aids are not required. As the fishing fleet increased and deep-sea fishing came to be pursued mainly during the winter, and as the regular shipping lines to other countries developed, also during the darker seasons of the year, the want of lighthouses began to be felt. Since 1900 rapid progress has been made with the building of lighthouses. In 1936 there were 110, of which sixty-five were maintained by the state and the remaining forty-five by municipalities and parishes. The coast is now fairly well covered (see Fig. 53).

Two of the lighthouses (Dýrhólaey and Vestmannaeyjar) have wireless fog signals, while Dálatangi and Sauðanes are provided with fog sirens.

Chapter III

CLIMATE

Introduction: Meteorological Stations: General Weather Conditions: Pressure and Winds: Temperature: Humidity: Visibility: Clouds: Precipitation and Snow-cover: Sunshine: Thunderstorms

Introduction

The climate of Iceland is influenced not only by the northerly situation of the island, and the prevailing winds of the North Atlantic, but also to a great extent by the temperature conditions of the surrounding seas.

The characteristic features of the coastal waters are largely dependent on the situation of Iceland on the submarine ridge running from Scotland to Greenland (Fig. 1). This ridge separates the cold and heavy bottom water of the Norwegian Sea from the warm bottom water of the North Atlantic Ocean. In general, the position of the ridge also marks the line of separation between the cold surface water of the Norwegian Sea and the comparatively warm water of the Atlantic.

Ocean Currents. The currents in Icelandic waters have been studied by means of numerous drift-bottle experiments, and evidence is also given by the stranding of drift material from Central America and Siberia (see p. 82). These investigations indicate a current system as shown in Fig. 54. Cold water from the Greenland Sea penetrates to the north and east coast and then follows the direction of the Iceland-Faroe ridge towards the Faroes. This current, which seems to be strongest east of Iceland, is called the East Icelandic Polar Current. From the south, a branch of the North Atlantic Drift follows the Faroe-Iceland ridge to Iceland. It is there deflected towards the west and flows on along the south and west coasts. At the Iceland-Greenland ridge, the main part of the current turns to the west, following the East Greenland Polar Current. The part which does so is called the Irminger Current.

These currents induce a clockwise movement of the coastal waters round Iceland. The average velocity of this current is about 8 nautical miles a day, but the drift is subject to great variations due to wind conditions and tidal streams. For details of tidal streams see p. 249.

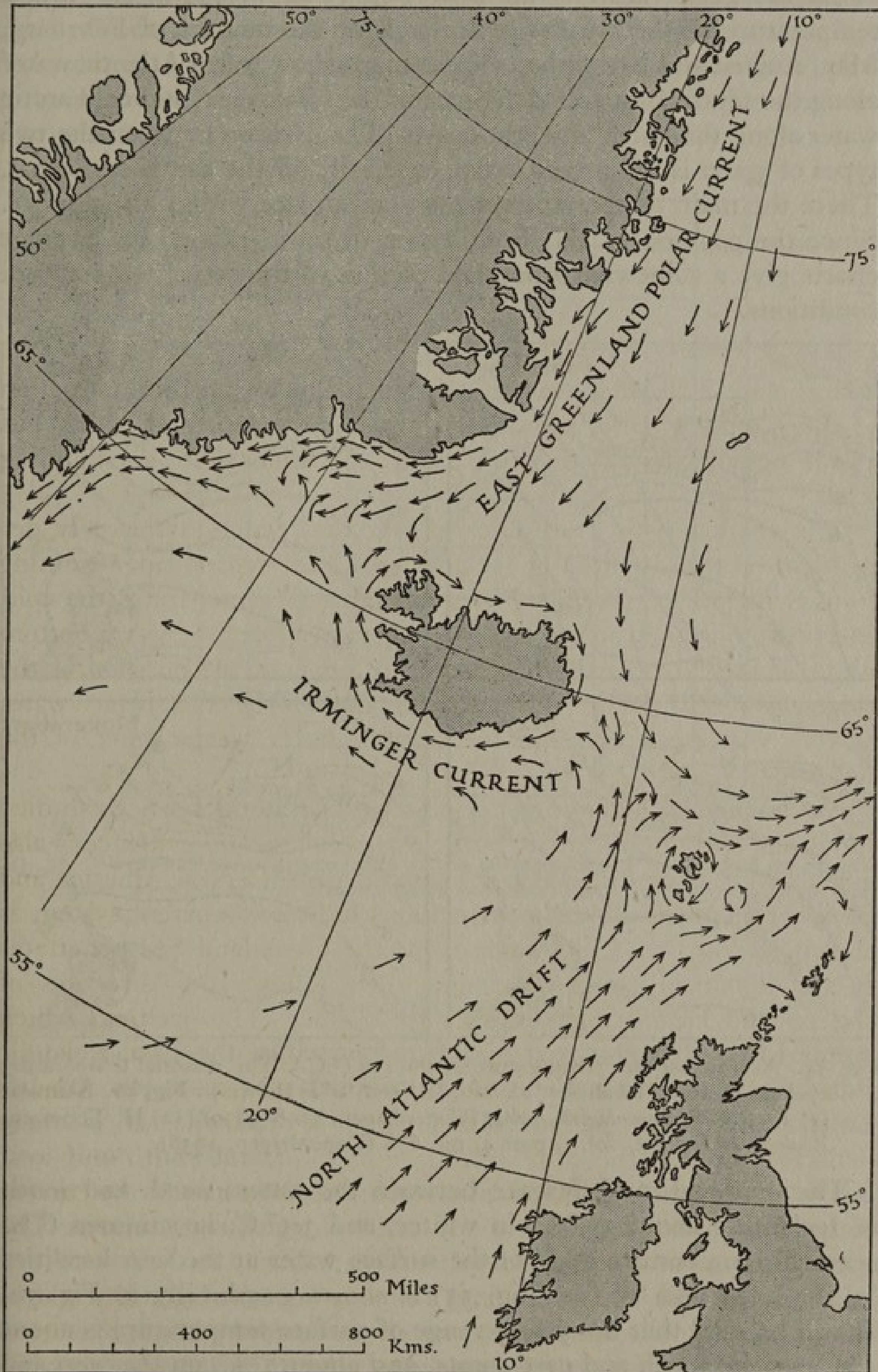


Fig. 54. Ocean currents in the North Atlantic.

Surface Temperature of the Sea. Fig. 55 shows the mean surface temperature of the sea round Iceland for the months of February, May, August and November. These maps show warm Atlantic water along the south coast and along part of the west coast, and cold arctic water along the north and east coasts. The division between the two types of water is often very sharp, especially off the south-east coast. There the main temperature change takes place within a few miles. Since the position of this limit varies to some extent, the average charts give a somewhat smoothed picture of the actual temperature conditions.

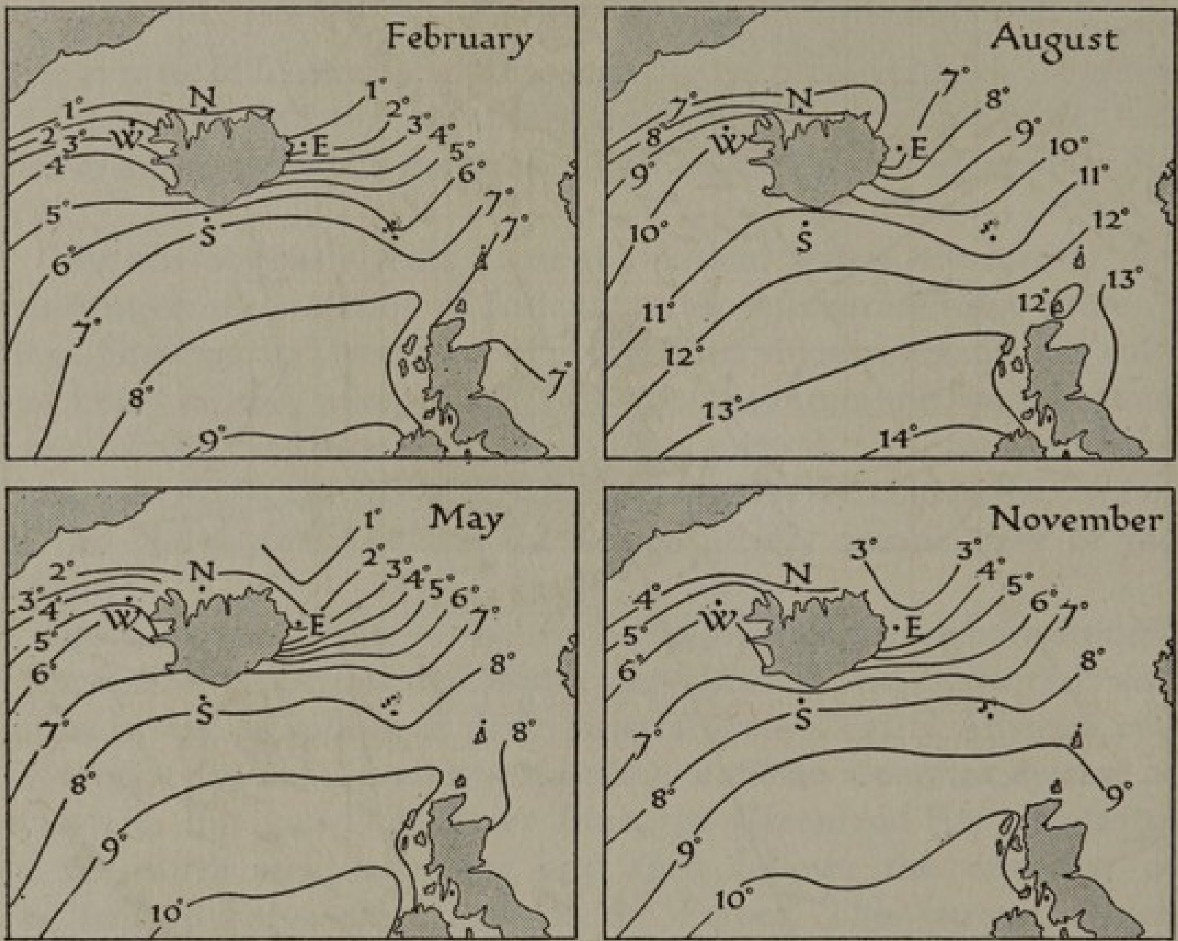


Fig. 55. Average surface temperature of the sea (° C.). The seasonal temperature cycle at the four localities 'S', 'W', 'N' and 'E' is shown in Fig. 56. Sources: (1) *Nautisk-Meteorologisk Aabog* (Copenhagen, 1898–1939). (2) H. Thomsen, *Zoology of Iceland*, vol. 1, part 4, pp. 6–8 (Copenhagen, 1938).

The temperature difference between the waters north and south of Iceland is about 5·5° C. in winter, and 3·5° C. in summer. The seasonal temperature cycle of the surface water at the four localities 'S', 'W', 'N' and 'E' (see Fig. 55) is shown graphically in Fig. 56. It will be seen that the yearly range of surface temperature is about 5° C. on the south and east coasts, and about 7° C. on the west and north coasts.

Appendix VI, table 1, gives the monthly average temperature at ten localities on the coast, calculated from daily observations during the years 1924 to 1933. Near the coast and in the fjords the winter temperature is lower and the summer temperature is higher than in the open sea.

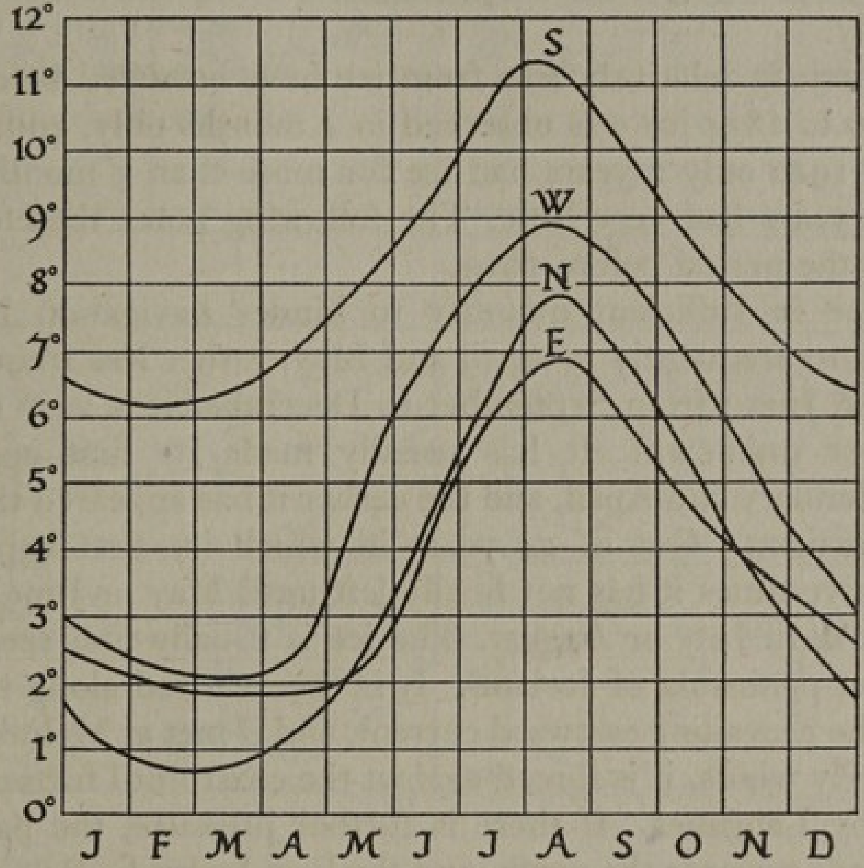


Fig. 56. Seasonal temperature cycle of the surface water (° C.), based on observations collected by the Danish Meteorological Institute between 1876 and 1915. **S**, 63° N, 20° W; **W**, 66° N, 27° W; **N**, 66½° N, 20° W; **E**, 65° N, 13° W.

Drift Ice

At certain seasons of the year drift ice may visit the coasts of Iceland and act not only as a serious hindrance to navigation and the fisheries, but also have a marked influence on weather conditions throughout the island.

It is not possible to lay down any rules as to the coming of the ice, since no periodicity occurs. For several years in succession it may remain absent, whilst years of much ice may also occur singly or in groups. During the 136 year period between 1800 to 1892 and 1895 to 1938, for which observations are available, there were 40 years without ice, 35 years in which it stayed less than 1 month, 28 years in which it stayed between 1 and 3 months, and 33 years in which it stayed for more than 3 months. In some of these years the ice was unusually severe, but it is rather remarkable that since 1919 the coasts of Iceland have been almost completely free of ice. In 1929, 1932, 1937 and 1938 it approached the coast, but not in sufficient quantities to cause serious hindrance to navigation. There is no reason for assuming that the present ice-free period will continue indefinitely.

Long periods relatively free from ice have occurred before; thus from 1840 to 1854 ice was observed in 4 months only, and between 1895 and 1910 only 2 years had ice for more than 3 months, while the other years had very little. The following notes therefore refer mostly to the period before 1919.

Drift ice in sufficient quantity to hinder navigation has been present most frequently in April and May, rather less frequently in March and June; from September to December it is very rare, and in October unknown. It has usually made its first appearance between January and April, and the earlier it has appeared the longer it has remained. Out of 24 years in which ice first appeared in January, five times it has not finally left until May or June, and ten times not until July or August. The ice is usually first seen off the north-west peninsula of Iceland. It is then carried along the north coast by the prevailing eastward current, and if met at Melrakkasljetta by northerly winds, it is forced against the coast until further drift is stopped by Langanes. If there is further pressure, the packed ice then spreads towards the north, and the East Icelandic Polar Current carries it down the east coast. East winds may then cause it to move in and block the fjords of the east coast. Ice is rare on the south-east, south, and west coasts, but in exceptional years it has drifted round to Vestmannaeyjar, where in 1888 it filled the harbour at Heimaey. The most severe ice year known was 1695, when drift ice surrounded the whole island with the exception of Snæfellsnes.

Fig. 57 illustrates the monthly state of the coasts in three typical ice years and demonstrates the unpredictable character of the ice.

Further notes on local ice conditions are given in the chapter on ports, pp. 245–86. Information concerning the condition or absence of ice may be obtained by telegraph from the meteorological station at Siglunes (Siglufjörður).

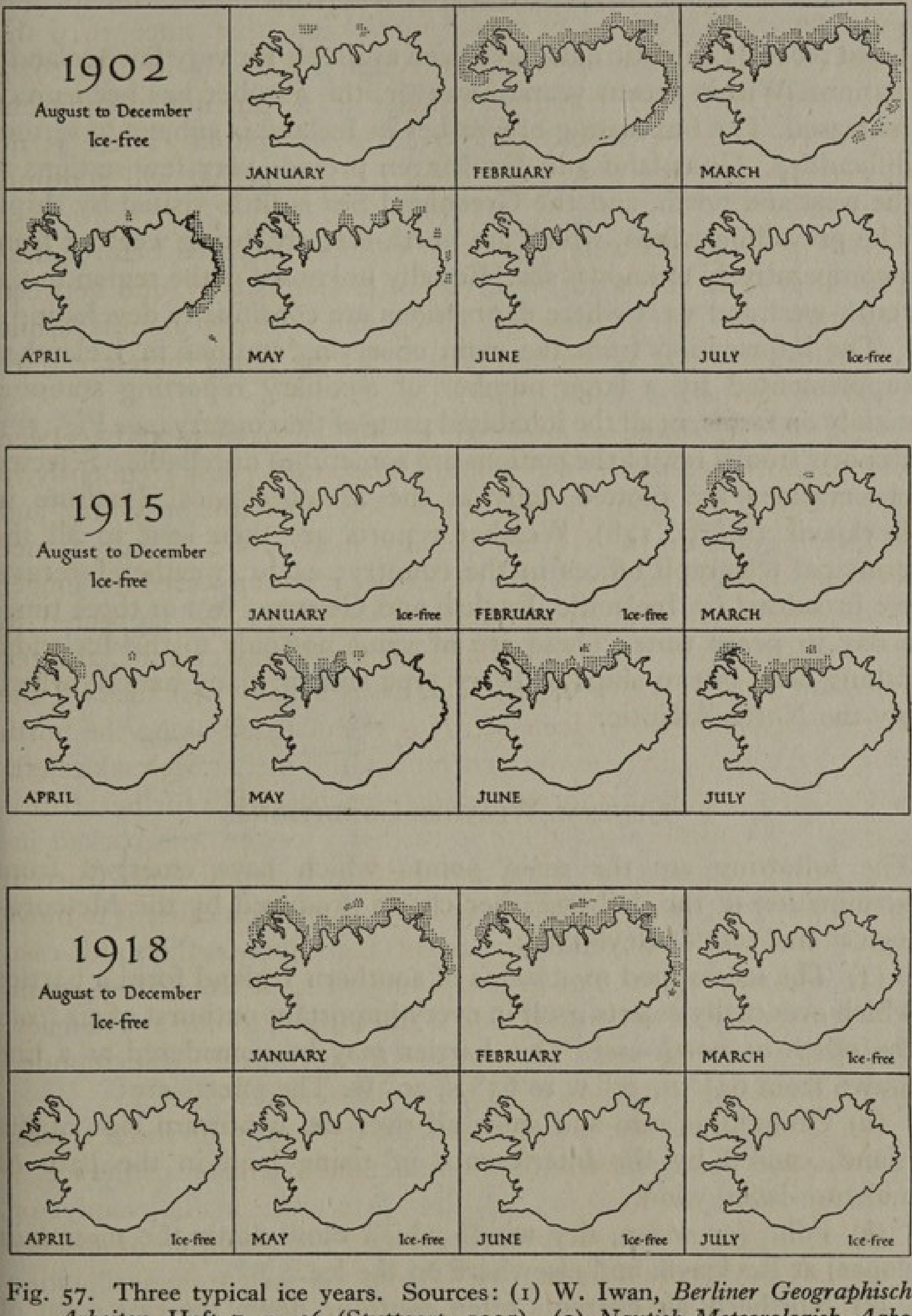


Fig. 57. Three typical ice years. Sources: (1) W. Iwan, *Berliner Geographische Arbeiten*, Heft 7, p. 36 (Stuttgart, 1935). (2) *Nautisk-Meteorologisk Aabog* (Copenhagen, 1898–1939).

Meteorological Stations

Until recently climatic data have been available for very few Icelandic stations. Within recent years, however, the number has been much increased. The forecasting of weather in Iceland is subject to serious difficulties. Greenland and Jan Mayen provide very few stations to the west and north, and the Greenland Sea is little visited by ships. The prevailing winds, which are north-easterly, bring weather from a comparatively unknown sea. Equally unknown is the region to the south-west and west where depressions are continually developing.

The information from the main observing stations in Iceland is supplemented by a large number of auxiliary reporting stations, mainly on farms, in all the inhabited parts of the country (see Fig. 58). Reports from a few of the stations are sometimes unreliable. Selected observations are plotted daily at the Meteorological Institute in Reykjavík (see p. 148). Weather reports are then sent to all the principal telegraph offices in the country; 24 hr. weather forecasts are broadcast (in Icelandic, English and German) two or three times a day in peace time. These are of value not only to the Icelandic fishing fleet, but to ships of every type and of many nations which ply the North Atlantic.

General Weather Conditions

The following are the main points which have emerged from examination of the daily weather charts produced by the Meteorological Institute at Reykjavík:

(1) The ice-capped mountains of southern Iceland form a barrier which eventually asserts itself in every important outburst of air from the north or north-east. This barrier may be considered as a line drawn from $64\frac{1}{2}°$ N, 15° W to 65° N, 20° W. The effects are:

(*a*) Orographic rain and snow all over the windward side of the island, caused by the interference of rising land in the path of moisture-laden wind.

(*b*) Föhn (or warm, dry winds which blow down the mountain slopes) at Reykjavík and elsewhere on the lee.

(*c*) Northerly air currents often continue down the east coast of Iceland, where a considerable rise of pressure sets in whilst pressure remains low in south-west Iceland. Hence the east coast air current spreads around the south coast, and eventually approaches Reykjavík from the south-east after becoming somewhat warmed by its long

Fig. 58. Weather reporting stations in 1939. A full list, with the altitudes of the stations, is published in *Veðrattan* (Reykjavík). Möðruvellir, which was formerly an important station, is 15 km. north-west of Akureyri.

sea track. Off western Iceland a new depression is then formed with frontal effects between the two branches of the cold air current. For the successive positions of the cold front in the development of this low-pressure area see the series of maps in Fig. 59. The cold front is the boundary line between advancing cold air and a mass of warm air under which the cold air pushes like a wedge.

(2) To winds coming from the east or south-east, the same mountain mass presents a barrier from $64\frac{1}{2}°$ N, $15°$ W to the most

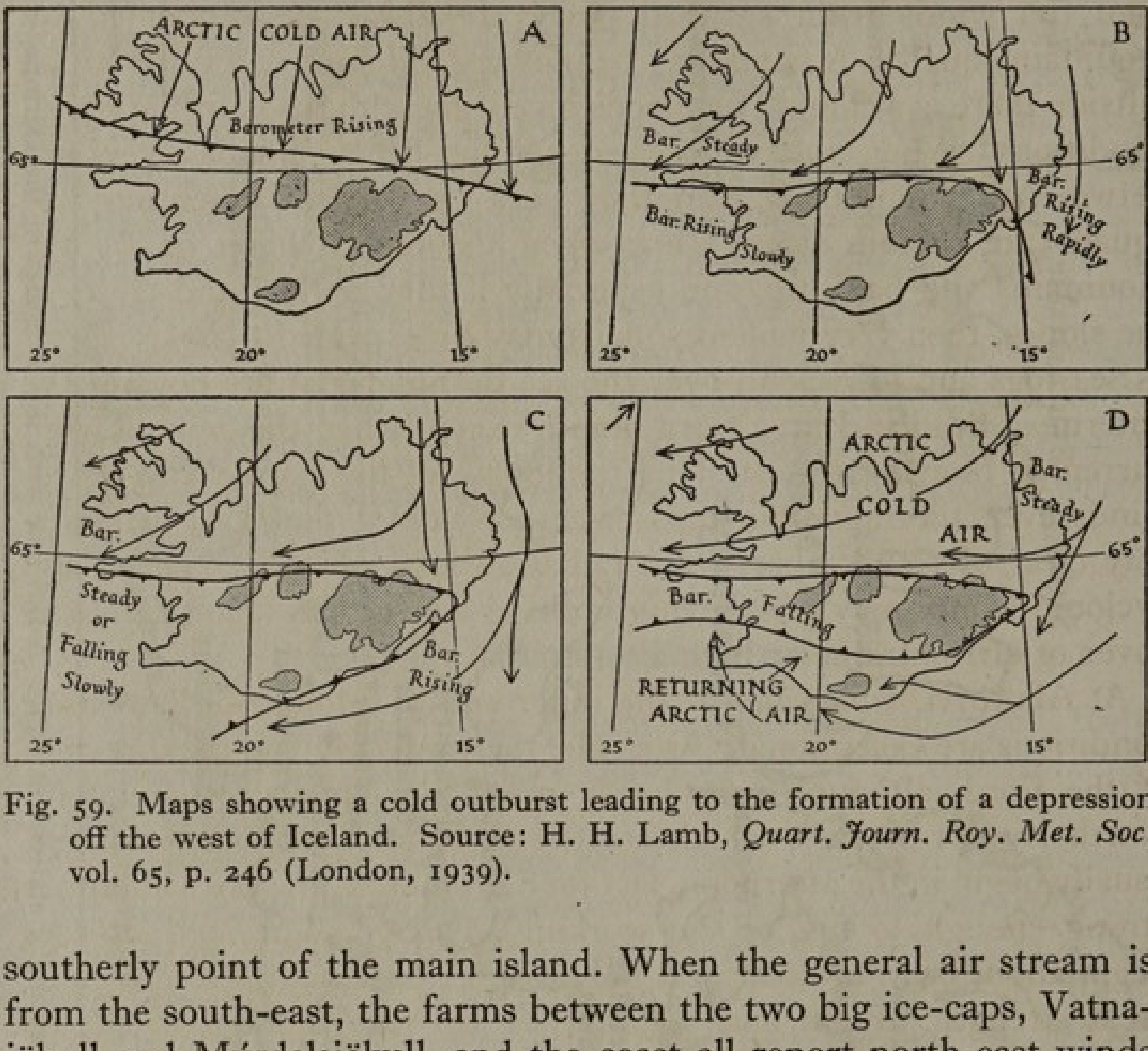


Fig. 59. Maps showing a cold outburst leading to the formation of a depression off the west of Iceland. Source: H. H. Lamb, *Quart. Journ. Roy. Met. Soc.* vol. 65, p. 246 (London, 1939).

southerly point of the main island. When the general air stream is from the south-east, the farms between the two big ice-caps, Vatnajökull and Mýrdalsjökull, and the coast all report north-east winds with resulting convergence near Iceland's southernmost headland and excessive wind strength in that neighbourhood.

(3) Local influences affect barometric readings occasionally everywhere in Iceland. This is due to what may be called windward and leeward effect. Small ridges of high pressure appear to windward of a mountain massif through banking up of air, and troughs of low pressure or even shallow cyclonic centres appear on the leeward side.

Fjords and Local Weather

The marked indentations of much of the coastline have a considerable effect not only on local winds but also on low cloud systems and fog.

In most of the fjords squalls are frequent and sometimes very sudden. It often happens that a vessel will enter a fjord with a fresh wind from seaward, and when she has moved in a little way encounter calms with strong mountain squalls. Offshore winds, on the contrary, blow throughout the length of the fjord, and usually blow harder than the winds from seaward; they are always accompanied by mountain squalls. A wind may be blowing hard out of a fjord whilst outside there is a calm. The clouds give some indication of the squall conditions. When the wind carries light fleecy clouds over and between the mountains, and they pass on without detention, the squalls are seldom strong; but when the clouds hang on by the mountains and bank up, and especially if they lie low and close on the slopes, then very violent squalls may be expected.

Sea fogs and low cloud over the sea do not penetrate beyond the outermost headlands at a fjord mouth except when the general wind current is blowing almost along the length of the fjord. With cross-winds even the mountain tops on either side of the fjord generally stay clear of cloud, apart from radiation mist on snow slopes, and cyclonic fronts may pass giving nothing worse than a complete sky cover of cirro-stratus or high alto-stratus.

At Akureyri, which lies at the inner end of a long fjord, weather conditions are exceptional. As a rule, the winds blow in the direction of the fjord, although very heavy mountain squalls are frequent. Northerly sea breezes, which are the most frequent and strongest, usually begin in the afternoon, last for a few hours, and are sometimes strong enough to hinder the working of cargo. The land breezes begin about 0500 or 0600, last only a short time, and are seldom of great strength. Land and sea breezes are very marked in all the fjords round the island except in the north-west peninsula near Drangajökull. Here the proximity of the glacier complicates the situation so that forecasts are as yet impossible.

Influence of Drift Ice on Weather

The most unfavourable weather occurs with north and north-west winds in winter and spring. These bring not only cold but also drift ice.

When there is drift ice in the sea to the north of Iceland, the weather is very variable and stormy; fog and snow are frequent, and even a strong breeze seldom lasts more than 12 hr. Once the ice gets set fast to the land, the weather becomes settled with a clear sky and a light frost. Coastal fog is frequently associated with nearby ice.

In heavy ice years there is a tendency toward a filling up of the Icelandic low-pressure region (see below). This appears to be accompanied by a diminution of cyclonic frequency and a southward displacement of the average cyclonic path over the North Atlantic during the following summer, autumn and early winter.

Pressure and Winds

Iceland lies towards the north-east side of the semi-permanent low-pressure system known as the 'Icelandic low', a system which extends on the average from Norway to Greenland between lat. 55° and 75° N. Pressure is consequently rather low at all times of the year, and it is lower in winter than in summer. Owing to the passage of cyclonic storms, the variations in pressure are probably greater in the region of Iceland than in any other part of the world. In winter, rapid oscillations of as much as 30 mb. may occur in 24 hr. Averages are given in Appendix VI, table 2.

Iceland lies in or near the track of the numerous depressions which pass from the North Atlantic towards the Greenland Sea or north-west Europe. Preliminary analysis of cyclone frequencies between November 1931 and October 1934 has shown that depressions are about twice as numerous in winter as they are in summer. Fig. 60 emphasizes the contrast between winter conditions and those of the rest of the year. The relative concentration of winter depressions along a narrow route is clearly brought out. The tongue-like forms in the eastern part of the March–October distribution are the nearest approach to separate tracks revealed by the analysis.

The contrast between the predominance of the Denmark Strait track in winter and the relatively unpredictable courses followed during the rest of the year is of importance in regard to prevailing winds, the distribution of gales, and the general weather mechanism of the area. Winter depressions are often so large that although the 'track' of the centre passes through Denmark Strait, the associated front may itself sweep across the British Isles.

Surface Winds. Owing to the passage of cyclonic storms, winds are very variable. The effect of thermal and orographic factors upon wind records at coastal stations in Iceland is so great that it is difficult to demonstrate the general nature of air movement over the area. Inferred wind-roses for points over the neighbouring seas suggest that winds of force 4 or more on the Beaufort Scale are rather more common than off the coasts of Scandinavia. The main air stream in this part of the Atlantic is from the north and north-east, though it is frequently invaded, particularly in the winter

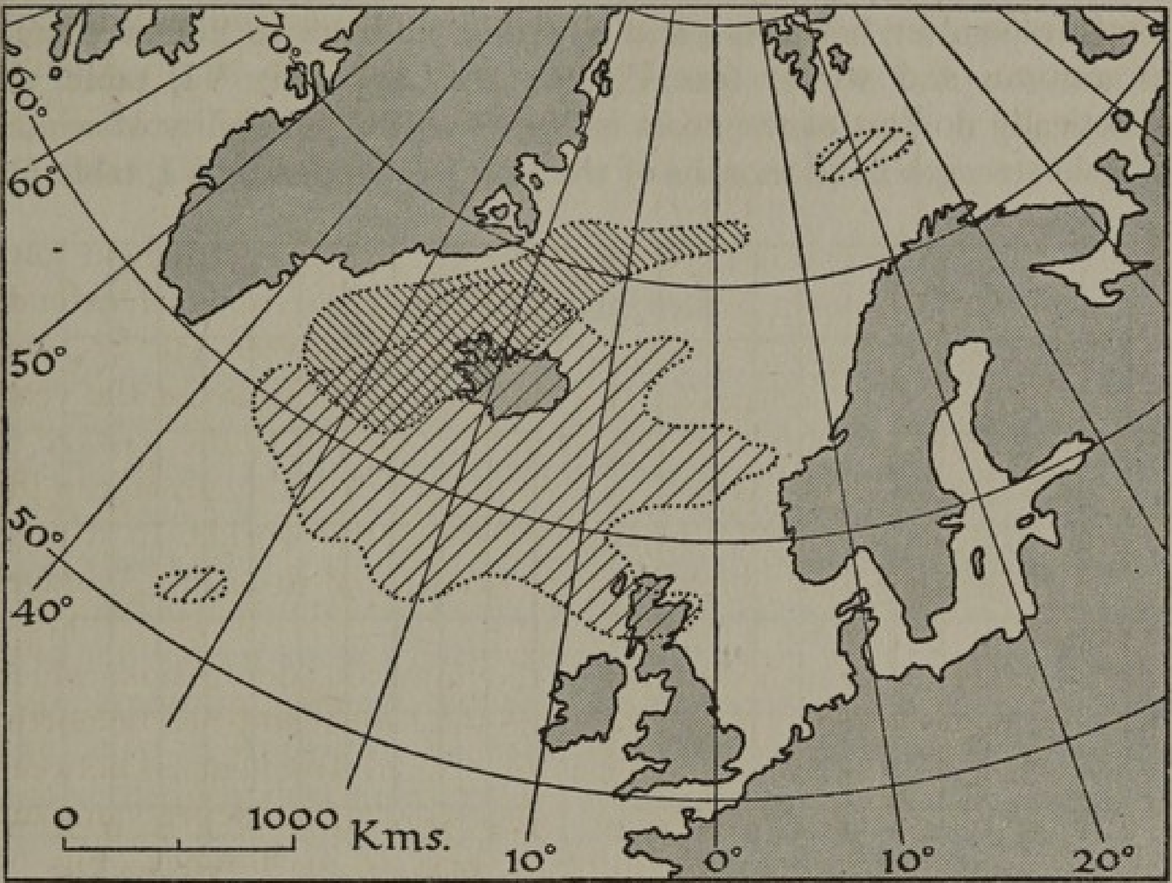


Fig. 60. Areas most frequented by depressions from November to February (heavy shading) and from March to October (light shading). The region of overlap is the centre of the 'Icelandic low'. Source: *Weather in Home Waters and the North-eastern Atlantic*, vol. II, part 7, p. 27 (London, 1941).

months, by air from the south. The marked contrasts in the general direction of air circulation across a relatively narrow zone is clearly illustrated by the following frequencies of surface winds of force 4 or more at the two points, $67\frac{1}{2}°$ N, 15° W and 62° N, 15° W for the winter and summer four-month periods. The figures are percentage frequencies of all observations, including calms.

	N and NE	E and SE	S and SW	W and NW
$67\frac{1}{2}°$ N, 15° W				
Winter	24	22	18	12
Summer	14	19	7	7
62° N, 15° W				
Winter	11	15	37	16
Summer	11	15	22	10

At coastal stations there is a slight preponderance of north-east winds, but it is easier from published data of wind frequencies (see Appendix VI, table 4) to pick out directions from which the wind is very infrequent. Calms are frequently recorded; the exceptionally high frequency at Berufjörður is probably due to the development of a local air pocket. The average wind force for the year in exposed localities is often between 4 and 5, with a tendency to higher values in autumn and winter (see Fig. 61 and Appendix VI, table 3). Practically no part of the coast is free from the possibility of winds of gale strength in all months of the year (see Appendix VI, table 5).

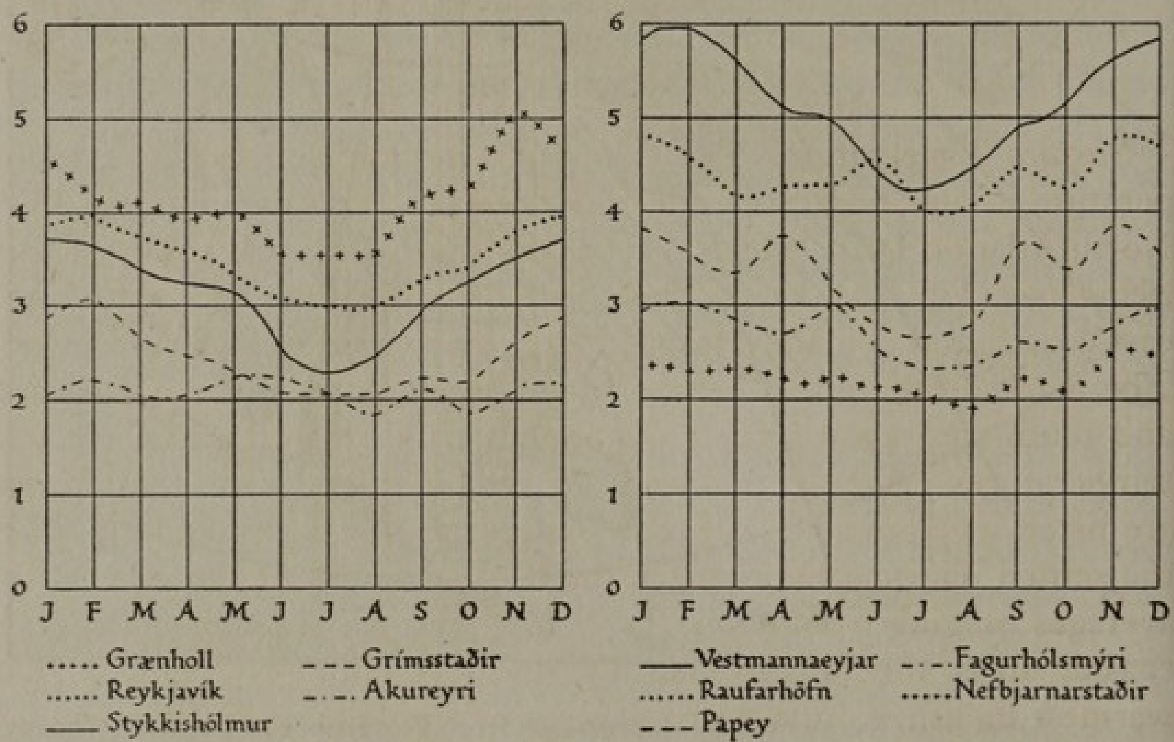


Fig. 61. Average wind force (Beaufort Scale) at ten stations, 1920–9. Source: W. Iwan, *Berliner Geographische Arbeiten*, Heft 7, p. 41 (Stuttgart, 1935).

The number of days on which the wind reaches force 9 or more at Vestmannaeyjar averages 56 in the year. From November to March, each month has 4–10 of such days. Elsewhere, although gales are still frequent, they are much less so than at Vestmannaeyjar.

Upper Air Winds. Information capable of yielding a clear picture of the general upper air circulation over Iceland is completely lacking. A series of observations was made above Reykjavík during the Polar Year 1932–3. Even at 100 m. the figures then obtained show a contrast in the frequency of east winds between winter and spring, on the one hand, and summer and autumn on the other, which does not agree well with what is known of surface winds in the area. East winds are comparatively rare above about 1,000 m., but little in the way of positive generalization can be made of the records from that level to about 1,500 m. Ascents to greater heights indicate with some certainty a fairly uniform air flow from between south and west in winter and between west and north during the rest of the year, up to at least 9,000 m. North-east winds, which are common at lower levels, occur with steadily decreasing frequency at heights above 1,500 m. Up to 500 m. an average wind speed of 9–10 knots seems common in summer and of 16–20 knots in winter. Corresponding figures for the zone between 1,000 and 1,500 m. are 15 and 20 knots, so that the increase with altitude is greatest in summer.

Temperature

Surface Temperature. The chief characteristic as regards air temperature is that Iceland is mild in winter and cool in summer. The North Atlantic Drift, which reaches the south and west coasts of the island (see Fig. 54), keeps these parts warmer than the north and east coasts, and is mainly responsible for the mildness of the winter. The marked differences between the temperatures of the north-east and south-west show a fairly close relationship with the adjacent sea temperatures. Average monthly air temperatures at seven stations are listed in Appendix VI, table 6 (see also Figs. 62 and 63). In the settled districts February is the coldest month of the year, with averages ranging from about $-3{\cdot}7$ to $-0{\cdot}9°$ C. In the south-west coastal areas the lowest monthly mean is about $-1{\cdot}2°$ C. The warmest month is July, with averages of from about $8{\cdot}9$ to $10{\cdot}9°$ C. In the last decade the absolute extremes at Reykjavík were $22{\cdot}1$ and $-15{\cdot}7°$ C., and for Iceland generally $30{\cdot}5$ and $-29{\cdot}5°$ C.

While winter is mild for the latitude, and 10° C. may be reached with a southerly wind, it is often prolonged far into April or even May. As a rule the temperature rises notably during May, when potatoes are sown, to be gathered about the time of the first frosts in mid-September. With regard to the uplands, the temperature at Grímsstaðir, at a height of 385 m. and about 70 km. inland, is much more continental in character, with a February average of $-6{\cdot}1°$ C. and a July average of 9° C. Möðrudalur, at a height of 480 m. and 90 km. inland, has an average January temperature of about $-7{\cdot}2°$ C. Here, averages for the seven months, October to April, are also below freezing-point, and night frosts occur in every month of the year. No reliable observations are available for anywhere else in the central highlands, where the average winter temperature is possibly as low

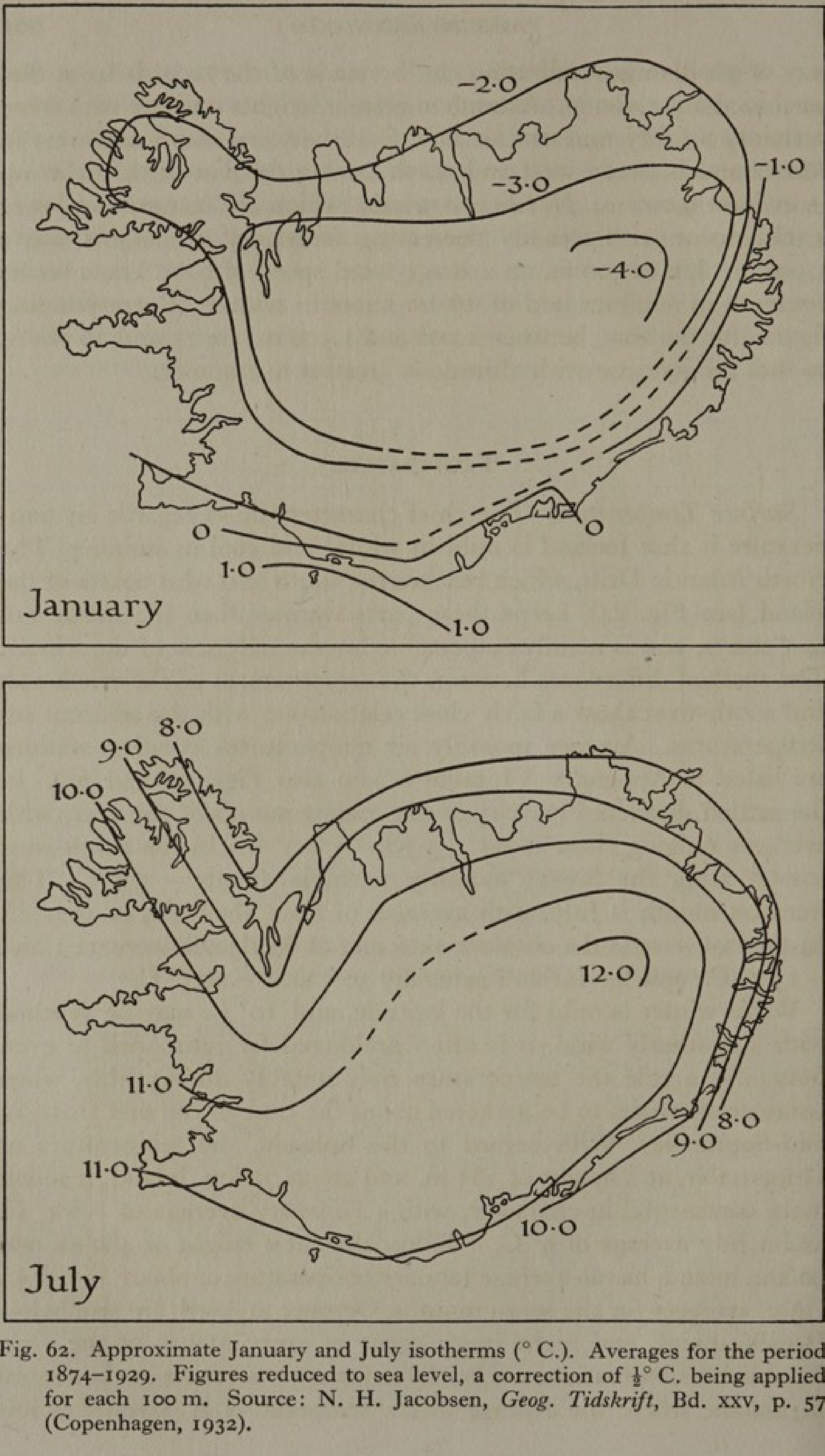


Fig. 62. Approximate January and July isotherms (° C.). Averages for the period 1874–1929. Figures reduced to sea level, a correction of ½° C. being applied for each 100 m. Source: N. H. Jacobsen, *Geog. Tidskrift*, Bd. xxv, p. 57 (Copenhagen, 1932).

as −8° C. During the summer it may sometimes become fairly warm in the middle of the day, but it usually freezes during the night, so that small streams and pools are ice-covered early in the morning. The contrast in the effects of prolonged insolation upon the lava plains on the one hand, and the permanent snow fields on the other, is thought to have important effects upon atmospheric circulation.

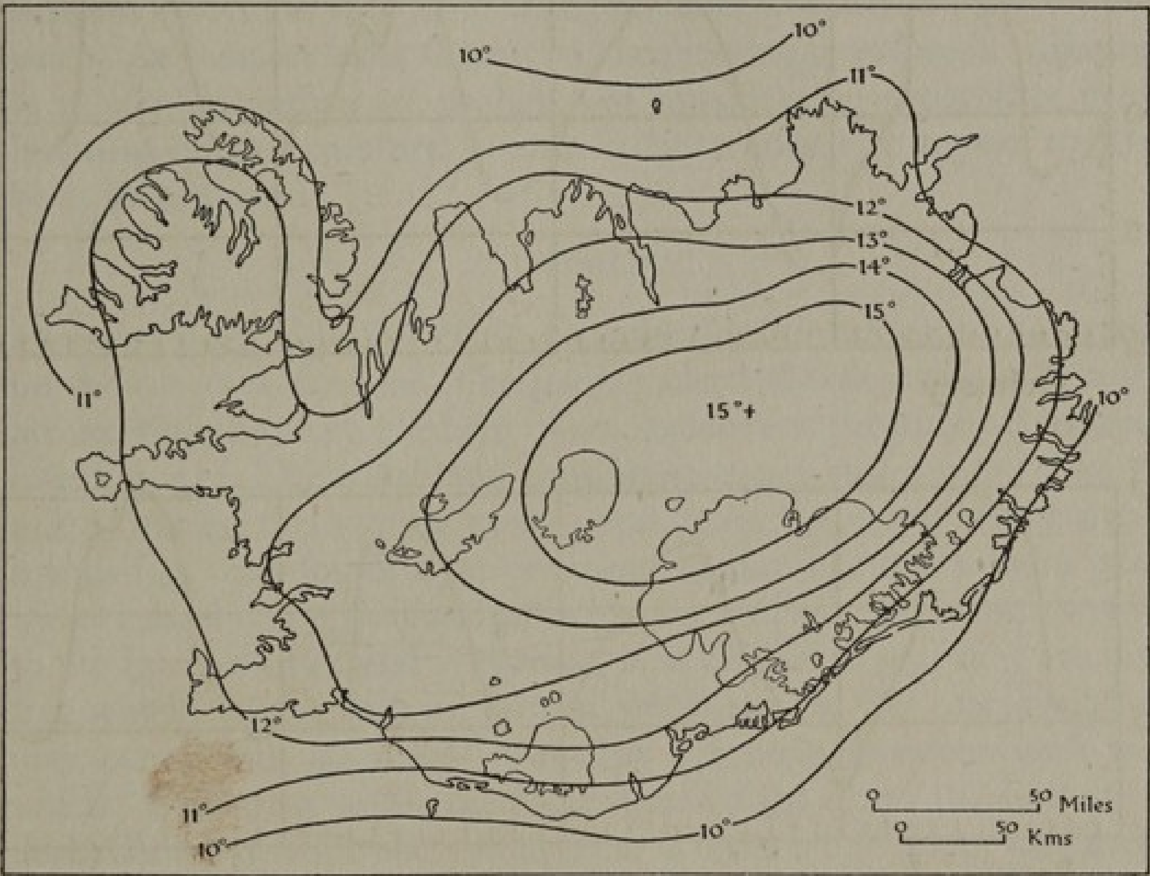


Fig. 63. Approximate annual temperature ranges (° C.). Source: J. Askelsson, *Dansk Geologisk Forening*. Bd. 9, p. 316 (Copenhagen, 1938).

On the coast, the first frosts usually occur in the middle of September and may occur at any time until the middle of May (see Appendix VI, table 7).

Owing to the small number of observations upon which Fig. 62 is based, too much attention should not be paid to the smooth curves of the isotherms, since they do not show irregularities due to local influences. At intervals, the drift ice on the north and east coasts of Iceland has a noticeable influence on the air temperature (see Fig. 64).

Average ground temperatures at Reykjavík are listed in Appendix VI, table 8.

Upper Air Temperature. Temperature changes with increase of altitude are subject to a wide range of variation. Data for Reykjavík are given in Appendix VI, table 9. There is a lapse rate of from 15° to 17° C. in the first 3,000 m. approximating to the adiabatic rate for saturated air.

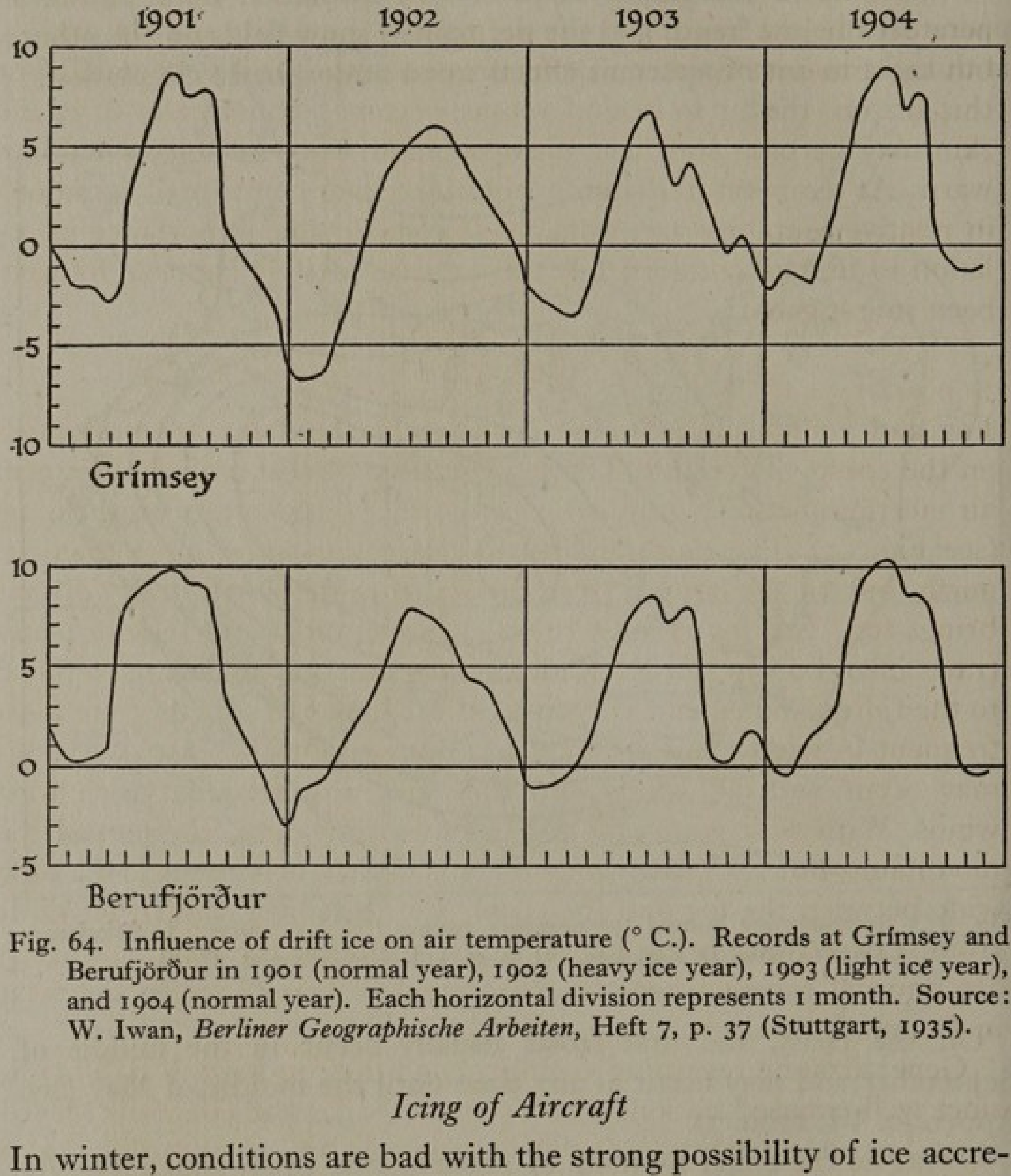


Fig. 64. Influence of drift ice on air temperature (° C.). Records at Grímsey and Berufjörður in 1901 (normal year), 1902 (heavy ice year), 1903 (light ice year), and 1904 (normal year). Each horizontal division represents 1 month. Source: W. Iwan, *Berliner Geographische Arbeiten*, Heft 7, p. 37 (Stuttgart, 1935).

Icing of Aircraft

In winter, conditions are bad with the strong possibility of ice accretion during precipitation, in many cases from the surface upwards. In summer, icing conditions seldom occur near the surface in the south; the average height of the freezing level is probably about 1,500–2,100 m. in midsummer, but falling to 600 m. with cold north-east winds. In the north, the freezing level is usually 1,200–1,500 m., but icing occurs occasionally at ground level in midsummer, and frequently at mountain level when there is bad weather from the north and north-east.

Humidity

Relative humidity is high throughout the year, averaging about 80%, with only small variations from month to month. At temperatures below freezing point the relative humidity may be 100%, but the amount of water vapour present in the air is very small. For this reason, the air in heated rooms becomes abnormally dry; the skin may become sore and chapped, and wooden objects tend to warp. At temperatures slightly above freezing point small variations in relative humidity are probably of considerable importance in relation to human comfort, but the subject does not appear to have been investigated.

Visibility

Fog and poor visibility cause considerable hindrance to navigation on the coasts of Iceland. The fog is caused almost entirely by warm air meeting the steep gradient of sea surface temperature off the coast (see Fig. 55). The south and south-east coasts suffer more than the north, but on the latter a fresh breeze from the north nearly always brings fog. Sea fog is most prevalent in summer and seldom penetrates inland or up fjords. Radiation fog and sea smoke are confined to the fjords and extend very little, if at all, out to sea; they are most frequent in winter and are rare in summer. On the east coast fogs may occur with all winds, but they are most frequent with west winds. With west winds the fog extends right up to the foot of the mountains, but with east winds there is often a belt about half a mile wide between the fog and the coast. On the south coast it is winds from seaward that bring fog and rain, while on the west coast fogs are unusual except when there are great masses of ice to the west in Denmark Strait.

Generalization regarding visibility conditions in Iceland is difficult, since well-exposed stations, like Vestmannaeyjar and Grímsey, record most fog in midsummer, while Reykjavík and Akureyri show a distinct maximum in January, February and March. This is due to the contrast between real sea fog in exposed situations, and drifting snow, frost smoke, or dust from the lava deserts in the interior. Proper comparison between the two sets of data is difficult, but an attempt to express them in common terms has been made in Appendix VI, table 10.

Sea fog is usually only from 60 to 90 m. thick and appears to be most common in the east, where Papey records from 60 to 70 days with fog, as compared with only about 8 days per year at Stykkishólmur. Akureyri, with its alternation of sea and land breezes (see p. 97), appears to be the only locality in which a marked contrast has been recorded between misty mornings and clear evenings.

Polar air in Iceland (i.e. air belonging to these parts and latitudes) has an opalescent quality whereby although mountains 50 or 60 km. away can usually be seen from near sea level, they appear blue and are seen without detail except in outline. Extreme visibility, with detail in the distant view, occurs at Reykjavík in föhn air from the north-east. Visibility in Iceland is seldom less than 'good' (16 km.) unless there is precipitation or actual fog. Intermediate degrees of haze appear to be rare. 'Very good visibility' (48 km.) occurs during 50–60% of all observations at Reykjavík. During aerological flights of the Dutch Polar Year Expedition to Reykjavík in 1932–3, the observers were frequently able to see the mountains of Greenland, 300 km. away, from a height of 600 m.

Clouds

The cloud-cover shows little seasonal variation. Average figures for four stations are listed in Appendix VI, table 11. At Vestmannaeyjar about 1 day in 12 may be reckoned as 'clear' (less than two-tenths). On the south and west coasts about 1 day in 3 is 'overcast' (greater than eight-tenths), while at Grímsey 1 day in 2 is 'overcast'.

Precipitation and Snow-cover

Rainfall

The climate of Iceland is prevailingly very damp. At sea level the conditions closely resemble those on the highest moorlands of north England. Evaporation is slow, and drizzle, sleet or wet snow occur very frequently, although the amount of precipitation is rarely sufficient to record high totals in any one day. As the rainfall is usually accompanied by strong winds, the weather is frequently very unpleasant for man and beast.

The amount of precipitation varies greatly in different parts of Iceland, but four regions may be distinguished (Fig. 65). Recorded totals are greatest along the south and south-east coasts, where the rainfall reaches 2,175 mm. at Vík. Here the greatest fall is in January, about 213 mm., and the dryest period is in July and August, with about 109 mm. in each month. The wettest inhabited region is undoubtedly the narrow strip of land lying between the southern ice-caps and the sea, but quite exceptional conditions exist on the ice-caps themselves, and the southern margin of Vatnajökull must be considered as a separate precipitation region (see p. 39). Average monthly rainfall figures for seven stations are listed in Appendix VI, table 12. Measurable precipitation in the south-western lowlands is recorded on 150–200 days a year, a figure comparable with north England; but there are many more days on which small amounts of precipitation are associated with a general impression of cool, even raw dampness.

Along the west coast the rainfall is lower, and is still less on the north coast, where the annual totals are from 300 to 550 mm., with monthly totals ranging from about 20 mm. in spring and summer,

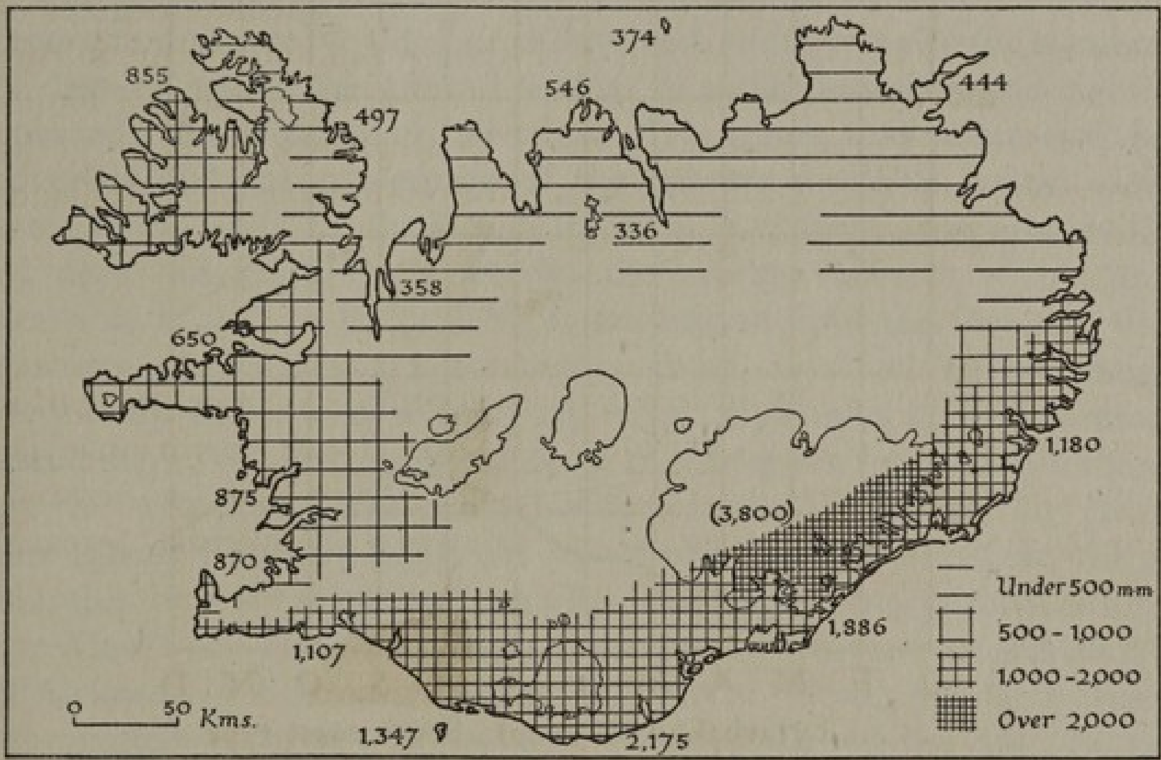


Fig. 65. Estimated rainfall regions. Annual means for 50 years are given in mm. On the south margin of Vatnajökull precipitation was measured in 1936–7.

to 40 or 50 mm. in the later months of the year. In general, the greater part of the precipitation in any locality occurs with the winds from the sea. The driest weather in any part of Iceland is associated with winds that have passed across the island.

There are no continuous reports of precipitation from the interior. It is probable that the very high figures recorded on the southern slopes of Vatnajökull are only typical of this limited region. The decrease in snowfall from south to north is one of the most striking features of the ice-cap. In the south, orographic precipitation is high owing to the frequency of moisture-laden winds which meet the steeply rising plateau and cause the very heavy snowfall at higher levels on Vatnajökull.

The total amount of precipitation shows a similar seasonal distribution in each of the three main rainfall regions (see Fig. 66, and Appendix VI, table 12). Rainfall usually reaches a maximum in early autumn (September and October). This is especially marked on the south and west coasts, but throughout the island the number of days on which precipitation falls is greatest during the winter months (see Appendix VI, table 13). During 50 years of observation

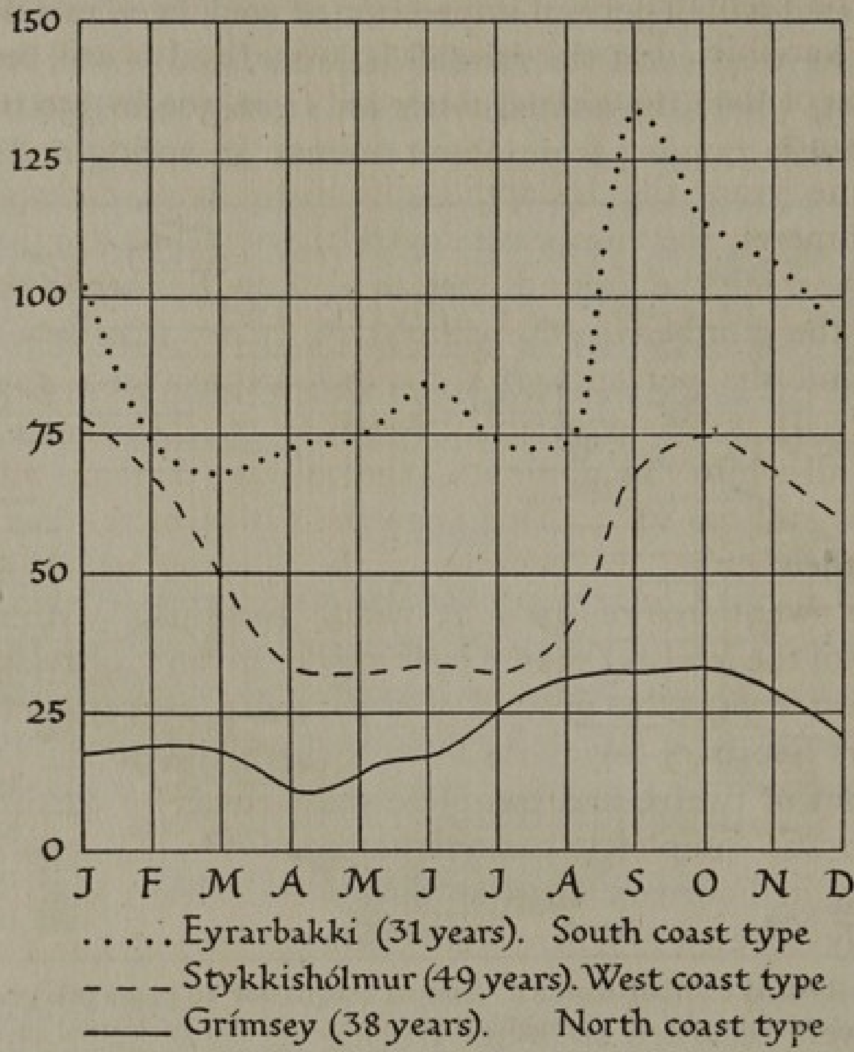


Fig. 66. Monthly rainfall averages (mm.). Source: W. Iwan, *Berliner Geographische Arbeiten*, Heft 7, p. 39 (Stuttgart, 1935).

at Vestmannaeyjar there were less than 112 mm. on forty occasions in August, whilst in September this figure was greater than 112 mm. on thirty-eight occasions. Such a contrast indicates some quite fundamental change in the atmospheric conditions between mid-August and mid-September. The reasons for this abrupt change remain obscure, but are possibly connected with changes in the direction of cyclone tracks owing to the return of cold conditions in the Arctic.

Snow and Snow-cover

Coastal Lowlands. Snow falls frequently during the winter, especially in the north-west peninsula and towards the north-east coast. At the coastal settlements, in most years the number of days with snowfall and snow-cover is greatest in the north-west. The number of days with snowfall ranges from about 40 in the south-east to 100 or more in the north-west.

In the southern lowlands the number of days with rain approaches or slightly exceeds the number with snow—even in mid-winter. It will thus be seen that the extent and persistence of snow-cover is decidedly variable. Excessive drifting over the treeless moors may leave much of the ground bare, especially towards the coast, with its stronger winds.

For some years the Icelandic authorities have endeavoured to record not merely the number of days with snow, but also the number of days on which the ground is clear of snow (less than one-eighth covered); the number of 'all-white' days (more than seven-eighths covered) and the percentage of the pasture available round each settlement. It is by no means unusual to observe that even with 25 days 'all-white' in a month, the average amount of pasture available is still 70–80%. This is an indication of the fact that the pastures themselves are commonly those areas which are most frequently swept free of snow by wind. Examples of the extreme variability of the lowland snow-cover may be given: at Stykkishólmur on the west coast, the ground was recorded as completely clear throughout February 1932. At Þórustaðir in the north-west, three Marches out of twelve had complete snow-cover for 31 days, while one March was completely clear throughout. On the exposed island of Grímsey in February 1930 no days were 'clear', yet none were 'completely covered'. Whereas at Grímsey during the past 10–11 years the average number of 'all-white' days was only 32, only 241 days were recorded as 'all clear'.

Tables 15 and 16 in Appendix VI may be consulted for average frequencies, but it is stressed that variations from year to year are large. For comparison: if 'snow-lying' in Iceland were recorded in the same manner as in Britain (more than half the ground covered at station level), yearly averages would be found of about 45 days in the extreme south of Iceland, between 75 and 80 at Reykjavík and Berufjörður, upwards of 120 on the north-east coast and about 140 in the north-west peninsula (cf. Hampstead 12, Harrogate 21, Balmoral 60 days).

Based on the past 12 years, in south and south-west Iceland the last occurrence of snow in spring is generally early in May, while the first snow of autumn falls early in October. In northern Iceland occasional snow showers may occur even in summer. It is of some interest to note that, since 1926 at least, the winter climate of Iceland has in general been distinctly milder than that which prevailed during the period from 1873 to 1920, which forms the basis of previous discussions. Stykkishólmur, for example, has averaged 58 days with snow since 1927, whereas the former average was 81 days. For Grímsey the corresponding figures are 46 and 56. The rise of sea temperature in recent years (see Appendix VI, table 1) and the absence of drift ice are of interest in this connection.

Interior Uplands. In very recent years observations of the frequency of snow-cover on the *fell* near each station have been kept, the average height being taken as 600 m. These are too brief for extensive discussion, but it is clear that whatever the vicissitudes at lower levels, snow covers the ground at 600 m. almost continuously for 6 months (late October to late April) and that a good deal remains into June.

Figures are given in Appendix VI, tables 15 and 16, for one upland station towards the north (Grímsstaðir, 385 m.). Snow has been recorded here in every month of the year. While even at this level occasional 'all-clear' days are experienced in winter, four Aprils out of twelve have had 25 or more days 'all white', and snow-cover must be expected for a day or two in June and September. The aggregate number of days with snow-cover is about 150.

No continuous observations are available from the high plateaux and ice-caps. Indeed, the combination of excessively heavy snowfall at all seasons, with intermittent rain and violent winds, affords a series of climatic obstacles only to be overcome by a well-equipped expedition.

Sunshine

The average annual amount of 'bright sunshine' at Reykjavík is about the same as that at Aberdeen. As in Scotland, there are considerable variations from year to year and from month to month; for example, the total for July (average 205 hr., 1927–38; average at Greenwich 195 hr.) has varied from 117 to 308 hr. The averages from the other recording station, Akureyri, are throughout lower than at Reykjavík (see Appendix VI, table 14).

Thunderstorms

Thunder very rarely occurs in summer, but may occur once or twice each winter in exceptionally stormy weather.

Chapter IV

VEGETATION

Introduction: Distribution of Main Types: Deserts and Oases: Modifications due to Changes in the Environment

INTRODUCTION

Only a small part of Iceland is covered with a continuous carpet of vegetation. Even in the lowlying inhabited districts, large areas are occupied by rocks, bare stony deserts, sandy wastes and lava streams. The plants which are found therefore attract greater attention and interest than in more southern countries, where they are accepted as part of the normal familiar landscape.

The rigorous climate and similarity of soils, formed from basaltic rocks and their weathering products, are probably responsible even more than the isolated position of the island for the relatively small number of species. The most recent work on the Iceland flora gives a total of only 375 phanerogams (flowering plants) and vascular cryptogams (plants having no proper flowers), as compared with a corresponding figure of 2,323 for the British Isles.

Of the higher plants, the majority of the species belong to the Cyperaceae (grass-like herbs), of which there are forty-four, and the Gramineae (grasses), of which there are forty. There are twenty-five species of Compositae (herbaceous plants and shrubs), twenty-two of Cruciferae (plants having flowers with four petals), seventeen of Juncaceae (rushes) and seventeen of Filicales (ferns). The lower plants have not yet been closely investigated, but about 350 mosses, 250 lichens, and 550 fungi are known.

It is probable that the present vegetation of Iceland bears some resemblance to that of the British Isles at the close of the Quaternary Ice Age. The main interest of botanical studies in Iceland for British biologists therefore lies in their use in interpreting various problems connected with the northern element of the British flora, and in the help which they can provide in giving a clearer picture of the early post-glacial conditions in Britain.

There can be no doubt that the vegetation has been greatly modified during the ten centuries of the human occupation. The earliest colonists reported that the country was wooded 'from the coast to the mountains'. This was doubtless partly exaggeration intended to encourage colonization, but place names suggest that forests were present in places where they are now absent, e.g. Breiðamerkurjökull

= broad-wood glacier, Skogey = wood island, Sandmerkisheiði = sand-wood heath. According to tradition these were all wooded sites, the woods having been destroyed in the thirteenth and fourteenth centuries. Further evidence is provided by the discovery of birch trunks of considerable size in peat deposits, and by historical records. It has been estimated that between 4,000 and 5,000 sq. km. were covered with forest scrub at the beginning of the tenth century, but that by the beginning of the present century this area had been reduced to about 450 sq. km., or 0·44 % of the total area of the island.

Distribution of Main Types

The vegetation of Iceland has been classified by the Danish botanist H. M. Hansen into a number of convenient and easily recognizable types. Investigation of the peculiarities of the flora in various localities and at different altitudes shows that the low temperature in winter is the chief factor which determines the formation of these types of vegetation. The temperature of the soil varies according to the degree of snow-cover and water-cover, though in different ways. In winter the areas with constant snow-cover as well as those with constant water-cover are protected from the frost. Hence the result in both cases is a vegetation consisting principally of typically southern species, even though the two areas have not one species in common. The snow-bare vegetation, which is most exposed to the cold of winter, consists principally of typically arctic species, while the intermediate areas, both as regards environment and species, occupy an intermediate position.

A natural system of the Icelandic types of vegetation is therefore set out in the order of importance of the physical factors which influence the vegetation. It is convenient to use the Icelandic names for these types, for they are now commonly used in botanical literature abroad as well as in Iceland, and some of them are represented by special symbols on the 1 : 50,000 and 1 : 100,000 maps.

I. Vegetation not snow-covered in winter:
- (1) Thick moss carpet... ... ... *Mosathembur* (moss heath, *Grimmia* heath)
- (2) Gravel, with very scattered vegetation ... *Melar* (fell field)

II. Vegetation with normal winter snow-cover:
- (1) On dry soil... ... ... *Mo*
- (2) On moderately moist soil:
  - (*a*) Continuous vegetation, surface level *Valllendi*
  - (*b*) Continuous vegetation, many knolls *Jaðar* (grass *mo*)
  - (*c*) Knoll vegetation, scattered on bare soil *Flag* (clayey flats)

(3) On moist soil	*Mýri*
(*a*) With stagnant water	*Fór mýri* (swampy *mýri*)
(*b*) With running water	*Fét mýri*
(*c*) At springs	*Halla mýri*
(4) On soil always covered with water:	
(*a*) With stagnant water	*Flói*
(*b*) With running water	*Fén*
(*c*) At springs	*Dý*

III. Vegetation with deep snow-cover for most of the year:

(1) Normal light conditions, no leaf fall ...	*Geiri* (snow patch)
(2) Shade and leaf-fall	Forest ground

In any typical lowland area of south Iceland the country appears in summer as an immense monotonous greyish green carpet sprinkled with patches of a yellowish or vivid green colour. The three colours represent the three most widespread types of vegetation: the *mo*, which forms the bulk of the vegetation, the *mosathembur*, which covers the more prominent parts of the landscape as a yellowish moss carpet, and the *geiri*, which form fresh green oases in the shelter of slopes and hills or in the old beds of rivulets. In spring, when the snow has largely melted, the *mo* and *mosathembur* vegetations have their natural colour, while the snow still covers the *geiri* vegetation. In winter, the *mo* as well as the *geiri* are covered with snow, while the *mosathembur* vegetation is bare.

The following is a brief description of the major types of vegetation:

Mosathembur vegetation is found in exposed situations where the snow is at once swept away by wind in the winter. Even at great distances it is easily recognizable by its yellowish colour, due to *Grimmia hypnoides*, which covers the surface in a dense and springy carpet. In this moss carpet there occurs a scattered vegetation of high arctic plants poor in species. *Mosathembur* vegetation seems to be peculiar to the higher levels of the rainy and foggy east, south and south-west of Iceland.

Melar vegetation is found when large areas of *Grimmia* heath are swept almost bare by wind erosion, leaving a surface which is paved with scattered stones dispersed in the layer of mould. It is peculiar to *melar*, in contrast with other types of vegetation, that it is the colour and appearance of the soil rather than of the plant cover which dominates the landscape. In the lowlands it occurs to the greatest extent near the sea, but it is more common in the highlands where for miles there is often no other vegetation. The surface is dry, and the stones frequently arrange themselves in the form of polygons (see

p. 56). The vegetation is open, but with a relatively high density and number of species in individual patches.

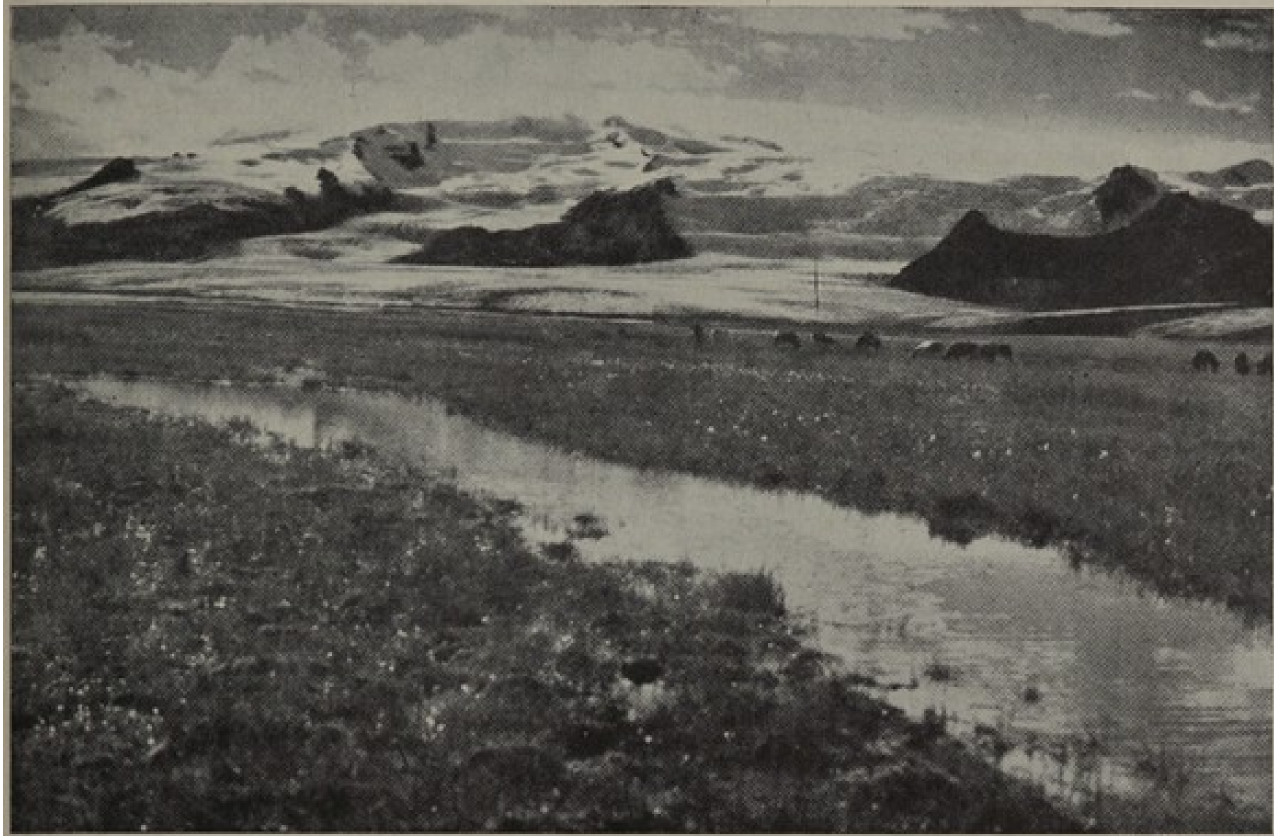
Mo vegetation is the commonest and most widely distributed type of vegetation in the lowlands. The term *mo* includes all vegetation forms which are normally covered with snow in the winter, whose degree of moisture is exclusively determined by the precipitation, not by the ground water, the soil of which is uncultivated, and not covered with forest. The soil of the *mo* is always more or less covered with knolls (see p. 56). Where the surface is level or slightly inclined, the knolls are almost polygonal, perhaps half a metre high and broad, and separated from each other by narrow furrows. Where the soil is more inclined, the knolls grow smaller and elongate and arrange themselves in rows along the contours. On steeper slopes, the soil frequently creeps downhill, leaving the upper sides of the knolls bare of vegetation. The *mo* vegetation is very dense and rich in species, and consists of an equal mixture of arctic and southern plants. Usually the landscape is dominated by grasses and dwarf willow (*Salix herbacea*).

Jaðar vegetation has a normal snow-cover in winter like the *mo*, but it is confined to soils which are dry in summer and wet in winter. The surface has large knolls and is covered with a dense vegetation rich in species. Both the number and density of species attain their maximum in *jaðar*. The vegetation consists of an equal mixture of arctic and southern species.

Valllendi vegetation is a variant of *jaðar*, characteristic of level surfaces with a luxuriant carpet, principally composed of grass and moss. There is no knoll formation, and the vegetation is that of a more southern environment.

Flag vegetation is characteristic of bare clayey flats with scattered knolls and stones. The plant growth is scant. Arctic species are more dominant than in the two preceding types.

Mýri vegetation (Plate 57) is found in areas where the degree of moisture is determined both by the precipitation and the ground water. These stretches are known as *mýrar*. Owing to the abundant precipitation, *mýri* is very extensively distributed throughout the Icelandic lowlands wherever there is standing water not derived directly from glaciers. The soil must not, however, be covered with water throughout the year. The vegetation consists of an equal mixture of arctic and southern plants. The characteristic plant at the water's edge is cotton grass (*Eriophorum*), with rushes and sedges growing in the shallow water. This type of vegetation always presents a luxuriant appearance,



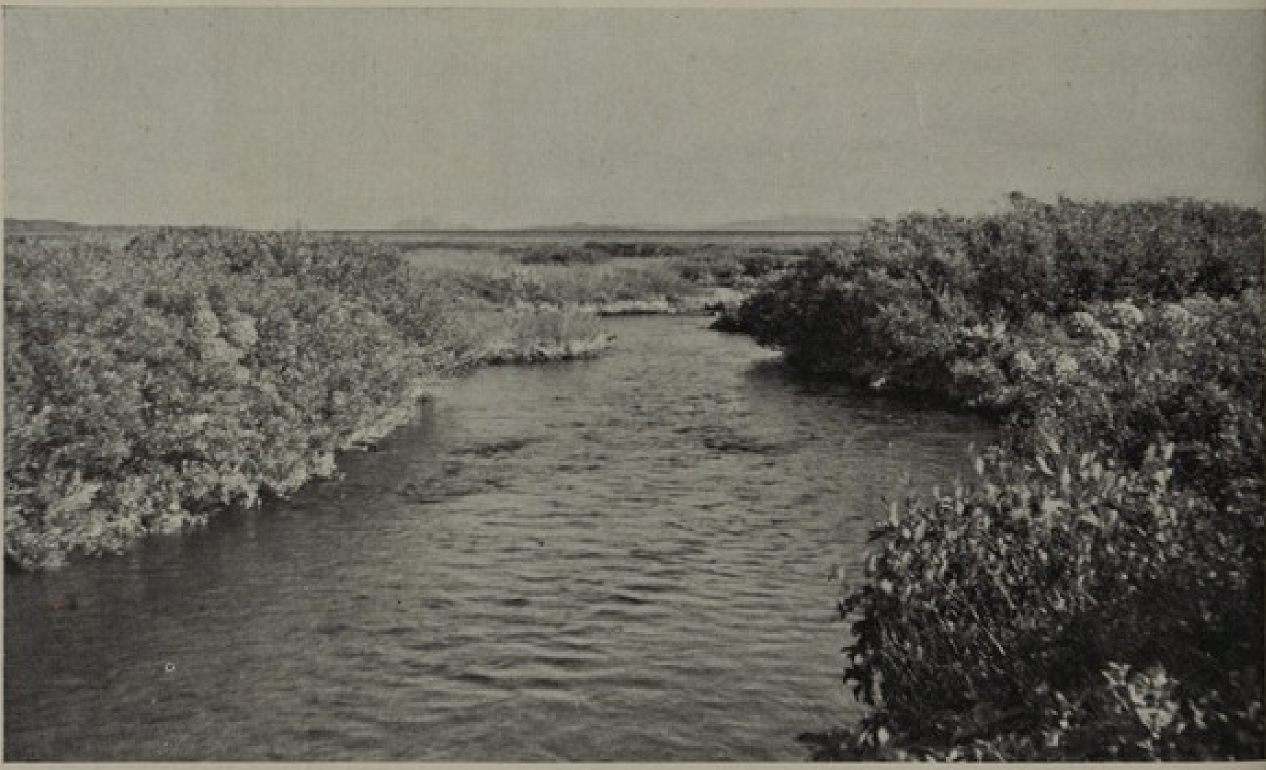
P. Hannesson

Plate 57. Many of the volcanoes are covered with glaciers. Öræfajökull, the highest mountain in Iceland (2,119 m.), was last active in 1727. Note the *mýri* vegetation in the foreground.

Plate 58. Birch grove near the hospital in Akureyri. In the ninth century there was much forest of this type in Iceland 'between the mountains and the foreshore', but since then most of it has been destroyed by grazing sheep and wood cutting for fuel. The 'South Quay' is seen in the background.

W. Heering

Plate 59. Cotton grass near Hvítárvatn.



M. M. Swann

Plate 60. Oasis at Herðubreiðarlindir. There is a dense growth of *Salix* on the banks of the stream.

although the number and density of the species are appreciably less than in *mo* and *jaðar*. It is found in all swampy areas and on the banks of rivers, especially in deltas near the sea. Where there is less water, grasses and mosses become more common, and the *mýri* passes into *mo*.

Flói vegetation develops only where the soil is covered with water during the greater part of the year. The surface is level, without knolls. The vegetation is very scattered and poor in species and consists almost exclusively of southern plants.

Geiri vegetation occurs where the snow forms a covering early in the autumn, remains on the ground in a fairly deep layer throughout the winter, and does not melt until late spring. This is the vegetation of the snow patches. It is characteristic of the snow patch that the underlying ground is never knolly as is the case with the surrounding *mo*, and further that the vegetation is fairly luxuriant. These two circumstances make *geiri* very conspicuous even from considerable distances. The species found vary with differences in the depth and duration of the snow-cover and the altitude, but they are mainly southern plants which require the highest temperatures.

Forests

As already stated, Iceland formerly had a relatively large proportion of woodland, although the word forest (*skógur*), when applied to Iceland, carries a somewhat different meaning from that which it has in Norway, from which the first settlers brought the word. The forests consisted, and consist where they still exist, mainly of dwarf willows (*Salix* species), birch, and mountain ash (*Sorbus aucuparia*). The forest-forming birch (Plates 58 and 92) is the mountain species (*Betula odorata*), while the dwarf or scrub birch (*Betula nana*), which is also common, creeps along the ground. In some places the birch attains a height of 4 m. The undergrowth resembles the *geiri* vegetation already described. As in many other countries, the natural supply of wood was thoughtlessly used up. Timber was needed for houses and boats, although driftwood provided some of the heavier building material. Wood was, of course, used for fires, and great quantities were consumed as charcoal for the smithies. Sheep, goats, cattle and horses were left free to strip the branches from the trees, and during exceptionally hard years the people harvested the leaves to eke out the supply of fodder. Even brushwood and heather were taken, and the wind carried off the loose exposed soil so that nothing was left but gravel and lava on which no new vegetation could grow. Volcanic action also contributed to the devastation. Only in a few favoured spots, especially where there is shelter from the wind, are woods still to be found, but in recent years trees have begun to appear in new places (see p. 299). Building material is largely supplied from other sources; people no longer forge their own scythes in charcoal fires, and the cattle are given other kinds of fodder.

The Distribution of Vegetation at Different Altitudes

In broad outline, the vegetation types described above are distributed in the altitude zones of Iceland as follows:

Lowlands. 0–300 m. Forest, *mo*, *jaðar*, *flag*, *mýri*, *flói*, *dý*, *fén* and *melar*.

Lower Highland Zone. 300–600 m. *melar*, *mosathembur*, *mo*, *jaðar*, *mýri*, *flói*, *dý*, and *geiri*.

Upper Highland Zone. 600–800 m. Either *melar* or *geiri*.

Snow Zone. 800–1,200 m. Very scattered *melar* with frequent snow drifts. Above about 1,200 m. all the higher types of vegetation are excluded on account of the continuous snow-covering.

Deserts and Oases

All the country above about 600 m. may be regarded as desert (Plates 18, 21 and 22). In spite of considerable precipitation the plants suffer from drought. Over large areas the water disappears immediately owing to the porous nature of the lava, volcanic gravel and blown sand. The movement of the surface soil by wind action and on slopes also hinders plant growth. The few plants that exist in these inland wastes are widely scattered. It is possible to walk in the valleys for days without seeing any healthy plants other than sea lyme grass (*Elymus arenarius*) and sea pink (*Armeria maritima*); but above the scree slopes the weathered lava may support dwarf willow, fescue grass, mountain sorrel, and saxifrages of several species.

Scattered in the desert area are occasional oases with a denser vegetation. These are found in places where water is present, especially where springs issue from under the edge of the lava streams. Some of these plant patches are only a few square metres in extent, and the largest of them are little more than 2 sq. km. in area. They often originate around hot springs, the temperature of which need not be very high, but is frequently somewhat higher than the average temperature of the locality at which they rise. Thus north-west of Vatnajökull there are oases near Gæsavotn, 929 m. above sea level, where the springs have a temperature of 5–7° C.; near Marteinsflæða at 744 m., with a spring temperature of 35° C.; and near Hitalaug at 672 m., with a temperature of 33° C. The oases have a characteristic flora of willows (*Salix* species) and grasses, with eyebright (*Euphrasia latifolia*) and *Polygonum viviparum* forming a type of heath, giving way to swamps with cotton grass (*Eriophorum scheuzeri*) and species of rush and sedge in the wetter parts (Plates 59 and 60). The height of the soil surface above the water level appears to determine the existence of vegetation zones round the oases. Where the height of the soil surface is not more than about ½ m. above the water level, the riverside community or swamp dominated by cotton grass can exist. At heights from ½ to 1 m. the willow community exists, and above that only sea lyme grass occurs, probably because this species can exist in the sand dunes by the depth of its root system.

It is difficult to plot the positions of the oases on a map, partly because the central desert has not yet been accurately surveyed, and partly because the oases themselves are unstable. Some of them change in size or disappear altogether, while new ones appear with alterations in the courses of streams or changes in the direction and quantity of water draining beneath the sand. Fig. 67 is prepared from records collected over a large number of years, and therefore represents only a general idea of the conditions likely to be found in any one year.

Modifications due to Changes in the Environment

It is important to note that the classification of vegetation types described above is related to existing climatic conditions. This should not suggest that the vegetation is static, for if it is to be considered intelligently a primary distinction must be drawn between 'climax vegetation', which is in relative equilibrium with all the conditions to which it is subject, and 'seral vegetation', which is on its way to change into something else.

In any area, the natural vegetation varies according to its age in that area. When a bare surface is presented to colonization by plants, these settle upon it and establish themselves in a more or less definite sequence. All the plants which actually settle, at whatever time, must of course be able to tolerate the prevailing climatic conditions, the fundamental soil characters, and other conditions such as the local land relief. Of those species whose seeds or spores are transported to the area, some will arrive before others, or in greater numbers, and

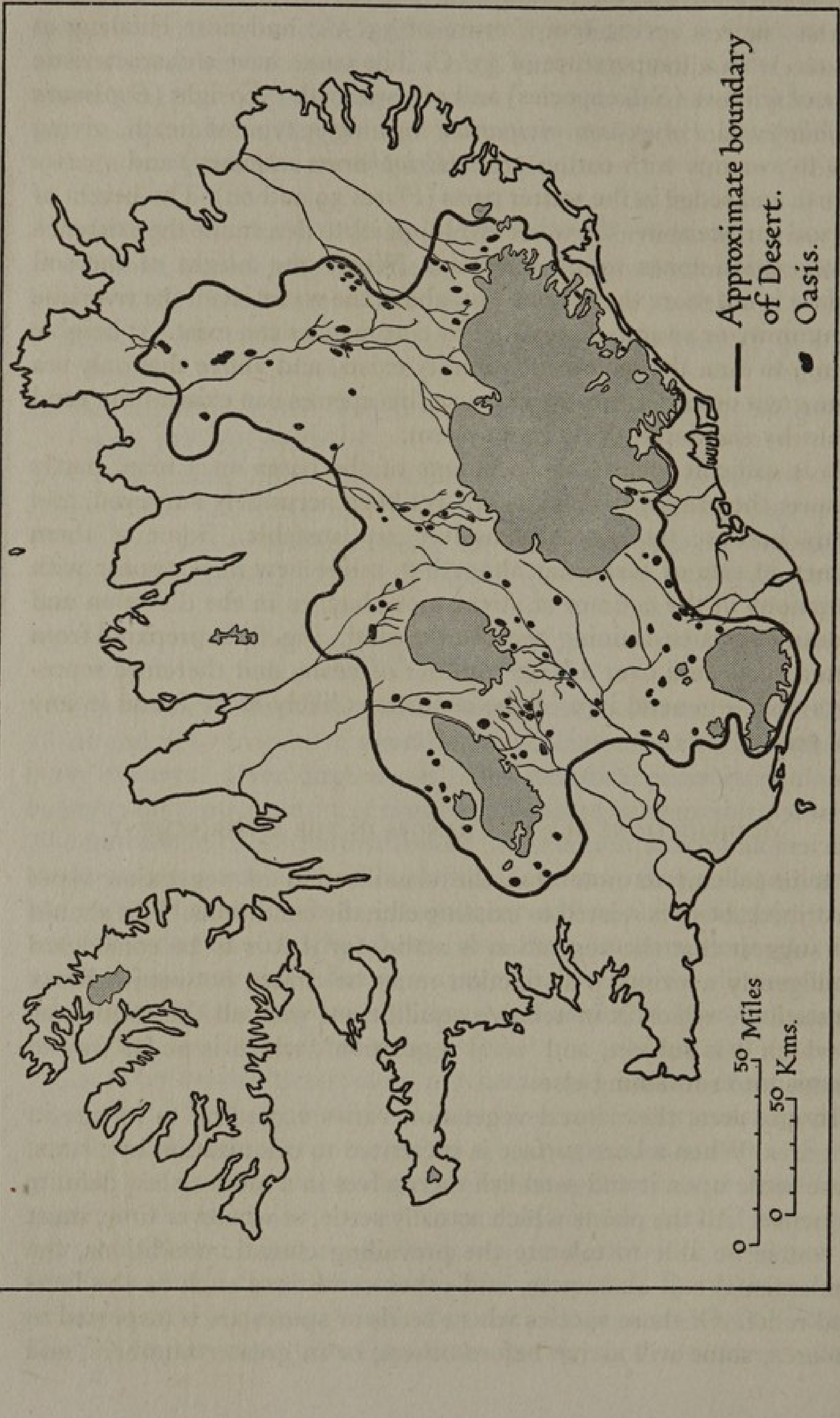


Fig. 67. Sketch map to show the central desert region and the main oases.

only some will be able to establish themselves. These are the 'pioneers' of the 'succession' that will ensue. The habitat will then be progressively modified partly by forces independent of the vegetation, partly by the activities of the plants themselves. Thus, if the primary habitat is bare rock, the surface of this will disintegrate, slowly or rapidly, mainly by weathering, but also by the action of the plants. If it is composed of loose soil, the surface layers will be modified by the same two agencies, the contribution of the plants being partly the shelter they afford to newcomers which could not tolerate completely exposed positions, and partly the gradual accumulation of their dead parts to form additional soil. These changes enable other species to establish themselves. As the available space becomes filled, a new factor, competition, comes into play, resulting in the failure to establish themselves or later death of some individuals.

In these ways the first plant communities to appear are gradually suppressed and superseded by others. This succession of communities culminates in a 'climax' community dominated usually by the largest plants which can arrive and flourish under the particular conditions.

In spite of the fact that so much of Iceland is unaffected by human activities, a relatively small proportion of the vegetation consists of 'climax' types in equilibrium with their environment. Many agencies are constantly at work to destroy them. Completely new bare soils are formed by rivers in flood laying down tracts of gravel or silt; by the high tides in estuaries and lagoons spreading layers of mud between tide marks; by the wind blowing of sand; by the retreat of glaciers and ice caps exposing ground moraine; by the accumulation of talus fallen from mountain cliffs and moving screes; by the frost shattering of rocks; by the eruption of volcanoes spreading lava and ash over the surrounding country. All these soils, except in the most unfavourable regions, are colonized by pioneer communities of various kinds, followed by regularly succeeding populations. Considerable areas are thus always occupied by different stages of 'seral' vegetation. No visitor to Iceland can fail to be impressed by the continual changes that are taking place.

Chapter V

MEDICAL SERVICES AND HEALTH CONDITIONS

Administration: Main Diseases: Medical Personnel: Hospitals, etc.: Sanitation: Water Supply: Diet: Insect Pests

Until about 1890 health conditions in Iceland were in most respects truly medieval. Volcanic eruptions, famines, and diseases repeatedly decimated the population. The progress which has been made during the last forty years in raising the general health standard is remarkable. Details of some of the health insurance and other social reforms concerning the improvement of the standard of living will be found on pp. 342–5. This chapter deals with the present-day organization of medical services.

Administration

The administration of public health affairs is in charge of a Minister who combines this office with one of the other Ministries, as convenient. The executive officer and expert adviser to the government is a medically trained official, the Director of Public Health (*Landlæknir*), who is a permanent official. Other appointments include a medical officer in charge of anti-tuberculosis measures, the chief medical officer of the Social Insurance Institution, and a Director of State Food Control.

The country is divided into forty-nine* medical districts or *Lækhishéruð* (see Fig. 68), each with a district physician in charge. In addition, committees are appointed to enforce specific regulations. For example, there are sanitation committees to supervise disinfection, vaccination, and animal diseases such as hydatids (tape worms), which are communicable to humans. They also supervise quarantine regulations on both Icelandic and foreign ships. Local inspectors carry out the instructions of these committees. In 1938 the total number of trained medical men in Iceland was 144, or one to every 820 people.

* In May 1940 an act was passed to make one more district in the neighbourhood of Reykjavík.

Main Diseases

Iceland is still visited by a great number of epidemics. Influenza, measles and whooping cough, which have been endemic in other places, are periodically brought into the country and become major epidemics. This is largely due to the isolated position of the country. Influenza comes about once every two years and is epidemic for about three months. Rheumatic fever is rare. Typhoid is very rare, and there are few countries with a lower death-rate from diphtheria.

Iceland is usually considered to have three endemic diseases of special local interest—leprosy, hydatids (echinococcosis or tapeworm infection), and tetanus in small children. Tetanus has not been reported in recent years. The Leprosy Acts of 1898 and 1909 provide free supervision and quarantine. Only twenty-eight lepers were left in 1938, most of them old people, and it is probable that the disease will die with them. Hydatid disease was until recently one of the most frequent things that Icelandic surgeons had to deal with. It was estimated in 1880 that at least one in every sixty persons was afflicted. The Hydatids Acts of 1890 and 1924 provide for instruction as to the nature of the disease and outline preventive measures, the most important of which are the curing of tapeworm in dogs and the improved control of slaughterhouses. The act is carried out through funds from the sale of dog licences. By its provision dogs may be limited in number, or even forbidden entirely, as has been done in Reykjavík. These control measures have proved so effective that very few cases are now reported.

The disease which is now of the greatest social importance is undoubtedly tuberculosis. This has only been a serious cause of trouble since the latter half of the nineteenth century, just when health conditions were improving in nearly every other respect. The chief measure taken by the authorities has been to care for patients in special free hospitals, and this seems now to be having some effect (see Fig. 69). In former times it was not unusual for doctors to treat as many as 2,000 tuberculosis cases in every year, and for a time it was one of the chief causes of death. In 1930 the disease reached its peak, with 232 deaths (in a population of 111,555). During 1933 there was a decrease to 173, and in 1934 to 149. This improvement has continued since, except that in 1936 an epidemic of measles and whooping cough caused the deaths to rise to 165. The 1938 tuberculosis rate was less than 9 deaths per ten thousand, but it is still too high. Tuberculosis is now sixth on the list of causes of death.

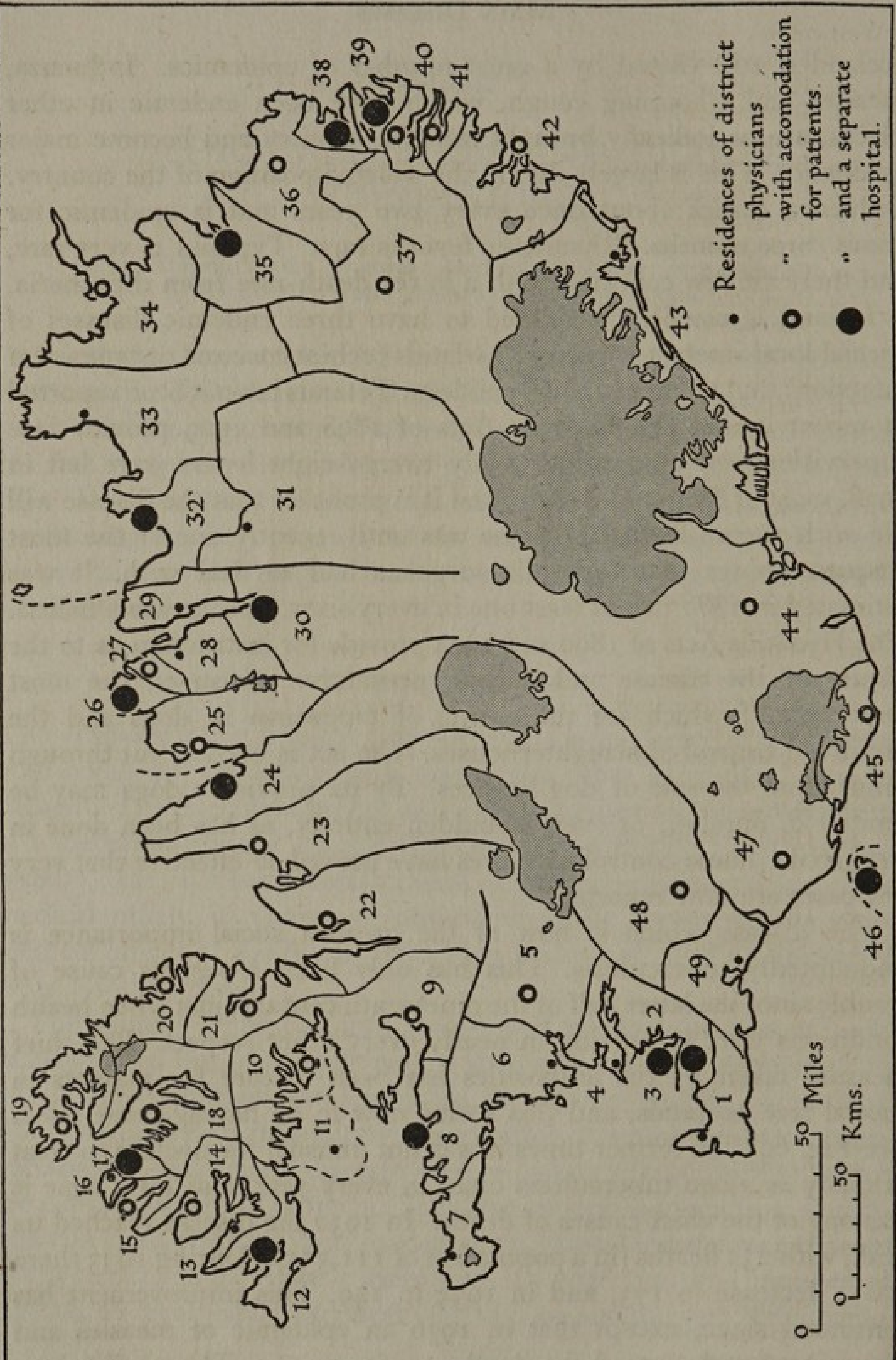


Fig. 68. Medical districts. Source: *Heilbrigðisskýrslur*, 1938, p. 161 (Reykjavík, 1940).

Key to Fig. 68

Medical district	Residences of district physicians and hospitals	Population in 1938
West coast		
1. Keflavíkurhérað	Keflavík	3,229
2. Hafnarfjarðarhérað	Hafnarfjörður	5,053
3. Reykjavíkurhérað	Reykjavík	37,765
4. Skipaskagahérað	Akranes	2,253
5. Borgarfjarðarhérað	Kleppjárnsreykir	1,328
6. Börgarneshérað	Börgarnes	1,544
7. Ólafsvíkurhérað	Ólafsvík	1,522
8. Stykkishólmshérað	Stykkishólmur	1,549
9. Dalahérað	Buðardalur	1,466
10. Reykhólahérað	Reykhólar	467
11. Flateyjarhérað	Flatey	458
12. Patreksfjarðarhérað	Patreksfjörður	1,555
13. Bildudalshérað	Bildudalur	590
14. Þingeyrarhérað	Þingeyri	1,132
15. Flateyrarhérað	Flateyri	1,218
16. Hólshérað	Bolungarvík	725
17. Ísafjarðarhérað	Ísafjörður	3,149
18. Nauteyrarhérað	Ögur	1,005
19. Hesteyrarhérað	Hesteyri	643
North coast		
20. Reykjarfjarðarhérað	Arnes	521
21. Hólmavíkurhérað	Hólmavík	1,267
22. Miðfjarðarhérað	Hvammstangi	1,807
23. Blönduóshérað	Blönduós	2,113
24. Sauðarkrókshérað	Sauðarkrókur	2,535
25. Hofsóshérað	Hofsós	1,391
26. Siglufjarðarhérað	Siglufjörður	2,828
27. Svarfdælahérað	Olafsfjörður	896
28. Höfðahverfishérað	Dalvík	1,780
29. Höfðahverfishérað	Grenívík	595
30. Akureyrarhérað	Akureyri	7,927
31. Reykdælahérað	Breiðamyri	1,225
32. Húsavíkurhérað	Húsavík	1,932
33. Axarfjarðarhérað	Kópasker	1,060
East coast		
34. Þistilfjarðarhérað	Þórshöfn	1,045
35. Vopnafjarðarhérað	Vopnafjörður	716
36. Hróarstunguhérað	Hjaltastaður	1,118
37. Fljótsdalshérað	?	918
38. Seyðisfjarðarhérað	Seyðisfjörður	1,181
39. Norðfjarðarhérað	Nes	1,510
40. Reyðarfjarðarhérað	Eskifjörður	1,418
41. Fáskrúðsfjarðarhérað	Fáskrúðsfjörður	1,035
42. Berufjarðarhérað	Djúpivögur	878
43. Hornafjarðarhérað	Höfn	1,127
South coast		
44. Siðuhérað	Breiðabólsstaður	900
45. Mýrdalshérað	Vík	1,004
46. Vestmannaeyjahérað	Heimaey	3,506
47. Rangarhérað	Stórólfshvoll	3,114
48. Grímsneshérað	Laugarás	1,848
49. Eyrarbakkahérað	Eyrarbakki	3,043

Of the venereal diseases, gonorrhea is endemic and increasing in the towns, where numerous cases are brought in by Icelandic and foreign seamen. Cases are very rarely found in the rural districts. Syphilis is rare; in most cases the infection has been acquired abroad. Chancre is unknown. Free advice and medical aid are provided by the government. The law provides that all cases of venereal disease must be notified to the medical authorities, who have power to compel a sufferer to undergo treatment. Iceland is a party to the international agreement (Brussels, 1924) facilitating medical treatment for sailors of the mercantile marine. About 18% of the children are born out

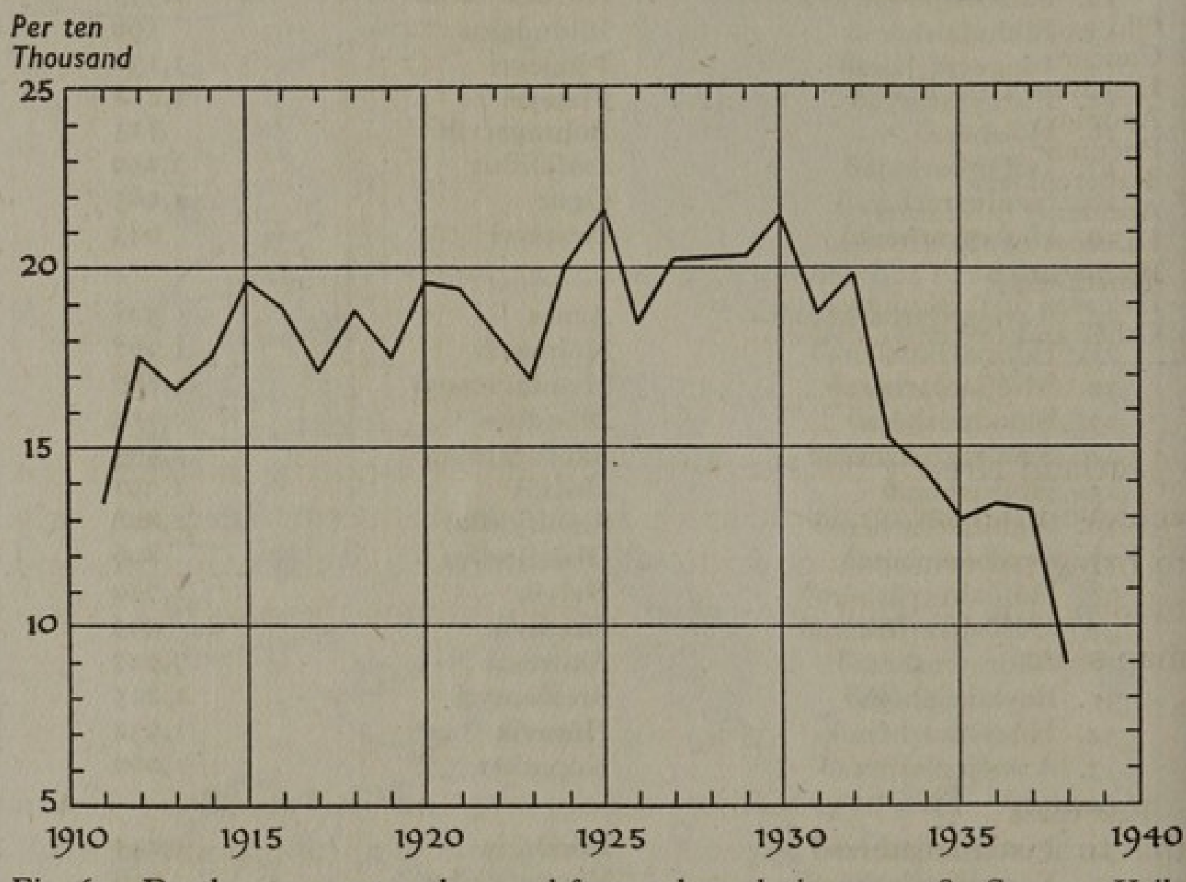


Fig. 69. Death rates per ten thousand from tuberculosis, 1911–38. Source: *Heilbrigðisskýrslur*, 1938, p. 183 (Reykjavík, 1940).

of wedlock. The corresponding figure for England and Wales is 4%, and for France 8%. The Icelandic Government guarantees to mothers of illegitimate children a maintenance allowance from the fathers, and there is no social stigma attached to such children. There is hardly any prostitution, but promiscuity is common in the towns.

Persons confined in lunatic asylums number about 3·5 per thousand, which is about the same as in other Scandinavian countries. Suicides are estimated at about 1 in 10,000. At least 300 cases of epilepsy are known, or up to 3 per thousand. Congenital mental deficiency is comparatively frequent. There are about 2 per thousand who on this account require permanent support from others.

Blindness is common, involving about 4 per thousand of the population, as compared with 0·5–0·7 in other Scandinavian countries. There are about sixty or seventy deaf and dumb. Dental caries, which used to be practically absent, is now one of the commonest troubles.

The most common causes of death (1938) are listed in the following table:

	Number	°/oo of deaths	°/oo of the population
Old age	184	153·1	1·6
Cancer	147	122·3	1·2
Diseases of the heart	135	112·3	1·1
Apoplexy	125	104·0	1·1
Pneumonia	114	94·8	1·0
Tuberculosis	106	88·2	0·9
Accidents (all forms)	75	62·4	0·6
Diseases of the arteries	34	28·3	0·3
Premature birth and debility of the newborn	27	22·5	0·2
Diseases of the kidneys	24	20·0	0·2
Other and unknown causes	231	192·1	2·0

Source: *Heilbrigðisskýrslur*, 1938, p. 189 (Reykjavík, 1940).

Iceland already has nearly the lowest death-rate in the world. To achieve international leadership in this field it seems necessary only to bring tuberculosis down to what is normal in other countries and to lower the accident rate, which is high through the risks of a fisherman's life.

Medical Personnel

Training. The first medical school was founded in 1876. Up to that time students had to receive their whole medical training abroad. When the University was founded in 1911, the medical school was incorporated in it and is at present attended by sixty to seventy students a year. The training takes six years and about ten candidates qualify each year.

The school of medicine is weak both in facilities for research work and in staff. It cannot stand comparison with foreign medical schools, but it does turn out fairly competent doctors for general practice. The students receive their practical training in the State Hospital and in the various isolation hospitals. Those who wish to specialize continue their training abroad, mainly in Denmark and Germany, and most Icelandic physicians have been abroad for a period of graduate study. Students of pharmaceutical chemistry must complete three years with a practising pharmaceutical chemist in Iceland, followed by a two-year course abroad. Dental surgeons or technicians and veterinary surgeons can only receive their training abroad.

All of the medical practitioners and other sanitary officers have their own associations, which are organized on the same lines as in other countries.

Conditions of work. District physicians combine health measures with the regular duties of their profession. It has, however, been proposed that this dual function be abolished so that they will be concerned only with direct public health work. At present there are only full-time health officers at Reykjavík and Akureyri.

The medical districts vary considerably in area and population. About half of them have populations of 1,000–2,000. Except in Reykjavík and some of the larger towns, the district physician is frequently the only doctor in the entire area. In large and sparsely populated districts the distance from his house to the remotest farms may be as much as 100 km. Over this he used to make his way on horse, on foot or skis. Formerly his journeys were often extremely difficult, especially in winter. Modern improvements now make such journeys rare. To-day all district physicians are within reach of telephone or telegraph. Bridge and road construction have made motor transport possible, and aeroplanes have proved useful in urgent cases.

District physicians are paid by the Treasury. Salaries are highest in the more sparsely populated regions, ranging from Kr. 4,500 down to Kr. 2,500 in the townships. Doctors who work in remote districts have the double advantage of a higher salary and lower living costs. Outside their state work they charge fees in accordance with a tariff fixed by the public health authorities. Their total annual income may range from Kr. 6,000 to Kr. 12,000.

Other doctors paid from government funds include professors and lecturers of the medical faculty at the University, the permanent staff of the larger hospitals, such specialists as the one in charge of the State Free Clinic for Venereal Diseases, and the school and poor-relief doctors.

There are about forty private practitioners in Reykjavík and about fifteen in other places in the island. As in some other countries, too many medical students are restricting their work to one speciality with a view to a town practice, for they find work among the rural population unattractive.

Medical Fees. There is a system of fixed payments for all medical services. According to the authorized tariff, district physicians are allowed to charge Kr. 2 for a simple examination; Kr. 3 to Kr. 6 for a thorough one. An extra Kr. 1 is allowed for visits at the patient's home, and fees may be increased by 50% for night calls. The fees for surgical operations range from Kr. 2 for slight operations, up to Kr. 80, with extra fixed charges for further attendance. When travelling, the doctor is to be paid, in addition to free means of conveyance, Kr. 2 an hour for the first 6 hr., Kr. 1 for the next 6 hr., and Kr. 0·50 an hour thereafter. This reduction is made for the benefit of those who live in remote districts. All doctors who receive a salary from the state are bound by these rates, but the schedule applies only to the native population. A foreigner may not be charged a higher fee than would be thought reasonable in his own country.

Private practitioners' fees are regulated by a tariff by which they are allowed to charge 50% more than district physicians, and specialists 100% more when treating a condition in which they have specialized. Private practitioners are dissatisfied with the present tariff scale.

Most people in the towns are covered by compulsory sickness insurance (see p. 344). Private practitioners are paid an annual fee for each insured person on their panel; the most popular doctors have up to 1,500 insurance clients.

The Sale of Medicines. Dispensing chemists are only to be found in the towns. There are fifteen in all, of whom four are in Reykjavík. In villages and in the country dispensing is done by the district physicians who obtain their supplies from the State Pharmaceutical Monopoly. Medicines are sold at prices fixed by the Ministry of Public Health, and are cheaper than in most other countries. There are signs of a popular desire for even further state control of the sale of medicines, and it is not improbable that the state may take over all imports, even if the present retail distribution is continued.

Dental Surgeons and Mechanics. There are few dentists in Iceland, although this is in no way due to lack of work. The population is too scattered for them to make a living in the rural districts, and they are therefore concentrated in the towns. Many of the rural inhabitants feel that they cannot afford to visit a dentist until their teeth are entirely decayed, and they then buy false teeth. To remedy this situation, many of the younger district physicians are taking up the simpler forms of dentistry. There are altogether twelve dentists in Iceland who have dental clinics, nine of whom are in Reykjavík. Dental mechanics only work in the service of the dentists, and may not practise independently, but where there are no dentists the technician may make artificial teeth under the supervision of the district physician.

Eye Specialists. During the summer eye specialists travel about the country under the auspices of the Minister of Public Health. In this way the country people have an opportunity to consult them at least once a year.

Midwives and Nurses. For obstetrical purposes the country is divided into 207 districts. In 1938 the total number of midwives was

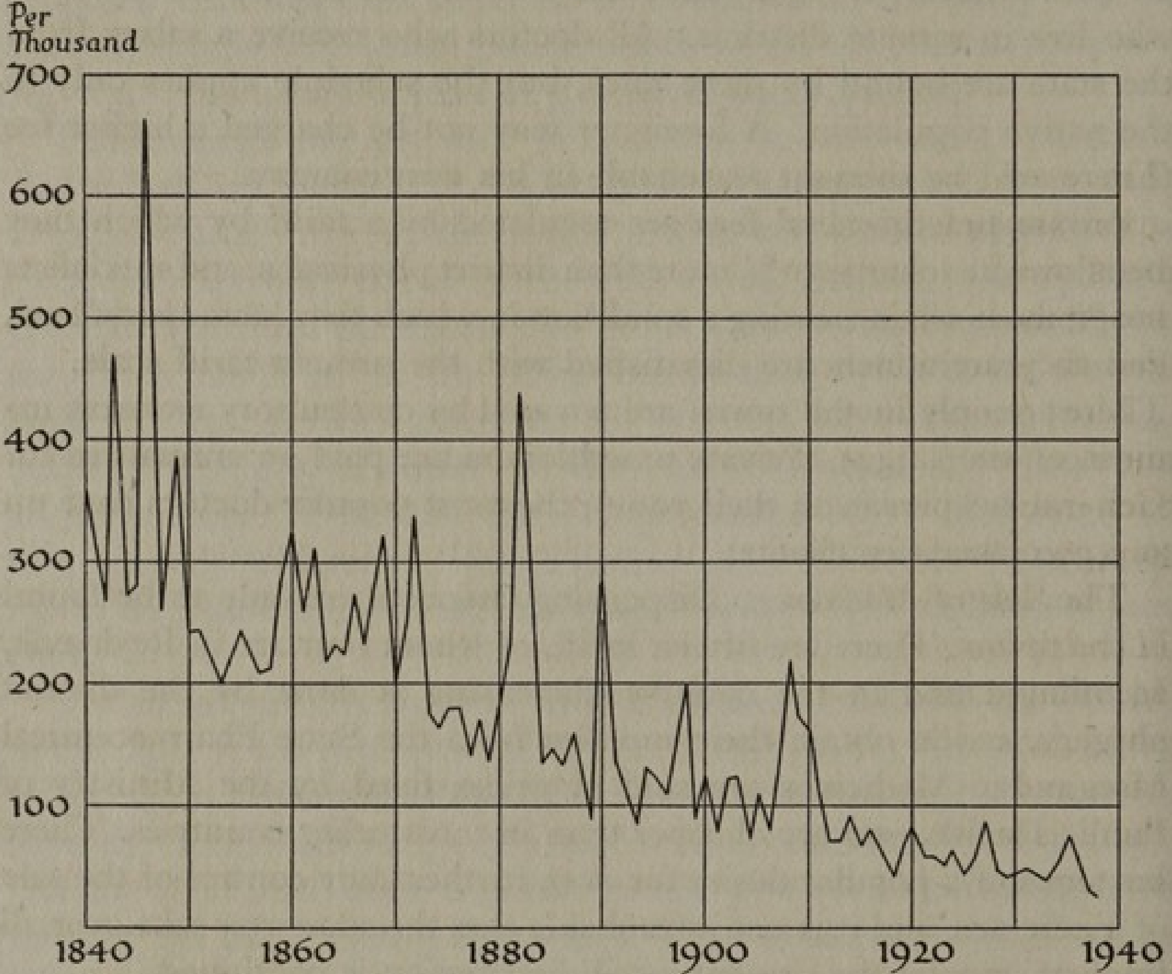


Fig. 70. Infant mortality per thousand during the first year, 1840–1938.
Source: *Heilbrigðisskýrslur*, 1938, p. 182 (Reykjavík, 1940).

199, of whom twelve were in Reykjavík. Out of a total of about 2,500 births a year, some 900 are in Reykjavík, leaving an average of about eight births a year for each midwife in the rural districts. As a result of these measures infant mortality is now the lowest on record in the world, whereas in the past it has often been extremely high (see Fig. 70). Frequently the midwives are also in charge of vaccination, which is compulsory.

All the chief hospitals employ qualified nurses, but private nursing is hardly found outside Reykjavík. There are also school nurses in some of the larger towns and others who are employed in preventive work against tuberculosis. Some masseurs have been authorized to practise and have settled in the largest towns, chiefly Reykjavík.

Veterinary Surgeons. There are only six qualified veterinary surgeons in Iceland, five paid by the state and one practising privately in Reykjavík. This is because the scattered population makes it difficult for them to be of service. In addition to their normal duties, the veterinary surgeons are responsible for the compulsory inspection of all meat exported from the country.

Hospitals and other Health Institutions

There are just over 1,100 beds in all the hospitals in the country, or approximately one bed for every 100 persons. About 57% of these beds are in forty general hospitals. Some twenty of these general hospitals, however, are only small cottages with two to five beds each, and they are attached to the physician's houses in isolated districts. There are only nine hospitals which have more than twenty beds, but most of the larger towns can accommodate forty to fifty patients. General hospitals are well equipped and modern in design, but the supply of beds is insufficient for the needs of the population.

The largest of the general hospitals is the National Hospital (*Landsspitalinn*) in Reykjavík, intended for 100 patients, but usually accommodating up to 150. It has three main departments—medicine, surgery, and X-ray. There are also smaller departments for maternity cases and for skin and venereal diseases. In connexion with the hospital there is a well-equipped laboratory for research in pathology and bacteriology. The Roman Catholic Hospital in Reykjavík has 100 beds.

There are three special sanatoria for tuberculosis patients, with a total of 280 beds. The two chief sanatoria are at Vífilsstaðir near Hafnarfjörður, with 185 beds, and on Kristnes near Akureyri, with seventy-two beds. In the neighbourhood of Reykjavík there is a lunatic asylum with 130 beds, which is insufficient, and a leper hospital with twenty-five beds. The latter is now almost empty, for the disease is disappearing. Finally, there is the State Isolation Hospital, with twenty-five beds, and a fever hospital, with thirty-five beds, both in Reykjavík.

Since 1919 a health protection institution has been run in Reykjavík by a local nursing society. This is primarily concerned with the prevention of tuberculosis, but also to a certain extent with mother and child welfare. This institution has expanded recently, and the running expenses are now practically all defrayed from public funds. Similar institutions are now being established in all the larger towns. In Reykjavík there is a state deaf-and-dumb school, and an asylum for mentally deficient women and children. The excellent and modern swimming bath in Reykjavík may also be included with health institutions. The water is supplied from the hot springs near the town. In Reykjavík and some other towns there are state institutions for old people.

The National Life Saving Association of Iceland, a voluntary organization, operates actively all over the country. There are societies to care for the blind and deaf. An active division of the International Red Cross has taken the lead in general instruction in home nursing, first aid, and so on. The boy scout clubs belong to the International Boy Scout movement. The International Order of Good Templars have, for some sixty years, fought consistently for prohibition. Finally, there is the Cremation Association of Iceland, whose object is to establish cremation as a general custom.

Sanitation

The position of the household lavatory is almost invariably governed by a desire to save space. Both bathroom and lavatory, separate or combined, are placed in some corner of the house, a favourite place for the latter being under the stairs. Ventilation is rare even to adjoining passageways, and no law or by-law exists forbidding this practice. Windows are frequently made so that they cannot be opened.

The majority of houses have a one-pipe system leading into sewers which discharge into the sea. In many small towns there is no water carriage system and conservancy systems are used. These vary in type. In the country a simple sump, placed directly underneath a seat structure, is not uncommon. In towns the pail system is used, and the refuse is periodically cleared by the municipal authorities and dumped into the sea. In Reykjavík in 1940 there were 538 houses with such closets, estimated at 10% of the total houses. In country houses near streams it is usual for the house drain to open directly into the stream; if this is not possible, a simple cesspool is used. Generally the accumulation of excreta near dwellings is not regarded as dangerous or offensive and is frequently deliberately carried out to provide manure. Fish waste and refuse are often deposited in large heaps at the same place. Decomposing fish heads are spread over the gardens in towns to serve as fertilizers.

Water Supply

The water supply is from wells and streams. Only the large towns have main supply from upland surface reservoirs. The streams are frequently polluted from causes described above. Wells also become polluted from lack of proper care and through faulty construction. Poor construction makes surface pollution common. Generally, main supplies may be regarded as good, all others should be suspect. Chemically the water from all sources is good and soft, being derived from glacier streams or melting snow in the highlands and flowing over rock in its course.

The following is an analysis, made in October 1940, of the water in the Reykjavík mains:

Clear, colourless, tasteless, without smell:

*p*H value	7·2
Sodium chloride	21·5 mg./l.
Sulphate (SO_4)	4·0 ,,
Total solid	78·0 ,,
Total hardness	12·0 mg. CaO/l.*
Permanent hardness	Trace
Phosphate	0·1 mg./l.

At Reykjavík the main supply comes from two tanks, each with a capacity of 1,000 tons. The average consumption (1940) is 240 l./sec. There are main supplies from natural wells or reservoirs at Hafnarfjörður, Selfoss, Borgarnes, Vík, Akureyri, Norðfjörður and Eskifjörður. There are natural wells at Ísafjörður, Húsavík, Siglufjörður (with regulating tanks), Stykkishólmur (with private main supply to hospital), and Reyðarfjörður. Seyðisfjörður has an artifical well with a small tank. At Vestmannaeyjar the inhabitants have to rely on rain water for all their requirements.

Diet

The diet of the ordinary individual is well balanced except for the scarcity of fresh fruit and vegetables. Although fruit and vegetables can be purchased in small quantities, they are not popular and are expensive. Ample protein is derived from meat and fish, the latter being used considerably.

Icelandic medical authorities state that there is no evidence of vitamin deficiency in the population. Nevertheless, there is no doubt that the dental condition is universally bad and caries extremely

* This figure is less than 1 degree in the English scale of grains per gallon by weight.

common. Some years ago an investigation was carried out at the State Hospital on vitamin C sufficiency. It was concluded that the average person had sufficient vitamin C, but only the minimum requirements. Icelandic medical authorities evidently do not consider that it is urgent to encourage the import and consumption of fresh fruit 'as they have done quite well without it'. It is, in fact, contrary to the policy of the Government to import fresh fruit, which appears in the shops only at Christmas time. The only regular sources of vitamin C in the diet seem to be potatoes and milk.* The latter is of good quality, but simple milking methods make farm milk almost universally dirty. Central pasteurization by the flash method (to preserve the vitamin C content) is carried out in large towns. Milk-borne epidemics are not common, but occasional outbreaks of Sonne dysentery are thought to have milk as the vehicle of infection. Bovine tuberculosis does not exist in the country.

Insect Pests

There are apparently no records of mosquitoes in Iceland. Small flies (Simuliidae, Ceratopogonidae and Chironomidae) are sometimes so numerous as to constitute a serious problem to those who are not immune. In some special areas, such as Mývatn (= fly lake), *Simulium vittatum* can sometimes be seen in the distance, appearing like great columns of steam rising 8 or 10 m. above the ground, and it is difficult not to swallow several with every breath. *Simulium* breeds mainly in running water, but control of the larvae by oiling of streams is impossible as they do not come to the surface. Fortunately they are very local in distribution. They can penetrate netting which would exclude mosquitoes; their bite does not pierce the skin, but rasps the surface and may produce septic sores. Army type 28- to 29-mesh 'Mosquito netting' is inadequate to keep out *Simulium*. Army 'Sand-fly netting' of 46-mesh will keep out most of them, but about 53-mesh is necessary for complete protection. However, the latter mesh usually obscures vision rather too much for practical use. Culicifuges (anti-fly ointments) are useful for short periods, but their effects wear off very quickly. Reports indicate that during 1940 British troops in Iceland had no trouble with biting insects, but it is known that there is great variation from year to year in the number of insects present at any locality.

There are few records of the occurrence of lice in Iceland. It seems likely that they are rare as in other parts of Scandinavia.

* See pp. 292–3 for details of fresh vegetables.

Chapter VI

THE PEOPLE

Origin and Racial Affinities: Language: Religion: Education: Politics: Modern Cultural Life

Origin and Racial Affinities

Icelanders are of mixed Scandinavian and Celtic origin. Iceland became inhabited last of all the European countries. Little is known about the first discoverers who visited the island at the end of the eighth century (see pp. 169–73), but it is certain that there were some Irish monks there when the real settlement began in the later half of the ninth century.

Although there is great vagueness about the arrival of the first Irishmen, there is remarkable clarity about the whole story after the year 874. The *Landnámabók*, or 'Book of the Settlement', is a systematic record of the settlement of Iceland, unique in the world's literature. It enumerates about 400 chief colonists, who were accompanied by their dependents, and it gives some account of their ancestry, whence they emigrated, and exactly where they took land.

The settlers were chiefly Norwegians, who emigrated from western Norway to escape the tyranny of King Harald Fairhair. The remainder came from the British Isles, chiefly from Ireland and the Hebrides. Most of the chieftains recorded in *Landnámabók* had Norwegian names and are known to have been partly or wholly of Norwegian descent. However, a proportion of them came to Iceland by way of Britain; some had lived in the British Isles for several years, while a few had been there for one or more generations. The wives of many of these chieftains are known to have been Celts, and they had Celtic servants. Still more Celts are known to have joined themselves voluntarily to the Norwegian chieftains, and these brought their own retainers with them. There is little doubt that between 874 and 930 the number of colonists in Iceland grew to about 40,000. Estimates of the proportion of these colonists who were of Norwegian origin vary from 60 to 90%, and about 12% are thought to have come from the British Isles. Taking as a basis the information about the settlers given in *Landnámabók*, and assuming that the population in 930 was 40,000, there would be 33,000 of Norwegian origin and some 5,000 derived from the British Isles. The proportion of those from the British Isles who originally came from Norway is not known. After 60 years they had occupied all the districts which are inhabited to-day.

Following the colonization, the Icelanders began a series of extensive trading voyages to foreign lands, in some cases going as far south as the coast of Africa and east through the Dardanelles. When these expeditions declined in the twelfth and thirteenth centuries, traders from other countries came north. The records show that Icelanders often brought back wives and slaves from foreign countries, and there is also good evidence that foreign traders visiting Iceland married into the families of their Icelandic hosts.

Thus, there were contributions from several southern races to the predominant Scandinavian stock. The races which made these contributions via Norway and the British Isles were the Alpine, the Dinaric, and the Mediterranean. Many Icelanders can still trace their descent back to the first settlers. The surviving descriptions of many of the first settlers are recognizable as those of Scandinavian types, but there are also accounts of men with other features, such as dark hair and low stature.

These racial elements have blended through a thousand years to produce the Icelander of to-day. The census of 1930 shows the present non-Icelandic element to be only 1·4%, of which Danes are a third. This does not mean that there is any legal or popular discrimination against foreigners, but it may perhaps reflect the general desire to keep non-Icelandic elements from permanent residence. Contact with foreign merchants and seamen may to some extent have altered the racial constitution since the original settlement, but, in the centuries that followed, the culture of the Icelandic people suffered comparatively little foreign influence.

The Icelanders have struggled through years of terrible distress, caused by a severe climate, volcanic eruptions, the Black Death, pestilence and famine. They were severely oppressed by the Danish trade monopoly from 1602 to 1884 and continued their struggle for political independence until it was finally achieved in 1918. The people of Iceland have often been led by men of great energy, with faith in their ability to achieve their aims. They have preserved not only their excellent physical constitution, but their rich cultural heritage as well. Without the latter they might long ago have given up the struggle. On the other hand, a certain indifference to practical matters has been noticeable down to present times, and likewise a lack of aggressive energy and precision. These limitations are very natural in a people who have suffered so much from forces outside their control.

Language

Icelandic is the most archaic and purest Germanic language spoken to-day. Its nouns are declined in four cases, in singular and plural. There are three genders and the verbal system is very complicated. The grammatical forms of Icelandic are also complex. Up to the Viking age, one language was spoken throughout Scandinavia, and there were only small regional variations. During that period some noticeable changes took place, and the Norse language was divided into two main dialects, now known as East Norse and West Norse. The differences between these two dialects remained small until the latter years of the Middle Ages.

The majority of the settlers in Iceland were Norwegians, and they spoke the dialect then spoken in western Norway. A certain number of them were the sons of Scandinavian families who had lived in the Gaelic-speaking lands, western Scotland, the Hebrides and Ireland. In some cases these men brought Gaelic-speaking wives and dependents to Iceland. The Gaelic element in Icelandic, however, is very small. It is most noticeable among personal names, e.g. *Njáll* (Anglo-Scottish *Neil*), *Kaðall* (Irish *Cathal*), *Kjarvalr* (Old Irish *Cearbhall*), *Kjartan*. A number of these names are still in use to-day. Gaelic influence also survives in a few isolated expressions, such as *verða að gjalti* (to rave, cf. Irish *gealt*, a wild man).

After the introduction of Christianity in A.D. 1000 a number of ecclesiastical Latin and 'learned' words appeared in Icelandic. In most cases they reached Iceland through the medium of Norwegian, English or German. Examples are: *messa* (Mass), *páfi* (Pope), *prestur* (priest), *prófastur* (provost), *djákni* (deacon), *meistari* (master). Although ecclesiastical words of Latin origin are fairly numerous in Icelandic, it is plain that early Christian teaching influenced Icelandic much less deeply than it did the other Scandinavian dialects.

During the thirteenth and fourteenth centuries, the period when the most important literature of Iceland was written, the language suffered some further changes, though most of them were trivial. The popularity of romance literature in Iceland caused a number of literary loan words to be introduced. These were often derived from French or German sources. Examples are: *riddari* (knight), *damma* (lady), *ess* (horse), *kurteisi* (courtesy), *kastali* (castle), *palata* (palace). Many of these words were quickly absorbed into the native language, changing their form and adopting Icelandic declensional endings. When they failed to be absorbed in this way, such words died out.

After the union with Norway in 1262, Norwegian influence on Icelandic appears to have increased. But this influence is to be seen chiefly in the spelling of Icelandic manuscripts of the period. Many Icelanders visited Norway, and some of them worked there as scribes. It is improbable that Norwegian influenced the spoken language of Iceland to any considerable degree. Such influence as it had has since been largely obliterated.

During the fourteenth and fifteenth centuries the languages of Iceland and Norway diverged widely. Norwegian suffered much foreign influence, particularly Danish and German. Its grammatical structure changed, and it began to lose its declensional endings. The structure of Icelandic, on the other hand, remained remarkably constant. The declensions of its substantives and its complicated verbal system showed hardly any signs of weakening. Its pronunciation altered to some extent, but unlike Norwegian, Icelandic developed practically no dialectal differences.

Throughout the long period of Danish rule, Icelandic preserved its archaic grammatical system. Nevertheless, the political officials and tradesmen resident in Iceland were mostly Danes. Many Icelanders studied in Denmark, and many wrote scholarly and literary works in Danish. Consequently the influence of Danish on the Icelandic vocabulary became very marked. The titles given to administrative officials in Iceland were mostly derived from Danish, e.g. *landfógeti*, *amtmaður*, *stiptamtmaður*. Icelandic documents written in the seventeenth and eighteenth centuries often contain an abundance of Danish words, many of which are never heard to-day. In some instances, indeed, it is questionable whether the words ever were used except by a small section of the Icelandic community. Nevertheless, Danish remains by far the largest foreign element in the Icelandic language.

The growth of national consciousness during the nineteenth century led the Icelanders to a desire to purify their language of its foreign, and particularly of its Danish, elements. The leading Icelandic writers, both of prose and verse, sought to abandon words of foreign origin and, when possible, to use native ones in their place. Undoubtedly this 'purist' movement was much more successful than it has been in Norway, or in other countries where it has been tried.

One of the reasons for its success was, no doubt, that many of the loan words of the seventeenth and eighteenth centuries had never taken root, and were always felt to be foreign terms.

The scientific inventions and ideas which developed in the nineteenth century required new words. The Icelanders were faced with the choice either of adopting international terms, or of inventing terms of their own. Attempts have been made to invent words of pure Icelandic origin to correspond to the international technical expressions used in such advanced sciences as engineering, medicine and chemistry. Since the intricacies of these subjects are seldom discussed among laymen, it is hard to estimate the success of these attempts. Nevertheless, native Icelandic words are generally used to denote those products of modern science and thought of which the layman most frequently needs to speak. To an Icelandic ear, at any rate, the native word seems generally less cumbersome and, moreover, less meaningless than the foreign one. Thus, 'electricity' is called by the Icelanders *rafmagn*, which means literally 'amber-power'. For 'telephone' the Icelanders say *sími* (thread), for 'photograph' *ljósmynd* (light picture), and for 'broadcasting' *útvarp*. A 'bicycle' is called *reiðhjóll* (riding wheel) or *hjólhestur* (wheel horse), and a 'cigar' *vindill* (something screwed up). The word *sígaretta* for 'cigarette', on the other hand, is much more frequently heard than the pure Icelandic *vindling*, a diminutive of *vindill*. Two recent examples of naval interest may be added. A 'submarine' is called *kafbátur* (dive boat), and a 'mine' *tundurdufl* (tinder buoy).

In some instances, when a modern foreign word has been generally accepted, it has been adapted to suit the Icelandic grammatical and phonetic systems. Thus the international word 'automobile' becomes *bíll* (genitive *bíls*), and appears so much like a native Icelandic word that the consciousness of its foreign origin is almost lost.

In finding native words for modern political terms the Icelanders have been hardly less successful. If cumbersome, the terms which they use are certainly less cumbersome and less unpleasing to the ear than the international ones. The following political terms will serve as examples: *íhaldsemi* (conservatism), *frjálslyndi* (liberalism), *jafnaðarmenska* (socialism). The word *kommunisti*, for which there is no native equivalent, shows a tendency to become nationalized as *kommi* (pl. *kommar*).

In Reykjavík and the larger towns considerably more loan words are heard to-day than in the rural districts. Many of these are seldom written, and are used mostly by the less educated sections of the urban communities. Examples are *móður* (fashion), *prís* (price), *gentilmaður* (gentleman). It is doubtful whether such words should be called a part of the Icelandic language. They certainly supply no shade of thought which the native vocabulary lacks. Most probably they will disappear from Icelandic, just as many of the Danish loans, which were current 150 years ago, disappeared during the nineteenth century. There is every reason to believe that Icelandic will remain comparatively pure, and that Icelandic words will be found to fulfil such needs as the future may bring.

The changes which have occurred in the grammar and vocabulary of Icelandic throughout its history have thus been remarkably small. The greatest changes which the language has suffered have been in pronunciation. Most of the vowels have changed their value since the Middle Ages. The sounds of some of the consonants have also changed. The conservative tendencies, so marked in Icelandic, are largely due to the high standard of literary education, which has been maintained among the Icelandic people from the Middle Ages to the present day. Icelandic literature, which reached its peak about the middle of the thirteenth century, was read among all sections of the population throughout the whole island. Until the nineteenth century, when Icelandic books were first printed in large numbers, it was customary to copy the sagas and other ancient literature by hand, and these copies were circulated among the people. Some of the medieval literature of Iceland is preserved only in copies made in the eighteenth century. Such practises undoubtedly helped to keep the language unchanged, and to prevent it breaking up into dialects, as other Scandinavian languages did.

The Icelandic of to-day remains so close to that of the classical period, the thirteenth century, that an Icelander is able to read the sagas just as easily as an Englishman reads Shakespeare.

Religion

All the colonists from Scandinavia were heathen. Many of the Vikings who came from the British Isles were Christians, as were all the Celts. Even at this early date, doubt in the old northern deities had begun to show itself. Early missionary efforts, the example of baptized Christians in the days of colonization, and especially the conversion of the northern kingdoms of Europe, made Christianity well known in Iceland and created a religious unrest which is clearly reflected in the sagas. A summary of the events leading to the official establishment of Christianity in the year 1000, and of Lutheranism in the years preceding 1551, will be found on pp. 181–2 and 193–4 respectively.

The Evangelical Lutheran Church is the Established Church of Iceland. There has, however, been full religious liberty during the last 50 years. Other religions are few; the total number of dissenters recorded at the census of 1930 being 1,503, or 1·4 % of the population. Of these, 782 were unattached to any religious denomination, while 721 belonged to various other religious bodies. Some of these, for example the Roman Catholics and Adventists, are recognized by the government, and marriages and other offices performed by their clergy are valid in law. In 1930 there were three free (Lutheran) congregations in the country, with a total membership of 8,470. Although holding the same doctrines as the Established Church, they have separated themselves from it, and are entirely self-governing bodies with their own churches and paying their own ministers.

No one is obliged to pay personal dues to any religious body other than the one to which he adheres. The Constitution, however, provides that if a person does not belong to the Established Church or to any other recognized religion he shall pay to the University of Iceland or to some fund of the University such dues as he would otherwise have had to pay to the Church.

Iceland forms one bishopric with its see in Reykjavík. Besides the bishop there are two assistant bishops, one for each of the two dioceses into which the country is divided. The dioceses are subdivided into twenty deaneries (*Prófastsdæmi*). The number of livings is 111, some of them including more than two parishes. *Íslands Addressebog* for 1940 records 102 priests of the Established Church. There are 276 ecclesiastical parishes (*sóknir*).

The majority of candidates for the priesthood have taken a theological degree at the University of Iceland. Clergymen are chosen by majority vote at a secret ballot on the part of those parishioners who are over 21 years of age and of 'blameless reputation'. Deans and assistant-bishops are appointed by the government on the advice of the clergy of the deanery of diocese in question. The bishop is chosen by a majority vote of all clergymen and the theological professors of the University.

The clergymen are paid out of the Clergymen's Salaries Fund (*Prestlaunasjóður*), which is made up partly of the income derived from church rates (Kr. 1·5 payable by every parishioner of 15 years and over), partly by rents paid by tenants of church estates, and partly by interest on the money realized from capital funds. The fund's own receipts are not enough to cover the annual expenditure and are supplemented by a government grant.

In addition to their clerical duties, clergymen are responsible for the annual public registration. They also have to record all births, deaths and marriages, as the church registers are the only official records of these events.

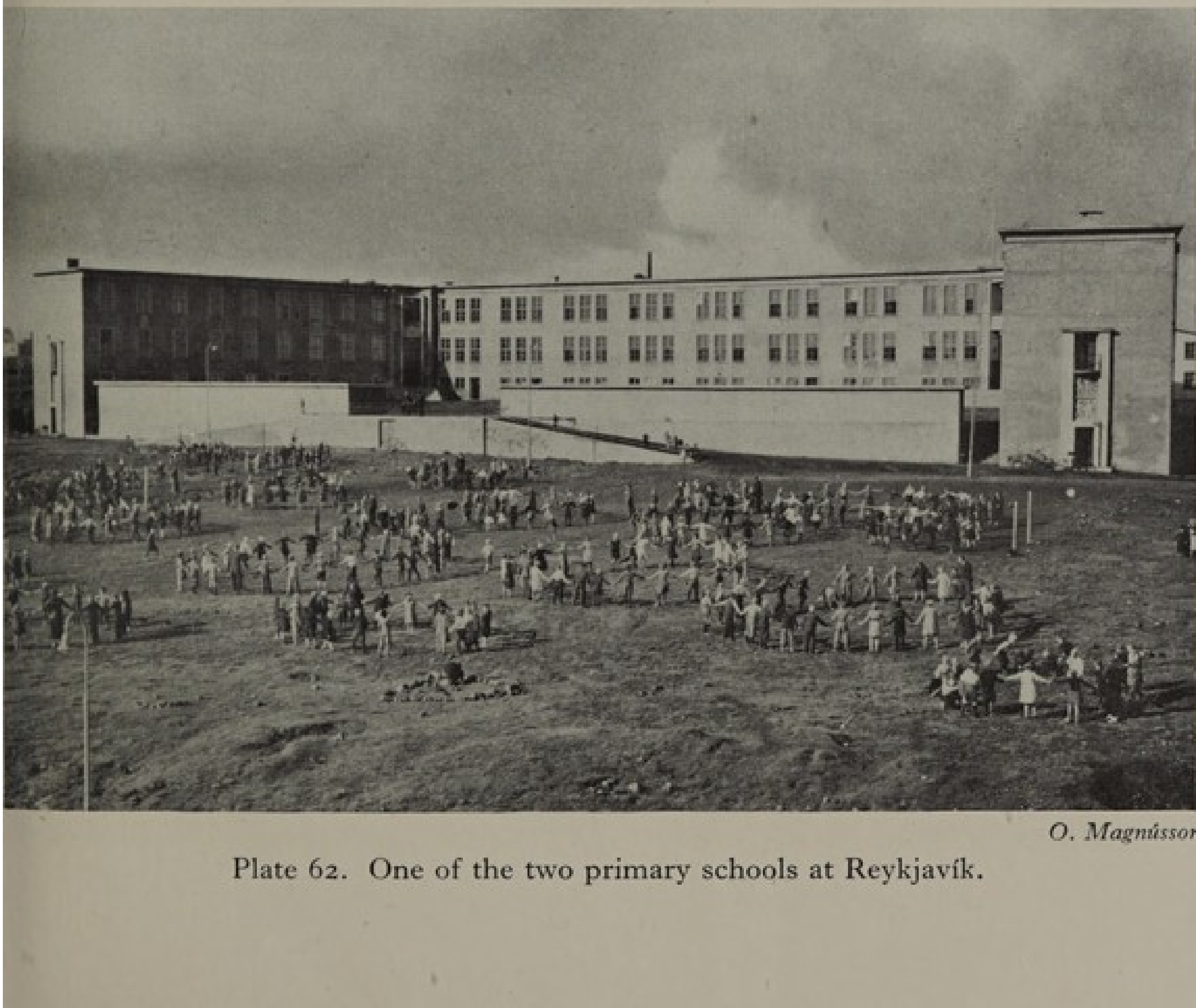
The Icelandic Church has always been liberal in outlook, and religious controversies are almost unknown. The pastor is commonly a farmer also, and there is no gulf between the outlook, manners and intonation of priest and layman.

During recent years the Roman Catholics have shown great interest in Iceland, but elaborate ritual and ceremony have a limited appeal. Cultured Icelanders do not take much interest in religious problems, and they are tolerant in matters of faith. There would certainly be strong opposition to any attempt at religious compulsion. The average Icelander is intellectual in his approach. For that reason he remains a rationalist even in religious matters, although there are individuals who have a leaning towards mysticism, and there is a considerable interest in Spiritualism.

Education

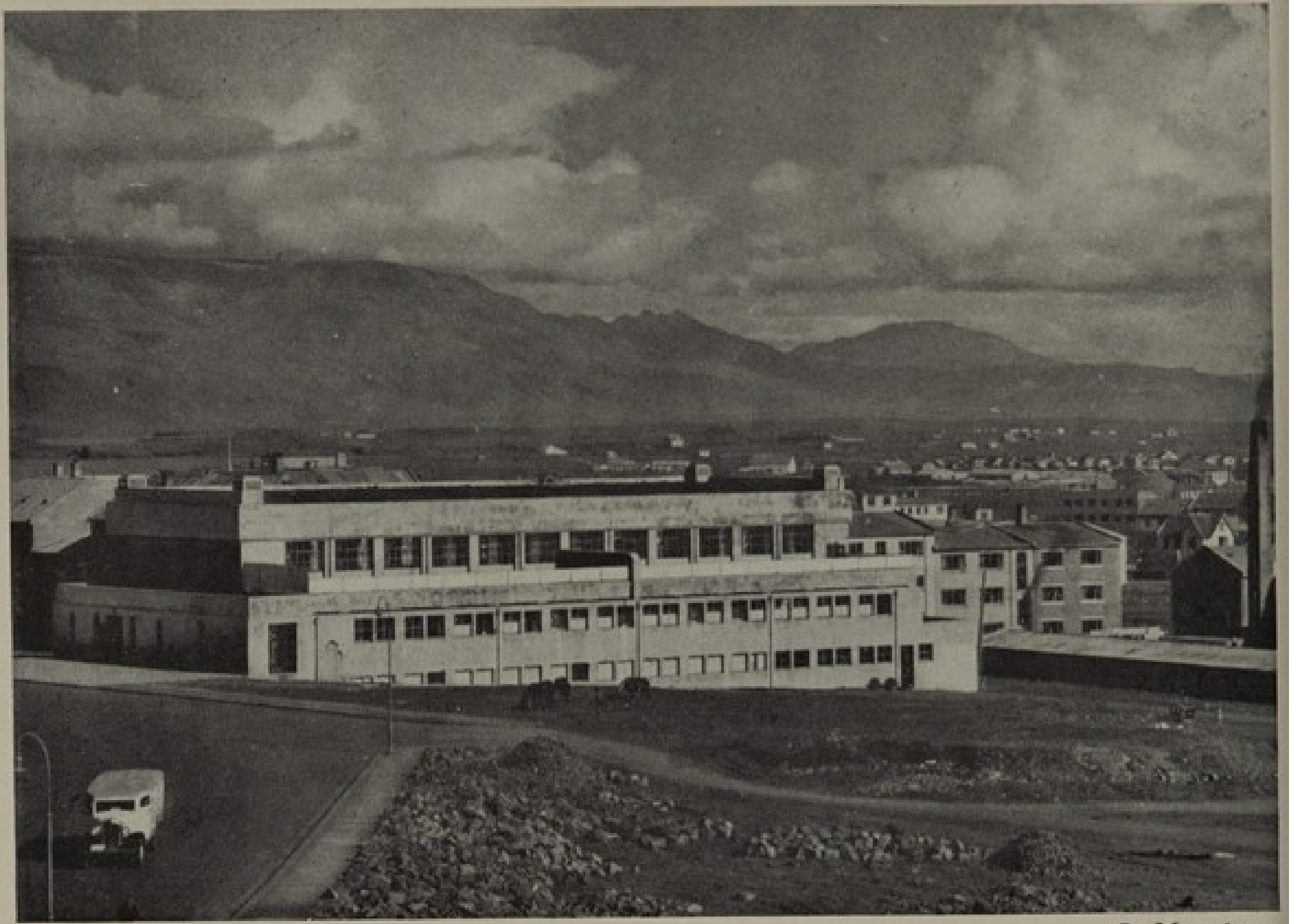
The first schools in Iceland were founded during the eleventh and twelfth centuries, and later the monasteries were great centres of education. There was a school at each bishopric, Skálholt in the south, and Hólar in the north, but these were closed in 1785 and 1802 respectively. Later a new school was built at Reykjavík, and for a long time this remained the only educational establishment in the country. Nevertheless, a high degree of literacy was maintained by home instruction, and this was greatly aided by the characteristic 'evening wake' (*kvöldvökur*), where one person read aloud from the sagas or recited historical poems while the others worked at quiet indoor tasks. In the tenth to fifteenth centuries professional bards or *skálds* went from farm to farm, but later one member of the family group was selected to do the reading, especially since the sixteenth century, when printing was introduced and the old manuscripts and personal memory were no longer the only sources of knowledge. The *kvöldvökur*, the saying of family prayers, and the reading aloud from religious books, survived down to the second decade of the twentieth century. Changed occupations, increased mechanization, and es-

Plate 61. Characteristic old-style Icelandic farm. The roofs are covered with turf.



O. Magnússon

Plate 62. One of the two primary schools at Reykjavík.



O. Magnússon

Plate 63. The hot-water swimming hall at Reykjavík.

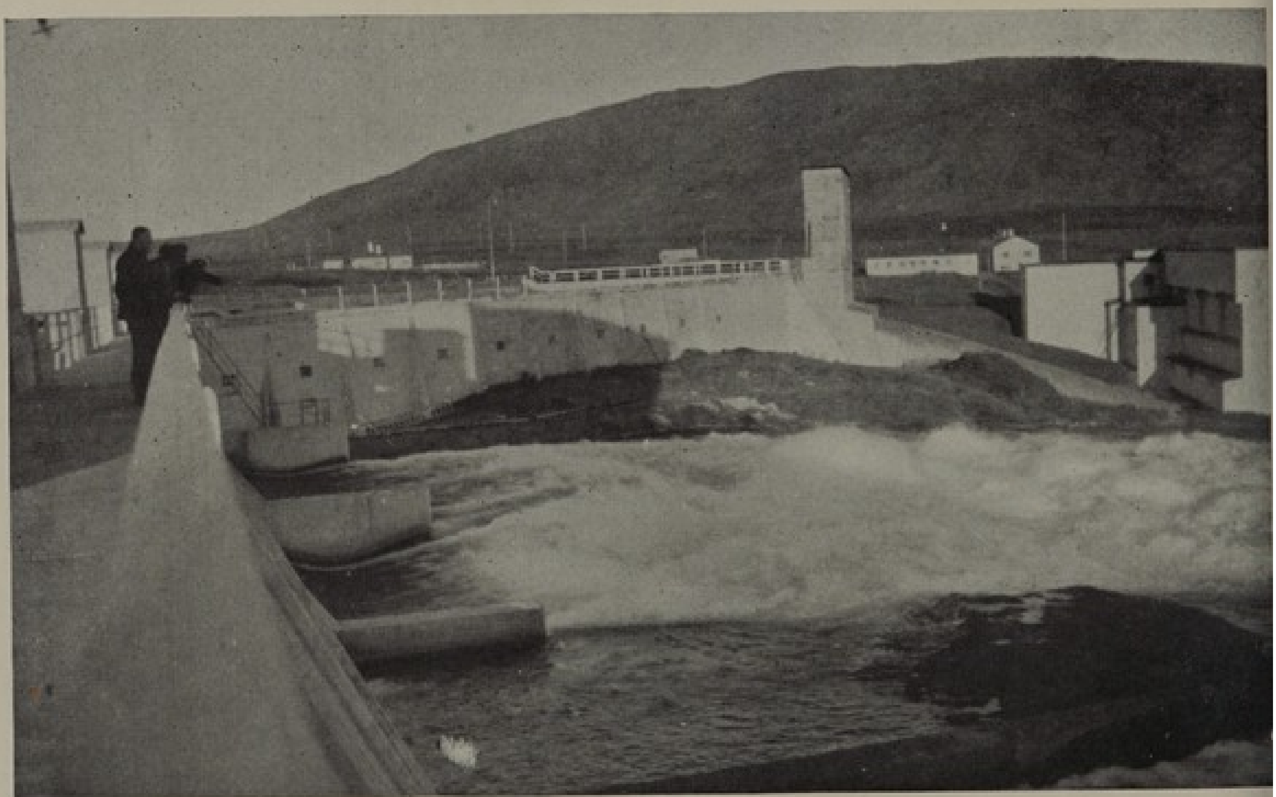


Plate 64. The dam for the hydro-electric plant on the river Sog, the outlet of Þingvallavatn.

pecially the wireless, are now bringing these old customs into disuse.

The new conditions presented Iceland with a new educational problem. Parents were no longer able or willing to instruct children at home as they themselves had been instructed. An elementary school system therefore had to be developed, and with it have come those group distinctions between the educated and uneducated which are familiar in other countries. The establishment of numerous schools following 1900, and the more widespread teaching of one or more current foreign languages, has now almost completely displaced the old conversational Latin which was formerly an interesting cultural element in Iceland.

The development of an adequate educational system has been a part of the programme of every political party of this century. The problem has been to deal with three main categories of children—large concentrations in the towns, smaller groups in the villages, and children living on isolated farms. The towns and larger villages now have satisfactory day schools, but the problem of educating the country children has not yet been solved. Wherever possible, boarding schools have been set up to accommodate children who cannot reach schools from their homes daily, but this project is not yet far advanced.

In 1907 attendance at school was made compulsory for children between the ages of 10 and 14, while parents were required to provide for the instruction of their children up to that age. In 1936 compulsory attendance was extended to include all children of 7–14 years. All receive their instruction at elementary schools except those who are granted special exemption up to the ages of 8, 9 or 10. Exemption is only granted when alternative teaching arrangements are recognized as satisfactory by the local education authorities.

For purposes of elementary education, Iceland is divided into districts. The boundaries coincide with those of the administrative provinces (*sýslur*) or townships (*kaupstaðir*), which each comprise one or more educational districts. In each of these educational districts there is at least one day school, or a boarding school where the distances from their homes are too great to allow children to attend daily. In the day schools the annual minimum period of teaching prescribed by law is 33 weeks for children of 7–9 years, 24 weeks for those of 10–14 years. In districts where boarding schools have had to be established, the children are divided into groups, each group attending in turn and receiving instruction for 12–13 weeks a year.

Where stationary schools have not yet been established, 'travelling' schools are temporarily provided. In these schools every child receives instruction for at least 8 weeks a year. They begin at one of the larger farms in the district, and then move with their teacher to another large farm.

Elementary education is free for all children of school age. The expenditure is defrayed partly by the state and partly by the parishes or municipalities.

Compulsory education ends with the elementary schools. In each of the eight townships there is a science school (*Gagnfræðaskóli*), with 2-year courses, where young people who have passed their final examinations are given further instruction to enable them to attend the various technical schools. Although maintained by the townships, these schools receive considerable support from the state. Outside the townships there are five district schools, organized on the same lines as the *Gagnfræða* schools. These are self-governing institutions, but receive large state grants. Their object is to prepare students for work under Icelandic conditions of life through books and through manual and physical training. There is also one state-owned district school, and a number of other state-supported schools in different parts of the country, which, however, do not come up to the district school standard. There are two state-owned co-educational secondary schools (*Menntaskólar*), one in Reykjavík, the other in Akureyri. Final examinations at these two schools entitle those who have passed to go to the University. In Reykjavík there is a private school providing exactly the same education as the junior divisions of the *Menntaskólar*. There are also several special schools, most of which provide general as well as technical instruction. State schools of this kind include a training college for teachers at elementary schools, with a 3-year course; a nautical school, with a 2-year course; a school for marine engineers and electricians, with a 2-year course; four agricultural schools, with 2-year courses; and training schools for midwives and nurses. The townships and larger villages have evening technical schools for apprentices, and courses in domestic science at 'finishing schools' (*Húsmaeðraskólar*). There are two commercial schools in Reykjavík, one run by the Icelandic Chamber of Commerce and the other by the Federation of Icelandic Co-operative Societies. Both are partly supported by the state.

In most of the schools which provide secondary education the period of instruction is from 26 to 30 weeks a year, but for the *Menntaskólar* the school year begins about the middle of September and ends about the middle of June. All teaching is suspended during the summer months so that the scholars may have an opportunity to earn enough funds to pay their expenses, usually by working on the farms or in the herring factories. During the summer vacation most of the district schoolhouses and some of the other schoolhouses are turned into tourist hotels.

The administration of educational affairs is in the hands of the Director of Education (*Fræðslumálastjóri*), who is under the direct control of the government. To assist him there are two educational councils—one for the elementary schools, the other for the district and *Gagnfræða* schools.

Until 1847 the Latin School in Reykjavík was the highest educational establishment in Iceland, while those who wished to study for professions went to Copenhagen. The Latin School prepared candidates for the Church, but in 1847 a Theological Seminary was established, followed by a Medical College in 1876 and a Law School in 1908. Finally, in 1911, these three organizations were united into one—the University of Iceland. The University has five faculties: Theology, Medicine, Law, Philosophy and Research. Philosophy is defined as representing Icelandic philology and history; Research covers the departments which work for the benefit of the fisheries, industry and agriculture. There is a small but flourishing biological department, which deals with marine biology, fresh-water biology, economic ornithology and mycology. A chemical laboratory gives instruction in analytical chemistry and undertakes analytical work. There are also bacteriological and pathological laboratories. The University is a co-educational state institution, and the new buildings in which it is housed are being built with the proceeds of a state lottery instituted in 1933.

The academic year is counted from 15 September to 15 June. The final degrees conferred by the University are *Kandidat*, in the three first-named faculties (Candidatus theologiae, Candidatus medicinae et chirurgiae, Candidatus juris), but in the faculty of philosophy there is a *Kennaraprof* (Candidatus magisterii), and *Meistaraprof* (Magister artium) for those who intend to take up a scientific career.

There is no fixed time for the duration of courses, but the minimum for theology is assumed to be 4 years, for law 5 years, and for medicine 5½–6 years. For the degree of Candidatus magisterii 4½–5 years are required, and for that of Magister artium 6–7 years.

Each faculty has the right to confer doctor degrees, either honorary (*honoris causa*) or for scientific treatises. The intending doctor must, as a rule, be a graduate of a University; he must submit a thesis and defend it publicly at the University. Anyone, having acquired the doctor degree, is entitled to lecture in the University on his particular branch of study.

The development of education is now one of the most hotly debated political issues in the country, for, like some other countries, Iceland has a surplus of students. A steady improvement in standards is being effected by the introduction of carefully selected foreign ideas and methods, and by the exchange of teaching staff with foreign Universities.

Politics

Ever since the Icelanders obtained their constitution in 1874 they have been intensely interested in party politics. They are idealists, but they have frequently shown themselves fanatical and unable to compromise. Strong party feeling has sometimes weakened their position in dealings with other countries.

Ideas such as the co-operative movement (see pp. 303–6) or the socialist commercial policy of monopolies (see p. 357) tend to divide the country into rival groups. It is difficult for a foreigner to arrive at any trustworthy conclusions regarding the issues involved, more especially as he can hardly count on receiving much objective guidance in a community which is so intensely partisan.

Apart from the constitutional relations with Denmark, the conflicts of opinion have recently shown every gradation between a rather narrow nationalism and a real desire to adopt new ideas from other countries. The press gives a reliable indication of party strife. The unqualified political abuse which is printed probably surpasses what is produced in most other civilized countries, but this does not prevent bitter opponents from meeting privately in pleasant social relations.

Political Parties

Party division on home affairs was not very marked until 1918, when the country achieved its independence. Before that time the issue was mainly on the degree of independence. The Home Rule Party and the Independence Party were the two chief parties during the second decade of the present century; the main difference between them being in the more far-reaching demands made by the latter. Minor parties were then beginning to develop. Thus in 1916 some agrarian members formed what was to be the forerunner of the Progressive Party, which called for the promotion of co-operative societies (see pp. 303–6) and agricultural interests. In the same year the Socialist Party was formed by the working classes. In 1924 the Conservative Party was formed, mainly from what was left of the Home Rulers. The Independence Party continued as such until 1926, when it changed its name to Liberal. In 1929 the Conservatives and Liberals joined forces and became the Independence Party, with a programme calling for political and financial independence of the country, free trade, and individual initiative. They are the chief opponents of the Socialist Party and derive their support from the commercial classes, employers and from a number of rural workers. In 1930 the left wing of the Socialist Party branched off and formed the Communist Party, affiliating themselves with the Third International in Moscow. In 1933 the Nationalist Party was formed, with the German Nazi Party as its pattern. At the same time some members left the Progressives to form a new Agrarian Party, because they felt that their colleagues had gone too far in collaboration with the Socialist Party. So far no Nationalist has received enough votes to enter the *Alþingi*.

The elections of 1934 and 1937 gave the following results:

	Percentage of total votes		Number of Members returned	
	1934	1937	1934	1937
Independence Party (*Sjálfstæðisflokkur*)	42·3	41·3	20	17
Progressive Party (*Framsóknarflokkur*)	21·9	24·9	15	19
Socialist Party (*Alþyðuflokkur*)	21·7	19·0	10	8
Agrarian Party (*Bændaflokkur*)	6·4	6·1	3	2
Communist Party (*Kommúnistaflokkur*)	6·0	8·5	—	3
Nationalist Party (*Þjóðernissinnaflokkur*)	0·7	0·2	—	—
Non-party member	1·0	—	1	—
Total	100·0	100·0	49	49

Since 1918 the parties have been in power as follows:

1918–20. A coalition cabinet (the Home Rule, Progressive and Independence Parties contributing one minister each).

1920–22. Home Rule Party.

1922–24. Home Rule and Independence Parties (two Home Rule ministers and one Independence).

1924–27. Conservative.

1927–33. Progressive.

1933–34. Progressive and Independence Parties (two and one respectively).
1934–38. Progressive and Socialist Parties (two and one respectively).
1938–39. Progressive.
1939– A Coalition cabinet (two Progressive, two Independence and one Socialist).

In the 1937 elections the Socialists and Progressives combined to enable the former to carry the election. Soon afterwards, owing to lack of sympathy with what they considered an important issue, the Socialists withdrew their member from the cabinet. At the same time some of the more radical members of the Socialist Party left it in order to join with the Communists to form another new party. Even after this defection, the Progressives had a slight majority in the *Alþingi*, but they did not feel strong enough to take the responsibility of devaluating the currency. The hard-hit fishing industry, which depends chiefly on export, pressed the issue, and in April 1939 the former Prime Minister, Herman Jónasson, formed a new coalition government consisting of Independence members, Progressives and Socialists, who together command forty-five out of the forty-nine members of the *Alþingi*. No general election was held.

The 1939 situation may be summarized as follows: The strongest party (Progressives) favours co-operatives; the second strongest (Independence) favours private capitalism; the third strongest (Socialists) favours government ownership; and the weakest, with four members, is the Communist Party.

Modern Cultural Life

Rapid changes in cultural life are taking place. The old and the new, often indeed the very old and the ultra-modern, are in conflict. Revolutionary changes in almost every sphere of life have been brought about by new and quicker means of transport, which have brought Iceland into close connexion with foreign countries, and have facilitated internal intercourse. The volume of trade has increased, and the methods of fishing modernized. Rural life, community organization, style of building, general culture, art and literature, are all being affected by outside influences.

Many old customs may still be found. For example, except in a few cases where foreign practice has been adopted, surnames are not handed down as such. A boy's 'surname' is invariably the first name of his father with the word for 'son' added. Thus a son of Ólafur

Jónsson whose first name is Sigurður will have Sigurður Ólafsson for his full name; his grandson Jón would be Jón Sigurðsson. A girl's surname is the first name of her father with 'daughter' added. Thus Ólafur Jónsson's daughter Sigriður would be Sigriður Ólafsdóttir. Girls are still being christened with archaic names such as Hrafnhildur and Geirþruður. These names, however, are quickly dispensed with and in their place such names as Stella and Mimi are adopted. A girl does not change her name when she marries. A foreign way of naming, used by a few families, arose among those who either studied or worked abroad. The surname was usually derived from the home neighbourhood, as, for example, Blöndal from Blöndudalur. The introduction of 'foreign' names was disliked by the majority, and in 1926 a measure was enacted which forbade the adoption of new family names. Those already existing were allowed to continue.

Much of the old and simpler style of life has survived down to modern times. In many spheres, the struggle between the old and new has been concentrated into a few decades, and in some instances into a few years. The changes were given a strong impetus, and became more intense, after 1918, when Iceland attained political independence. The national feeling, which had been concentrated on the fight for independence, has now been released to find other channels. The situation in Iceland is now somewhat like that in Norway after 1905. A great effort is being made to rise to a higher plane of living.

Cultural and Scientific Institutions

Apart from formal education there are many societies and funds for the promotion of science and culture.

The Union Fund (*Sáttmálasjóður*) was founded in 1918 to initiate and encourage scientific research. At the time of the Union, Denmark established two funds of Kr. 1,000,000 each, one at the University of Copenhagen and one at the University of Reykjavík, for the promotion of intellectual intercourse between the two countries. In Reykjavík this fund is used chiefly to support the publication of learned works and University textbooks; to give grants to aid laboratories, museums and the University Library, to award prizes to Icelanders who achieve scientific distinction; and to provide research grants which enable scientific workers to go abroad.

The Fund for the Promotion of Culture (*Menningarsjóður*) was created in 1928 to promote general culture and national art and to further the study of Icelandic natural history. This fund is derived from fines paid for violations of the liquor law and also receives a share of the profits made by the State Liquor Monopoly. The fund is administered by a council of five members, all elected by the *Alþingi* for a term of 4 years.

The Icelandic State Broadcasting Service (*Ríkisútvarp Íslands*) was opened at Reykjavík in 1930. It is owned and operated by the state, deriving its revenue from a tax on receiving sets. The broadcasting service is managed by a government-appointed director, but the programmes are arranged by a committee of seven members who are elected for 4-year periods. The chairman is appointed by the cabinet, while the *Alþingi* and the listeners each appoint three of the other members.

There are several societies which work for the diffusion of science and general culture. The oldest of these is the Icelandic Literary Society (*Hið íslenzka Bókmenntafélag*), founded in 1816. Besides an annual containing short articles, it publishes works chiefly dealing with Icelandic history and literature. The Society of Friends of the Icelandic People (*Hið íslenzka Thjóðvinafélag*), founded in 1869, was originally political, but soon began to issue a popular science series in addition to two annuals. The Icelandic Archaeological Society (*Hið íslenzka Fornleifafélag*), founded in 1879 for the collection and preservation of antiquities, issues a yearbook on archaeological matters. The Icelandic Natural History Society (*Hið íslenzka Náttúrufræðisfélag*), founded in 1889 for the collection and study of natural history specimens, publishes an annual report. The Icelandic Historical Society (*Sögufélag*), 1902, publishes texts dealing with the history of Iceland from about 1500 onwards. The Early Icelandic Text Society (*Fornritafélag Íslands*) was founded in 1928 to bring out standard editions of the old Icelandic classics.

Among societies of a more exclusive character are the University Men's Union (*Stúdentafélag Reykjavíkur*), Iceland's Scientific Society (*Vísindafélag Íslendinga*), the Icelandic Medical Society (*Læknafélag Íslands*), the Teachers Association (*Kennarafélag Íslands*), the Association of Icelandic Clergymen (*Prestafélag Íslands*), and the Association of Civil Engineers (*Vérkfræðingafélag Íslands*), each publishing a professional journal.

The Meteorological Institute (*Veðurstofan*) in Reykjavík was established in 1920. Up to that time the Danish Meteorological Institute had climatological stations in Iceland. The Meteorological Institute in Reykjavík gathers information from various parts of

Iceland (see p. 95) and from a number of foreign stations. The data collected are published in a monthly periodical called *Veðráttan*, and in an annual summary published each January since 1924.

Early in 1939 a Government Committee (*Rannsóknanefnd Ríkisins*) was formed to try to co-ordinate and control all scientific work done in Iceland, and to give advice to foreigners. The *Alþingi* expects all who visit Iceland for scientific purposes to consult with this committee before completing their plans, and to furnish it with a brief report of their investigations before leaving the country. The duties of the new committee are primarily to collect material relating to such investigations as have been carried out on the unused natural resources of the country, and to bring together and summarize all useful knowledge of this nature; also to make proposals for future research and to take charge of its organization and execution.

Literature

The art of printing reached Iceland in about 1530, when Jón Arason, the last catholic bishop in Iceland, established a press at Hólar. For over 200 years this was the only printing plant in the country. Since the middle of the nineteenth century the number of presses has been gradually increasing, and at present there are several in the capital and in some of the other towns.

In a country with only about 120,000 inhabitants, book production can hardly be expected to be a very lucrative trade; yet there are many publishers in Iceland, and the annual number of books issued is greater in proportion to the population than in any other country in the world. In Iceland there is one publication for every 466 of the inhabitants, while the number in Denmark is 1,106, in Norway 1,558, in Sweden 2,309, in Britain 3,205, in the U.S.A. 12,497. The Icelandic number is thus 2·4 times that of the Danes, who otherwise stand highest in this respect, and 27 times that of the United States. The recent literature of Iceland is more extensive than it has been at any time since the thirteenth century. A large amount of lyrical poetry is published, and there are several distinguished Icelandic novelists. Many of the novels and short stories published in other European languages have been translated into Icelandic. Especially noteworthy is the increase in scholarly works. It is clear that historical, linguistic and literary research has been greatly promoted by the establishment of the University in 1911. The publication of scientific textbooks and of the results of scientific research is steadily advancing, and the declaration of political independence in 1918 has been followed by an ever-increasing output of government publications and periodicals of all types.

Libraries and Museums

In addition to the private collections to be found in every household, there are many excellent public libraries.

The National Library in Reykjavík (*Landsbókasfn Íslands*), founded in 1818, is the largest in the country; it contains about 138,000 printed volumes and 8,500 MSS. The library receives free two copies of every publication printed in Iceland. Other large library collections in Reykjavík are those of the *Menntaskóli*, the *Alþingi*, the University, and the Public Library.

Outside the capital there are four regional libraries, one for each quarter of the country. Each is entitled to one free copy of every publication, of two pages and over, printed in Iceland. Almost every province has its public library, and circulating libraries are to be found in the parishes, some of them possessing large and valuable collections.

The National Record Office (*Þjóðskjálasafnið*), founded in 1889, contains all the archives of the central and local official administration, the various departments having to hand in their material as soon as it is 20 years old. These archives are very complete for the last 200 years.

The collection of Icelandic Antiquities (*Forngripasafnið*), founded in 1863, is now the Icelandic National Museum, which may pre-empt all Icelandic finds of historic interest that are discovered. The curator or 'guardian of folk monuments' (*þjóðminjavörður*) has the care of these and of all ruins.

The Natural History Museum (*Náttúrugripasafnið*) was founded in 1889 by the Icelandic Natural History Society. It is managed by the Society, but expenses are partly defrayed by the state. The collections are mainly of local mammals, birds, fishes, plants and rock specimens. Since 1936 the Museum has been actively carrying out an investigation into bird migration.

Newspapers and Periodicals

The first Icelandic newspaper appeared about the middle of last century; it was a fortnightly, but was soon changed to a weekly publication. The first daily paper was started in 1896.

The majority of current Icelandic newspapers represent different shades of political opinion, and can therefore be grouped according to political parties.

Papers supporting the Independence Party are: *Morgunblaðið* and *Vísir* (dailies), *Ísafold og Vörður* and *Stormur* (weeklies), all published in Reykjavík; *Íslendingur* (weekly), published in Akureyri; *Vesturland* (weekly), Ísafjörður; *Siglufirðingur* (weekly), Siglufjörður; and *Víðir* (weekly), Vestmannaeyjar.

Papers supporting the Progressive Party are: *Tíminn* (three times a week), Reykjavík; *Dagur* (weekly), Akureyri; *Einherji* (weekly), Siglufjörður.

Socialist papers are: *Althýðublaðið* (daily with a weekly edition), Reykjavík; *Althýðumaðurinn* (weekly), Akureyri; and *Skutull* (weekly), Ísafjörður.

The Communist Party has two papers: *Thjóðviljinn** (daily), Reykjavík; and *Verkamaðurinn* (twice a week), Akureyri.

The Agrarian Party issues a weekly paper, *Framsókn*, in Reykjavík. The constitution provides the right for free speech and a free press.

The first periodical in Iceland appeared in 1773. There are now a large number of monthlies, quarterlies, and annuals, some literary and general, others representing special interests or professions (see pp. 148–9).

Fine Arts

In the field of art little had been accomplished in Iceland until the latter part of the nineteenth century. The poverty and general misery prevalent in the seventeenth and eighteenth centuries did not provide the necessary background for artistic development.

Music. The Icelanders as a whole are not only gifted musically but are much interested in music. Before the more recent generations, two string instruments were popular, the *langspil* and the *fiðla*, both primitive types of fiddle which were placed on a table and played with a bow. The melody was played on one string, and the other strings were scraped with the bow to produce harmonic sounds. As in many other fields, it is the modern contact with foreign lands that has quickened the development in music. Scandinavian melodies are frequently sung to the accompaniment of the *harmóníum*, or parlour organ, which may be seen everywhere in the larger homes. The first organ is said to have been imported in 1800, and pianos may be found

* Suppressed by the British authorities in April 1941 for incitement to sabotage and continued opposition to the British occupation. The editors have since been released and another Communist paper has been started.

even in the most remote farms. Wind bands have been formed in all the larger towns and a symphony orchestra in Reykjavík. Choral song is part of the regular curriculum in schools, and Icelandic student songs are now being enthusiastically cultivated. Male-voice choirs are very popular; an annual festival is held at Þingvellir.

Sculpture. Iceland's first and greatest sculptor is Einar Jónsson, born in 1874. This artist has undoubtedly created something new on a national basis, and has achieved world-wide fame. The government has brought his works together in a separate Museum in Reykjavík, where they are preserved as a national art treasure. The sculptor, who lives in the building on a pension granted him by the *Alþingi*, is himself the curator of the museum. Several other Icelanders have made a reputation as sculptors, among them Miss Nína Sæmundsson, who executed the decoration above the entrance to the Waldorf-Astoria in New York.

Wood Carving and Weaving. These have been practised in Iceland from the earliest times. A recent industrial exposition at Reykjavík exhibited some very fine modern tapestries and hand-carved articles of wood and whalebone, showing that these old arts are being revived under the stimulus of the new intellectual awakening. The festival costumes, especially those worn by the women, used to be richly embroidered and ornamented with gold and silver; hence artistic needlework and skilled metal workers were in great demand. A representative collection of all these articles is to be found in the National Museums at Reykjavík and Copenhagen.

Dramatic Art. This has so far existed mainly in school and amateur theatricals. A dramatic society was formed in Reykjavík in 1897, and this has enjoyed some pecuniary support from both the government and the municipality. In 1923 a tax was imposed on entertainments to raise the funds for a national theatre which is now being constructed. There are several cinemas, but the films shown are entirely foreign and are mostly of the poorest quality.

Architecture. The scarcity of durable building materials prevented architecture from playing an important role in Iceland until recently. The different districts had characteristic types of farm houses, but the few official buildings which were constructed of lasting materials and are still preserved are in the Danish manorial style. It was not until the close of the nineteenth century that Icelanders began to feel the need of employing trained architects. Concrete was then introduced as building material and the erection of permanent structures became general. A State Architect is responsible for the design of most of the state-owned public buildings erected during the last 20 years, as well as a number of other important buildings.

The most common building material is wood, which is subsequently covered with brightly coloured corrugated iron. Inspected at close range, this material has a rather inferior appearance; but at a distance the colours are pleasing in a region where the landscape is predominantly dark grey or black. This form of architecture is likely to be superseded by buildings of reinforced concrete, of which there are already many interesting examples such as the new University building and the swimming hall in Reykjavík (Plates 62 and 63). Corrugated iron and reinforced concrete are used largely because of the high cost of importing bricks.

Sports

In the interests of physical culture a number of athletic clubs and unions have been organized. These are all under the control of a central authority, the Icelandic Sporting Union (*Íþróttsasmband Íslands*), founded in 1912.

Glíma. The form of wrestling known as *glíma* is purely Icelandic and is fundamentally different from the Graeco-Roman style, depending more on suppleness than strength or weight. There is no classification into heavy-weights, feather-weights, and so forth, but there are plenty of rules and a far greater number of tricks. For centuries *glíma* has been practiced principally where people have congregated, such as at festivals, at fishing stations, and at the coralling of sheep in the autumn. Modern Iceland is expending considerable energy on the sport. *Glíma* is an established part of any athletic programme in the country, and there is now an officially recognized national champion.

Swimming. In 1884 the first swimming society was formed for the purpose of arranging regular instruction at Laugarnar, near Reykjavík, where the bathing pool is warm. Long-distance swimming in the sea is handicapped by the low temperature of the water (see Fig. 55). For this reason it was considered a great achievement when a young lady swam from Engey to Reykjavík, a distance of 2·5 km. When it is simply a matter of learning how to swim, the hot springs can be used in the construction of modern concrete swimming pools. Considerable progress in this direction has already been made, and there are excellent open-air and indoor swimming pools at several places in the country.

Skating. Evidence of skating is lacking in Icelandic antiquity.

The sport is first mentioned in 1840, and it is probable that metal skates were introduced from Denmark about that date. Until quite recently, however, the metacarpal or metatarsal bones of horses, calves or sheep were commonly used as substitutes for proper skates. The ponds in south Iceland do not often remain frozen for long, but Reykjavík now has a skating rink. In the north of Iceland skating has long been a popular sport.

Ski-ing. There are good reasons for believing that the earliest settlers in Iceland may have brought the art of ski-ing with them from Norway, but there is no definite mention of ski-ing in the literature until the eighteenth century. The initiative for a more widespread use of skis came from the government in Copenhagen. The latter had heard that a certain man of Norwegian extraction in Húsavík, north-east of Akureyri, was able to travel on skis. He was encouraged with promises of reward, both for himself and for any pupils who might desire to spread knowledge of the art and work for its improvement. The first award was given in 1786, and it seems to have been from this time on that interest in ski-ing began to increase more and more. In 1839, there were said to be three or four pairs of skis on every farm in Ólafsfjörður, north-west of Akureyri. Now the art is known everywhere in regions where there is an abundant snow-cover in winter. In some regions a primitive type of snowshoes called *þruga* are still in use, the same word being employed in the south-west for the pieces of board utilized for walking over swampy ground. Ski-ing is no longer regarded simply as a means of getting from one place to another; it has become a sport which is rapidly growing in popularity. In recent years ski clubs have been organized and experts have been brought from Scandinavia as instructors. Near Reykjavík there is seldom snow for ski-ing, but suitable fields can easily be reached by car. Thirty km. east of the capital there is an excellent ski club house at Hveradalir on Hellisheiði. The hut is heated with water from hot springs. Near Akureyri there is a ski club house in Glerárdalur. Judged by Norwegian or Alpine standards, the snow surfaces are usually rather poor, but it should be possible to overcome this difficulty by the use of suitable waxes.

Other sports practised are football and various other ball games, which appear at modern sports festivals along with horse racing, running, jumping and *glíma*. Camping and hiking are becoming popular during the summer. Many tourists are attracted each summer by the excellent salmon and trout fishing (see pp. 319–20).

Chapter VII

SAGAS AND OTHER MEDIEVAL LITERATURE

Learning and Literature in the Middle Ages:
The Classical Period in Iceland: Archaeology

Learning and Literature in the Middle Ages

When the settlers came from Norway they brought with them an alphabet known as runes. The runes were ultimately derived from the Greek and Roman alphabets, and were used extensively in all Germanic countries, especially in England and Scandinavia, until the Christian missionaries introduced the pure Roman alphabet. The runes were used for inscriptions cut on wood or stone, or for charms engraved on precious metals. Parchment was not used, and consequently the runes belong rather to the field of magic and pagan religion than to that of literature. Nevertheless, the absence of writing among the Norwegian settlers does not imply that poetry and narrative were unknown to them.

Poetry. During the Viking Age, Norway had been rich in poetry. A large part of this was 'Court' poetry, composed in honour of living chiefs. It is distinguished particularly by its complicated metres and abstruse imagery. Poetry of this sort was highly developed in the Icelandic colony, and persisted throughout the Middle Ages. Some of its metres are still used by Icelandic poets.

A less popular type of poetry composed in Norway during the ninth and tenth centuries was the heroic. The Icelandic settlers brought the heroic lays with them from Norway and remembered them until they were written down in a thirteenth-century manuscript, known as the *Edda*. These poems deal with various subjects, with heroes of the Dark Ages, such as Attila and Wayland Smith. They are the oldest source for the stories of Siegfried (Sigurðr) and Brünhild (Brynhildr), which were popularized by Richard Wagner, and are particularly important for our knowledge of Germanic paganism. Nevertheless, the Eddaic poetry, though it was remembered, did not develop in Iceland. Few poems of this type were composed in Iceland.

Prose. It is as writers of prose that the Icelanders are particularly distinguished among the nations of Europe. The prose literature of Iceland is closely associated with the Christian religion. It is said that the first to write in Icelandic was Ari Þorgilsson (died 1148). Ari's sole surviving work was his *Íslendingabók* or 'Book of the Icelanders', which, in its present form, gives a short history of the settlement of Iceland. Another eminent scholar in twelfth-century Iceland was Sæmundr Sigfússon (died 1133). His works are lost, but it is known that he was a very learned man, and that his studies took him both to England and France. Sæmundr belonged to the family of the Oddaverjar, or Men of Oddi, in the extreme south of Iceland. The Oddaverjar were perhaps the most influential family in the twelfth century in Iceland. Among them were Jón Loftsson (died 1197) and Bishop Páll (died 1214). Undoubtedly this wealthy and cultured family did much to foster learning and scholarship in Iceland throughout the twelfth century.

The works of Ari and Sæmundr belong to the category of learning rather than that of literature. It was not, in fact, until the latter decades of the twelfth century that the 'sagas' began first to be written. It cannot be said with any certainty what was the origin of the sagas, nor the causes which promoted this branch of literature, unique among the literatures of the world. Undoubtedly, ecclesiastical life, and especially the monasteries, played a noteworthy part in the growth of the saga literature. The oldest, and probably the most important of the Icelandic monasteries, was that of Þingeyrar on Húnaflói, which was founded in 1133, and followed the Rule of St Benedict. Other important monasteries in the early Middle Ages were the Benedictines at Þverá in Eyjafjörður, and the Augustinian Þykkvibær in Skaftafellssýsla, and that on the island of Flatey in Breiðifjörður. It appears that the earliest sagas were closely linked with the European literature of the period. Before the lives of Icelandic heroes came to be written, the Icelanders wrote lives of foreign saints and heroes, particularly of the kings of Norway. Thus, in about 1170, Oddr Snorrason, a monk of Þingeyrar, wrote a life of Ólafr Tryggvason, King of Norway. This work was written in Latin but the original is lost, and it is preserved only in an Icelandic translation. Gunnlaugr Leifsson (died 1218) was a monk at Þingeyrar at the same time as Oddr. His works appear to have been more varied than those of Oddr. Among them were a life of St Ambrose, and an adaptation into Icelandic of a part of Geoffrey of Monmouth's *Historia Britonum*. Yet more eminent than the monks Oddr and Gunnlaugr was their abbot, Karl Jónsson (died 1213). Abbot Karl was a friend of King Sverrir of Norway and wrote his biography in Icelandic.

It has been seen that during the latter years of the twelfth century the Icelanders, largely influenced, no doubt, by foreign models, had begun to write the lives of foreign saints and of Norwegian kings, especially those who had espoused the Christian cause. About the end of that century men of literary ability began to turn their attention to the native traditions and popular heroes of Iceland itself.

The Classical Period in Iceland

Early Icelandic prose and poetry are studied to-day in most of the great universities of the world, and they have exerted an influence upon Iceland comparable with the combined influence of Shakespeare and the authorized version of the Bible upon England.

The general title of 'Icelandic Sagas' is used to denote a very extensive body of prose literature written in Iceland at various dates between the middle of the twelfth century and the beginning of the fifteenth. The common feature of these works, which vary greatly in length, value, and interest, is that they have the outward form of historical or biographical narratives; but the matter is often fictitious, and in many cases fact and fiction are inseparably blended.

The word *saga* (pl. *sögur*) is related to the word *segja*, 'to say'; it is the usual Icelandic word for a story or any other form of narrative, and was in use long before there was any written literature in Iceland. From an early period it had been a custom, which in course of time became an accomplishment and an art, to put together in a connected form the exploits of some notable man or the record of some memorable event, and to relate the story as a means of entertainment or instruction. These oral narratives provided the substance of the family sagas.

This literature reached its highest level in about the middle of the thirteenth century, at a time when there was practically no writing of narrative prose either in England or in Germany.

Some general indication may be given here of the value of the sagas as historical records. They contain the fullest accounts of early Scandinavian history, and they throw much light upon the history of the British Isles during several centuries. As history, the sagas may be unreliable and sometimes proved to be so, but they present their historical information in a form which is full of life and colour. They provide a picture of the Scandinavian leaders who played such an important part in the early history of western Europe and who altered the whole fortunes of countries like England and France. They do not merely record the names and exploits of these men;

they present their characters, their aims, their daily lives and occupations. It is the great triumph of the saga writers that they succeeded in providing an almost complete picture of old Scandinavian life in all its aspects, and thus help towards an understanding of the early civilization in other parts of northern Europe. They were also masters in the delineation of character, sometimes by a brief indication of the leading qualities in the man or woman described, but much more often by the mere action of the story itself. Among the hundreds of real persons mentioned, it is surprising how many can be clearly and sharply distinguished from each other, and how skilfully the writers have brought out the contrasts between them. More is known about scores of Icelanders of all ranks in life than about most of the kings of England at the same date.

In every district of Iceland the memory of great men and distinguished families was handed down. These memories were preserved mainly in three ways—by oral memory of genealogies, in verse and in popular stories, which were often associated with particular localities. Out of these traditions came the collection of sagas now commonly grouped under the name of *Íslendinga sögur*. Sagas which deal with the lives of Icelanders before the middle of the eleventh century would amount to more than 2,500 pages similar to those in this book. The geographical distribution of these is very unequal. The five largest ones relate to the western half of Iceland; and of the remainder at least seven-eighths are connected with the west and north, the east and south-east being represented only by a few short stories, which are, however, of particularly high literary merit. Fig. 71 indicates the districts in which the main events of thirty-two of the most important sagas took place. In most of these the narratives deal chiefly with the period between the middle of the tenth century and the first quarter of the eleventh. Any visitor to these districts will find that every detail of the local sagas are well known to the inhabitants, and he will be able to see the exact localities where recorded events are supposed to have taken place 1,000 years ago.

The longest and most famous of these sagas is that of Njál. The characters of all the leading persons, both men and women, are brought out with masterly skill, not by any attempt at description or analysis on the part of the writer, but by the simple account of their own words and actions. *Njáls saga* is also of importance for the interest in legal matters which it everywhere displays; it throws considerable light on the history of Icelandic law. Another particularly interesting one is *Egils saga.* This relates the life of the hero Egil, son of Skallagrímr, whose home was at Borg. Egil travelled widely in Europe, and a considerable part of the saga deals with a visit which he paid to England, where he fought in the Battle of Brunanburh on the side of King Athelstan.

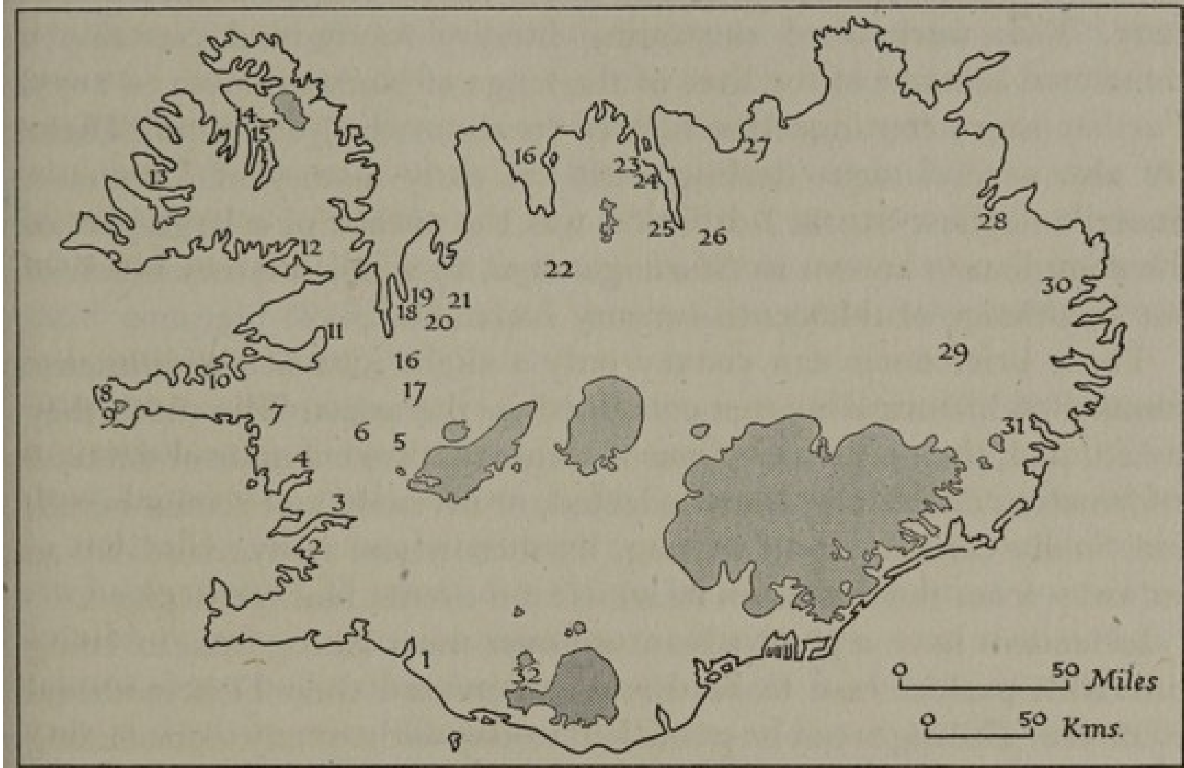


Fig. 71. Main Saga districts. Source: W. A. Craigie, *The Icelandic Sagas* (Cambridge, 1913).

1. Flóamanna saga
2. Kjalnesinga saga
3. Harðar saga
4. Egils saga
5. Gunnlaugs saga
6. Hœnsa-Þóris saga
7. Bjarnar saga
8. Víglundar saga
9. Bárðar saga
10. Eyrbyggja saga
11. Laxdœla saga
12. Gull-Þóris saga
13. Gísla saga
14. Hávarðar saga
15. Fóstbrœðra saga
16. Grettis saga
17. Heiðarvíga saga
18. Bandamanna saga
19. Þórðar saga
20. Kormáks saga
21. Vatnsdœla saga
22. Þorvalds saga
23. Svarfdœla saga
24. Valla-Ljóts saga
25. Víga-Glúms saga
26. Ljósvetninga saga
27. Reykdœla saga
28. Vápnfirðinga saga
29. Hrafnkels saga
30. Droplaugarsona saga
31. Þorsteins saga
32. Njáls saga

The saga writers were as diligent in recording foreign historical matter as in preserving the traditions of their own island. There is thus a considerable quantity of interesting material dealing with Norway, and Greenland, which was first colonized from Iceland. There are also accounts of the first European expeditions to America in *Eiríks Saga Rauða* and *Þorfinns Saga Karlsefnis* (see pp. 179–81).

In the second half of the tenth century the art of poetry began to decline in Norway, and thenceforward, with very few exceptions, it was by Icelanders only that the profession of *skáld* was followed. The numbers of such poets during the tenth and eleventh centuries was very great. They visited all the courts of Europe, and circulated stories of contemporary and past events. Their importance as historical evidence is strongly emphasized by the great Icelandic historian, Snorri Sturluson, in the prologue to his *Heimskringla*, written about 1225. This work is of surpassing literary merit, and contains a connected account of the lives of the kings of Norway down to 1177. Further sagas continue this history to about the year 1230. There are also several sagas dealing with the early history of Denmark. Snorri's nephew Sturla Þórðarson was the author of a large part of the compilation known as *Sturlunga saga*, to which we owe much of our knowledge of thirteenth-century Iceland.

These brief notes can convey only a slight idea of the immense amount of historical matter contained in the sagas. The more they are studied, the more marvellous it seems that such a mass of detailed information could have been collected, or invented and remembered, and finally committed to writing, by men whose native land lay so far away from the countries in which the events had taken place.

Icelanders have a great advantage over most Europeans, in being able with perfect ease to read and understand their best medieval literature. The sagas can be published to-day without any modernizing of the language. During the nineteenth century the study of the older literature had a great influence upon the style of the best Icelandic prose, which is now purer and more flexible than it has been at any time since the fourteenth century. The genuine type of saga prose is a purely natural style, developed from the form in which the stories were originally told. As a result of this it is extremely hard to reproduce it successfully in any other language.

In one respect the sagas are disappointing—references to natural phenomena and conditions are surprisingly meagre—interest is concentrated on the doings of people.

A considerable number of sagas have been translated into English, and most of these have been selected to illustrate the different phases of old Scandinavian life in Iceland, Norway or the British Isles. Some of the best of these translations are listed on pp. 410–11.

Archaeology

It is difficult to attempt to understand the life of a country without some knowledge of the historical background, and that background is itself rather lifeless unless it can be linked to the present by visible things. These things may either be the actual sites where historical incidents occurred or they may be the surviving objects used by the people who made the history. In most of the rest of Europe there are so many great monuments of the past still to be seen that the visitor to Iceland, where no such things remain, may be inclined to look on the history of the country as something which can no longer be joined to the present time by anything more definite than imagination. This is wrong, and though it is of course impossible in a short chapter to do more than sketch the possibilities, yet it may be long enough to show that a fuller account properly illustrated with references to the saga literature could be very interesting and would compare favourably with a similar work on the antiquities of any other country.

The Norwegian colonists and those from the Hebrides and Ireland were so vigorous and their saga literature is so famous that comparatively little attention has been given to the Christian monks who preceded them by a hundred years at least. These monks, who were called Papar or Culdees, had the custom of forming small monastic settlements or cashels on lonely islands all round the coasts of Britain and Ireland. They crossed very great distances in skin-covered boats of which the curraghs of western Ireland are direct and the wooden cobles of Scotland indirect descendants. The remains of the cashels are to be seen on many islands to this day, Skellig Michael off the coast of Kerry being the most famous. The monastic buildings were beehive huts, built like an Eskimo snow house, but with courses of flat stone in place of snow. They were covered outside with turf. The Irish and Scottish also frequently constructed earth houses or weems which were artificial caves underground. No actual cashels are known in Iceland. There is a report of some ruins on Papey which are thought to be earlier than the Norse colonization, but they have not been examined by any competent person. On the summit of Heimaklettur in Vestmannaeyjar there is also a small ruined foundation which from its shape and position recalls ruins in cashels in Ireland.

In the valley of the Þjórsá there are several places where artificial underground caves exist. Notable examples occur at Hellir and Ægisíða. These caves are without doubt very ancient, and at intervals a new one is accidentally discovered. The caves are now used for sheltering beasts in winter and for the storage of forage. Because of their resemblance to the earth houses in Scotland and Ireland, it has been suggested that they were the work of the Papar. It seems improbable, however, that these caves are of such great antiquity, for the Papar showed a greater liking for inaccessible islands than for inland plains. On the other hand, many Scottish and Irish slaves were brought to Iceland by the later Norse immigrants, and the idea of constructing the caves may well have come from them.

More definite traces of the Irish may be found in the Museum at Reykjavík. Here are about a dozen bronze 'Pins'. Most of them are really specimens of 'Stylus' used for writing on wax enclosed in wooden tablets. One of them is still fixed in the binding of such a tablet. These pins were in most cases made in Ireland where they have been found in considerable numbers and their date is known with some accuracy. Several of these pins are certainly much older than the Norwegian colonization. In the same collection there is a bronze comb, which is very like an example from the early monastic cemetery at Whitby, and jet beads from the same district of Britain, which was famous for its early Christian settlements. Some of these objects may have belonged to the slaves, but it is unlikely that they all did.

Although several Norwegian voyagers visited Iceland, it was not until 874 that Ingólfr became the first known Norse settler there. He was a great landowner and was soon followed by others of the same kind who were driven by the growing power of the King of Norway to settle overseas. They brought with them a somewhat primitive but thoroughly organized way of life, which remained almost unchanged in Iceland down to the beginning of the twentieth century. They were stockbreeders and ranchers, and when their home was near the sea the farmer was a fisherman as well. The farmer of Iceland and the crofter of western Scotland are both direct descendants of an ancient form of civilization which the Vikings took with them wherever they conquered new territory. The old culture of Iceland had almost as much in common with that of the Hebrides as it did with that of Norway. The early settlers were pagans even though their slaves may have been sometimes Christian. They buried their dead with their war gear if they were men and with their ornaments if they were women. The objects found in the graves of the ninth and tenth centuries are remarkably similar whether they are found in Sweden or in Dublin, in the Hebrides or in Iceland. The warrior has his outfit of sword, spear, battle-axe, shield-boss, knife, and perhaps smith's tongs, hammer and whetstone. The shield was a small round 'target' of wood with an iron hand-grip in the middle protected by a hemispherical iron boss. The shape of these objects changed with the years, and it is possible to date a given form of sword or axe with some accuracy. The women were buried with a pair of large elliptical convex bronze 'tortoise' brooches, glass beads, bone combs, iron weaving swords and iron shears. Unfortunately, there is a difference in time of many years between the objects found in the graves and those described in the sagas. There is indeed a collection of burnt weapons from Bergþórshvoll in the Reykjavík Museum, but they are dated more closely to the days of the first colonists in the ninth century than to the burning of the place by Flosi early in the eleventh century. Those who wish to look at specimens of the great horned battle-axes which were so often described in the sagas will not find them preserved in Iceland. There is, however, in the London Museum a fine series of axes which were apparently lost in the attack on London Bridge in the early years of the eleventh century, and which is vividly described in the *Heimskringla*. The 'kite-shaped' shield of the sagas is not preserved in Iceland, or, for that matter, anywhere else. It is said to have been evolved to protect the heavy horseman of chivalry, but it seems more likely that it was designed as a counter to the Norsemen's habit of trying to cut off each other's legs. 'Skamkell ran behind Gunnarr's back and makes a blow at him with a great axe. Gunnarr turned short round upon him and parries the blow with the bill, and caught the axe under one of its horns with such a wrench that it flew out of Skamkell's hand and away into the river....Otkell smites at Gunnarr with his sword, and aims at his leg just below the knee, but Gunnarr leapt up into the air and he misses him. Gunnarr thrusts at him the bill, and the blow goes through him' (*Njáls saga*).

Icelandic culture was based on the farmstead or ranch of the big landowner, who might be compared with the early 'squatters' in Australia. Conditions in Norway forced his emigration, and whether he came direct to Iceland or whether there was an interval during which the family settled for a while in Scotland or Ireland, he was still the chieftain when he reached Iceland. The national life which grew up there is the only example in European history of a community which began from the first as a farming aristocracy.

By a fortunate chance several old *skálar* (halls), as farmhouses were called, were covered by the ashes from an eruption in the twelfth century in the valley of the Þjórsá. Three of these were excavated in 1939, and thus complete plans of the *skálar* of about the time when the sagas were being compiled have been recovered. These *skálar*, of which the biggest was uncovered at Ásólfsstaðir, were long narrow buildings up to 40 m. in length. They belong to a class of houses known as 'Fire-Halls', from the great open hearths which ran longitudinally for much of their length. This type of building was known in Jutland at least as early as the first century B.C. Roughly one-third of the central section of the building was subdivided by two lines of posts, which gave it the appearance of a central 'nave' with two side aisles. Big open fires were kept permanently alight in the nave. The post holes were clearly visible at Ásólfsstaðir, but the posts themselves must have been small. At the two ends there were no posts and the roof was probably rather low. The walls were made of turf. The roof is known to have consisted of two coverings—an inner one of wooden laths or planks, reeds or bark, and an outer one of turf. It was formerly considered bad manners to let one's horse eat the grass on some other person's roof. At Keldur in Rangárvellir

Fig. 72. Old types of farm building with turf roofing, Barðaströnd. Source: J. Jónasson, *Íslenzkir Þjóðhættir*, p. 446 (Reykjavík, 1934).

a *skáli* exists which is of great antiquity but which is still in occupation. It is the site where lived Ingialdr who refused to take part in the assault on Njál by Flosi (early eleventh century), and it is possible that some of the building is as old as the saga time. Traces of the aisle structure remain, and there are inner doorways with wooden arches and pillars which resemble the timbering of eleventh-century wooden churches such as Urnes in Norway. The saga accounts of the *skálar* give the impression of grand buildings rich in carved woodwork and tapestry. Nothing at Keldur or Ásólfsstaðir bears out this impression. It is probable that all the Icelandic *skálar* were comparatively simple and that the saga accounts are based on descriptions of royal buildings in Norway. At the back of the hall was an *eldhus* or kitchen such as is still to be seen at Keldur, and there were two doorways on the front side. These were probably placed in short wooden gables. The characteristic farm in Iceland a hundred years ago had several such gables set at right angles to the longer axis of the building (Fig. 72). It is certain that when the first settlers came the beaches must have been littered with great accumulations of drift-wood like those of Jan Mayen to-day. The suitability of this wood for building houses may however be doubted. Many settlers brought their house timber from Norway.

Iron working appears to have been carried out at the largest of the Ásólfsstaðir *skálar*. It is mentioned as being an accomplishment of several saga heroes, and the ore was obtained as 'bog iron' (see p. 68). 'Then Skallagrímr set up a household in Knararnes, and there had a farm for a long time after. He was a great iron smith, and used much red iron ore during the winters. He had a smithy made close to the sea not far from Borg, at Rauðanes' (*Egils saga*). Traces of Skallagrímr's smelting have been found at this place, and other sites are widely distributed in the west of Iceland as well as sporadically in the north. Smiths' work was particularly necessary in this country because the whole existence of the stock often depended on the hay crop in winter, when little grazing was to be had. Scythe blades were thus an absolute necessity.

The long dark winter evenings must have been very cheerless in the north. The women could be occupied with carding wool, spinning, weaving, and the like, but it was less easy for the men, and many a fancied slight grew to a blood feud during the idle talk over the remains of the evening meal. Men could of course be occupied in making the numerous wooden vessels which took the place of earthenware for household utensils. Potsherds have not been found in the Þórsárdalur houses, and at Keldur there are numerous surviving specimens of wooden vessels of all kinds. The same scarcity of pottery was true of medieval Wales, Scotland and Ireland, but there glazed earthenware was used to some extent. The men in Iceland presumably made the fishing nets, horsehair ropes, and all the necessary gear for the farm. It is easy to see how the telling of sagas like the 'ceilidh' of the Hebrides became a necessary part of the life of the people (see p. 157). Games such as chess were also played, and there are two very interesting chessmen of the saga period preserved at Reykjavík.

The general apathy which descended on Iceland when it became joined first to the Norwegian crown, in 1272, and then to the Danish crown in 1397, is reflected in the way in which all progress halted for many centuries. Ornamentation did not change with the fashions of Europe, and on the carved wooden vessels of the eighteenth century we may see patterns which have remained with little alteration since the eleventh century. The *skáli* of Keldur in its main essentials is the *skáli* of Ingialdr, and this is true not only of the building but of its contents, of the saddles on the horses, of the horsehair ropes which bind the hay on the horses, of the scythes which mow the hay, of the spindles, carding combs and other weaving utensils of the women, and of the food which the people eat. Country life in Iceland is now changing in one jump from what was in many essentials the life of Norway or Scotland in the ninth century to that of the twentieth century.

At the little fishing villages around the coast the same story is being repeated. Here can be seen the decaying hulls of the great open boats which with crews of nine or ten men went to the winter cod fishing in precisely the same manner as Þóroddr of old. 'But in the winter a little before Yule, goodman Þóroddr went out to Nes after his stock-fish. They were six together in a ten-oarer and were out there night-long.... The morning that Þóroddr and his men went out westaway from Nes, they were all lost off Enni; the ship and the fish drave ashore under Enni, but the corpses were not found. But when this news was known at Froðiswater, Kjartan and Þuriðr bade their neighbours to the arvale, their Yule ale was taken and used for arvale. But the first evening whenas men were at the feast, and were come to their seats, in came goodman Þóroddr and his fellows into the hall, all of them dripping wet' (*Eyrbyggja saga*). In this passage we see the custom of winter fishing for the stock-fish, which was dried and eaten raw with milk and *skyr*, as it still is in Iceland. Then there is the custom of the Yule-feast, which was a constant and most welcome break in the long winter. There is the arvale or inheritance feast, when the heir drank himself into his inheritance. There is the Irish name of Kjartan pointing to the mixed stock of the settlers, the use of the ten-oared boat, and finally the danger of this particular fishing. Until the introduction of the decked fishing boat and the provision of motor propulsion for it, the loss of life from the fishing villages under Snæfellsjökull was always great. Except for a certain increase in the power and depth of the boats, and the disappearance of the characteristic flat floor of the viking boat, which can still be observed in the Scottish 'scaffie', the Iceland cod-boat might have been that of Þóroddr himself.

The study of marine archaeology is not so advanced as that of things ashore, but certain matters have been investigated. It is interesting to note that here and there in odd corners among the decaying boats or the vats of rotting fish livers, may be seen specimens of very primitive stone anchors or killicks, which are similar to those found in Cornwall, Ireland or Brittany. These must surely be a Celtic contribution to the gear of the Norse fisherman.

Little remains of purely medieval antiquity in Iceland. Enamelled bronze figures from crucifixes, and candlesticks which probably came from Limoges, bronze aquamaniles, possibly from England, and a few similar relics do little more than show that there was trade with western Europe, and this is already known from historical records. The curious and primitive Lutheran churches are probably a natural compromise between the old *skálar* and earlier churches which have not survived. Of the bishop's church at Skálholt little is left but a sketch made in 1772 and now in the British Museum (Fig. 73). It depicts a building of the Norwegian 'stavkirke' type. The English

Fig. 73. Old church at Skálholt, 1772. From a drawing in the British Museum.

fishermen and traders who visited Vestmannaeyjar in the fifteenth century and their Hanseatic rivals at Hvalsnes have left little behind but occasional scraps of green glazed pottery and a name for barbarity. The only important change in the way of life in Iceland which occurred between saga times and the Reformation was the gradual dying out of corn growing, which had been practised to some extent in the time of Gunnarr and Njál, but which almost vanished in the succeeding centuries: 'It happened that Gunnarr had gone away from home out of his house all alone; he had a corn-sieve in one hand, but in the other a hand-axe. He goes down to his seed field and sows his corn there, and had laid his cloak of fine stuff and his axe down by his side, and so he sows corn a while' (*Njáls saga*).

Chapter VIII

HISTORICAL OUTLINE

Introduction: Settlement: the Republic (930–1262): The Later Middle Ages (1262–1551): The Period of Decline (1551–1800): The Nineteenth Century: Note on the Constitutional Relations between Iceland and Denmark

INTRODUCTION

The history of Iceland falls into three main periods:

(1) 874–1262. The settlement of Iceland began in 874. The majority of the settlers were Norwegians, many of whom were seeking freedom from imposed authority. They organized their state as a republic, under the joint control of a number of leading chiefs, who held a general parliament, the *Alþingi*, each year, from 930 onwards. This form of government was unique in Europe at that time. The Icelanders were vigorous and enterprising, and their mental culture reached its height in the thirteenth century. Rival factions in the state broke down their system of government, and the Icelanders gave their allegiance to the King of Norway in 1262. This section is treated in some detail.

(2) 1262–1800. During these centuries there was a gradual decline in Icelandic life. The provisions of the agreement of 1262 which safeguarded Iceland's interests were disregarded, and Iceland came to be governed by foreign officials, whom the Icelanders had little power to resist. After the Reformation, Iceland was governed from Denmark, and new taxes were laid on the people, and the officials became more oppressive. A series of natural disasters, coupled with the crippling effects of the Danish commercial monopoly on Iceland's economic life, reduced the country to the lowest state in its history at the end of the eighteenth century. Iceland had little say in her own affairs, and this period in general has been treated briefly.

(3) 1800 to the present day. After 1800 conditions in Iceland gradually improved. The Icelanders themselves now began to show great initiative, and their leaders began a long struggle for increased national rights. Under the leadership of Jón Sigurðsson, Iceland was granted the right of free trade with other countries (1854), and a constitution bringing partial self-government in 1874. Though some material progress was made in the nineteenth century, the great

advance belongs to the present century. The change in Iceland's political status is the most important development in this period of the history of Iceland, and is treated in detail. Iceland's material progress is discussed elsewhere.

THE SETTLEMENT

Towards the end of the eighth century, a period of Scandinavian expansion and maritime enterprise began, which continued until the middle of the eleventh century. There is evidence of earlier Scandinavian penetration, for example in the Shetlands, but during this main period bands of sea adventurers, or Vikings, sailed out from Denmark, Norway and Sweden, sometimes only to seize what plunder they could in raiding expeditions, sometimes to conquer whole territories, and settle them after conquest. The settlement of Iceland belongs to this period. It was carried out mainly by Norwegians, and began in 874, at the time when Alfred the Great was resisting the Danish armies in England.

Knowledge of Iceland before the Settlement

There is no trace of stone or bronze age man in Iceland, and it is now agreed that the 'Ultima Thule' of the classical authors was not Iceland. In his *De Ratione Temporum*, the Venerable Bede (A.D. 674–735) provides evidence indicating that by his time Thule was the name for Iceland.

Irish monks in Iceland. The earliest discoverers of Iceland of whom there is any reliable record were some monks who came from Ireland at the end of the eighth century. The source of this information is a chronicle of the Irish monk Dicuil, written in 825. The monks had been there in the spring and early summer, and it had been so light that they were able to pick the lice out of their shirts at night as easily as in the daytime. Additional evidence that a few Irish hermits had sought the solitude of Iceland before the settlement is given in the works of early Icelandic historians. They record that when the first settlers came to Iceland they found some Irish monks there. The Icelanders called them *papar*, 'priests', and they did not remain in Iceland because they were unwilling to live among heathens. They are said to have left Irish books, bells and croziers behind them, and place names such as Papey and Papós are an indication of their presence in Iceland.

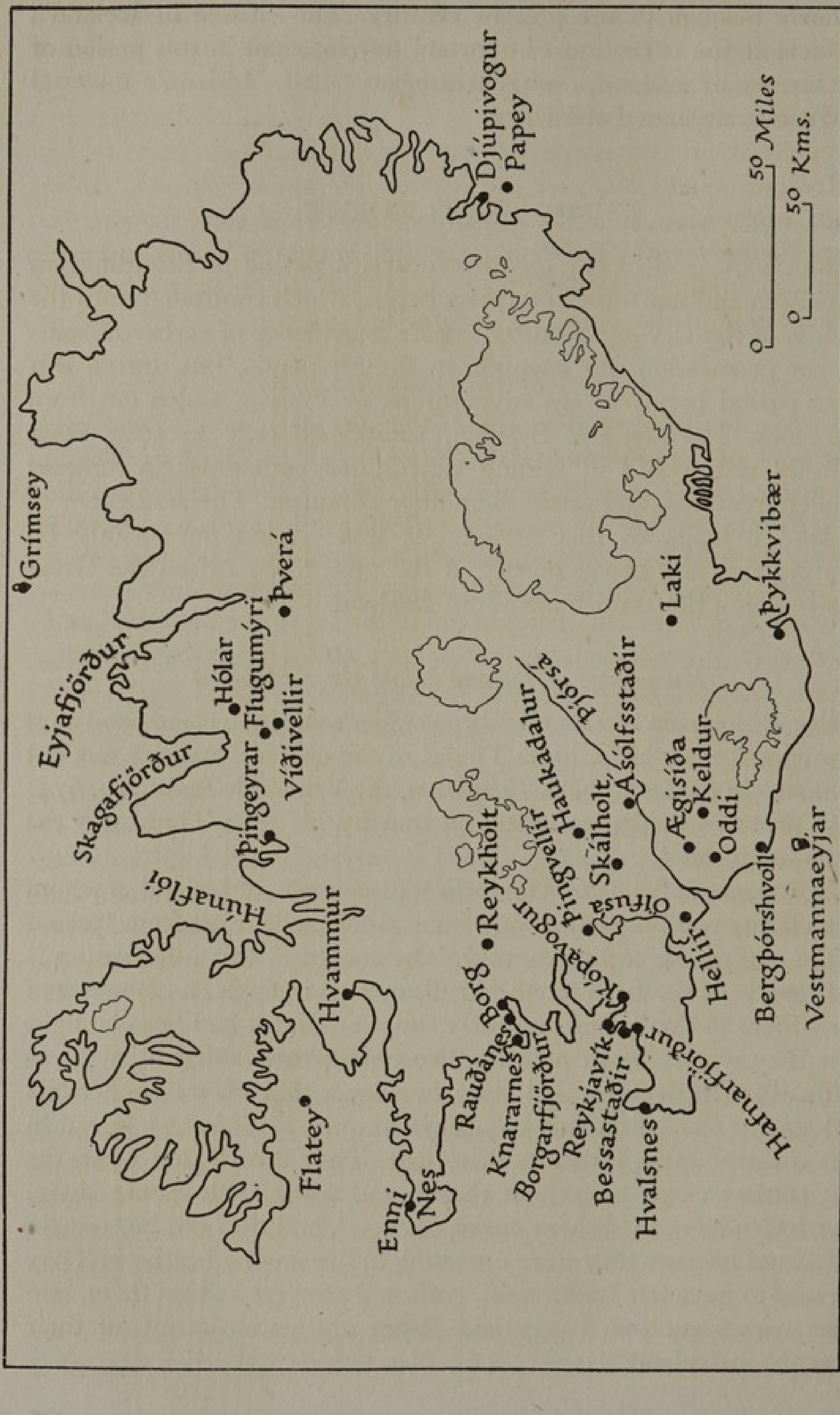


Fig. 74. Map showing place-names in Chapter VIII.

Early Scandinavian Explorers. Whether the Scandinavians heard of Iceland from the Irish is debated, but they first began to visit it in the decade before the settlement.

We do not know whether it was a Norwegian, Naddoddr, or a Swede, Garðarr Svafarsson, who was the first Scandinavian to set foot in Iceland. Naddoddr gave the country the name *Snæland*, 'Snow-land', but it was a later Norwegian explorer, Flóki Vilgerðarson, who first called it *Ísland*, 'Ice-land'. He had brought followers and cattle with him, hoping to settle in the country, but after his cattle had died of starvation in the winter, he returned to Norway.

The First Settler

In 874, according to the account in the Icelandic *Landnámabók*, 'the book of the settlement', two Norwegians, Ingólfr Arnarson and his foster-brother, set off for Iceland, each in his own ship, intending to settle there. Ingólfr brought with him the two pillars between which the high seat of his Norwegian home had been set. Such pillars were often adorned with carvings of the gods and were objects of veneration. As soon as Ingólfr sighted land, he threw these pillars overboard and declared that he would settle wherever they drifted ashore. After a long search, his pillars were found, and there at Reykjavík, Ingólfr made his home and took possession of the land round about. In the meantime his foster-brother had been murdered by the Irish slaves he had brought with him. Ingólfr put these slaves to death on the islands to which they had fled, islands afterwards to be known as Vestmannaeyjar, 'the islands of the men from the west', from *Vestmenn*, the Icelandic name for the Celts. Ingólfr was followed by other settlers, and the settlement of Iceland, by about four hundred chief settlers in all, was complete in a few decades after 874.

Causes and Manner of the Settlement

The settlement of Iceland may be considered as a further stage of Norway's expansion to the islands lying to the west. Norwegians had already settled in the Faroes, the Orkney and Shetland Islands, the Hebrides, and parts of Ireland. According to the medieval Icelandic historian, Snorri Sturluson, his country was founded as a refuge from the oppressive rule of King Haraldr Hárfagri (Harold Fairhair).

King Haraldr, who became King of Vestfold in south-east Norway in 860, made the vow that he would not have his hair cut or combed until he had united the petty kingdoms of Norway under his sole authority. He finally accomplished his purpose by a great naval victory at Hafsfjord in 872, whereupon he had his hair groomed and acquired his nickname. He imposed taxes on men who had hitherto held their land as a family possession, and many fled to the Viking settlements in the west, from which they harried Norway. Haraldr drove these Vikings from the Shetlands, Orkneys and Hebrides in 890, and many of them settled in Iceland.

Snorri's account involves chronological difficulties, but it is true to the aristocratic origin and independent spirit of the majority of the *landnámsmenn* or chief settlers, who undoubtedly left Norway to escape the imposition of authority over them.

Landnámabók. No country possesses so detailed a source for the history of its foundation as Iceland's *Landnámabók*, which is a thirteenth-century compilation of the traditional evidence about the settlement. [For an account of the origin of the settlers, see pp. 133–4.]

Most of the chief settlers were of good Norwegian family, whether they came direct from Norway or from Viking settlements. Many came from the Hebrides, bringing with them wives or dependents of Celtic birth. Auðr the Deepminded, the widow of a Viking king of Dublin, brought many other colonists with her from the Hebrides. She had been baptized and remained a Christian till her death. Of another settler from the Hebrides, Helgi the Lean, it is told that though he was a Christian, he prayed to the god Þórr when he was in distress or danger on the sea.

The first settlers took possession of as much land as they wished, but later gave or sold portions of their property to friends or relatives. When much of the habitable land had been claimed, settlers were only allowed to own the land they could traverse between a fire they lighted at sunrise and a fire they lighted at sunset.

The Religion of the Settlers

At the time of the settlement, Norway was still heathen, but many of the settlers had come into contact with Christianity in the western colonies, and some of them had been baptized. The Christian faith, however, died out in one or two generations after the settlement.

The Icelanders worshipped their heathen gods, the *Æsir*, but their belief in their powers was limited, partly by their belief in fate, and partly by their belief in magic. Nor was one god regarded as the highest of the gods, but the god to receive most honour varied in the different families. Some men refused to honour any god. In Norway

Óðinn had been the patron of the warrior and the poet. Poetic imagination and the creed of the warrior are united in the conception of Valhalla, where Óðinn gathered his best warriors round him after their death, to form the army which was to follow him to the last great battle of Ragnarök, the Twilight of the Gods. Þórr was the god of the farmers and peasants, and his cult throve in Iceland. Though the gods were worshipped to secure their favour, the Icelanders believed that fate exercised a higher power than did the gods. One aspect of this was the belief that the fortunes of a man and of his family were watched over by spiritual forces. Moreover, the belief in magic and enchantment, with their attendant arts and rites, flourished in Iceland.

In Norway there had been no organized priesthood. Any landholder could have his own temple, where he himself sacrificed to whatever god he honoured most. In Iceland, similarly, a settler who built himself a temple on his land performed the office of priest. He was known as a *goði*. Naturally it was the leading settler in any district who built his own temple, and so he administered justice, as well as serving as *goði*.

The construction of the heathen temple, or *hof*, is known from descriptions in the sagas, and from excavations which have been carried out in Iceland. Christian churches, so often pillaged in other lands, served as models for heathen temples. At the end of its main hall there was a section containing the altar and the images of the gods. The rites of worship consisted of sacrifice and prayer. By the sacrifice, or *blót*, a beast was slain and its blood sprinkled on the altar, the images of the gods, the temple walls and those who took part in the ceremony. Ale was the sacrificial drink. All social functions were associated with religious rites, and all oaths were sworn with one or more of the gods to witness.

THE ICELANDIC REPUBLIC (930–1262)

There was at first no central authority of any kind in Iceland, but in each district the leading settler made himself responsible for maintaining law and order, just as he presided over religious ceremonies as *goði*. It was in his power to set up a local assembly, known as a *þing*, at which he presided and where all the freemen of the district could meet to discuss matters of common interest and have their disputes settled.

The Establishment of the Republic

The chiefs founded the Icelandic Republic by adopting a national code of law and establishing a General Assembly, the *Alþingi*. A man called Úlfljótr was sent to Norway to frame a code of law, and when he returned after several years' absence, a suitable place to hold the General Assembly was chosen. In 930 the first *Alþingi* was held on the banks of the river Öxará, about 30 miles from Reykjavík, and at this meeting Úlfljótr's code was adopted. The unique system of government that was then established was not changed in essentials until the loss of independence in 1262. Certain changes were introduced about 965, when Iceland was divided into four administrative districts, or quarters (*fjórðungar*), and again in about 1005.

The Icelandic Constitution

The main outline of the system of government, including the later changes, is this. Both local and central government were in the hands of the *goðar*, who had arisen as the leaders of the new community. There were thirty-nine *goðar* (earlier thirty-six), nine for each quarter, except the northern quarter which had twelve *goðar*.

Local judicial assemblies (*þing*) were held in the spring, three courts being set up in each quarter except the north, which had four. Difficult cases were referred to the *Alþingi*. The *Alþingi* met annually at Þingvellir for two weeks of the summer. It had both legislative and judicial authority, which it exercised by means of the *lögrétta*, the legislative body, and courts of law.

At the *lögrétta*, only the thirty-nine *goðar*, together with nine others chosen to make the representation of the four quarters of Iceland equal, had the power of making or emending laws, though each of these had two advisers. Later the two bishops attended the *lögrétta*.

The *lögrétta* elected a law-speaker, or *lögsögumaðr*, who held office for three years, though it was often renewed at the end of the period. He presided both over the *lögrétta*, and over the *Alþingi* as a whole. It was his duty to recite the national code of law from the *Lögberg* or Rock of Law (see Fig. 75), a recitation which was only completed in three sessions of the *Alþingi*. The *lögrétta* referred to him to supply any section of the national law they needed in their legislation, and it was he who publicly announced to the assembly any law they passed. The office of law-speaker, especially in the days before the laws were

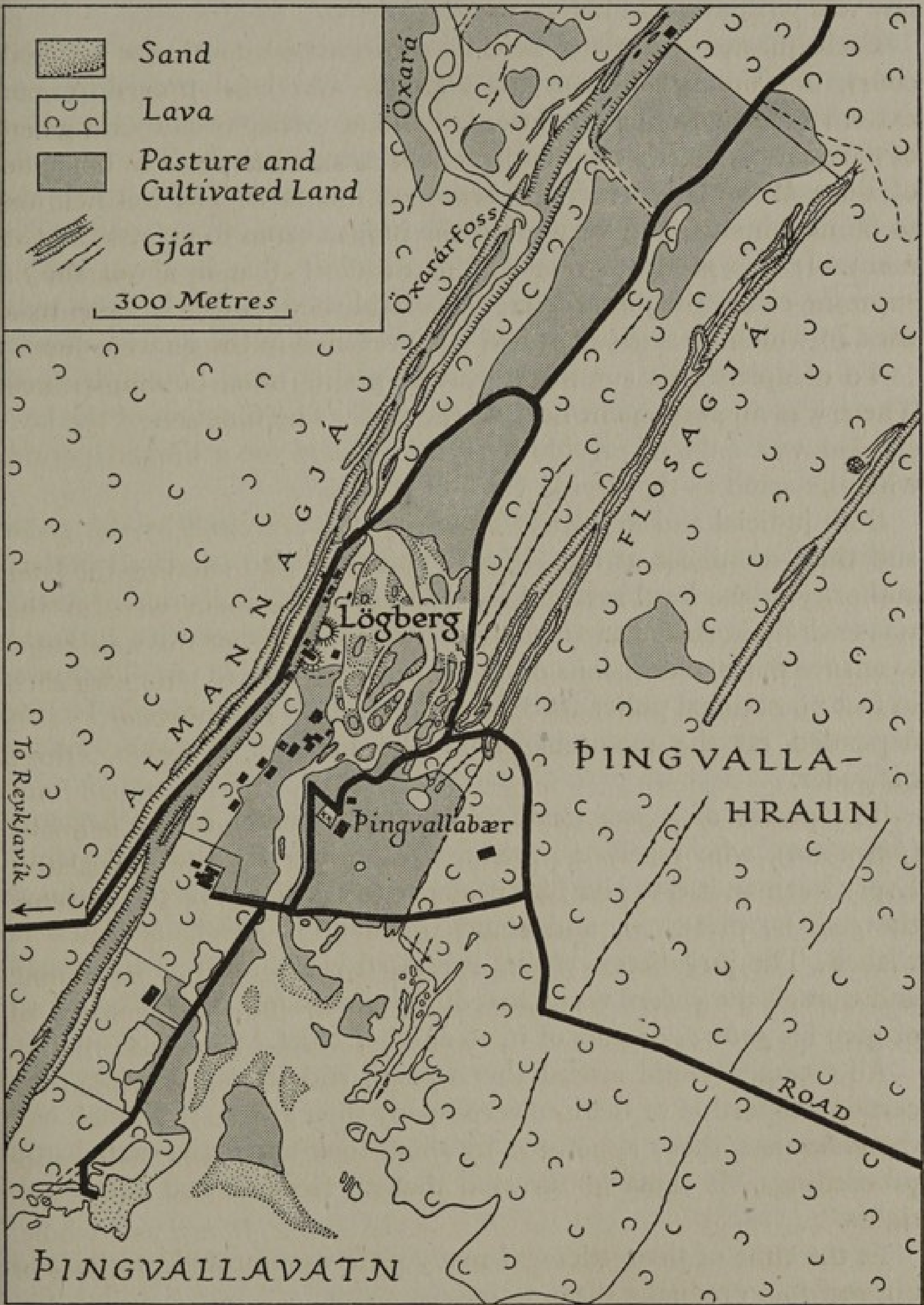


Fig. 75. Þingvellir. Source: *Updráttur Íslands*, 1 : 250,000 (Copenhagen, 1930).

written down, demanded outstanding legal ability. No part of the law was written down before 1117.

Each quarter of Iceland held its own judicial court, the quarter-court, or *fjórðungsdómr*, at the *Alþingi*. The legal procedure was extremely formal and complicated. Sentence was passed by the *goðar* of the quarter, together with others nominated by them. The payment of fines or outlawry was the sentence imposed. The verdict had to be unanimous, and very often the judges came to no such agreement. It was partly to remedy this deadlock that in about 1005 a supreme court, the *fimtardómr*, was established, and here cases were tried in which no settlement had been reached in the quarter-courts.

To complete this summary, certain points must be emphasized. There was no permanent head of the state. The function of the law-speaker was only to preside over the *Alþingi* for a limited period, when he acted as the 'living voice of the law'.

Both judicial and legislative authority was exercised by the *goðar* and their nominees at the *Alþingi*, and they also exercised judicial authority at the local assemblies. Moreover, the execution of justice was entirely in their hands, as the *Alþingi* had no executive authority to ensure that the decisions of the courts were carried out. There was in fact no national police force in Iceland. Law and order in Iceland depended on the maintenance of the balance of power among the *goðar*.

The power of a *goði* depended on the number of his liegemen (*þingmenn*), who received protection in return for their allegiance. Every freeman had to give his allegiance to a *goði*, but he could choose the *goði* he preferred, and could transfer his allegiance when he wished. The jurisdiction a *goði* exercised was known as his *goðorð*, and though the *goðorð* was a hereditary possession, a chief could sell or give his *goðorð*, or part of it, to another chief.

All freemen could attend the *Alþingi*, and it was the duty of a certain proportion of them to accompany their *goði* to it, though only the *goðar* and those appointed by them took any active part in the proceedings. It must be stressed that all freemen had equal legal rights.

At the time of the settlement many serfs were brought to Iceland, but serfdom gradually disappeared.

Aspects of Icelandic Life

The *goðar*, the lesser chiefs and the freeholders were bound together by their common occupation of maintaining means of subsistence in Iceland. Sheep and cattle farming was the main occupation, for though grain was grown in a few places, hay was the only regular crop. Fishing, fowling and other occupations were carried on (see p. 165). The farms were not grouped together in villages, but the spring assemblies and the *Alþingi* were social gatherings as well as legal assemblies. The *lögrétta* and the courts of the *Alþingi* were held in the open air, but booths were set up in the valley of Þingvellir to accommodate those who were attending the session, to which the chiefs brought their families and followers. The aspect of Icelandic life that is of the greatest permanent importance is that in their new home the settlers not only maintained but developed the traditional culture they had brought from Norway, which lay both in the art of verse and the art of story telling.

Family Feuds. Though the Icelanders were keenly interested in the processes of the law, they were far from law-abiding, and the history of the first century after the establishment of the republic is the history of constant local disputes between different Icelandic families. In cases of manslaughter, it was the duty of the next-of-kin to enact vengeance on the slayer. In *Njáls saga*, Flosi, who burnt Njál and his family to death in their home, took up the blood feud with reluctance, but was ruthless in carrying it out. Vengeance could be enacted, either by claiming compensation and bringing a lawsuit if this were withheld, or by personal revenge on the slayer. The absence of any central executive authority in the Icelandic constitution resulted in constant bloodshed, for the chiefs disregarded the decisions of the courts. The Icelandic family sagas paint a vivid picture of this period in Iceland, when family feuds caused by local disputes dominated its history, and so the years 930 to 1030 are known as the Saga Age. A list of English translations of sagas is given on pp. 410–11.

Icelanders at the Norwegian Court. After the settlement the Icelanders often sailed abroad, especially to Norway, for trade and other purposes. It became the regular custom for the youthful sons of chiefs to go abroad to gain profit and renown. Many of these joined the court of the King of Norway, and there learnt courtly accomplishments. In one such accomplishment, however, the Icelanders themselves gained pre-eminence. This was the art of skaldic verse. Among all Germanic nations poetry had flourished in the halls of the kings and great chiefs, where poems were recited in honour of great leaders and great events. In Norway a distinctive type of poetry was developed by the court poets, or skalds. This skaldic verse was elaborate and artificial in diction, and used highly developed metrical forms; both long poems and single epigrammatic stanzas were composed in it. It flourished in the time of Haraldr Hárfagri, and so the settlers brought it to Iceland, where it was practised with great skill for several centuries. Icelandic skalds won high favour at the Norwegian court, when the art was declining in Norway itself.

Further Travels of Icelanders. The son of a wealthy leader had his own ship. He employed sailors and followers, and spent periods of up to three years trading in foreign lands, in some cases going as far south as the coast of Africa and east through the Dardanelles. In

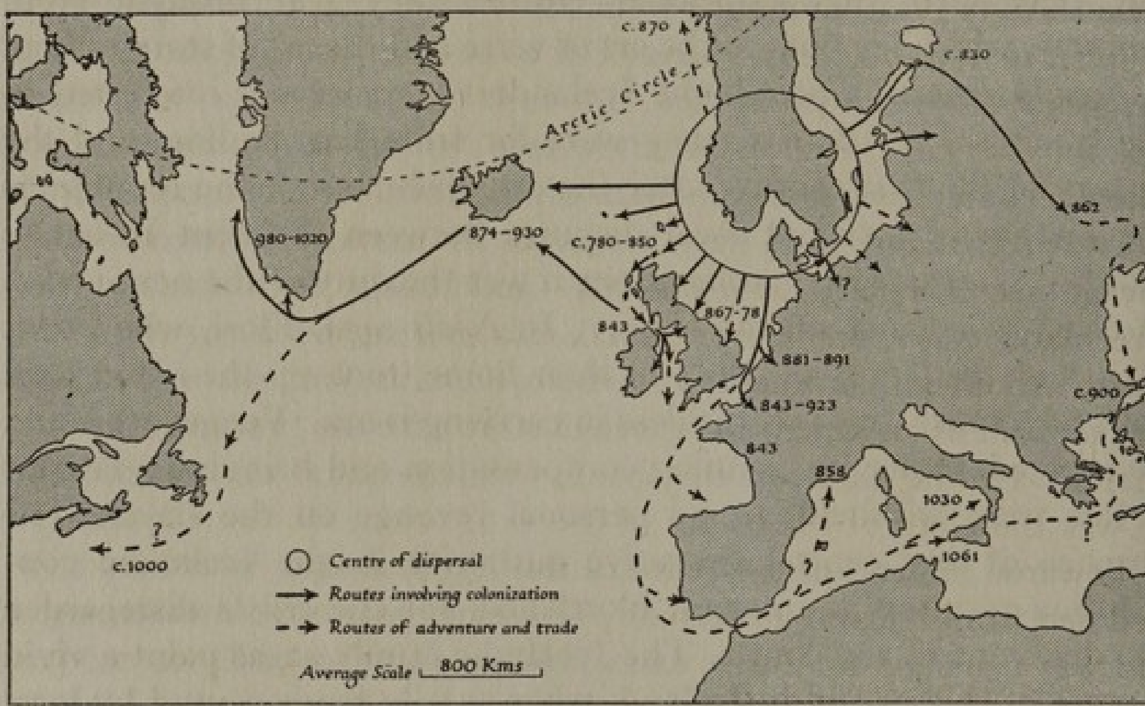


Fig. 76. Diagrammatic map of Norse migration routes, with approximate dates. Single figures indicate the dates when visits are first known to have occurred.

winter the travellers were usually honoured guests at the court of some king or noble. Piracy often played an important part in these voyages. On the final return they frequently sailed up the Irish coast around harvest time, went ashore and captured an entire farm, taking master and servants along with livestock and property. They even took buildings, for timber was scarce in Iceland.

Apart from trade, there was a social advantage for Icelanders who spent a period at the courts of foreign kings. There are records of Icelanders in the bodyguard of the emperors at Constantinople, and at one time or another they served as lifeguards or mercenaries for almost every king north of the Mediterranean. These men usually returned to their homes in Iceland, bringing their foreign wives and dependents with them.

When Icelandic sailing expeditions declined in the twelfth and thirteenth centuries, partial compensation was found in the trading voyages which were made to Iceland from other countries, especially Norway. It was the custom for the trader to arrive in summer or autumn. He would put up his tents, display and sell his goods, and then be invited by some local chieftain to spend the winter, leaving the following spring.

The Colonization of Greenland and the Discovery of America

The Vikings were pioneers in Europe of navigation across the open ocean. An indication of the routes followed during their expeditions is given in Fig. 76. Some idea of the speed of sailing during these voyages was given by a replica of the Gokstad ship (Fig. 77), which took four weeks to cross the Atlantic from Norway to America in 1893. The Icelanders were descendants of the men who had sailed from Norway to Iceland in 3½ days—this was the traditional length of the voyage according to *Landnámabók*—and it was from Iceland that Greenland was colonized. Icelanders also reached a region of the North American continent, known to them as Vínland, and it is in one account of an expedition there that we have the first record of the birth of a white child on that continent; his name was Snorri, and he was the child of the leader of the expedition, Þorfinnr Karlsefni.

Towards the end of the tenth century, a man known as Eiríkr the Red fled from Norway to Iceland. There he committed manslaughter and was banished for three years. He sailed to seek islands reputed to lie to the west of Iceland, and landed on Greenland which he explored for the period of his exile. He then returned to Iceland to find men who would colonize the new land with him, and gave it the name Greenland as an incentive to colonization. From this time (985 or 986) many Icelanders emigrated to Greenland, and two main settlements, known as the Eastern and Western Settlements (*Eystribygð* and *Vestribygð*), were organized on the model of Icelandic society. The Greenland colony flourished as long as communications with Iceland and Norway were maintained, but these languished in the fourteenth century and ceased entirely in the fifteenth.

Members of the new Greenland colony carried out further explorations. In 1000, a son of Eiríkr the Red, Leifr Eiríksson, lost his way when he was returning to Greenland after a visit to Norway, and he came upon unknown lands where he found self-sown wheat fields and wild vines. The territory he discovered was given the name

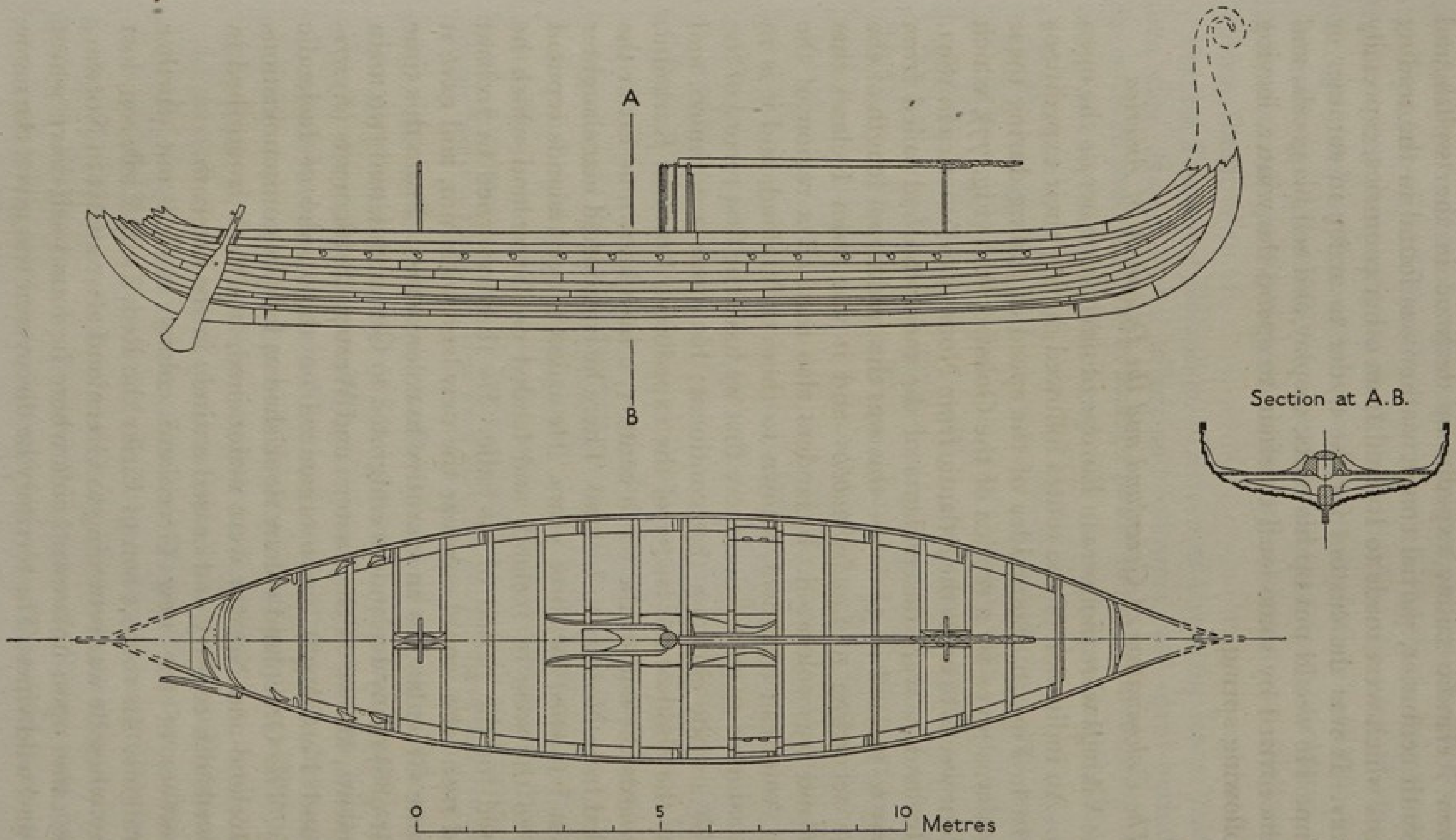


Fig. 77. Plan of the Viking ship discovered at Gokstad in Norway. This ship, 23·5 m. long, was perfectly adapted for long voyages. Vessels larger than 15 m. were rare exceptions, the majority being of similar construction, but only 5–8 m. long. The plan is constructed from data published by N. Nicolaysen, *Langskibet fra Gokstad* (Christiania, 1882).

Vínland, 'Wineland', and an attempt was made later to found a colony there, but it was frustrated by the hostility of the natives. In spite of much controversy, the locality of 'Wineland' has not yet been established, and all that can be said with certainty is that it was some part of the North American continent. There is very doubtful evidence that Columbus visited Iceland in 1477, but even if he did, the Icelanders by then no longer knew the route to Vínland.

The Christian Church in Iceland

The Introduction of Christianity

The first Christian mission to Iceland was undertaken in 981 by an Icelander, Þorvaldr *víðförli* ('the far-traveller'), and the German bishop who had baptized him during his travels abroad. They had indifferent success, and were expelled from Iceland after Þorvaldr had slain two men as a reprisal for the mocking verses that had been composed against them. The conversion of Iceland was due to the efforts of the King of Norway, Óláfr Tryggvason (995–1000), who was a zealous convert to the Christian faith, which he and his army enforced in Norway.

Óláfr Tryggvason first sent an Icelander, Stefnir Þorgilsson, to spread Christianity. He was so violent in his destruction of temples and images that a law was passed at the *Alþingi* that any Christian must be prosecuted as a blasphemer of the gods. The mission of Óláfr's German chaplain Thangbrand (997) was more successful, and both chiefs and others received baptism. Finally, Óláfr sent two of the chiefs whom Thangbrand had converted, Gizurr the White and Hjalti Skeggjason, to Iceland in 1000, after he had exacted their promise to establish Christianity. They proceeded to the *Alþingi* which was in session, and at the assembly the two parties, Christians and heathens, nearly began open battle. However, the law-speaker, Þorgeirr, a heathen *goði*, undertook to announce a decision. He realized that the political organization of Iceland would be disrupted if there was a conflict of religions, as the *goðar* were at the head of both state and church. The choice he made may have been influenced by the facts that many Icelanders by then had little active faith in their heathen gods, and that they desired to maintain good relations with Norway. Þorgeirr's decision was that there must be one law and one faith in Iceland. All men must be baptized Christians, but men could continue to worship the heathen gods, provided they did so in private with no witnesses, nor were such heathen practices as the exposure of newly born infants forbidden. This decision was made legal by the *Alþingi*.

The Early History of the Icelandic Church

King Óláfr Haraldsson (1015–1030), who was to become the patron saint of Norway, induced the Icelanders to remove the enactments providing for heathen practices from their law; when they had done so, he sent timber from Norway to erect a church at Þingvellir. Though some chiefs built churches at this time, teachers of the new faith were lacking, and there was no church organization. Several foreign bishops came out to Iceland, but no see was established.

The First Icelandic Bishops. The most fortunate period of Iceland's national development can be said to begin with her first native bishop. Ísleifr, the son of Gizurr the White, was consecrated bishop by the Archbishop of Bremen in 1056. He was a *goði* and was eminent both in practical affairs and in learning. At his home at Skálholt he instructed and ordained many priests.

His successor was his gifted son Gizurr, who during his episcopacy (1082–1118) kept the dissensions of the chiefs in check. One early source refers to him as serving both as king and bishop over the land. Because of his personal influence, no opposition was made to the introduction of the tithe system (1096), a measure which ensured a fixed revenue for the church. In Gizurr's time, Skálholt was made the permanent seat of the bishopric.

In 1106 a second bishopric was founded for the north of Iceland, with its seat at Hólar, where the first bishop, Jón Ögmundarson (1106–21), established a famous school. He, too, was a man of outstanding ability, and did his utmost to promote Christian observances and to eradicate superstition.

The First Ecclesiastical Code. At some date between 1122 and 1133, a code of ecclesiastical law was passed by the *Alþingi*. This is known as *Kristinnréttr inn forni*, 'the old ecclesiastical law'. The Icelandic church was wholly national. All legislation for the church was done by the *Alþingi*, and all cases affecting the clergy were tried by the secular courts. The churches were owned by the laity; sometimes the owner himself was ordained, and was the church priest, but later he usually appointed a chaplain. In another aspect, also, the Icelandic church was national. The metropolitan see to which the bishoprics belonged was first Bremen, later Lund, and neither maintained close relations with the Icelandic church. Consequently, in Iceland, the learning of the church did not dissociate itself from national literary traditions.

The Last Century of the Icelandic Republic

In the second half of the twelfth century the government of Iceland began to deteriorate, when it passed out of the hands of a considerable number of *goðar* of roughly equal power into those of a few great chiefs and their families. Such chiefs might hold several *goðorð* (by direct and indirect inheritance, and by purchase), and so could call on large forces of liegemen to fight for them. The rival ambitions of these great families plunged Iceland into violent internal strife, and when this was reaching its height in the first half of the thirteenth century, the chiefs of the north of Iceland were also involved in a long struggle against their bishop. The intervention of the Archbishop of Norway in this conflict was followed by King Hákon's determined and successful effort to gain control of Iceland.

Ambitious chiefs fought both against other families and against rivals in their own, and often formed temporary alliances. During this period, the most important families were these: in the south of Iceland the *Oddaverjar* (of Oddi) and the *Haukdælir* (of Haukadalur); in the north the *Skagfirðingar* (of Skagafjörður); it was in the west that Sturla of Hvammur, whose descendants are the *Sturlungar* or Sturlungs, rose to be a great chief; his eldest son remained at Hvammur, but another, Sighvatr, established himself in Eyjafjörður in the north, and the third, Snorri, at Reykholt in the south-west. No family was more typical of the age nor played a greater part in the history of Iceland at this time than the Sturlungs, and the last century of the Icelandic Republic has been given the name of the Sturlung Age.

The Struggle between Church and Chiefs in Iceland

The Southern Diocese. In the eleventh century and the first part of the twelfth, the Icelandic church throve as an integral part of the republic, but after that it was anxious to emancipate itself from secular control. Its relations with the universal Catholic Church became much closer when, in 1152, a metropolitan see was established at Nidaros (Trondhjem), and the two Icelandic sees were put in its jurisdiction. The great Norwegian Archbishop Eysteinn (1157–88) strove to assert the authority of the church in Norway, and in

Þorlákr Þórhallsson, Bishop of Skálholt from 1178 to 1193, he found a man eager to promote the same cause in Iceland.

Before he became bishop, Þorlákr had been abbot of the monastery of Þykkvibær. At this time the monasteries, the first of which, Þingeyrar, had been dedicated in 1133, were of growing importance. On the one hand, they were virtually independent organizations and were acquiring much wealth, and on the other, they were great cultural centres of literary activity.

In Iceland, the churches, their property and their revenue from tithes belonged to the laity. Soon after his consecration Þorlákr began to lay claim to churches in his diocese on behalf of the church and in the name of the archbishop, but he soon abandoned the attempt after he met the opposition of Jón Loptsson of Oddi, at this time the head of his family and the most powerful chief in Iceland. He also came into conflict with Jón and other chiefs in his efforts to improve the prevailing moral licence of the time. Most of the chiefs had concubines, and Jón, though he was lawfully married and was also a deacon by ordination, had Þorlákr's own sister Ragnheiðr as his concubine at Oddi. In this attempt, too, Þorlákr had small success, but he had at any rate voiced the claims of the church and striven to enforce them against the chiefs.

He died in 1193, and so great had been his personal piety that he was declared a Saint by the *Alþingi* of 1198.

His two successors in the diocese of Skálholt, the first of whom was Páll, the son of his own sister and Jón Loptsson, kept on good terms with both the Oddaverjar and the Haukdælir.

The Northern Diocese. In the northern diocese, the rights of the church against the power of the chiefs found a zealous and unyielding advocate in Guðmundr Arason, Bishop of Hólar from 1203 to 1237. As the chiefs who opposed him were equally unyielding, the result could only be constant bloodshed.

Guðmundr claimed that lawsuits, in which one of the parties was a priest, should not be tried by the courts of justice, but by himself. This was in accordance with the canon law of the Catholic Church, but was in direct opposition to the national law of Iceland—the only law recognized there—which held all men equally subject to it. The chiefs collected their liegemen to execute their judgments by force; Guðmundr used the ecclesiastical weapon of excommunication in vain; his followers, for he had many men of good birth as well as wastrels to support him, joined battle with his opponents.

In 1208, Kolbeinn Tumason, of Skagafjörður, the most powerful chief in the north, marched to Hólar to demand the surrender of some members of Guðmundr's household to whom he was giving asylum after they had been convicted by the law courts. A fight ensued, against Guðmundr's command, in which Kolbeinn himself was killed. His avengers brought a force of 700 men to Hólar, drove out Guðmundr and took possession of the episcopal residence.

Guðmundr had sent an appeal to Archbishop Þórir of Nidaros, who could not ignore the position in the see of Hólar. He summoned both Guðmundr and six chiefs to Norway; the chiefs did not obey, and indeed he had no authority to summon Icelandic laymen. Guðmundr spent some years in Norway, and on his return took up residence at Hólar, but was driven out once more. His followers then made a raid on Hólar, in which they killed a member of the Sturlung family, so that when Guðmundr fled to Grímsey, which lies off the north coast of Iceland on the Arctic Circle, the Sturlungs pursued him there (1222), and, after defeating his followers, banished him to Norway, where he again remained for several years. After his return he became reconciled with the chiefs, who restricted his activities to the purely religious duties of his office.

Guðmundr was a faithful servant of the Catholic Church. As a priest he served it well, but as bishop he could obey its orders only by challenging the authority of the northern chiefs. His policy was the immediate cause of the intervention of Norway in Iceland's internal affairs. Hence several Icelandic historians have held him unduly responsible for the loss of Iceland's independence, which was mainly brought about by the skilful use a strong king of Norway made of the rivalries between the Icelandic leaders.

Iceland and the King of Norway

Óláfr Haraldsson of Norway (St Óláfr) had been anxious to bring Iceland under the Norwegian crown, and on two occasions had the proposal put before the *Alþingi* (1024 and 1027), which firmly rejected it. It was nearly two centuries before a king of Norway renewed the attempt. This was Hákon Hákonarson (1217–63). The general method he adopted was to make leading Icelanders members of his court, and to induce them to further his cause in Iceland by promising them high favour at the Norwegian court and superiority over their rivals in Iceland.

Snorri Sturluson. The most famous member of the Sturlung family was Snorri Sturluson (1178–1241). His mental qualities were outstanding, for apart from the genius of his literary works (see

p. 160), the fact that he was law-speaker of the *Alþingi* for two periods bears witness to his legal ability. He was as ambitious for wealth and authority as most of the Icelandic chiefs of his time, though less warlike in disposition.

When Snorri was paying his first visit to the Norwegian court, the young King Hákon was preparing to send an expedition to Iceland (1220), to avenge an act of injustice Sæmundr Jónsson of Oddi had inflicted on some Norwegian merchants. Snorri dissuaded him from this by offering to try to influence the Icelandic chiefs to submit to the king. The motive underlying his conduct is unknown. It may have been an expedient to prevent the dispatch of the expedition; if it were not, the motive may have been self-interest, or perhaps Snorri felt that the only hope of establishing order in Iceland lay in accepting the king's authority. Whatever his motive, Snorri apparently took no steps in the matter on his return to Iceland.

It was with a similar mission that Snorri's nephew Sturla Sighvatsson returned to Iceland from Norway in 1235, having promised King Hákon to drive any refractory chiefs out of Iceland to Norway. Sturla was young, venturesome and ambitious, and had taken part in a number of feuds. He and Snorri's branch of the Sturlung family had generally supported opposing factions. He now forced Snorri and others to go to Norway, but in 1238 he, his father and three of his brothers met defeat and death in the battle of Örlygsstaðir, near Víðivellir, against the combined forces of Kolbeinn the Young, the head of the Skagfirðingar, and Gizurr Þorvaldsson, the head of the Haukdælir.

Snorri returned from Norway in defiance of Hákon's orders. Carrying out instructions which had been sent to him by the king, Gizurr led a party of men by dead of night to murder Snorri (his father-in-law) in 1241.

Now that both Sturla and Snorri had been overcome, the Haukdælir and the Skagfirðingar held authority over most of Iceland. The members of the Oddaverjar family at this time were unambitious, with no wish to take part in disputes for power. Gizurr left Iceland for the king's court in 1242.

Sturla's brother Þórðr Kakali was determined to regain the Sturlung estates in the north and to avenge the battle of Örlygsstaðir on Kolbeinn the Young and Gizurr. Unlike the other chiefs of his time, he prevented his followers from looting and pillaging the districts through which they passed. When he had gained not only his father's possessions, but also those of the Skagfirðingar in 1246, he and Gizurr (who had just returned to Iceland) decided not to fight out their disputes, but to submit them to the arbitration of the King of Norway.

On the advice of a papal legate who was then in Norway, Hákon decided in favour of Þórðr (1247). Þórðr was to return to Iceland and obtain pledges of allegiance to the king, while Gizurr was to remain at the court, to prevent further conflict between them.

The Norwegian Bishops of Iceland. King Hákon did not neglect the help the church could give him in his efforts to gain authority in Iceland. Both the Icelandic bishoprics had fallen vacant in 1237, and the king persuaded the archbishop to reject the men the Icelanders had chosen and appoint two Norwegians (1238). The Icelandic church was now no longer national. Henceforward till the end of the Republic, the bishops were Norwegians, and they supported Hákon's cause.

Heinrekr Kársson, a newly appointed Bishop of Hólar (1247–60), went out to Iceland at the same time as Þórðr, and it was probably he who brought the injunction from the papal legate that the Icelanders should submit to Hákon on the grounds that 'it was unfitting that Iceland should not serve under a king, like all other lands in the world'. Heinrekr zealously guarded Hákon's interests, and when Þórðr, who met little opposition in Iceland, seemed to be more anxious to bring the state under himself than under the king, he ensured that Þórðr was recalled by Hákon in 1250.

The End of the Republic, 1262

In 1252 the king sent Gizurr and Þorgils Skarði from his court to replace Þórðr in Iceland.

Þorgils Skarði was a young member of the Sturlung family, who had been Hákon's retainer for many years and showed himself loyal to him in Iceland. He administered the Borgarfjörður district for Hákon. This had been under Snorri's authority, and Hákon had claimed that Snorri forfeited all his property and rights when he disobeyed him in 1239. Gizurr administered not only his own districts, but most of the north as well, and here he encountered the hostility of friends of Þórðr, one of whom set fire to his house at Flugumýri in Skagafjörður. Gizurr managed to save his life, but his wife and children and many others were burnt to death. He was on bad terms with Bishop Heinrekr and consequently was soon recalled to Norway (1254).

By now the administration of many districts of Iceland was in the king's hands, for not only had the two greatest chiefs, Þórðr and Gizurr, accepted his right to appoint first one, then the other, of them to govern their combined possessions as his representative, but other lesser chiefs had also handed over their authority to him. He as yet received no taxes from these districts, and others still remained independent. To reinforce his influence he now began to send Norwegian *hirðmenn* (members of his court) to Iceland. The first of these, together with Þorgils and Bishop Heinrekr, achieved the result that in 1256 most of the yeomen in the north agreed to pay taxes to the king.

Þorgils was killed in 1258, and Gizurr was once more dispatched to Iceland, this time with the title of royal earl (*Jarl*). He lived in great state, but did little for the king's cause, until one of Hákon's *hirðmenn*, Hallvarðr Gullskór, came to Iceland in 1261. The Republic came to an end in the following year, when the Icelanders at the *Alþingi* swore their allegiance to the King of Norway and promised to pay him taxes.

All the districts of Iceland were not represented at the *Alþingi* of 1262, but the pledge of allegiance was taken by representatives of the remaining districts in the course of the next two years.

King Hákon did not live to initiate any policy as King of Iceland, for he died in 1263.

THE LATER MIDDLE AGES (1262–1551)

The Ancient Covenant

The agreement which the Icelandic people made with the King of Norway in 1262–4 came to be called 'The Ancient Covenant' (*Gamli Sáttmáli*). Under this agreement the Icelanders recognized the authority of King Hákon and his descendants in return for economic and administrative assistance. The text of the Covenant stated that native Icelandic laws were to remain in force. The Icelanders promised to pay taxes to the king, and to accept the Jarl's authority, and the king on his part promised that Icelanders should have certain privileges in Norway, and that six ships (or a different number later by mutual agreement) should be sent annually from Norway to Iceland.

A highly important provision of the Covenant is ambiguously worded, namely, that the Icelanders should be freed of their allegiance to the King of Norway if he broke the Covenant 'in the opinion of the best men' (*at beztu manna yfirsýn*), though no doubt the Icelanders intended that the *Alþingi* was to decide whether the Covenant were broken.

All the people of Iceland had now given a personal pledge of allegiance to the King of Norway, as individual Icelanders had done before, and though united with Norway under a common king, Iceland did not become a part of the Norwegian kingdom. For four centuries the Ancient Covenant was to be the sole basis of union between Iceland on the one hand, and Norway and (later) Denmark on the other. Because of the vagueness of its text, its exact implication is still a matter for dispute.

The Government of Iceland under the King of Norway

The Introduction of New Laws

Within a few years it was made clear that the effects of the Ancient Covenant were to be more radical than the Icelanders had intended, for they soon had to give up their national code of law.

Hákon was succeeded by his son Magnús, nicknamed *laga-bætir*, 'the Law amender' (1263–80), who was the first king to establish a uniform code of law for all the districts of Norway. The new form of government in Iceland made some revision of its legal code essential, and Magnús was also anxious to make the Icelandic laws conform with those of Norway. He therefore decided to frame a new code of law for Iceland. His first code, known as *Járnsíða* ('Iron-side'), was prepared with the assistance of Sturla Þórðarson. This was accepted by the *Alþingi* (1271–3), but Magnús soon replaced it by another code, known as *Jónsbók*. Both codes had been constructed on the model of current Norwegian law, but *Jónsbók* was more carefully compiled than *Járnsíða*, and was based on the old laws of Iceland to a greater extent.

At the *Alþingi* of 1281, though the Icelanders first disputed the king's right to be their law-giver, *Jónsbók* was accepted, and it remained in force for several centuries, in part even till the present day.

The System of Government

After *Jónsbók* was accepted by the *Alþingi*, the main changes in Iceland's system of government were established.

The King of Norway was at the head of the state, and its government was carried out by officials appointed by him. His chief representative, or governor, in Iceland was known by the title of *hirðstjóri* (later *höfuðsmaður*). Under the *hirðstjóri* were district magistrates (*sýslumenn*). They acted as the justices of their districts (*sýslur*), and also ensured that the sentences of the law were carried out, and collected taxes and fines on behalf of the king.

There were two chief justices of the land, called lawmen (*lögmenn*), one of whom represented the south and east of Iceland, the other the north and west. The *Alþingi* was still held, though its character was changed. There was now only a single court, over which the lawmen presided, and whose members were nominated by the *sýslumenn*. This court exercised both judicial and legislative functions, the latter jointly with the king. It was stipulated in the Ancient Covenant that the lawmen and *sýslumenn* should be Icelanders.

One important result of the new legal system was that violation of the law was no longer viewed as a private affair to be settled by the offender and the party injured, but as a crime for which the wrong-doer had to answer to the government. In the days of the Republic the man who was judged guilty by the courts of law paid his penalty in the form of damages, but after *Jónsbók* the king as the head of the government received all fines, and also the land and possessions of men who were outlawed for the most serious crimes.

Changes before the Reformation

After the death of King Magnús the Law-amender, the royal power did not bring about any great changes in the government of Iceland until after the Reformation. The death of King Hákon VI of Norway resulted in a personal union between Norway and Denmark (1380), and in 1397 the three kingdoms of Norway, Sweden and Denmark were united under a common king by the Treaty of Kalmar. The union of these three kingdoms was a purely personal one, each country retaining its own laws and institutions. The Treaty of Kalmar had little immediate effect on conditions in Iceland. Iceland continued to be governed from Norway, and the King of Denmark was acknowledged as king by the Icelanders simply because he was King of Norway. In petitions and official documents written as late as the sixteenth century, the Icelanders still address their king as 'our Sovereign and King of Norway'.

But Denmark was by far the strongest country in the union, and the domicile of its ruler, and the claims of Iceland, like those of Norway, were subordinated to those of Denmark by the king, and her welfare neglected. In the early years of the fourteenth century

Iceland had successfully asserted some of the rights she had been granted in the Ancient Covenant, by expelling lawmen of foreign birth, and refusing to obey the king when he summoned Icelanders to Norway. But after the middle of the fourteenth century, many of the officials who governed Iceland were Norwegians or later Danes. The officials, whether they were Icelanders or foreigners, were more concerned with their own profit than with the welfare of the country, while the petitions of Icelanders for the redress of grievances were ignored by the king.

The Increasing Power of the Church

The most important general development in the history of Iceland in the centuries following the Ancient Covenant is the increase in the power and wealth of the church. It had gained certain independence of lay authority before the end of the Republic, because in 1253 it had been laid down by the *Alþingi* that where there was disagreement between canon law and national law, canon law should prevail. Thus the principle for which Guðmundr had fought was accepted.

However, almost all the churches in Iceland belonged to laymen, and consequently the administration of their property and the patronage of their livings was in their hands. In many cases most of the property of a church had been formally made over to it, but since the layman owned the church itself, he administered its property just the same. Almost a hundred years after Þorlákr had tried to lay claim to the churches, the issue was revived by Árni Þorláksson, the able and energetic Bishop of Skálholt (1269–98). The owners of the richer churches refused to give them up, and a dispute began between them and Árni which lasted for nearly thirty years. King Magnús and the archbishop decided in Árni's favour in 1273, but ten years later Hrafn Oddsson succeeded in getting this decision reversed, when an anti-clerical policy was being followed in Norway. Árni would not let the matter rest, and a final settlement was reached in 1297, by which the churches without formal possession of at least half their property should be administered by laymen, but all the rest by the bishop.

Unfortunately, the increased authority and revenue of the church were later put to bad use. After about the middle of the fourteenth century until the Reformation, the bishops, with very few exceptions, were autocratic and avaricious. Under them the clergy became undisciplined, corrupt and ill-educated. Many of the bishops were foreigners. Among them in the fifteenth century were several Englishmen; English merchants of the time brought them wine and more delicate food than they could get in Iceland, and also carried out profitable trading ventures on their behalf.

Trade with Iceland

In 1262, the King of Norway had agreed to send six ships annually to Iceland, as by this time Iceland's regular trade was carried on by Norwegian merchants. Soon, however, Iceland became commercially a dependency of Norway. The king concentrated her trade at Bergen, and it was heavily taxed and permitted only by his licence.

At this time the Hanseatic League was encroaching on Norwegian trade, and the Norwegians had been driven from many of their former fishing grounds. As a result Norway now began to export such vast cargoes of fish from Iceland that the Icelanders were left without enough for their own consumption, and asked the king for a redress of this grievance (1320). Hitherto, Norway's main exports from Iceland had been coarse woollen cloth (*vaðmál*) and hides.

In the latter half of the fourteenth century, the Hanseatic League gradually destroyed Norway's commercial power, and few ships were sent from Bergen to Iceland.

English Trade with Iceland

When the first English merchantman arrived in Iceland (1413), the people were thus in great need of the goods it brought, and in the following years a flourishing trade developed. Some of the merchants came with a licence from the king, many without it. They exchanged a variety of commodities (cloth and linen, food, wine, beer and hardware) almost exclusively for stockfish (*skreið*).

The English fishermen who were then flocking to Iceland were less welcome, for not only did they plunder the coasts, but they gradually wrested the fishing industry almost entirely from the Icelanders.

The English trade would have been of inestimable benefit to Iceland during a century of great want (see p. 193), if the king had not so frequently forbidden it, but since the royal officials tried to enforce his decrees, the English were provoked to acts of violence. On one occasion, when the Danish governor, Hannes Pálsson, tried to arrest English ships in the Vestmannaeyjar (the chief resort of both fishermen and merchants), his party was driven off with bows and arrows, and he himself was captured and carried off to England (1425). Hannes Pálsson had not been popular in Iceland, and the Icelanders did not suffer by his removal, but they did suffer from many general acts of lawlessness which the English merchants committed, especially in the latter half of the century.

One of the less reputable activities of the English in Iceland was the carrying off of young Icelanders. In King's Lynn in 1429 no less than eight of these children were found.

German Trade

The English trade began to diminish in the second half of the fifteenth century. The Hanse merchants, especially those of Hamburg, began to compete with the English, and there were violent clashes between them, which continued in the early sixteenth century. By then most of Iceland's trade was in the hands of the German merchants, who developed the export from Iceland of sulphur, *vaðmál*, train-oil* and hides.

Social Conditions

In the fourteenth century frequent earthquakes and volcanic eruptions had a disastrous effect on the economic life of the country. Smallpox and other epidemics, and cattle diseases reduced population and live stock. Agriculture declined and the general standard of living deteriorated. At the beginning of the fifteenth century, the Black Death ravaged Iceland (1402–5), and it is thought that between one-third and one-half of the population perished. The Black Death was followed by a succession of other plagues, and the fifteenth century is a period when both the material and the mental culture of Iceland sank to a low level. The number of landowners was reduced by the Black Death, and the survivors accumulated property and were rich in comparison with the extreme poverty of the majority of the people.

The Reformation

The Union of Kalmar had been broken in 1523. After the death of Frederick I of Norway and Denmark in 1533, the Norwegians, under the leadership of their archbishop, refused to accept his successor Christian III as king. Christian was Lutheran, and Norway was still mainly Catholic. After the opposition to King Christian

* This is a term used for oils derived from the blubber of marine mammals.

had been crushed, Norway lost her independence and became a dependency of Denmark. The Norwegian Council was suppressed, and its duties were assumed by the Danish Council, in which only Danes had seats. Henceforth, Iceland was governed from Copenhagen, and was subject to the King of Denmark and to the Danish Council. It had no further relations with the administrative authorities in Norway.

The last Catholic Bishops of Iceland were Ögmundur Pálsson of Skálholt (1521–41), and Jón Arason of Hólar (1524–50). Knowledge of the Lutheran faith had been brought to Iceland by German merchants, and it had some secret converts, notably Gizur Einarsson and Oddr Gottskálksson, who had both been to Germany themselves. The latter made a translation of the New Testament which was printed in Denmark in 1540, and is the first book printed in Icelandic of which a copy still exists.

The Danish authorities made their first attempt to establish the Reformation in Iceland after they had done so in Norway in 1537. It was unsuccessful, so in 1541 the King of Denmark sent two warships to Iceland, and at the *Alþingi* of that year the Reformation was adopted for the southern diocese, with Gizur Einarsson as bishop, and the oath of allegiance was sworn to the king. Danish officials carried off the infirm and old Bishop Ögmundur, and he died on the voyage to Denmark.

The new religion was resisted by a large section of the Icelandic population under the leadership of Jón Arason. The cause of the Catholic faith became identified with that of nationalism, because the King of Denmark had so flagrantly violated the terms of the Ancient Covenant. In 1549 Jón Arason was proclaimed an outlaw by the King of Denmark, and he and his two sons were captured and beheaded without trial in 1550. In the following year the king sent two warships to the north of Iceland, and the northerners had then no choice but to swear the oath of allegiance to the king and accept the Reformation.

THE PERIOD OF DECLINE IN ICELANDIC LIFE (1551–1800)

The Results of the Reformation

The immediate results of the Reformation were a strengthening of the king's authority, and an increase in the revenues which he drew from Iceland. The property of the monasteries was confiscated for the benefit of the royal exchequer, as well as that of those who had resisted the new faith. It is estimated that, as a result of the Reformation, the king came to own no less than one-fifth of the landed property in Iceland. Though the *Alþingi* continued to meet, real legislative power was placed in the hands of the king and his officers, and its administrative importance in general steadily declined. The bishops, who had previously been particularly powerful, were now servants of the king.

'*The Great Judgement.*' In 1564 a number of alterations were made in the criminal code at the instigation of the governor, Páll Stígsson. The new law came to be called *Stóridómur* ('The Great Judgement'). According to it, capital punishment was introduced for sexual crimes, such as adultery and incest. Men convicted of such offences were to be hanged, and women drowned. The provisions of the *Stóridómur* were modified by royal decrees of 1576, 1578 and 1594, though it remained in force until the nineteenth century.

Pirate Raids

No less than other undefended countries in those days, Iceland became the object of numerous raids by foreign pirates. The west coast of Iceland was raided by English pirates in 1579, and by numbers of Spanish pirates in the early years of the seventeenth century. A band of robbers led by an Englishman known as John Gentleman plundered the Vestmannaeyjar, and carried off the church bell together with other property. Yet more ruthless, and more disastrous for the Icelanders, was a raid undertaken by a band of Algerian pirates in 1627. These robbers were called 'Turks' by the Icelanders, and a number of contemporary documents, describing their assault on Iceland in detail, are still preserved. The 'Turks' ravaged the coasts of Iceland from Hafnarfjörður to Djúpivogur for nearly a month. On this occasion it was the Vestmannaeyjar which suffered most severely. There the Algerians landed a force of 300 men, destroyed the church and laid practically the whole settlement in ruins. When they returned to Algeria they took with them nearly 250 Icelanders as captives. These men were subsequently sold as slaves in Africa. Some of them were forced to accept the Mohammedan religion. A few years later thirty-seven of them were ransomed by the King of Denmark, though only thirteen ever returned to Iceland. Among those whom the Algerian raiders massacred in the Vestmannaeyjar was their clergyman, Jón Þorsteinsson, the poet.

The Danish Trade Monopoly

The first four years of the seventeenth century were a time of eruptions, plague and famine in Iceland, to which witness is borne by the names given to each year, such as *Píningsvetur*, 'The Year of Suffering', or *Eymdarár*, 'The Year of Misery'. It was at this time that the King of Denmark took a step which the Icelanders consider the worst disaster their country has suffered.

Already at the end of the sixteenth century, to promote Danish trade with Iceland, the king had closed certain harbours in Iceland to foreign merchants, who at this time were mostly Germans. But in 1602 he put an end to all foreign commerce with Iceland by granting three towns in his kingdom, Copenhagen, Malmø and Helsingør, the monopoly of all trade with Iceland. In granting this monopoly King Christian IV was following the commercial policy of the time, but its results were particularly bad in Iceland. The Danish merchants agreed to supply goods at the same prices as before, and to use the same weights and measures, while any disagreements between merchants and Icelanders were to be referred to the *Alþingi*. In practice, however, the Icelanders had little redress for any dishonesty the merchants employed against them. At once trade conditions in Iceland became worse, and after repeated appeals to the king he instituted a fixed scale of prices (1619). The scale of prices was altered at certain times later, the alterations of 1684 being very much in the merchants' favour.

In 1620 the monopoly was leased to a commercial company of Copenhagen, and for the next century and a half Copenhagen retained the monopoly, which passed through the hands of several different companies in succession. The rapid growth of Copenhagen's prosperity owed much to its profits from the Iceland trade.

As the seventeenth century advanced, the monopoly was more strictly and harshly enforced. Changes were made in the organization of trade in Iceland which put further restrictions on the native traders. Iceland, which had been divided into four commercial districts (*kaupsveitir*) in 1662, was divided into a greater number of districts, to each of which a harbour was assigned. The farmer had to take his goods to the harbour of his district, and since the division into districts in many cases disregarded geographical conditions, he often had to undertake a far more difficult journey than the one to his most convenient harbour. If, however, he traded outside his district, on however small a scale, he was liable to the loss of all his goods and to imprisonment. The same penalties were imposed if men traded with English or Dutch fishing boats. The new scale of prices which came into force in 1684 lowered the price of exports and raised the price of imports, especially the price of two essential commodities, flour and ship's timber. In addition to the hardships and difficulties caused by the system as a whole, the Icelandic farmers were often made the victims of fraudulent dealing on the part of the individual Danish traders.

The Government of Iceland

In 1661 the Danish Constitution was abolished and absolute sovereignty was granted to King Frederick III of Denmark and Norway. In the following year, Bjelke, the Governor of Iceland, summoned representatives of the Icelandic people to Kópavogur, near Reykjavík, and persuaded them to swear allegiance to the king as absolute ruler of Iceland. The immediate effects of the introduction of absolutism were small. The *Alþingi* continued to meet, and to exercise a small measure of autonomy in local affairs. Bills had still to be submitted to it before they became law in Iceland, though in reality this practice was little more than a formality, implying merely the publication of the laws.

The administration of Iceland was in the hands of the royal officials. In 1683, an important new office was instituted, that of the *landfógeti*, who was responsible to the King of Denmark for the financial and economic administration of Iceland and the enforcement of trade regulations. The royal estates were leased by the *landfógeti* to people of standing who sublet them to peasants, and the same practice was followed in the estates of the bishoprics. The peasants on these estates were not only exploited by their landlords, but had also to render various forms of service at the request of the *landfógeti* or the bishops; they were, for example, called on to row the king's fishing boats during the fishing season. The king was still represented by a governor (now called *stiftbefalingsmaður* or *stiftamtmaður*), but as he was often a Danish noble and did not even visit Iceland, a magistrate (*amtmaður*), and later several magistrates, acted as his deputies.

The Eighteenth Century

By the end of this century, conditions in Iceland reached their lowest level in history, in spite of some efforts of the Danish crown to ameliorate them.

In 1701 Láritz Gottrúp, the lawman of north and west Iceland, was sent by the *Alþingi* on a mission to the King of Denmark (Frederick IV) to put before him the hardships the country was undergoing, for a number of bad seasons had added to the miseries created by trade conditions and the oppression of the royal officials. An immediate result of his mission was that a much better scale of prices was fixed by the king and the penalties for breaking trade regulations were reduced.

Another important result was that the king appointed two Icelanders to carry out a survey of the whole of Iceland. This commission, known as the *Jarðabókarnefnd* or 'Rent-roll Commission', from its chief object, was carried out by Árni Magnússon and Páll Vídalín in ten years (1702–12). As well as a complete survey of the land and land tenure and a census of population and live stock, an investigation of trade conditions was also undertaken by the two commissioners. This survey gave Árni Magnússon an excellent opportunity for the collection of Icelandic manuscripts.

Trade and Industries

Skúli Magnússon was appointed *landfógeti* of Iceland in 1749. He was the first Icelander to hold this office. He directed all his abundant energies to free Iceland from the burden of the monopoly and to organize native industries. The two companies holding the monopoly fought their hardest against both his aims.

The Struggle against the Monopoly. In 1743 the trade monopoly had been sold to a company, the Hørkræmmer Company, whose conduct of it was the worst Iceland experienced. The officials of this company disregarded regulations; they imported an inadequate supply of essential commodities, though unlimited tobacco and spirits; their goods were inferior, the food spoiled and the timber rotten; they carried out their transactions without witnesses. A climax was reached in 1756 when, at a time when the Icelanders were dying of starvation in their hundreds, the meal they imported was mouldy. At last action was taken by the Danish government. It took over the monopoly in 1758 for a time, and then gave it to the General Commercial Company; their conduct of the trade proved to be little better than that of the Hørkræmmer Company, and finally after once more taking over the monopoly for some years, the government in 1787 made trade with Iceland free to all subjects of the King of Denmark and Norway. The credit for this momentous development was due largely to Skúli Magnússon, and the Icelanders were also fortunate in that at this time one of their countrymen, Jón Eiríksson (died 1787), was appointed as one of the king's ministers to be an advocate of their cause.

Industries. Skúli established a company to promote Icelandic industries, and this venture received the king's sanction in 1752. Factories were built in Reykjavík, and agriculture and fisheries were organized. The Hørkræmmer Company boycotted the products of these native industries, though they were kept alive by royal subsidies, and, finally, when the General Commercial Company took over the trade monopoly in 1763, it was given complete control of them, in spite of Skúli's opposition, and let them come to nothing through deliberate neglect.

The End of the Eighteenth Century

Though the stranglehold of the monopoly was relaxed, trade conditions showed little improvement, as there was no foreign competition to ensure a fair standard in price and value of the Danish goods. A general petition of the Icelanders that foreign merchants should be allowed to trade in Iceland was presented to the king in 1795, but was refused. The king had given some support to Skúli's industrial ventures, and various useful measures had been introduced as the result of royal commissions sent to Iceland in this century. But at the end of the eighteenth century the suffering and havoc caused by physical calamities had reduced the Icelandic people to a state of great misery. Skúli's supporter in Denmark, Jón Eiríksson, is said to have been driven to suicide by his sympathy for his fellow-countrymen. A series of bad seasons, famine, epidemics and volcanic eruptions had taken heavy toll of both population and live stock. It has been estimated that in the years 1752–9 between 9,000 and 10,000 men died of famine and the resulting epidemics. Sheep scab (introduced by some Spanish rams which had been imported to improve the stock) began in 1761 and was only stopped by the slaughter of all affected animals in the years 1772–9. A number of devastating eruptions culminated in the worst eruption Iceland has experienced in historic times, the eruption of the volcano Laki, in the south of Iceland, in 1783–4 (see p. 12). A commission was set up in Copenhagen (1785) to consider what help could be given to Iceland to relieve the distress caused by this disaster; the suggestion was even made that her entire population should be removed to Jutland. It is an epitome of the inefficiency of the distant Danish administration in the eighteenth century that only a fourth of the money contributed throughout Denmark for Icelandic relief was actually devoted to that purpose. There was small hope of improvement in conditions till Iceland controlled her own affairs, a control she struggled to gain in the nineteenth century.

Decay of Native Institutions

By this time native institutions had fallen into decay. The earthquake of 1784 had almost destroyed Skálholt, and in 1785 the bishop's seat and the Latin school were set up in Reykjavík and the episcopal estates sold. The see of Hólar came to an end in 1801, and thenceforward all Iceland was one bishopric. In 1798 the *Alþingi* met for the last time at Þingvellir. It had already lost its legislative authority and was by now of practically no judicial importance. When it met at Reykjavík in 1800 a commission presided over by the lawman Magnús Stephensen declared it to be a valueless institution. In July 1800 the *Alþingi* was dissolved by order of the king, and a new court of justice, the *landsyfirréttur*, was set up in its place, with Magnús Stephensen as chief justice.

THE NINETEENTH CENTURY

ICELAND IN THE NAPOLEONIC WARS

In the first years of the nineteenth century the dislocation of commerce caused by the Napoleonic wars brought severe hardship to Iceland. Few ships reached her from Denmark, and when they did, the commodities they brought were restricted and expensive. In the summer of 1807 Iceland was still more isolated by the outbreak of war between England and Denmark, and the consequent blockade of Danish shipping by the British. Fortunately, however, Magnús Stephensen, with the assistance of Sir Joseph Banks, succeeded in persuading the British authorities to allow Danish shipping to sail to Iceland. Sir Joseph Banks, the President of the Royal Society, who had travelled in Iceland in 1772, had her interests at heart.

Iceland had further troubles to come. In 1808, an English pirate, John Gilpin, landed in Iceland and plundered the royal chest. He sailed with his booty to England, but the British authorities condemned his conduct and returned the money to Iceland.

Yet more remarkable were the activities of the Danish adventurer, Jørgen Jørgensen, who acted in co-operation with a London merchant, Samuel Phelps. Phelps and Jørgensen arrived in Iceland in an armed merchantman in the summer of 1809. Jørgensen and his followers seized the Danish governor, and issued a proclamation stating that the rule of the Danes was at an end. Jørgensen himself, according to the proclamation, was to be styled 'Protector of Iceland, and Supreme Ruler on Land and at Sea'. All property of the king was to be confiscated, and Iceland was to be an independent country, entitled to fly her own flag. Jørgensen announced the immediate introduction of numerous social reforms, and the improvement of schools and hospitals. The Icelandic people scarcely resisted this intruder, partly because they feared his threats, and partly because his promises gave them hope. Some of them, moreover, evidently believed that Jørgensen was acting on behalf of the British government. This supposition was incorrect, and Jørgensen's 'reign' was short-lived. In August 1809, a British warship appeared in Reykjavík harbour; the usurper was seized and carried off to England, as he had been a Danish prisoner of war there, before his venture in Iceland. The British reinstated the royal officials and restored Danish property to its former owners. Jørgensen was imprisoned in England and afterwards deported to Australia, where he died in 1844. He came to be known in Iceland as 'King of the Dog-days' (*hundadaga-konungr*), for his 'reign' had lasted only through the hottest weeks of the summer.

The National Revival

In the early years of the nineteenth century there was a revival of national consciousness in Iceland. Her culture and institutions in the days of the independent republic were contrasted with the low level to which Iceland had sunk during foreign domination. The efforts of the Icelanders were directed into two channels, the first political, the other literary, and the new spirit of nationalism animated them both.

The years after 1830 were a time of unrest, when there were great progressive and liberal movements throughout Europe. It was then that there first began to be organized efforts to claim the recognition of Iceland as a distinct nation, with the right to a parliament to govern its own affairs.

In 1835 a group of young Icelanders founded a periodical called *Fjölnir* to rouse the national spirit of their fellow-countrymen. Its chief aim was the reformation and revival of Icelandic literature, and the purifying of the Icelandic language (see p. 136). Its leader in this was the poet Jónas Hallgrímsson (died 1845). But one of the founders of *Fjölnir*, Tómas Sæmundsson (died 1841), dealt with political and economic questions, and this side of the national issue was carried further by the greatest figure in the history of Iceland in the nineteenth century, Jón Sigurðsson (1811–79), who became the leader of his people in their struggle for national liberty and representative government.

Jón Sigurðsson was Iceland's greatest statesman, with a practical and constructive policy, and he was also one of Iceland's greatest scholars. From about 1840 he was the leader of the political struggle, and a prolific writer on political questions. He was president of the new *Alþingi* from 1849, and also succeeded in gaining Iceland the right of free trade with other countries in 1854. The change in Iceland's political status is the most important development during this period and is treated in detail in the following section. Iceland's material progress is discussed elsewhere. The *Alþingi* was revived in 1843; in 1874 Iceland received a constitution of her own within the Danish kingdom, a resident minister for Iceland was appointed in 1904, and in 1918 Iceland was established as a sovereign, independent state, united with Denmark under a common king.

NOTE ON THE CONSTITUTIONAL RELATIONS BETWEEN ICELAND AND DENMARK

Under the Treaty of Kiel in 1814, the King of Denmark ceded his rights over Norway to Sweden. Though the treaty expressly stated that Iceland, Greenland and the Faroe Islands were not to be ceded to Sweden, its language implied that these were Norwegian, not Danish, territories. However, a Norwegian attempt to claim them in 1819 was rejected.

The nineteenth century saw a revival of national consciousness in Iceland. Since its claim to be a distinct nation rested largely upon its unique culture, its archaic language and medieval literature, national aspirations naturally found complete expression in the scholar Jón Sigurðsson (1811–79), whom Icelanders regard as the founder of their constitution and national independence. In 1831, the king modified his absolute power in Denmark, establishing representative assemblies for consultation upon new bills. Christian VIII revived the *Alþingi* in 1843, but it was merely to be consulted on Icelandic questions. Of its twenty-six members, twenty were elected by Iceland and six appointed by the king. In 1848 Frederick VII surrendered his absolute authority by convoking a Danish Constitutional Assembly (*Rigsdag*). This consisted of 193 members, of whom 145 were elected and forty-eight appointed by the king. Among the latter, five represented Iceland. There, however, it was argued that the inclusion of these representatives in the *Rigsdag* reduced Iceland to the status of a Danish province. While Danish lawyers maintained that Iceland was legally an integral part of the Danish kingdom, Sigurðsson held that, both in 1262 and in 1662, the Icelanders had acknowledged only the personal authority of the king, who had no right to cede his absolute power over Iceland to the Danish *Rigsdag*.

In 1851, after lengthy deliberation, the Danish government convened a representative assembly in Reykjavík to consider the application of the Danish constitutional laws to Iceland, which was to be merely a province within the Danish kingdom, with some local autonomy. The proposal was altogether unacceptable to the assembly, which appointed a committee under Sigurðsson to draft an alternative. Sigurðsson urged that Iceland should have its own constitution, but that it should be united with Denmark under a common king and should leave in the Danish government's hands the conduct of foreign policy. Legislative authority should be divided between the king and the *Alþingi*. Executive authority should be exercised by native ministers resident in Reykjavík and responsible to the *Alþingi*. Iceland should have its own supreme court of justice. The king replied that to concede such demands would lead to the ruin of Iceland and dismemberment of the Danish kingdom. Attempts to revive the constitutional question were silenced. In 1871 the *Rigsdag* defined Iceland's position. It was to have certain rights of autonomy in domestic affairs, but was declared to be an inalienable part of the Danish kingdom. The latter clause was vigorously contested by the Icelandic leaders.

In 1874, Christian IX decided to grant Iceland a constitution of her own within the Danish kingdom. Iceland became self-governing in all domestic affairs. Legislative authority was divided between the king and the *Alþingi*. The *Alþingi* was now made to consist of thirty-six members, of whom thirty were elected by popular vote, and six appointed by the king. It was divided into an upper and a lower chamber. Executive authority was placed in the hands of the king, who was represented in Iceland by a governor responsible not to the *Alþingi*, but to a Danish minister in charge of Icelandic affairs. The latter office was generally held by the Danish Minister of Justice. Iceland was not represented in the Danish *Rigsdag*. The highest court of justice for Iceland was still the Danish Supreme Court in Copenhagen.

Although the Constitution of 1874 was accepted by the *Alþingi* and received with public rejoicing, the Icelanders were not satisfied. They regarded the new constitution merely as a step towards complete independence.

Sigurðsson's place as leader of the independence movement was taken by Benedikt Sveinsson, who proposed in 1881 that the Constitution of 1874 should be revised. The offices of governor and of minister in charge of Icelandic affairs should be abolished, and an administrative government should be established in Reykjavík, consisting of a viceroy and three ministers responsible to the *Alþingi*. All members of the *Alþingi* should be elected by the people. A supreme Court of Justice should be instituted in Iceland. Sveinsson's proposal was passed by the *Alþingi* in 1885 and again in 1894, but it failed to gain the royal sanction or the approval of the Danish government. Meanwhile, a compromise was suggested by the Icelander Valtýr Guðmundsson. There should be a special minister for Iceland resident in Copenhagen who should also take part in the deliberations of the *Alþingi* in Reykjavík, and be responsible to it. This proposal was accepted by the Danish government, but rejected in 1897 by the *Alþingi*, which finally accepted it in a slightly revised form in 1901. In that year, however, the Conservative government in Denmark was succeeded by a Liberal ministry, known to be more sympathetic to Icelandic aspirations. Therefore, after passing Guðmundsson's bill, the *Alþingi* addressed a petition to the king, stating that Iceland would not be satisfied without its own resident government. The king's consequent proposal to alter the Constitution of 1874 on several cardinal points was unanimously accepted by the *Alþingi* in 1903.

Under the revised Constitution of 1903, the office of governor was abolished. There was to be a resident minister for Iceland, forbidden to hold any other post, and responsible to the *Alþingi*. But he must visit Copenhagen occasionally and submit important bills to the king at cabinet meetings. The number of members of the *Alþingi* was increased to forty, but, as before, six of them were appointed by the king. The suffrage was extended to all men over 25 years who paid

Kr. 4 in taxes annually. In February 1904, the poet Hannes Hafsteinn was appointed minister for Iceland. The transfer of the seat of government from Copenhagen to Reykjavík was the most important step so far achieved by the Icelanders in their struggle for independence.

Many of the Icelanders, however, were still dissatisfied. Their chief objection was to the provision that the minister for Iceland should attend meetings of the Danish cabinet when questions relating to Iceland were discussed with the king. This seemed to imply acceptance of the law of 1871, by which Iceland had been proclaimed 'an integral part of the Kingdom of Denmark'. The dissolution of the union of Norway and Sweden in 1905 encouraged those who favoured complete separation of Iceland from Denmark.

Frederick VIII, who succeeded Christian IX in 1906, was particularly sympathetic to Iceland and appointed a commission, consisting of thirteen members of the Danish *Rigsdag* and seven of the Icelandic *Alþingi*, to reconsider Iceland's position in the Danish kingdom. In 1908 this commission passed a resolution declaring Iceland to be a free and independent country, forming, with Denmark, the United Kingdom of Denmark. The name of Iceland was to be added to the king's title. The minister for Iceland was no longer to take part in meetings of the Danish cabinet. Denmark and Iceland were to have a common king, common foreign policy, national defence, inspection of fisheries, supreme court, and flag. Icelanders in Denmark were to enjoy the same rights as Danes, while Danes in Iceland were to enjoy the same rights as Icelanders. All clauses providing for affairs common to the two countries, except those referring to the king and national defence, could be revised or annulled after 37 years.

This resolution was signed by all members of the commission except the Icelander Skúli Thoroddsen, who wished it to be made plain that Iceland was a sovereign state, with complete control of all its affairs, and having no constitutional relations with Denmark other than a common king. Hafsteinn and other leaders had supported the resolution, but the public shared the extremist views of Thoroddsen.

Party politics now became intense. The country was divided into two main parties—the Home Rulers and the Independence Party. The Home Rulers, following Hafsteinn, favoured close relations with Denmark for the time being. The Independence Party advocated immediate separation from Denmark in practically everything but the crown. Both parties desired the ultimate independence of Iceland, but differed largely in their estimate of the methods by which independence should be achieved.

The succeeding elections resulted in a sweeping victory for the Independence Party. Hafsteinn was succeeded as minister by Björn Jónsson, and the new *Alþingi* passed an amendment to the resolution of the commission, worded in such uncompromising terms that there could be no chance of its acceptance in Denmark. Efforts to revise the constitution were temporarily abandoned, but it was plain that the Icelanders were dissatisfied.

Two salient points remained in dispute. The first was the provision whereby the minister for Iceland must submit Icelandic business to the king at meetings of the Danish cabinet. The second was the obligation to fly the Danish national flag.

In 1911 the *Alþingi* adopted a proposal to revise the constitutional law of 1903. It was suggested that important resolutions of the *Alþingi* should still be submitted to the king, but not at meetings of the Danish cabinet. The king considered that he could not sanction this clause until the relations between Denmark and Iceland were readjusted with the agreement of the *Alþingi* and the *Rigsdag*. In 1913 the *Alþingi* adopted a similar proposal, with some modifications. Icelandic business should no longer be submitted to the king 'in cabinet', but at a place 'to be decided by the king'. The king replied that he would sanction this provided that the next *Alþingi* adopted it without alteration after a general election, but made it plain that he would decide that important Icelandic bills should be submitted to him at cabinet meetings, just as before. There would otherwise be no assurance that such bills did not concern Denmark.

The new *Alþingi* adopted the same proposal without substantial alteration in 1914, and, after discussions between the king, the leaders of the Danish government and the new minister for Iceland, Einar Arnórsson, agreement was reached in June 1915. It was understood that Icelandic affairs should still be discussed with the king at meetings of the Danish cabinet, though the words 'in cabinet', in the constitutional law, were replaced by 'where the king shall decide'.

Though the constitutional law of 1915 did little to alter Iceland's relations with Denmark, it substantially changed internal conditions. The *Alþingi* became more democratic. The six members appointed by the king were replaced by six elected by proportional representation. The remaining thirty-four were still elected by a majority of votes in their constituencies. Rights of suffrage were granted to all men and women over 25 years.

The king also authorized the use of an Icelandic national flag, to be flown, however, only on shore and within territorial waters. Such restrictions were irksome. In 1917 the *Alþingi* asked the Icelandic government to negotiate for an Icelandic flag which would be recognized internationally. Since this matter interested both Denmark and Iceland, the king could not authorize it without the consent of the Danish government. Though willing to discuss the question of Iceland's national flag, the government stated that it would prefer to review the whole problem of Iceland's relations with Denmark. It might thus be possible to place the two countries on a more friendly footing. Accordingly, a Dano-Icelandic Commission was appointed. Negotiations were opened in Reykjavík in July 1918, and resulted in complete agreement. The findings of the commission were subsequently approved by the Danish *Rigsdag* and by a large majority of the Icelandic people in a referendum. The result was the Act of Union, which came into force on 1 December 1918. The act finally established Iceland as a sovereign, independent state. No previous act had done so much to improve the difficult relations which had so long existed between Iceland and Denmark.

The Act of Union. According to the act, Iceland and Denmark were both independent, sovereign states, united under a common king. Danish nationals enjoyed the same rights in Iceland as Icelanders, Icelanders the same rights in Denmark as Danes. The nationals of each country were exempt from military service in the other. Danish ships enjoyed the same privileges in Icelandic harbours as Icelandic ships, and vice versa. Denmark undertook the protection of fisheries in Icelandic territorial waters until Iceland should undertake this duty herself, in whole or in part. Iceland was to have access to the Danish Supreme Court of Justice until she should establish her own Supreme Court.

The act also provided that Denmark should act for Iceland in foreign affairs in accordance with Iceland's wish. Nevertheless, Iceland might appoint her own consuls, and send special emissaries abroad to negotiate on her behalf. Treaties concluded between Denmark and foreign powers before the ratification of the act were to be binding for Iceland. Treaties subsequently concluded by Denmark were not to be binding for Iceland, without Iceland's consent. Iceland was declared perpetually neutral. There was, therefore, no common defence between Iceland and Denmark.

The act laid down that, after 1940, either the *Rigsdag* or the *Alþingi* could demand revision of the Act of Union. If negotiations did not result in a new agreement within three years after the demand, either the *Rigsdag* or the *Alþingi* could pass a resolution abolishing the Act of Union. Such a resolution must be approved by two-thirds of the *Rigsdag* or two-thirds of the *Alþingi* and must then be submitted to a referendum in the country concerned and be approved by three-quarters of those who exercised their votes. At least three-quarters of the electorate must vote.

In accordance with changes arising from the Act of Union, the Icelandic constitution was revised in 1920 and in 1934. A Supreme Court of Justice was established in 1920.

From 1918 to 1940, relations between Iceland and Denmark were uneventful. The four main political parties of Iceland—the Independence Party (corresponding to British Conservatives), Progressives (corresponding to British Liberals), Socialists and Communists—had many differences on home policy, but all agreed that, at a suitable time after 1940, the Act of Union should be abolished. An Icelandic republic should then be constituted. The maintenance of the union was not openly advocated by any political leader. Suggestions that Iceland should join the British Commonwealth found no favour. It appeared probable that Iceland would maintain friendly relations with Denmark, but that the act would be abolished and an Icelandic republic founded in 1943.

On 9 April 1940, Denmark was occupied by German forces. On the 10th the *Alþingi* passed a resolution placing the authority of the king in the hands of the Icelandic government, since circumstances prevented him from discharging his duties as King of Iceland. The *Alþingi* also decided that Iceland should undertake the conduct of her foreign affairs, and the full protection of her fisheries. The Prime Minister emphasized that this step implied no change in the Constitution of Iceland.

The British Occupation. On 10 May 1940, British forces occupied the island. The British authorities explained that this measure had been taken in order to forestall a German occupation. British military forces would be withdrawn as soon as the war ended. The Icelandic government and the rights of the people would be respected. The government thereupon protested to the British minister.

These events necessitated changes in Iceland's foreign representation. She appointed her own diplomatic representatives in the United Kingdom, Denmark, Sweden and the United States.

In the first few months of 1941 various leading Icelanders expressed their opinion that, since the German occupation, Denmark had not carried out her obligations towards Iceland under the act, and that Iceland therefore had the right to declare the act void. Some circles pressed for an immediate and complete severance from Denmark, and the proclamation of Iceland as a republic, but the two resolutions finally passed by the *Alþingi* on 17 May 1941 represent a compromise. The following is the substance of the two resolutions, which were passed unanimously:

The *Alþingi* decides to proclaim that Iceland has acquired the right to abrogate absolutely its union with Denmark, since Iceland has already been compelled to assume the conduct of all her own affairs, and Denmark has not been able to carry out the obligations towards Iceland laid down in the Act of Union.

Iceland will not raise the question of any renewal of the union, though it is not considered suitable at present to conclude a formal separation. It is intended eventually to establish an Icelandic republic, and this will not be delayed beyond the end of the war. For the present a *Ríkistjóri* (Regent, or Director of State) will be elected who will have the authority vested in the Icelandic cabinet by the decision of 10 April 1940 (i.e. virtually royal authority).

On 17 June Mr Sveinn Björnsson was elected regent, the election being timed to coincide with the 130th anniversary of Jón Sigurðsson, the great leader of the independence movement.

These decisions of the *Alþingi* appear to have met with general satisfaction in Iceland. The reply of the Danish government sympathized with the difficulties of Iceland, but considered it regrettable that the present moment should be chosen for making decisions which affect both states. In reply to this the *Alþingi* stated that they recognized and appreciated the desire of Denmark for mutual understanding, and the inaugural speech of Sveinn Björnsson contained many references to the ties which bound Iceland to Scandinavia.

The latest events have not so far led to any actual abrogation of the Act of Union or any change in the Icelandic Constitution. The right of abrogation claimed by the *Alþingi* is not based upon the provisions for termination laid down in the act itself, but on the general principle that a treaty can be denounced if one of the parties does not fulfil its obligations. It appears to be a very moot point of international law whether this contention is justified in the present instance. The reply of the Danish government expressed a willingness to enter, when circumstances permitted, on negotiations within the framework of the act. According to the present Icelandic Constitution a referendum would in any case be necessary in Iceland before the act could be formally abrogated.

It had been hoped in Denmark that the personal union under a common sovereign would continue even when the other provisions of the Act of Union had been terminated. The common sovereignty is part of the Act of Union, but the laws of succession are also contained separately in the Icelandic Constitution, and would have to be removed if and when an Icelandic republic was constituted.

The American Occupation. At the end of June 1941, after negotiations between H.B.M. Minister in Reykjavík and the Regent and the Prime Minister of Iceland, it was intimated to President Roosevelt that the Iceland government were willing 'to entrust the protection of Iceland to the United States'. An exchange of notes followed between the President and the Iceland Prime Minister, in which it was agreed that United States troops should be sent to Iceland 'to supplement and eventually to replace the British Force in Iceland'.

On 7 July a strong American naval force appeared off Reykjavík and the same evening the Prime Minister broadcast the text of the notes. The *Alþingi* met on 9 July, and by a majority of thirty-nine votes to three, passed the following resolution:

> The United *Alþingi* sanctions the agreement made by the Government with the President of the United States of North America that the United States shall be charged with the armed protection of Iceland during the present war.

A force of United States marines was accordingly landed, and has since been substantially reinforced by other United States troops.

The Icelanders, as their history shows, are an independent people, with a strong national feeling, and the armed protection which they have had to accept first from Great Britain, and then from the United States, has not been welcomed by them, particularly after the short period of complete independence which they enjoyed from 9 April to 10 May 1940. They have, however, accepted the situation with good sense and dignity, and while their pride restrains them from public gestures of friendship towards the occupying forces, there is little individual resentment to the occupation and much unofficial goodwill and hospitality.

Chapter IX

GOVERNMENT, ADMINISTRATION AND LAW

Central Government: Local Government: Legal System: Justice: Police System

Central Government

The Danish-Icelandic Act of Union of 1918 was followed in 1920 by the enactment of the constitution which now forms the basis of Icelandic administration. Theoretically, Iceland has a limited monarchy not differing substantially from that of Great Britain. Executive and legislative power both nominally rest with the King of Iceland and Denmark. Since June 1941, however, the *Alþingi* (parliament) has entrusted the royal power to a regent (see p. 209). The executive power is exercised through ministers, and the legislative power is held jointly with parliament.

Executive Power

The present Icelandic government consists of five ministers. The Prime Minister is Minister of Justice and Agriculture, and is also in charge of the departments of Education and Ecclesiastical Affairs. The Minister of Industries and Commerce is in charge of Fisheries, Transport, Post and Telegraphs. The Minister of Finance is in charge of Taxes, Customs and State Monopolies. The Minister of Commerce has charge of Banking Affairs, Imports and Currency restrictions, etc. The Minister of Social and Foreign Affairs had actually, until 10 April 1940, very little to do with Foreign Affairs, since these were in the charge of the Danish Government. The powers and organizations of the Minister of Foreign Affairs are not yet satisfactorily determined. Other members of the government deal direct with the representatives of foreign powers in Iceland on matters connected with their own departments. The distribution of their functions as between Cabinet Ministers is also not very clearly defined, and questions affecting labour occasionally involve both the Minister of Labour and the Minister of Social Affairs; matters affecting industry occasionally involve the Minister of Finance as well as the Minister of Industry and Communications, while matters affecting currency restrictions appear to be more the concern of the Minister of Commerce than the Minister of Finance. The ministers are responsible for their acts. They can be impeached by the *Alþingi*, and in this event their cause is decided by the *Landsdómur*, a special tribunal, which can only try parliamentary impeachments (see p. 220). No one may be appointed to an official position unless he is an Icelandic citizen.

Executive power is, for practical purposes, subject to control of the *Alþingi*, because it commands the sources of supply from the treasury.

Legislative Power

As already mentioned, legislative power rests jointly with the king and the *Alþingi*. From this general rule the constitution deviates in two ways: in certain instances, mentioned below, the king may issue provisional laws, and in some other cases a bill passed by the *Alþingi* and signed by the king requires a referendum before it becomes an act.

The Alþingi. The parliament is composed of up to forty-nine members, elected for a term of four years. Of these members, thirty-eight are returned by the twenty-seven constituencies*, each electing one or two representatives by simple majority, except the capital, where six members are elected by proportional party representation. There is also a system of supplementary seats, which may not exceed eleven, distributed among the parties which have received too few in proportion to the number of their electors. These seats are distributed only to parties which already have representatives in the *Alþingi* returned by one of the constituencies, as the others are not regarded as parliamentary parties. All members receive travelling expenses and a fixed payment per day as long as the sessions last. Members are bound to act solely in accordance with their convictions and not with any rules made by their constituents. No member may be made responsible outside the *Alþingi* for statements made by him in the *Alþingi*, except with the permission of the house concerned.

The Act of Union with Denmark provided that all Icelandic and Danish subjects have the right to vote at Icelandic elections (and Icelanders similarly in Denmark) provided they are over 21 years old, have lived in the country for five years immediately preceding the election, are capable of managing their own affairs, and have not been sentenced by a court for a 'dishonourable' offence. All those who qualify for franchise are eligible for election to the *Alþingi*,

* In July 1942 a bill was passed to rearrange the electoral constituencies.

except judges who do not hold administrative offices. The balloting is secret and takes place in every civil parish (*hreppur*) and township (*kaupstaður*). Absentee voting papers are supplied to those who are away from their constituencies on election day.

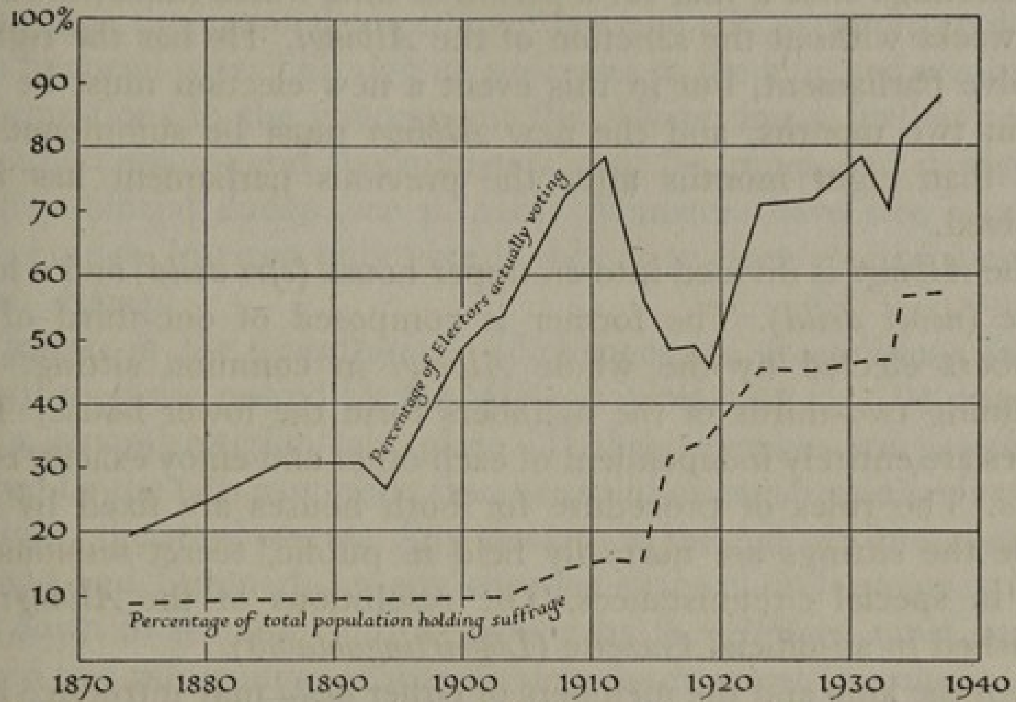


Fig. 78. Percentage of total population holding suffrage and percentage of electors actually voting, 1874–1937. Based on data in *Hagskýrslur Íslands*, No. 96 (Reykjavík, 1938).

Fig. 78 illustrates the growth of political consciousness which is such a feature of present-day Iceland. Women were granted the right to vote on local matters in 1882. Until 1908, elections were conducted verbally at appointed places in each district, but in spite of the difficulties in reaching the small number of polling stations, more than half of those holding franchise took part in the last verbal election. An increase in the number of polling stations in 1908 resulted in more widespread participation, but there was a falling off at the next four elections, especially in 1916 when universal suffrage was introduced. The percentage of electors participating was even lower in 1918, when only 48·3 % of the electors voted, for there was very little opposition to the Act of Union. In 1923 absentee voting by letter was allowed, and a further increase in the number of polling stations enabled more people to vote in their home districts. At the general election in 1938 nearly 90 % of the electors took part, a figure which is considerably higher than in England, where the parliamentary vote is normally only about 70 % of its full strength.

Political parties are discussed on pp. 144–6.

The *Alþingi* assembles, usually in Reykjavík, for its ordinary sessions on 15 February each year. According to the constitution, the king summons the *Alþingi* and decides when it shall be prorogued. The king may summon extraordinary sessions. He may also adjourn the meetings once a year for a period of time which must not exceed two weeks without the sanction of the *Alþingi*. He has the right to dissolve parliament, but in this event a new election must be held within two months, and the new *Alþingi* must be summoned not later than eight months after the previous parliament has been dissolved.

The *Alþingi* is divided into an upper house (*efri deild*) and a lower house (*neðri deild*). The former is composed of one-third of the members elected by the whole *Alþingi* in common sitting. The remaining two-thirds of the members form the lower house. Both houses are entirely independent of each other and enjoy exactly equal rights. The rules of procedure for both houses are fixed by law. While the sittings are normally held in public, secret sessions are legal in special circumstances. The resolutions of the *Alþingi* are published in an official Gazette (*Lögbirtingablaðið*).

Both the king and the members of either *deild* may introduce bills. A bill may be introduced in either house, where it receives three readings. If it passes them all, it is sent to the other house where it undergoes an exactly similar process. If amendments are made by one of the houses, the bill must be returned to the other one for approval. If the two houses do not agree, they meet in joint session and dispose of the bill at one sitting, but under these circumstances a two-thirds majority is required and more than half of the members of each house must take part in the voting. All these readings must take place in the same session. The king's right of veto is unrestricted, but as the royal veto on bills must have the signature of a minister, it has in reality been very little felt.

Shortly after the regular assembling of the *Alþingi* the finance bill is presented, and the *Alþingi* must not be prorogued until the budget has been passed. Apart from a provisional budget, which must not be issued if the budget of the financial year has already been passed, the king may issue provisional laws in the interval between the sessions of the *Alþingi*, provided that these do not infringe the constitution. Such provisional laws must be submitted to the *Alþingi* at its next session.

Although the *Alþingi* is in the main a legislative assembly, it can both control and influence the administrative work of the government because it commands the sources of supply; no payments can be made from the public treasury unless authorized by the *Alþingi*. Its sanction is required for imposing, changing, or abolishing taxes, duties and customs; for the taking up of state loans; for the uses to which public lands are put. It appoints a board of three auditors to examine the national accounts of revenue and expenditure during each financial year. Through its addresses to the king and resolutions and questions to the government the *Alþingi* has a further control on public affairs, and the ministers may be impeached if they fail in their official duties (see p. 220). Ministers have free access to both houses, but can only vote if they have been elected members of the *Alþingi*.

Changes in the Constitution. If changes in, or additions to, the constitution are passed by the *Alþingi*, it must at once be dissolved and a general election take place. If these changes are passed unaltered by the new assembly, they are valid as constitutional law after receiving the royal assent. Any changes in the Act of Union between Iceland and Denmark, or any changes in the church organization as laid down in the constitution, passed by the *Alþingi*, must be submitted to a referendum at which the ballot is secret (see also p. 213).

Local Government

For state administrative purposes, Iceland is divided into sixteen provinces (*sýslur*), each governed by a sheriff (*sýslumaður*). For local administration each province forms one or two municipal districts, with a district council (*sýslu-nefnd*). These are again subdivided into civil parishes (*hreppar*) of which there are at present 206. There are also eight townships (*kaupstaðir*) with town councils, independent of the provinces, and forming by themselves administrative units which are equal in rank with the provinces.

In the same way as the provinces, the townships are governed by sheriffs who are concerned with matters of state participation in local government. The main activity of these sheriffs is the collection of rates and taxes, and police administration. To assist them, especially in police administration, there are government-paid officers (*hreppstjórar*), one in each civil parish; while the town sheriffs are assisted by the police who are paid out of the local funds.

The municipal district councils are elected direct by universal suffrage (men and women over 21 years of age), with one representative for each civil parish. In town councils the elections are by proportional representation, but in parish councils by simple majority.

The district sheriffs preside over the district councils, which manage all matters concerning the district as a whole and supervise the work of the parish councils, from which appeals may be made to the district councils. The parish councils deal only with parish affairs, chief among which are poor relief and local roads. In some towns, the councils are presided over by the town sheriff, in others by a mayor, elected by the town councillors. Both district and town councils are under the supervision of the central government, to which, in case of disagreement, questions may be submitted for settlement.

List of Provinces (sýslur) *and Townships* (kaupstaðir) *with their populations in* 1935 *and* 1940 (*see Fig*. 79)*

	1935	1940
Reykjavík	34,231	38,094
Hafnarfjörður	3,735	3,707
Gullbringu- and Kjósar-sýsla	4,986	5,582
Borgarfjarðarsýsla	2,898	3,208
Mýrasýsla	1,778	1,816
Snæfellsnes- and Hnappadals-sýsla	3,557	3,467
Dalasýsla	1,498	1,424
Barðastrandarsýsla	3,019	3,019
Ísafjarðarsýsla	5,605	5,073
Ísafjörður	2,602	2,863
Strandasýsla	1,966	2,092
Húnavatnssýsla	3,757	3,650
Skagafjarðarsýsla	3,949	3,906
Siglufjörður	2,643	2,883
Eyjafjarðarsýsla	5,312	5,309
Akureyri	4,503	5,542
Þingeyjarsýsla	5,848	5,942
Norður-Múlasýsla	2,780	2,608
Seyðisfjörður	987	903
Neskaupstaður	1,157	1,097
Suður-Múlasýsla	4,368	4,300
Austur-Skaftafellssýsla	1,127	1,141
Vestur-Skaftafellssýsla	1,718	1,587
Rangárvallasýsla	3,442	3,310
Vestmannaeyjar	3,510	3,579
Árnessýsla	4,897	5,246
Total	115,873	121,348

Fig. 79 shows the locations of the provinces, municipal districts and townships. The municipal district boundaries indicate the divisions between two neighbouring administrations which share a sheriff. The province of Norður-Múlasýsla and the township of Seyðisfjörður have the same sheriff and administration. Suður-

* Since this book went to press Akranes has been made a *kaupstaður*.

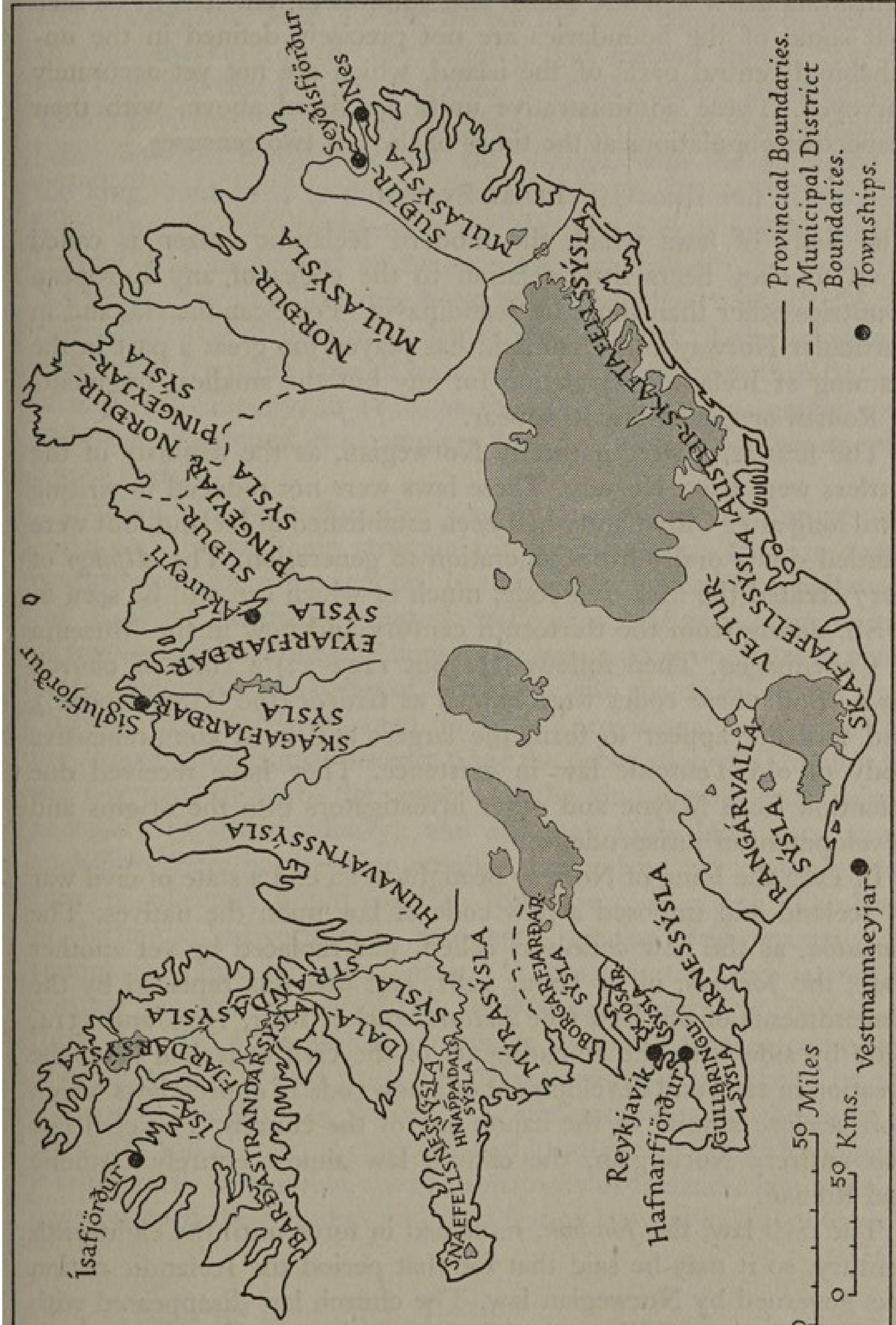


Fig. 79. Boundaries of Provinces, Municipal Districts, and Townships.

Múlasýsla has a separate sheriff and administration. It will be seen that some of the boundaries are not precisely defined in the uninhabited central parts of the island, which are not yet accurately surveyed. These administrative units are listed above, with their respective populations at the times of the last two censuses.

Legal System

The body of laws which the modern Icelandic citizen is called upon to obey bears little relation to the codes of any European countries other than those of Scandinavia. For Scandinavia, and in particular Norway and Denmark, has played too great a part in the framing of Icelandic legislation for any but the smallest fragments of Roman or Canon law to appear.

The first laws were naturally Norwegian, as the majority of the settlers were from Norway. These laws were not reduced to writing until long after Christianity had been established in Iceland, but were handed down orally from generation to generation. The *Alþingi* of 1117 created the first civil code, much of which can still be seen in MSS. dating from the thirteenth century and now in the Museum at Copenhagen. Then followed (about 1122–33) a code of church laws. Both these codes were known as *Grágás* (the 'Grey Goose'), and together appear to form the largest and most comprehensive body of old Teutonic law in existence. They have received due attention from Mayne and other investigators into the origins and development of jurisprudence.

In 1262 the King of Norway brought to an end a state of civil war in Iceland and imposed a new code of law upon the natives. The *Járnsíða*, as the new code was called, was replaced by yet another code, the *Jónsbók*, in or about 1281, and this was replaced by the Amendments of the Law (the *Réttarbœtur*) of 1294, 1305, and 1314. Side by side with the amendments of the civil code had been the creation in 1275 and development of a new code of church laws which bore a close affinity to the canon law of the church. The civil law was entirely Norwegian, the church law almost entirely Catholic and Roman.

The civil law, the *Jónsbók*, remained in force until the eighteenth century, so it may be said that for that period the Icelandic nation was governed by Norwegian law. The church law disappeared with the Reformation, which reached Iceland about 1550. The last remnant of the church law was abolished about 1622.

During the century or more which followed, the King of Denmark and Norway constantly applied his law for those countries to Iceland. In 1732 the king of the day ordered that Iceland should have its own code and that a Norwegian code of 50 years before should apply. This was virtually the end of the *Jónsbók*. In practice, the code never being imposed constitutionally, the *Alþingi*, with the authority of the king, continued to put into force both Danish and Norwegian laws. In 1734 the provisions of the Norwegian code with regard to larceny and manslaughter became law in Iceland; in 1769 the Norwegian law of inheritance became Icelandic law: and in 1786 the Norwegian law of bills of exchange was adopted. Later adoptions were made from the Danish code, as in 1831 with regard to the age of majority. Finally, in 1838, as though all hope of a native code had been abandoned, the complete Danish criminal code became the law of Iceland.

In 1849, the year after the 'year of revolutions' in Europe, the Icelanders began their struggle for independence after so many centuries of foreign domination. In 1874, following ceaseless agitation, the King of Denmark granted original legislative powers to the *Alþingi*, which had not functioned as a law-making body for so many years. Since then the codes of Denmark, with strong influences from Norway, have heavily affected the *ad hoc* provisional laws passed by the *Alþingi* (provisional because until the occupation of Denmark by the Germans in 1940, the consent of the king of that country was necessary for their validity), and although there have been many such laws there has been no attempt, nor indeed any pretence, that they, if collected, would form an Icelandic code of law. The basis of Icelandic jurisprudence was and remains Scandinavian. It cannot therefore be called native to the country, and is indeed entirely foreign. A few of the *Jónsbók* provisions still remain in force, but the whole of the remaining system of laws is composed of separate acts passed since the *Alþingi* was re-established. To the student of the laws of Iceland, an understanding of the laws of Denmark and Norway is essential, and, until recent events have made it temporarily impossible, the great majority of Icelandic law students have pursued their studies and qualified as lawyers in Copenhagen.

Justice

According to the constitution, the administration of justice is exercised by judges. Other authorities can, therefore, neither alter nor influence the decisions of the courts. The constitution also prescribes that the courts shall settle all disputes that may arise respecting the extent of power possessed by government officials. This implies that whenever there is doubt whether executive or judicial authority is to be exercised in a matter, the decision rests with the courts. Since the judges in all their official duties are to be guided solely by the law, the executive can in no possible way dictate to them how to give their decisions. The judges are appointed by the king, whose functions are at present fulfilled by the regent. To safeguard the independence of the judges against any interference from the executive, the constitution provides that those of them who have no other administrative duties cannot be removed from the bench unless a legal judgement has been passed upon them; nor can a judge be transferred from one office to another against his will, unless a new system is being introduced. When a judge has reached the age of 65 years, he is allowed to retire on full salary. Finally, the constitution prescribes that the system of administration of justice can only be fixed by an act of the *Alþingi*.

The courts of law are of two kinds—ordinary and special. In the former are tried all cases except those which are expressly excepted; in the latter are heard only such cases as specially fall within their provinces.

The ordinary judicial court has two instances. The first instance is the Lower Court, presided over by the district sheriffs in the country, and by the town sheriffs in the townships. The country is divided into twenty-four lower court jurisdictions (sixteen provinces and eight townships, see Fig. 79), but there are only twenty-one lower court judges. The second instance is the Supreme Court in Reykjavík, consisting of three judges.

As a general rule, the special judicial court has two instances, the Supreme Court being the higher one. Some of the special courts, such as the Maritime Courts (see p. 324), consist of an ordinary lower court judge and lay judges. Other special courts are organized on different lines. The most important of these is the Court of Impeachment (*Landsdómur*), which delivers judgement in first and last instance in cases brought against ministers in connexion with the discharge of their official duties. It comprises certain *ex officio* members of the legal profession and members chosen by the district and town councils, fifteen in all. A special court of appeal is the Ecclesiastical Court, which consists of three members of the Supreme Court and two ecclesiastical members. This court delivers judgement in the last instance in all cases over which it holds jurisdiction.

Juries are never employed in the trial of either civil or criminal cases.

Before a civil lawsuit can be brought into a lower court, it must generally be referred first to a board of conciliation which mediates between the parties to the dispute. Sometimes the judge himself undertakes the mediation, but in most cases it is performed by the conciliation boards which are appointed for this purpose. In minor debt cases, these boards may also decide a case by giving a ruling.

At the supreme court pleadings are oral; at the lower courts the system of written procedure is used. Certain lawyers are authorized to plead in the supreme court. In the lower courts anybody may plead.

The General Rights of Citizens. The constitution contains a number of provisions intended to safeguard the subjects in the enjoyment of certain rights, and also a few clauses which deal in general terms with their civil duties. Thus the constitution prescribes that there shall be freedom of the press, liberty to hold meetings, liberty to combine, and freedom of religion. The constitution forbids unlawful arrests; it guarantees industrial liberty, provides relief for those who are unable to earn their living, and education for destitute children. Houses may not be searched; nor may letters or other documents be detained and examined except by judicial warrant. Property is inviolate. Privileges reserved to nobility, titles and ranks may never be introduced by law. According to a system which may be introduced by law, the defence of the country is obligatory on every man able to carry arms. As yet Iceland has no military force and has declared herself permanently neutral.

Police System

The police system falls into two main divisions, the Criminal Investigation Department and the uniformed police, both responsible to the Minister of Justice.

Uniformed police officers, numbering about eighty in Reykjavík, are responsible for discipline in the town, the control of drunkenness, and the direction of traffic. All other crime is in the hands of the C.I.D. In the rest of the country there are not more than about thirty police officers, and these are found only in the larger towns. They receive their orders from the sheriffs.

Chapter X

GROWTH AND DISTRIBUTION OF POPULATION

General Features: Rate of Growth: Analysis of Movements of Population: Distribution of People by Occupations: Farming Settlements: Growth of Urban Settlements: Conclusion

General Features

The population of Iceland in 1940 was 121,348. More graphically expressed, all its inhabitants could find accommodation as spectators at the Glasgow Rangers' football ground, or they could all be housed in Bournemouth, Huddersfield or Kansas City. The area of the country is 102,819 sq.km., of which only 42,085 sq.km. were classed as inhabited land in the 1930 census. Thus three-fifths of the island is not peopled, and is likely to remain so for many years, since it is a waste of ice, lava or sand. Iceland is the most sparsely populated of all European countries. The average density in 1940 was 1·18 per sq.km. This corresponds with the figure for Wyoming with its broad area of National Park and high mountains. It is interesting that some of the most thinly populated regions of Britain, such as Inverness, Ross and Cromarty, are six times more densely peopled than Iceland.

A clear distinction must be drawn between average and effective densities of population. The effective density, which is based on the area of inhabited land instead of the total island surface, is 3 per sq.km. This figure is still very low, and the explanation is to be found in the adverse geographical conditions and in the past history of the country. The area of inhabited and uninhabited land and the corresponding density of population are summarized in the table on p. 224, where the figures for 1940 are calculated for each province. Reference should be made to the map on p. 217 for the positions of these administrative areas.

In 1880, 73 % of the population lived by farming; but the broken nature of the ground, the thin soils and the cold bleak climate gave no opportunity for the development of even a moderately dense rural population. Farmers lived on the coast and in the lower river valleys, not only because these areas offered the only stretches of fertile ground, but also because fishing provided a supplementary means of subsistence. A pastoral instead of an arable economy was inevitable; farms were necessarily extensive, and the density of settlement was correspondingly low. With the steady increase in population during the last forty years, a new feature has appeared in the settlement of the people. The coming of the steam trawler brought with it a specialization in the fishing industry. Fishing became more and more divorced from farming. The catch had to be handled, salted, dried, packed and shipped in large quantities, all of which called for a concentration of people in ports and coastal towns. An era of urbanization has set in which shows every sign of continuing. The growth of villages and townships is clearly shown in the following table, in which the figures for each year are expressed as percentages of the total population:

	1901	1910	1920	1930	1940
Reykjavík	8·5	13·6	18·7	26·0	31·4
Other townships	5·1	7·5	12·0	16·3	17·0
Villages of over 300 inhabitants	*c.* 6·4	11·1	12·0	12·2	13·3
Country districts	*c.* 80·0	67·8	57·3	45·5	38·3

The population of Reykjavík was 38,094 in 1940. This represents 31·4 % of the population of the whole country and is a phenomenally high figure, even when compared with Greater London, whose 9,000,000 people make up 21·7 % of the total population of England and Wales. There is scarcely another Scandinavian city which has developed so rapidly during the last fifty years. The remaining seven townships (*kaupstaðir*) are dwarfed by comparison; Akureyri, the largest port in the north, has only 5,542 inhabitants.

Several features emerge from an inspection of the map of population distribution (Fig. 80). The inhospitable interior limits the people to an extremely narrow marginal belt, though penetration of the country has taken place up some of the broader and more fertile river valleys. Rural hamlets are rare above an altitude of 100 m., and above this height isolated farmsteads are limited to sheltered oases in the mountain fringe. The peripheral distribution is indicated even more clearly in the road and telephone maps (Figs. 126, 130). Within the limits imposed by relief and distance from the sea, irregularities of distribution are determined by local variations in physical conditions. Thus the long north-flowing Skjálfandafljót and Lagarfljót have broad and comparatively well-populated valleys, whereas the Jökulsá á Fjöllum cuts a narrow gorge through desert country and the valley is consequently bare of settlement. Braided lower stretches are common to many Icelandic rivers, especially in the streams draining south from Vatnajökull. This feature may render broad stretches of lowland completely uninhabitable; communications across the numerous distributaries are extremely difficult and, through shifting of the stream channel, verdant pastures may suddenly be covered by infertile sands and shingle.

Area of Iceland and Density of Population

Provinces (*sýslur*) and townships (*kaupstaðir*)	Area (sq. km.) In-habited land	Moun-tain pasture	Deserts	Total	No. of inhabitants per sq. km. Of in-habited land	Of total land surface
Gullbringusýsla and Kjósarsýsla (including Hafnarfjörður and Reykjavík)	1,266	716	—	1,982	37·4	23·9
Borgarfjarðarsýsla	991	661	110	1,762	3·2	1·8
Mýrasýsla and Hnappadalssýsla	1,542	1,652	110	3,304	1·2	0·6
Snæfellsnessýsla	1,101	386	55	1,542	3·1	2·2
Dalasýsla	1,377	716	—	2,093	1·0	0·7
Barðastrandarsýsla	1,322	1,156	220	2,698	2·3	1·1
Ísafjarðarsýsla (including Ísafjörður)	1,927	1,266	771	3,964	4·1	2·0
Strandasýsla	881	1,266	661	2,808	2·4	0·7
Húnavatnssýsla	2,698	3,194	1,872	7,764	1·4	0·5
Skagafjarðarsýsla	2,092	2,038	1,046	5,176	1·4	0·8
Eyjafjarðarsýsla (including Siglufjörður and Akureyri)	2,643	1,487	1,156	5,286	5·2	2·6
Þingeyjarsýsla	7,324	5,286	4,625	17,235	0·8	0·3
Norður-Múlasýsla (including Seyðisfjörður)	5,561	5,506	386	11,453	0·6	0·3
Suður Múlasýsla	3,029	771	165	3,965	1·4	1·1
Skaftafellssýsla	2,478	2,973	8,755	14,206	1·1	0·2
Vestmannaeyjar	16	—	—	16	223·7	223·7
Rangárvallasýsla	2,533	4,625	1,817	8,975	1·3	0·4
Árnessýsla	3,304	3,854	1,432	8,590	1·6	0·6
Total	42,085	37,553	23,181	102,819	2·9	1·2

Sources: (1) Manntal á Íslandi, 2 Desember 1930, *Hagskýrslur Íslands*, no. 92, p. 15 (Reykjavík, 1937). (2) *Hagtíðindi*, p. 25 (Reykjavík, 1941).

Apart from the townships on the mainland the greatest density of population is to be found in the small island of Heimaey, one of the Vestmannaeyjar, off the south coast (224 per sq.km.). Excellently situated as a fishing and export centre, the island community (3,579) has developed rapidly within recent years. On the mainland, the provinces of Kjósársýsla and Gullbringusýsla in the south-west stand out as a region of pronounced urbanization. Reykjavík overshadows the neighbouring township of Hafnarfjörður (3,707), whose population has declined during the last five years; but farther west is the

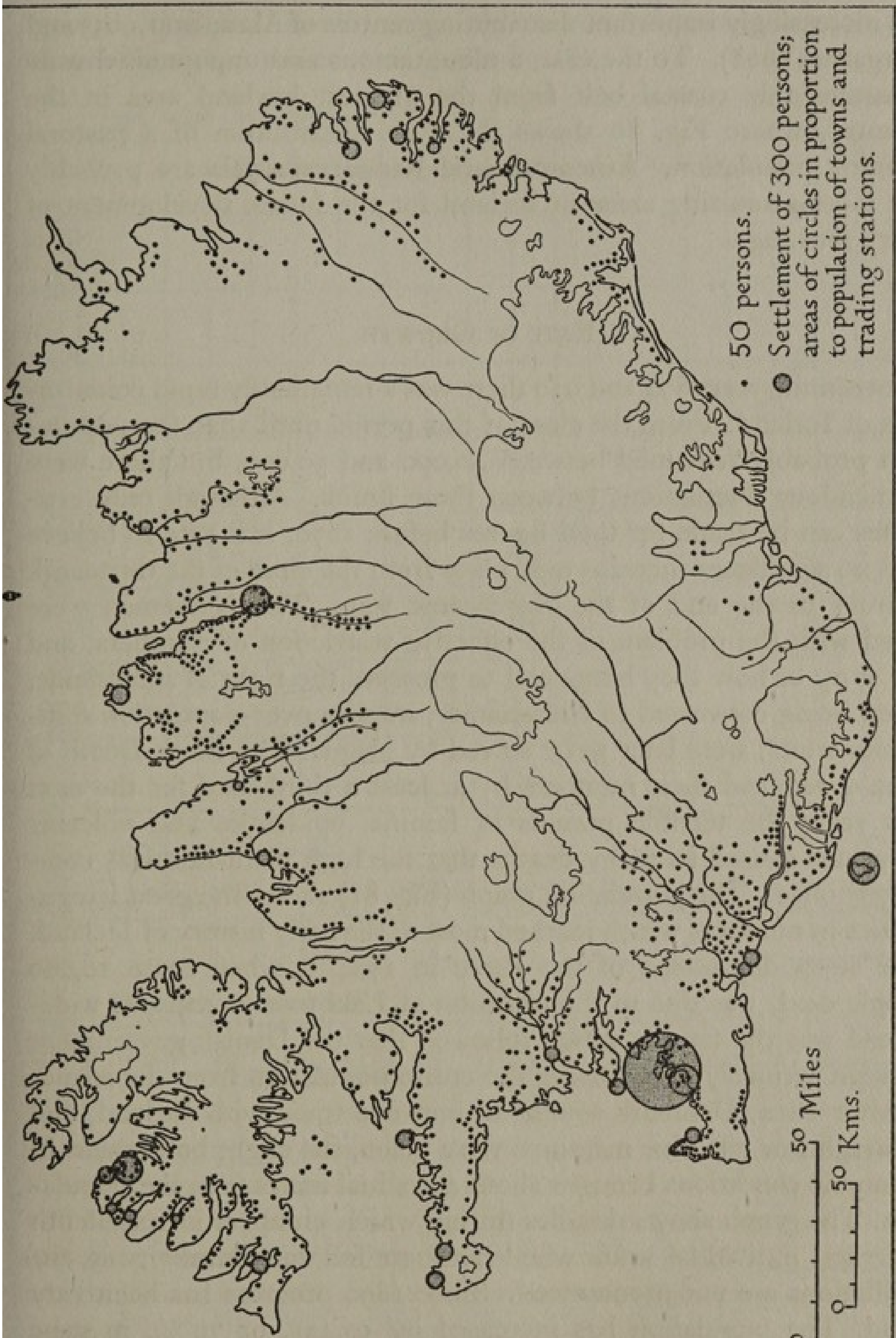


Fig. 80. Distribution of the population, based on the 1920 census. Source: E. Hanson, *Geog. Review*, Vol. XVIII, p. 42 (New York, 1928).

vigorously growing port of Keflavík (1,551), while to the north are the increasingly important distributing centres of Akranes (1,905) and Borgarnes (608). To the east, a mountainous and unpopulated zone separates this coastal belt from the greatest lowland area in the country, where Fig. 80 shows the even distribution of a pastoral farming population. Árnessýsla and Rangárvallasýsla are probably the most promising areas in Iceland for the future development of dairy farming.

Rate of Growth

Between the years 874 and 930 there was a remarkably rapid colonization of Iceland. From the close of this period until 1820 the population probably remained between 40,000 and 50,000, but there were tremendous fluctuations between these limits. Although only estimates can be made for total figures before 1670, it is safe to believe that no significant increase took place from the close of the thirteenth century to the end of the Napoleonic wars. The Norsemen were faced with the problem of the effective restriction of numbers, and the story of how they bargained to preserve the right of infanticide, when being converted to Christianity, implies over-population difficulties which were later to be solved by plague. The Black Death of 1402–4 reduced their numbers by at least a third, and for the next 400 years the terrible periods of famine, epidemics and volcanic eruptions caused so many deaths that the high birth-rate was completely offset. The population graph (Fig. 81) shows the great irregularities in numbers which marked most of the early history of Iceland. The steep depression of the curve in 1784–5, when some 10,000 people died, was due to the eruption of Laki (see p. 12). So widespread was the famine which followed that the Danish government thought seriously of removing the entire population from the island.

After 1814, Denmark sought to improve trade with Iceland, and although few effective measures were taken, the slight betterment in economic conditions brought about a gradual increase in the population. The graph shows decades during which numbers increased but little and individual years when numbers fell considerably, but the oscillations are not pronounced. Since 1890 progress has been very rapid. The population has increased by 50,421, or 72 %, in spite of the continuous decrease in the birth-rate. Improvements in the standard of living and also in public health services have increased the people's resistance to adverse conditions, and serious epidemics no longer develop into national catastrophes. Infant mortality, which was over 300 per 1,000 births in the 1850's, fell to 29·2 in 1938, the lowest figure for any country in the world.

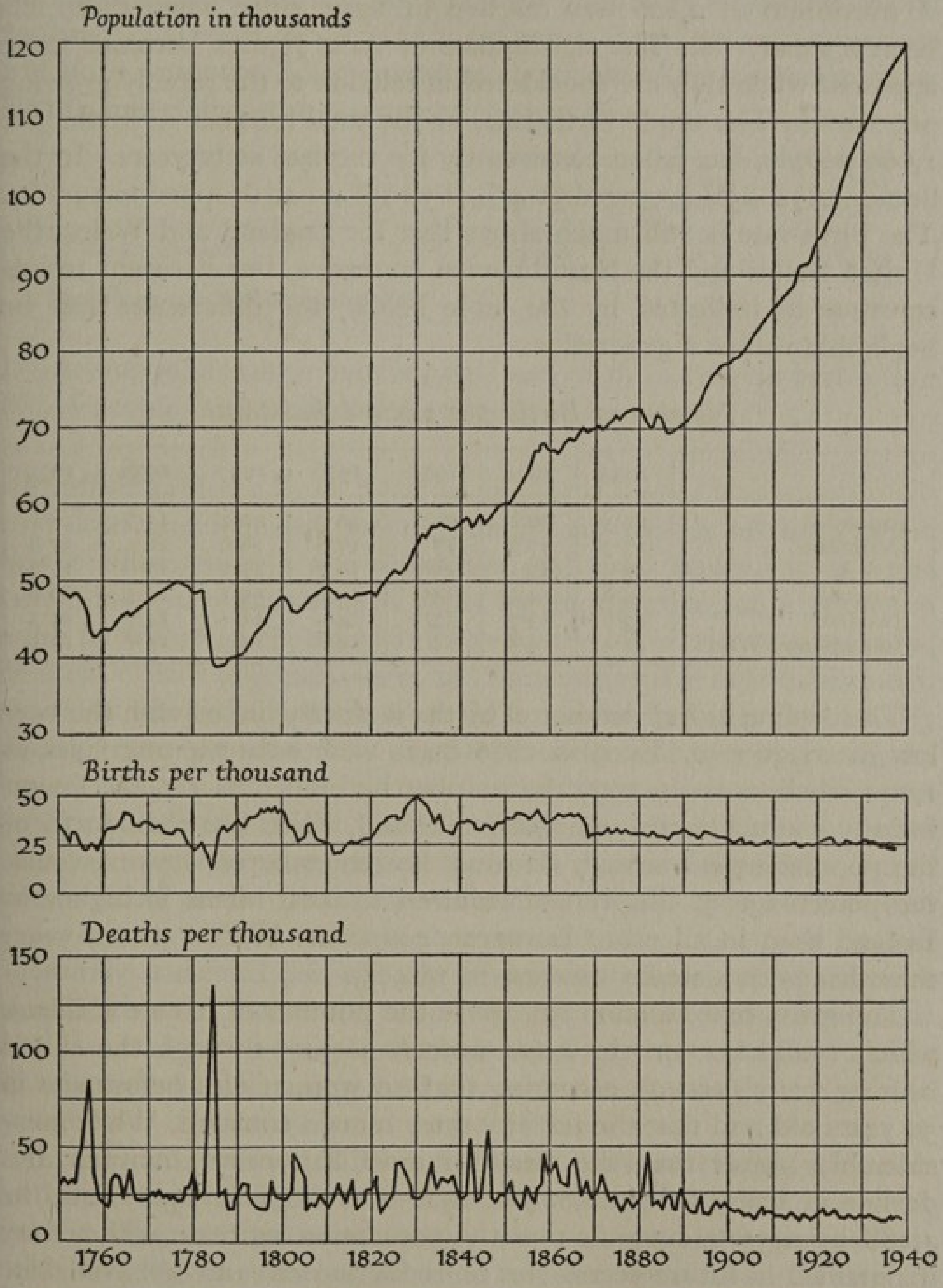


Fig. 81. Graphs showing vital statistics, 1751–1940. Adapted from (1) *Heilbrigðisskýrslur* 1938, p. 182 (Reykjavík, 1940). (2) G. Hanneson, *Árbók Háskóla Íslands*, p. 30 (Reykjavík, 1925).

The Birth-rate

The number of births to-day is much the same as at the beginning of the century; 2,200 children were born in 1902 and 2,326 in 1938. A maximum of 2,808 was reached in 1930, since when there has been a steady fall. The significance of these figures becomes more apparent when they are considered in relation to the rapidly growing population. The crude birth-rate, or the total number of births per 1,000 people, has fallen consistently for the last sixty years. In the decade 1876–85 it averaged 31·4 %; by 1938 it had dropped to 19·7 %. The birth-rate is still much above that for England and Wales, the United States and the Scandinavian countries, but if recent trends continue as indicated by the table below, the differences will be negligible within a generation.

Number of Births per 1,000 *Inhabitants*

	1933	1934	1935	1936	1937	1938	1939
Iceland	22·5	22·8	22·1	22·0	20·4	19·7	—
Denmark	17·3	17·8	17·7	17·8	18·0	18·1	17·8
U.S.A.	16·5	17·1	16·9	16·7	17·0	17·6	17·2
Norway	14·8	14·6	14·4	14·6	15·1	15·5	16·0
Sweden	13·7	13·7	13·8	14·2	14·4	14·9	15·3
England and Wales	14·4	14·8	14·7	14·8	14·9	15·1	15·5

The decline in the number of births is clearly linked with the very low marriage rate. Even in 1880 there were only 7·4 marriages to 1,000 inhabitants; in 1937 the number had fallen to 5·5, the lowest for any country in Europe except Ireland, while less than 30 % of the population is married. It must be remembered, however, that the percentage of illegitimate children to total births is higher in Iceland than in all other European countries. Within recent years there has been a steady increase to 18·4 %.

The gross reproduction rate gives the number of female children which would be born to 1,000 women passing through the child-bearing years (15–49), assuming that no woman dies before she is 50 years old and that the fertility rates remain constant. While considerably higher than the rates for most European countries, the decline in Iceland from 1,864 in 1920–1 to 1,695 in 1930–1 and to 1,488 in 1935–6, suggests that the population increase will not be maintained in future years. Net reproduction rates are not available.

Examination of the population by age groups shows that women are now marrying at a younger age than at the end of last century. During the period 1891–5 the average age was 28·2 years; from 1931 to

1935 it was 25·8. For men the decrease has been small, from 30·8 to 29·7. The future development of the capital and other towns will be strongly affected by the 'cityward drift' of men and women from the rural areas. Thus, 209 per 1,000 inhabitants of Reykjavík belong to the 20–29 group, whereas only 138 per 1,000 of corresponding age live in the country. This migration of people of marriageable age is clearly reflected in the 1935 marriage statistics:

	Reykjavík	Other townships	Country districts
Total population	34,231	19,137	62,502
No. of marriages	366	141	228
Marriages per 1,000 inhabitants	10·7	7·4	3·7

If present trends continue, they will lead to an increasing percentage of old people in the country districts.

The Death-rate

It is obvious that the growth of the population has not been determined by changes in the birth-rate, and since Iceland loses more people by emigration than it gains by immigration, an explanation must be found in the changing death-rate. With better sanitation, freedom from trade restrictions, and improvement in medical services, mortality has fallen from 245 per 10,000 inhabitants in the 1876–85 decade to 102 in 1938. The death-rate in Iceland is now among the lowest in the world, bettered only by the Netherlands and temperate regions within the British Empire. While the expectation of life has improved for every age group, the most outstanding change is the phenomenal drop in infantile mortality (see Fig. 70). A hundred years ago one child in three died before it reached the age of one; in 1938 only one child out of every thirty-four did not survive the first year of life. This rate is the lowest for any country in the world, and compares very favourably with those for England and Wales and the United States, where one child in every twenty dies during its first year.

In 1933 the excess of live births over deaths reached a maximum of 1,811, and while the total population has continued to increase, the annual rate of growth from that year has steadily diminished. It will probably continue to do so if recent trends in the birth- and death-rates are maintained. As yet, neither the ratio between the age groups nor the average age has varied greatly. But in Iceland young people now have a greater chance of surviving to old age, and provided that the birth-rate remains low an increasing percentage of old people will result. Iceland will thus pass to the position in which France and Britain now stand.

Analysis of Movements of Population

Three factors are responsible for inequalities in the regional growth of the population: variation in the balance of births and deaths, immigration and emigration, and most important of all in Iceland, migration of the people between different localities.

Births and Deaths

The balance between births and deaths shows little variation over the whole country. The drift of young people towards the towns has not had time to have its full effect on the birth-rate; nor has the decrease of women of reproductive age in country districts resulted in a proportionate decrease in the number of children born in these areas. The movement of people of marriageable age has been partly offset by the low marriage rate, by the practice of birth control, and by the fact that families in urban centres are smaller than in rural districts. It seems very likely that future generations will see an increasing preponderance of births over deaths in towns and an equalization of birth- and death-rates in country districts. This regional inequality in population growth may not develop if the government succeeds in finding some method of keeping the people on the farms.

Immigration and Emigration

Four-fifths of all the immigrants in Iceland come from Scandinavian countries, and as they are practically all merchants it is not surprising to find more than two-thirds of them living in Reykjavík. Immigration is not encouraged by the government, but the number of foreigners living in Iceland had risen from 710 in 1920 to 1,507 in 1930; an increase from 0·8 to 1·4 % of the total population.

No considerable emigration took place until 1870, when the incentive was a desire to find political and economic freedom rather than to avoid the rigorous conditions of life in Iceland. The highest emigration figure was reached in 1887, when about 2,000 people left the country. By 1901 a total of over 15,000 had found new homes in America. Since that time emigration has been on a small scale.

Census returns give the following statistics for Icelanders living in Canada and the United States:

	Canada		United States	
	1921	1931	1920	1930
Born in Iceland	6,776	5,731	2,400	2,764
Speaking Icelandic	14,933	16,034	2,369	2,714
Of Icelandic parentage	15,876	19,382	?	7,413

In Canada most Icelanders have settled in the Prairie Provinces, particularly in Winnipeg, while the greatest concentration in the United States is to be found in Minnesota and the Dakotas.

Internal Migration

The movement of young men and women from isolated farms to villages and townships (Fig. 82) is closely related to the changing economic conditions since 1914, to the increasing specialization in occupations, and to the attractiveness of town life. A hundred years

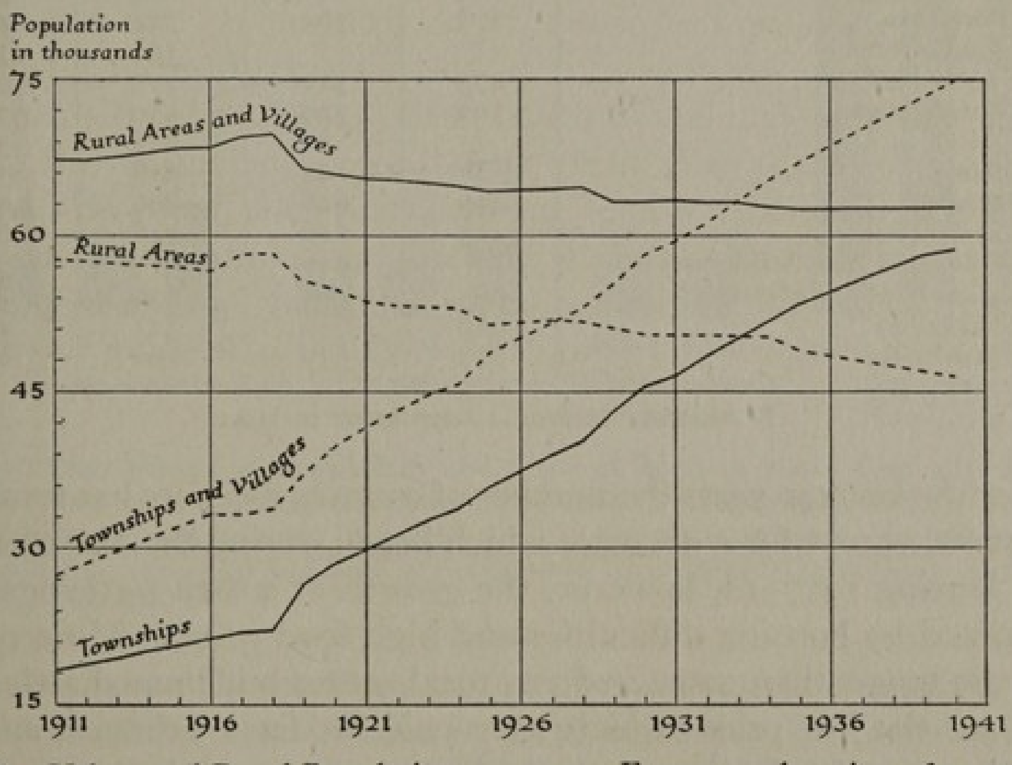


Fig. 82. Urban and Rural Population, 1911–40. For an explanation of townships (*kaupstaðir*) see p. 215. The villages include all other places with more than 300 inhabitants. Sources as in Fig. 85.

ago Iceland had no large centres of trade. It has been said that Icelandic ports were then on the European mainland, for example, at Copenhagen and to a lesser extent at Hamburg. In 1880, when the population of the island was 72,444, there were but three townships (*kaupstaðir*) with a total of 3,630 inhabitants. By 1940 the population had grown to 121,348, and eight townships housed 58,668 people. Villages have also grown considerably, and there are now twenty-seven places of more than 300 inhabitants (*verslunarstaðir*) with a total of 16,186 inhabitants. The following tables shows the growth of the *verslunarstaðir*:

	1910	1920	1930	1940
Keflavík	469	509	828	1,551
Akranes*	808	928	1,270	1,905
Borgarnes	157	361	418	608
Sandur	412	591	550	434
Ólafsvík	525	442	440	471
Stykkishólmur	591	680	642	656
Vatneyri (Patreksfjörður)	475	436	606	724
Bildudalur	285	291	323	349
Þingeyri (Dýrafjörður)	337	366	360	375
Flateyri (Onundarjörður)	218	302	327	440
Suðureyri (Súgandafjörður)	255	317	356	362
Bolungarvík	815	775	688	649
Hnífsdalur	144	434	380	313
Hólmavík (Steingrímsfjörður)	?	?	161	327
Hvammstangi	114	?	204	310
Blönduós	273	365	324	436
Skagaströnd	?	?	198	324
Sauðárkrókur	473	510	775	959
Ólafsfjörður	192	329	539	736
Dalvík	?	?	228	314
Hrísey	?	193	318	316
Húsavík	599	628	889	1,002
Eskifjörður	425	616	748	671
Búðareyri (Reyðafjörður)	?	217	311	343
Búðir (Fáskruðsfjörður)	393	461	630	539
Stokkseyri	680	732	521	469
Eyrarbakki	737	837	600	603

* Akranes became a *kaupstaður* in 1941.

For the last 140 years the number of country dwellers has remained constant, except for a decrease which began during the war of 1914–18. During 1917–18, however, the growth of urban settlement was restricted by housing difficulties and high food prices. More people left the towns than came in from rural areas; but immediately after the war the low prices which were paid for farm produce, and the development of foreign trade with consequent high wages in the fishing ports, led to a depopulation of the rural areas which has gone on uninterruptedly for the last twenty years. In 1929 there was a boom in Icelandic exports, and the fishing centres became even more attractive to the youth of the country.

The movement away from the farms has not been accompanied by a lowering in the standard of living, for the system of co-operative societies and the use of machinery have more than made up for the loss of man-power. In the towns, too, Iceland has been fortunate in avoiding the pauperization which so frequently accompanies the first stages of industrial development.

A study of the population by place of birth (Fig. 83) shows clearly that the inhabitants of the townships have come largely from country-dwelling parents, a fact which has so far prevented any major differences in cultural outlook between the urban and rural popula-

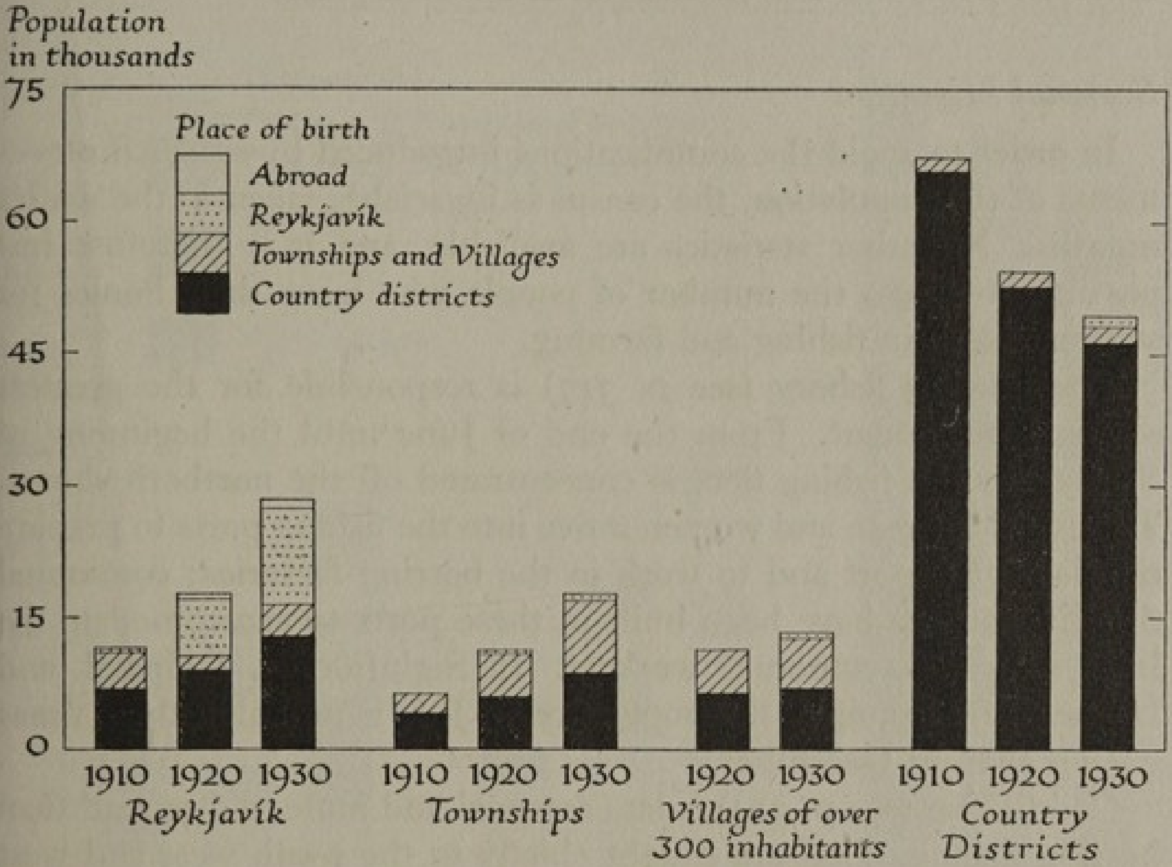


Fig. 83. Distribution of population and place of birth in 1910, 1920 and 1930. The 1910 census makes no distinction between villages with more than 300 inhabitants and country districts. Apart from the capital, Hafnarfjörður, Ísafjörður, Akureyri and Seyðisfjörður were then the only townships. Sources as in Fig. 84.

tions. In 1910 only one-third of the people living in Reykjavík had been born in the capital, while by 1930 more than half were still of country origin. During the last decade there has been a slight movement back to the land, but this does not balance the townward drift. In 1940 over 90 % of the country dwellers had been born on farms, and it is obvious that the land offers few attractions to those who have been brought up in towns.

The greatest movement of population from the various country districts has been in the south-west, where Reykjavík and Hafnarfjörður have drawn most strongly upon their immediate hinterland of Gullbringusýsla, Kjósársýsla and Árnessýsla. In the north-east of the country there has been little or no urban growth and the movement has not been so pronounced.

There has also been a considerable shift of the population within each province (*sýslur*). In the south-west, only one person in three has remained at the farm or village where he was born, and even in the more isolated areas of Strandasýsla and Austur-Skaftafellssýsla only one person in two has stayed at his birthplace.

Seasonal Migration

In order to avoid the complications introduced by seasonal movements of the population, the census is invariably taken in the winter months. No other statistics are available, and it is therefore impossible to assess the number of people who leave their homes for summer work in fishing and farming.

The herring fishery (see p. 317) is responsible for the greatest seasonal movement. From the end of June until the beginning of September the fishing fleet is concentrated off the northern shores. Thousands of men and women move into the fishing ports to prepare the fish for export and to work in the herring factories; communal dwelling houses have been built in these ports to accommodate the large influx of temporary workers. In Siglufjörður, Djúpavík and Hesteyri, for example, the population in July is probably three times greater than in December.

Cod fishing (see p. 314) is less seasonal and more widespread than herring fishing. Cod are caught chiefly to the south-west and west of the island from January to May, to the south and south-east in May and June, and off the north coast from September to January. Both ship and factory workers move round the coast to find employment in the most lucrative areas.

Hay making (see p. 292) provides temporary employment for about ten weeks in the year, starting in late June or mid-July, according to locality. The labour supply comes chiefly from the nearest urban centres. The problem of finding sufficient labour is becoming more acute, especially in the north, where the hay harvest coincides with the most profitable period in the herring season. Higher wages are offered in the factories than on the land, and the younger generation finds the town work more congenial.

Distribution of People by Occupation

An analysis of the principal occupations (Fig. 84) brings out the slight decline in the number of people dependent upon agriculture. On the other hand, farming has become a full-time occupation, and the loss in man-power has been largely due to a reduction in the

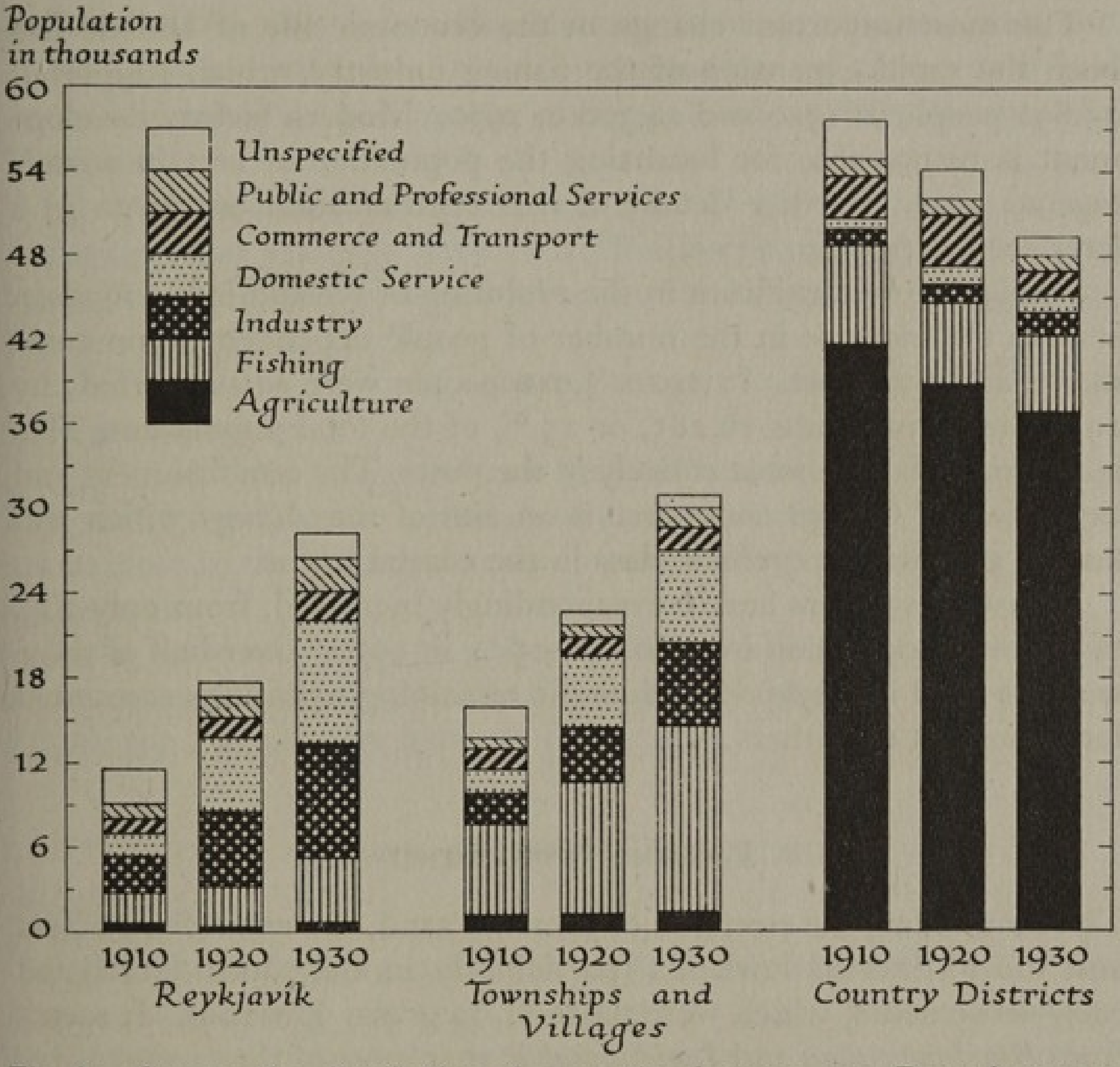


Fig. 84. Comparative distribution of occupational groups on 1 December 1910, 1920 and 1930. The sum of the columns for each individual year represents the total population of the country in that year. Sources: (1) *Manntal á Íslandi*, 1910 (Reykjavík, 1913). (2) *Hagskýrslur Íslands*, Nos. 46b and 92 (Reykjavík, 1926 and 1937).

numbers of part-time workers. From 1910 to 1930 there was a slight increase in the number of peasant proprietors, but during the same period the number of farm labourers and their dependents fell by over 5,000. There was also a marked fall in the number of young women employed in domestic work on the farms. A satisfactory man-to-land ratio has been reached, in that there is no poverty arising from agricultural over-population. Even the best land is but thinly peopled, and farms are very much richer to-day than at any time in the past. The Danish trade restrictions and the difficulties of securing a living in the more infertile regions were sufficient to initiate a large emigration. Within recent years the tendency has been for individuals to move into the coastal towns, whereas in the past it was usual for a whole family to leave for America.

The most important change in the economic life of Iceland has been the rapid expansion of the fishing industry, which supported 15,890 people in 1910 and 24,300 in 1930. Modern factory development is responsible for localizing the population at certain advantageous sites. Further details of this centralization are given in a later section (see pp. 237–9).

Perhaps more significant in the evolution of Iceland into a modern state is the increase in the number of people dependent upon commerce and transport. In 1910, 3,940 people were so supported; by 1930 the number was 16,285, or 15 % of the total population. This increase has been almost entirely in the ports. The establishment and expansion of foreign commerce is an aim of the *Alþingi* which will lead to a growing merchant class in the coastal towns.

Industrial workers have correspondingly increased, from only 2 % of the total population in 1880 to 14·5 % in 1930. Over half of these workers lived in Reykjavík, while the remaining townships accounted for almost all the others.

Farming Settlements

The mountains, the stretches of lava and sand, the extensive glaciers and the ill-drained lowlands (particularly in the south), restricted early settlements, which were pastoral, to grassy lowlands. It seems from *Sturlunga saga* and *Landnámabók* that most of the farms to-day are on the same sites as those built during the ninth and tenth centuries. The farms are usually widely separated, and it is rare to find more than two or three standing together. The effects of this isolation are frequent intermarriages, long-continued tenancy by one family, and the retention of old traditions.

Near the farm buildings there is a small patch of arable land and some improved pasture, while the rest is poor grazing land. Farmers whose holdings are near the sea find a supplementary means of subsistence in fishing. This mode of life resembles the Scottish crofting system.

The lowlands on which the farms are located are of five main types:

(1) The broad coastal pastures of the south-west, where there has been most settlement and where the distribution is fairly even. Some of these farms were built near hot springs; all are close to streams.

(2) The narrow stretches of flat or gently shelving shoreland. Farms built on raised beaches are common in the north-west peninsula and on the east coast. Usually they have a southerly aspect and are close to a small stream. Linear development of this type is best seen in Eyjafjörður and on the eastern shores of Skagafjörður and Húnaflói.

(3) The landward and sheltered side of storm-beaches, where deposition and drainage have converted lagoons into good pasture-land. The best examples are at the head of Húnafjörður, Skagafjörður, Skjálfandi and Axarfjörður.

(4) The heads of fjords, where there are extensive alluvial flats with good pasture.

(5) Broad river valleys, above the level of the flood-plain. Both here and on the narrow stretches of lowland around the coast, farms are as close to the cliffs and scree slopes as safety from falling stones will permit.

Perhaps the only examples of early industrial settlement are in the north and north-west, where local woods and bog-iron ore provided a basis for a small iron industry (see p. 68).

Growth of Urban Settlements

Trading Centres

Although the farming community was largely self-sufficient, many necessities had to be imported, and small trading stations (*verslunarstaðir*) grew up to meet the needs of the people. They were situated in central positions on the wider stretches of coastal lowland, usually where ships could find sheltered anchorage. There were no roads to the markets and farmers travelled either by boat or by pony. The difficulty of communication restricted the area which could be served and kept the size of the trading stations small. Economic difficulties imposed further limits on the growth of these stations. Until 1854 trading monopolies were held by foreign merchants who charged highly for their goods, despite the low purchasing power of the Icelanders, who had but a meagre surplus of farm produce with which to barter.

Four main factors have led to the rapid growth of the trading stations:

(1) The removal of trade monopolies.

(2) The development of co-operative societies.

(3) The building of roads and the use of motor transport, which have enlarged the area served by each market.

(4) The development of the fisheries, which greatly increased the purchasing power of the people; increasing specialization in this occupation made the people more dependent upon the trading stations for the ordinary necessities of life.

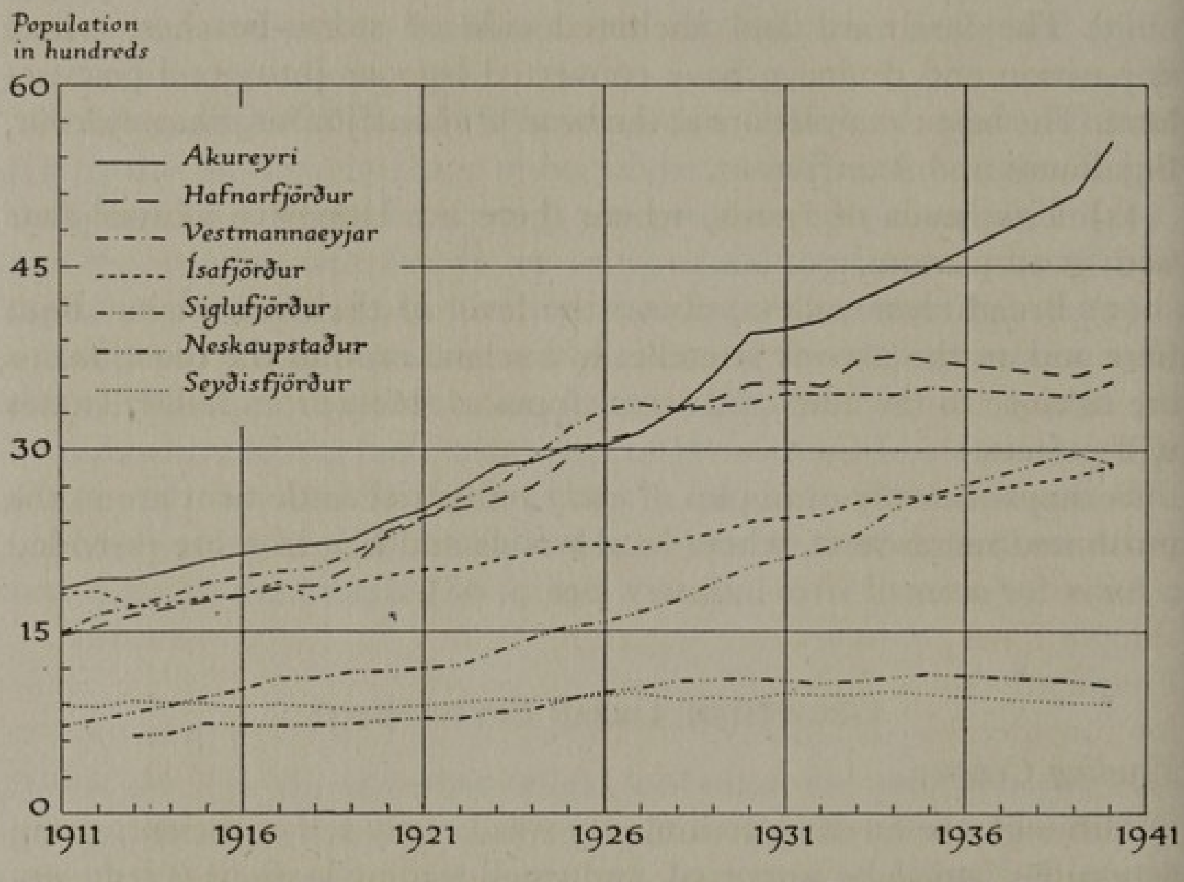


Fig. 85. Growth of Townships (*kaupstaðir*), 1911–40. Sources: (1) *Mannfjölda-skýrslur, Hagskýrslur Íslands*, Nos. 24, 56, 57, 77 and 99 (Reykjavík, 1921–38). (2) *Hagtíðindi*, pp. 22–3 (Reykjavík, 1941).

Akureyri is perhaps the best example of an urban centre which has grown up largely because of its flourishing co-operative society, founded more than fifty years ago. On the south-west coast, Borgarnes and Akranes are commercial centres which became important only with the increasing use of motor transport. Both are easily accessible by sea from Reykjavík and have good road connexions to the inland farms.

Fishing Centres

Urban development is so closely linked with the specialization and increasing importance of the fishing industry that it is difficult to distinguish between cause and effect. The building of factories and the improvements in shore facilities at favourable points tended to localize the landing of fish. The increasing catches in turn demanded further factories and more workers. Of the many factors which have determined the concentration of population at particular places, the most important have been nearness to the fishing grounds, safe anchorage, and a sufficient breadth of flat coastal land on which to build. So strong are these factors that the community of Heimaey in Vestmannaeyjar has grown up on a small island where rain, collected in tanks, provides the only water supply. The population of this township has increased from 607 in 1901 to 3,579 in 1940.

While the main feature of the last forty years has been a concentration of the fishing population into a few centres, the latest phase shows a slight tendency towards dispersal. The development of road transport now makes it possible to land fish at jetties lying close to the fishing banks. The catch is then taken overland to be dealt with in the factories of the nearest town. Subsidiary landing places may thus be expected to grow up at road termini. Thus fishing vessels put in at Suðureyri and their catch is taken by road to Ísafjörður.

'*Eyri*' *Towns*. Within many fjords low flat tongues of sand and shingle form promontories extending from a narrow low foreshore. Frequently these spits (Icel. *eyri*; pl. *eyrar*) are the only flat areas for considerable distances along the coast, and therefore provide the only possible sites for settlement. Some are delta flats, as at Siglufjörður, where the sides facing up-fjord have been moulded by current action and small lagoons have been enclosed. Many, however, are not deltas, but have been built up of material drifted up the fjords by long-shore currents. They may project at right angles to the shore, as at Ísafjörður, or incline towards the fjord head, as at Flateyri in Onundarfjörður. Nearly all are incurved at their ends. Some of these spits, for example Hjalteyri in Eyjafjörður and Vatneyri in Patreksfjörður, contain fair-sized lagoons bounded seawards by a narrow bar, with a broader area of deposit on the opposite side. Probably the growth stages were those of a narrow bar, which then recurved towards the fjord head, finally to rejoin the shore and enclose the lagoon; subsequent deposition on this lee side has broadened the flat.

The chief fishing ports of the north coast and of the north-west peninsula have grown up on these sand spits. Existing for the one purpose of preparing fish and fish products for export, they have no pleasing features. The overriding geographical factor in their development has been nearness to the fishing grounds. Siglufjörður, for example, with a population of 2,883 in 1940, but with probably more than three times this number of temporary summer workers, is one of the greatest herring centres in the world. Yet it still lacks road connexion with the rest of Iceland. The available area of flat land

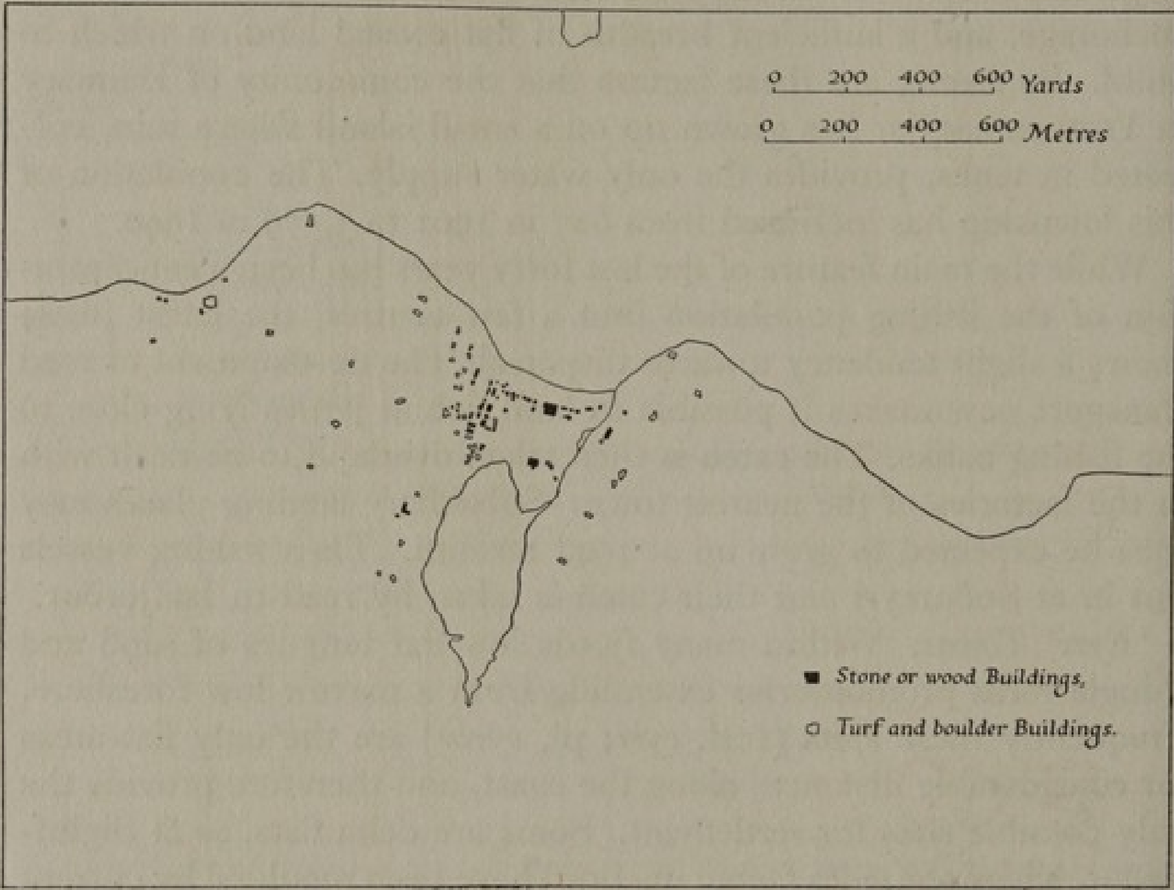


Fig. 86. Reykjavík in 1801. Source: P. E. K. Kålund, *Bidrag til en historisk-topografisk Beskrivelse og Island*, Bd. 1, p. 13 (Copenhagen, 1877).

on which to build is so limited that the town has a compactness which contrasts strongly with the straggling linear development of the townships of Seyðisfjörður and Neskaupstaður on the east coast. Ísafjörður, in the extreme north-west of the country, is an important cod-fishing centre with shrimp canning and cod-liver oil factories. The precipitous nature of the fjord coast has left no room for expansion on the mainland, and the density of population on the sand spit (570 to the sq.km.) is greater than for any other place in Iceland.

The quays and jetties of the smaller *eyri* towns are most frequently built on the up-fjord waterfront, where the best shelter and deepest waters are to be found. In the later stages of urban growth the town

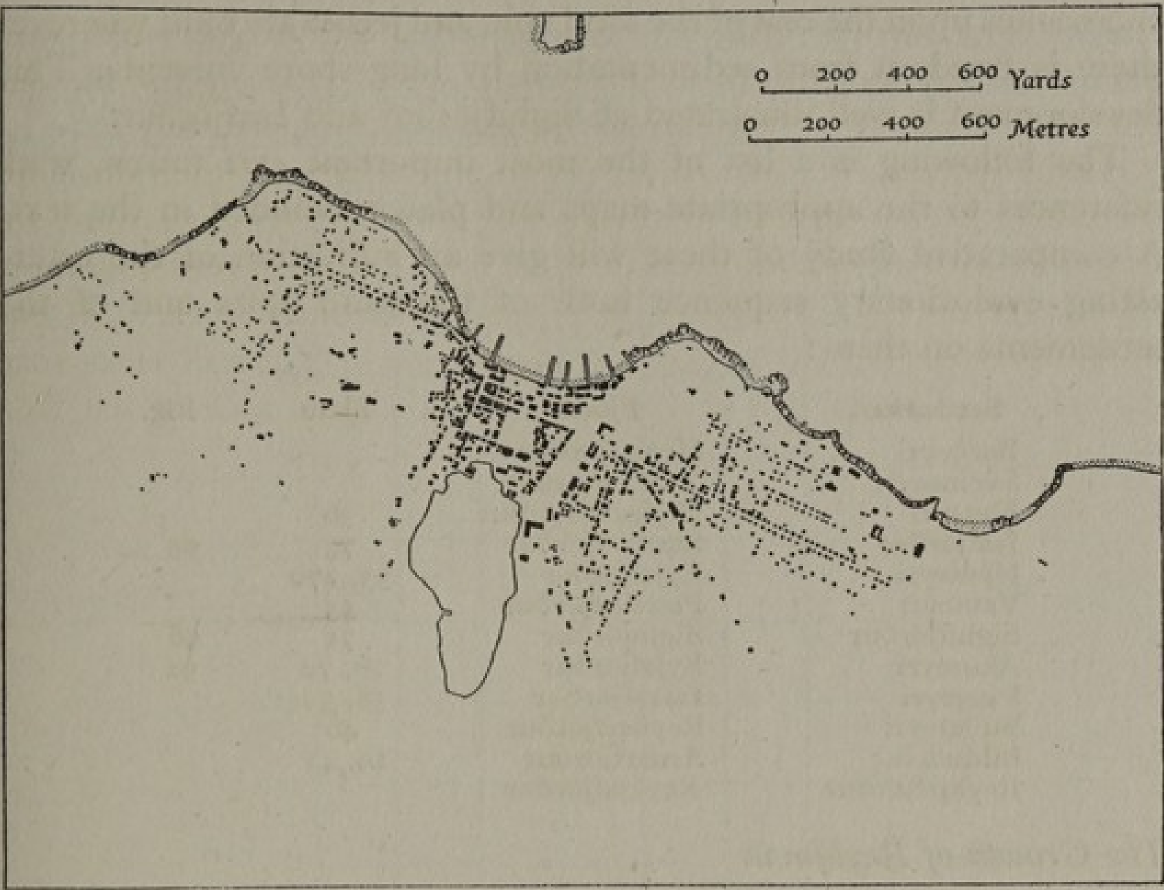


Fig. 87. Reykjavík in 1902. Based on *Islandske Specialkart, Reykjavík*, 1 : 5,000 (Copenhagen, 1903).

Fig. 88. Reykjavík in 1940. Based on 1 : 5,000 map (G.S.G.S. No. 4190), and corrected from air photographs. See Plate 67.

encroaches upon the rest of the sand spit, and jetties are built wherever there is freedom from sedimentation by long-shore currents. This development is well illustrated at Siglufjörður and Ísafjörður.

The following is a list of the most important *eyri* towns, with references to the appropriate maps and plates included in the text. A comparative study of these will give an indication of the interesting evolutionary sequence both of the sand spits and of the settlements on them:

Settlement	Fjord	Plate	Fig.
Borðeyri	Hrútafjörður		
Sveinseyri	Tálknafjörður		
Flateyri	Önundarfjörður	36	
Ísafjörður	Skutilsfjörður	73	95
Hjalteyri	Eyjafjörður	33, 270	
Vatneyri	Patreksfjörður	35	
Siglufjörður	Siglujörður	71	96
Akureyri	Eyjafjörður	70, 72	92
Þingeyri	Dýrafjörður	38, 39	
Búðareyri	Reyðarfjörður	46	
Bíldudalur	Arnarfjörður	19, 41	
Reykjafjörður	Reykjafjörður		

The Growth of Reykjavík

The capital stands on the southern shores of Faxaflói, where a low peninsula of irregular outline and a small group of islands gave slight natural protection for a harbour (Plate 68 and Fig. 91).

Reykjavík owes its rapid development to several natural advantages. Perhaps the most important is its closeness to the best cod-fishing banks and to the most fertile agricultural region in Iceland. It is also the first port of call on the west coast for all ships coming from abroad and has become the chief collecting and distributing centre for the whole island.

In 1874, when King Christian IX landed in Reykjavík, the settlement consisted merely of a few fishermen's huts built around a small church. By 1910 the population had increased to 11,600, but there was still only a small wooden jetty and the streets were unpaved. Stone breakwaters, enclosing the harbour, were built in 1913–17, and more than half of the total Icelandic trade now passes through the port. To-day the town is slightly smaller than Scarborough, yet it has 31·4 % of the total population of the country. The growth of Reykjavík is clearly shown in the three maps (Figs. 86–88) and in the population curve (Fig. 89).

The plan of the town shows a feature which is common to other *kaupstaðir*. The haphazard arrangement of the oldest buildings near the waterfront contrasts with the more careful planning of the suburbs.

Thus it is only in the newer parts of the town that the streets have a clearly defined rectangular pattern, a feature which is most clearly seen in the southern outskirts of Reykjavík.

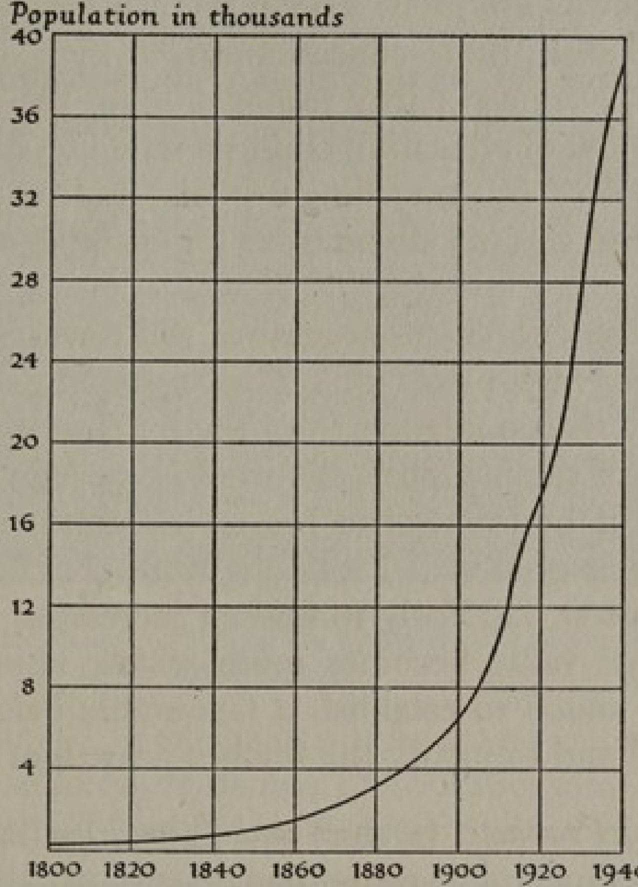


Fig. 89. The increase of the population of Reykjavík, 1800–1940. Sources: *Manntal á Íslandi* (Reykjavík, 1913), and *Hagskýrslur Íslands*, No. 46 and No. 92 (Reykjavík, 1926 and 1937).

Conclusion

Fortunately for Iceland, the increase in population has been accompanied by expanding trade, better social conditions and a rising standard of living. The island and the seas around it could well support more people without any lowering of standards. Despite rural depopulation, first by emigration and now by townward drift of the younger generation, the value of the farm holding has increased considerably. Yet full use of the land has not been made. Dairy farming could be more fully developed in the broad lowlands of the south-west, where there is an immediate market in the growing urban centres. The use of hot springs could help to counterbalance the adverse climatic conditions, and the production of fruit and vegetables is likely to increase. More pastureland could be improved, but man-power as well as the greater use of agricultural machinery is necessary for such development.

The *Alþingi* has adopted various measures to keep the people on the land. Cheap loans are made available for agricultural development; farmers are subsidized in the sale of exported farm produce, while prices in towns are high; machinery can be obtained through co-operative societies. State education, given by schools built only in urban centres, has been partly responsible for the movement into towns. The problem of educating children who live in isolated farmsteads is being solved by 'travelling schools' and by the building of boarding schools in country districts, as for example at Reykholt and Laugarvatn.

In spite of these efforts the growth of the towns shows no signs of slackening. The high prices offered for fish and fish products will continue to draw the population from the farm to the fishing town. At present most of the fish oil is exported in a crude state, but with the further use of hydro-electric power, refineries may be set up close to the fishing grounds. Liver oils from cod and redfish, rich in vitamins A and D, are likely to find an increasing foreign market as their medicinal value becomes more widely known. These industries may do much to establish a favourable balance of foreign trade for Iceland and to justify the further growth of urban centres.

Population of Provinces (sýslur) *and Townships* (kaupstaðir), 1801–1940.

Date of census ...	1 Feb.	1 Oct.	1 Nov.	1 Dec.	1 Dec.	2 Dec.	2 Dec.
Year of census ...	1801	1860	1901	1910	1920	1930	1940
Reykjavík	307	1,444	6,682	11,600	17,679	28,304	38,094
Hafnarfjörður:	3,698	5,001	5,343	1,547	2,366	3,591	3,707
Gullbringu- and Kjósársýsla				4,448	4,278	5,293	5,582
Borgarfjarðarsýsla	1,877	2,251	2,520	2,561	2,479	2,675	3,208
Mýrasýsla	1,468	2,033	1,696	1,753	1,880	1,764	1,816
Snæfellsnessýsla	3,545	3,499	3,494	3,933	3,889	3,536	3,467
Dalasýsla	1,599	2,237	2,060	2,021	1,854	1,602	1,424
Barðastrandarsýsla	2,487	2,713	3,394	3,381	3,314	3,119	3,019
Ísafjarðarsýsla	3,895	4,860	6,055	6,394	6,327	5,586	5,073
Ísafjörður:			1,220	1,854	1,980	2,533	2,863
Strandasýsla	982	1,677	1,812	1,757	1,776	1,833	2,092
Húnavatnssýsla	2,850	4,676	3,900	4,022	4,273	3,879	3,650
Skagafjarðarsýsla	3,146	4,366	4,436	4,336	4,357	4,012	3,906
Siglufjörður:	3,366	4,647	5,377	5,379	1,159	2,022	2,883
Eyjafjarðarsýsla					5,001	5,176	5,309
Akureyri:			1,370	2,084	2,575	4,198	5,542
Þingeyjarsýsla	3,119	5,497	5,166	5,150	5,535	5,674	5,942
Norður-Múlasýsla	1,695	4,183	3,585	3,014	2,963	2,766	2,608
Seyðisfjörður			841	928	871	936	903
Neskaupstaður:	1,928	3,462	5,046	4,643	5,222	1,118	1,097
Suður-Múlasýsla						4,514	4,300
Austur-Skaftafellssýsla	911	1,291	1,162	1,128	1,158	1,127	1,141
Vestur-Skaftafellssýsla	1,539	2,208	1,944	1,835	1,818	1,723	1,587
Rangárvallasýsla	4,030	5,034	4,366	4,024	3,801	3,505	3,310
Vestmannaeyjar	173	499	607	1,319	2,426	3,393	3,579
Árnessýsla	4,625	5,409	6,394	6,072	5,709	4,982	5,246
Total	47,240	66,987	78,470	85,183	94,690	108,861	121,348

O. Magnússon

Plate 65. The main quay in Reykjavík harbour. Note the 5-ton coal grab on the coal quay in the centre background.

J. H. Reynolds

Plate 66. Typical wooden pier, Stykkishólmur.

R.A.F.

Plate 67. Reykjavík from the west. The lake, Tjörnin, with its villa district, lies about 400 m. south of the harbour (see Figs. 88 and 91 for maps of this area).

Chapter XI

PORTS

Introduction: Major Ports: Minor Ports

INTRODUCTION

Iceland has many good natural anchorages, especially in the fjords of the west, north and east coasts. The south coast has few indentations and no anchorages of any importance. At a number of places round the coast, breakwaters, wooden piers and stone jetties have been built, where small cargo and passenger ships can be accommodated, but other modern facilities for handling cargo are generally lacking. All the harbours are tidal, but there is no wet dock in the country.

Most of Iceland's foreign trade passes through Reykjavík, the chief port in the country. It acts as a distributing and collecting centre and is served by small coastal vessels which ply round the island. Hafnarfjörður, 10 km. south-west of the capital, is available as a relief port when the facilities at Reykjavík are overstrained. The road connexion between the two ports is good; in fact this section of road is almost the only one in Iceland that is suitable for the regular passage of freight trucks.

The commercial towns along the coast have a character of their own. The Icelandic word for them is *verslunarstaðir* (from *versla* = to trade, and *staður* = town). Only eight of these trading places have so far attained the status of *kaupstaðir*, or 'townships' (see p. 215). Plans of these are given in this chapter, in which they are treated as 'Major Ports'.* Most of the other harbours are little more than fishing stations, with a small pier or jetty used for unloading fish and for handling small quantities of imported foodstuffs and other necessities. Such 'harbours' are frequently only landing places, often very exposed to wind and swell. In this chapter they are treated as 'Minor Ports'.

Iceland is so dependent on its maritime activities that many of the ports and harbours which are dealt with in the following pages have a national significance beyond that suggested by their small size.

* In Figs. 91–98 installations erected by the British and American occupying forces have been omitted. All names in italic lettering are Icelandic names; those in Roman lettering are either English descriptive terms or English names in common use by the occupying forces. All depths are Low-Water Springs.

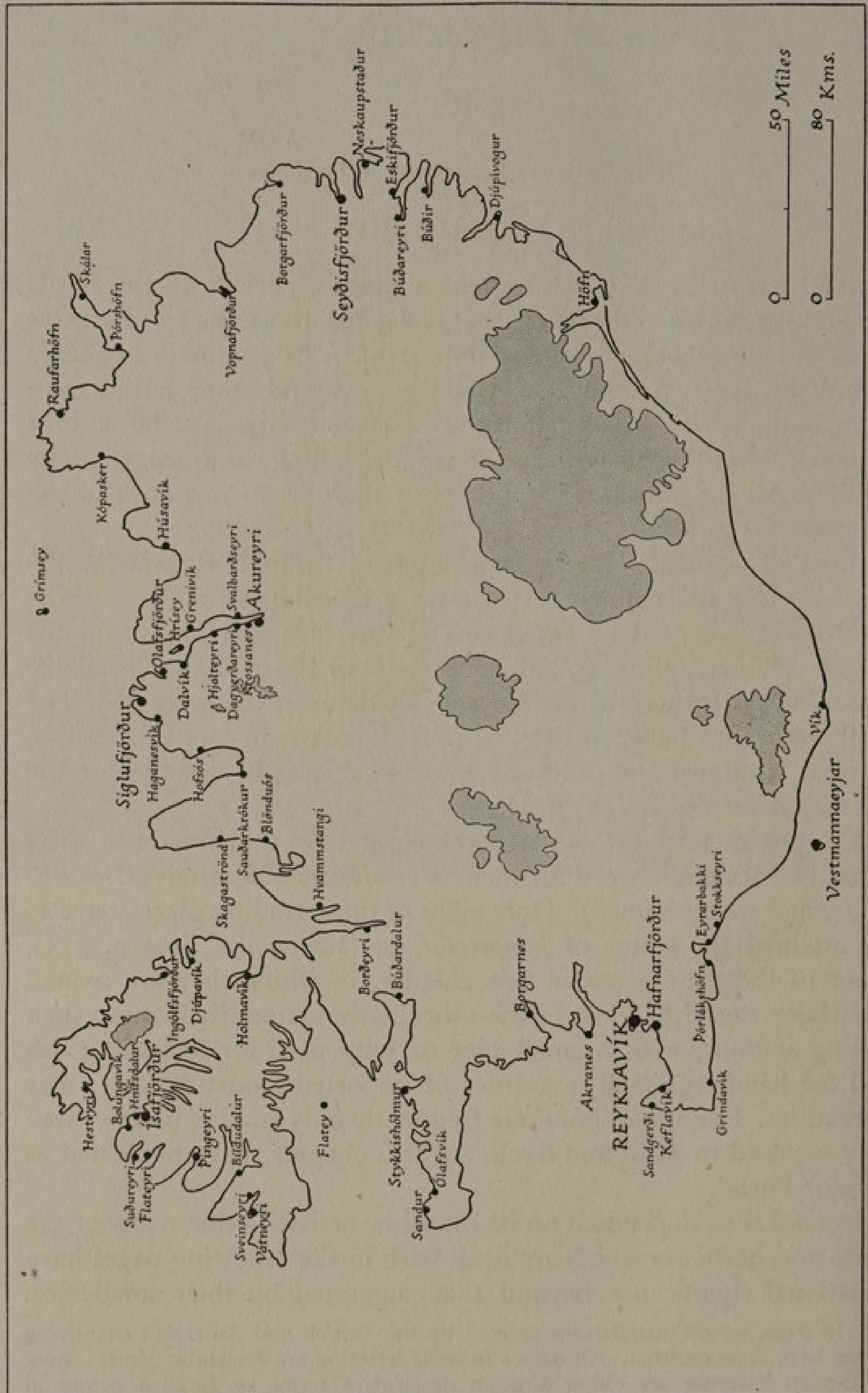
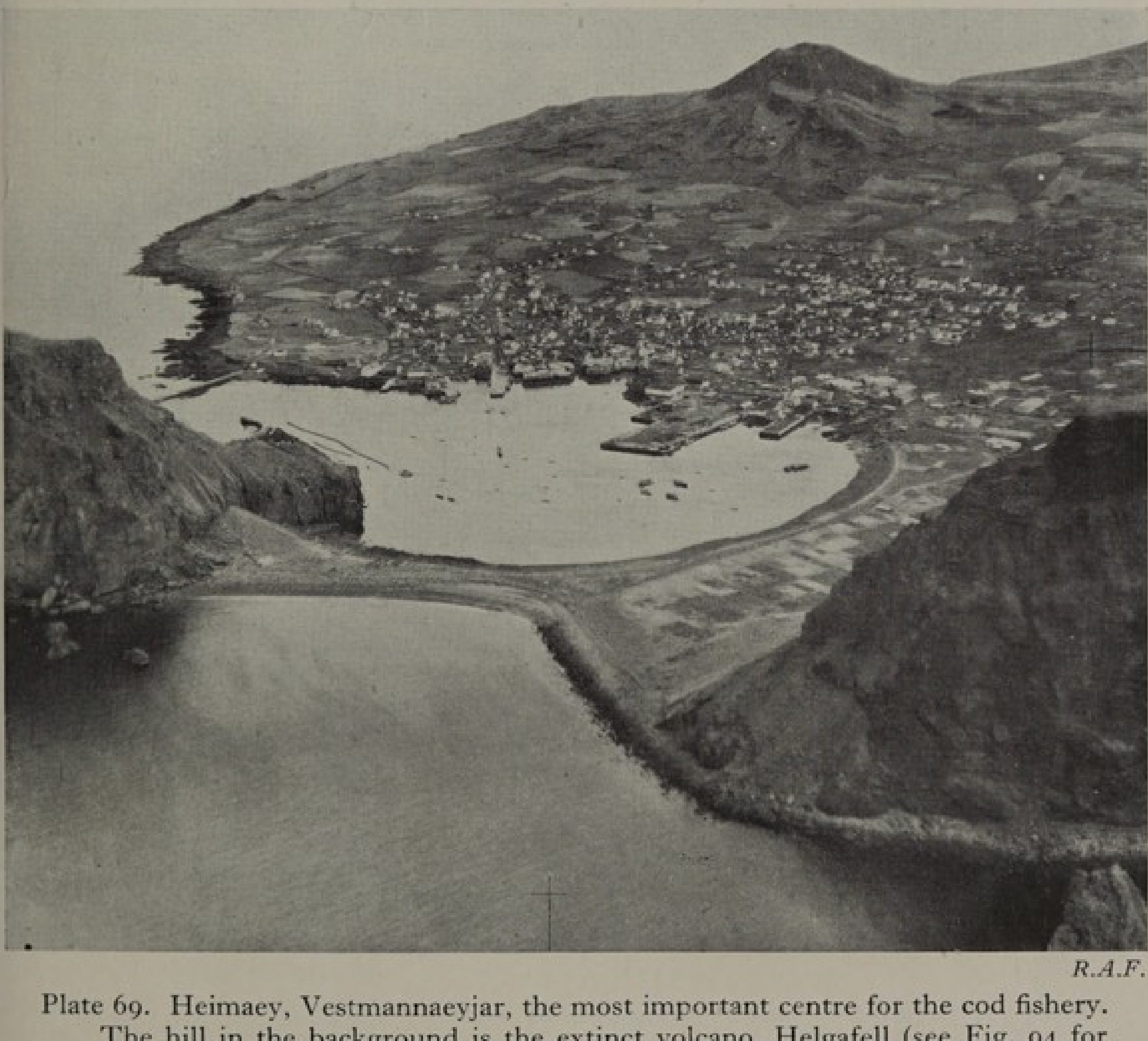


Fig. 90. The Ports of Iceland.

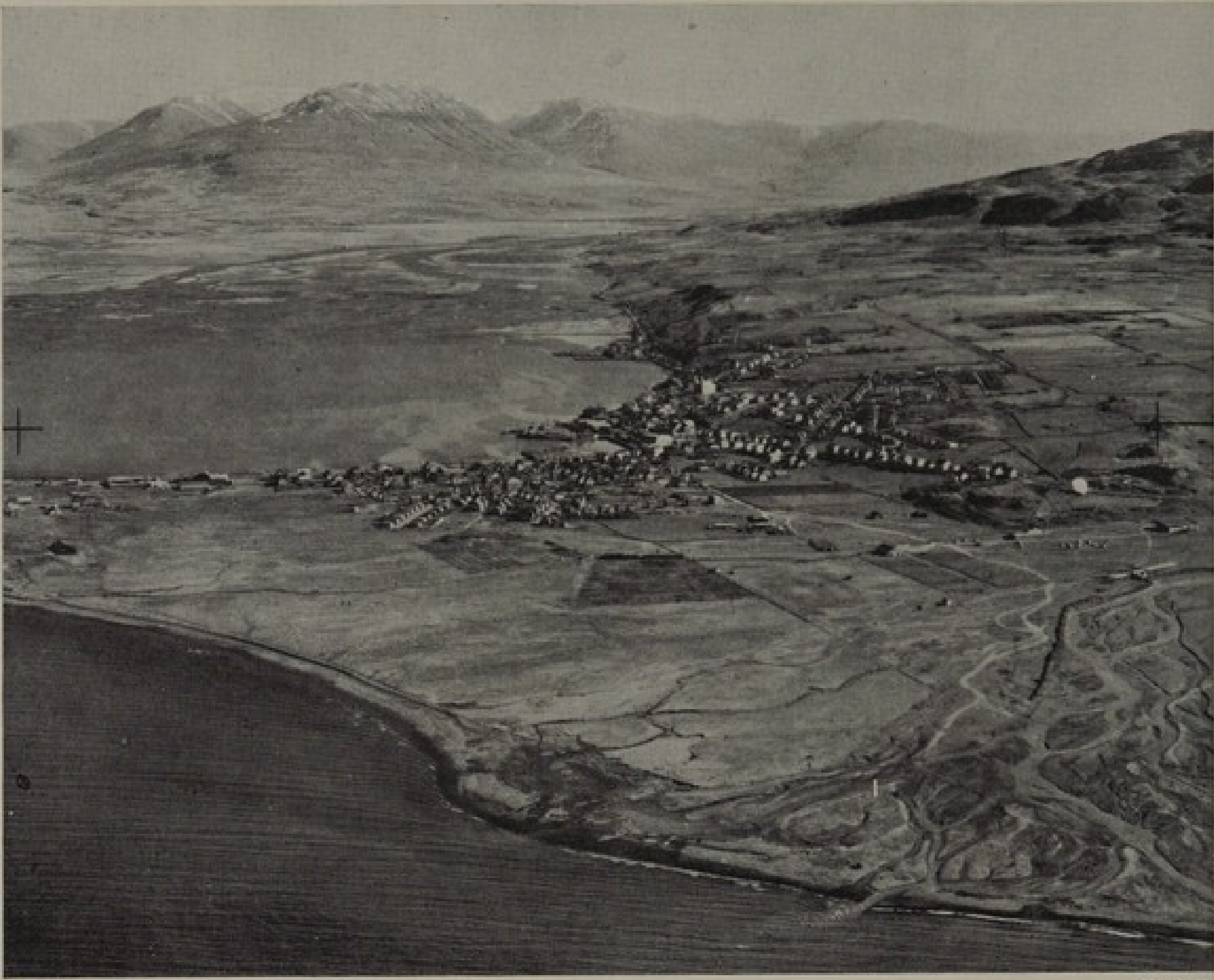
Graf Zeppelin

Plate 68. Reykjavík in 1931, showing the harbour and roadstead. The Esja plateau is in the distance (see Fig. 91 for map).



R.A.F.

Plate 69. Heimaey, Vestmannaeyjar, the most important centre for the cod fishery. The hill in the background is the extinct volcano, Helgafell (see Fig. 94 for map).



R.A.F.

Plate 70. Akureyri, the most important trading centre in the north and second largest town in Iceland (see Fig. 92 for map).

R.A.F.

Plate 71. Siglufjörður, the most important herring-fishing centre (see Fig. 96 for map).

As far as imports and exports are concerned, the comparative volume of foreign trade passing through the largest ports may be seen from the following figures for 1938:

	Imports %	Exports %	Total %
Reykjavík	62·7	53·4	57·7
Siglufjörður	6·5	21·0	14·3
Vestmannaeyjar	3·1	4·7	4·0
Akureyri	7·4	1·0	3·9
Hjalteyri	1·1	3·8	2·6
Ísafjörður	2·3	1·2	1·7
Hafnarfjörður	2·6	0·7	1·6
Djúpavík (Reykjarfjörður)	0·8	1·4	1·1
Other ports	13·5	12·8	13·1
Total	100	100	100

Source: *Verslunarskýrslur*, 1938, p. 28 (Reykjavík, 1940).

The economical and efficient use of coastwise transport is a prime necessity in the development of Icelandic communications. Owing to the large number of short runs on this traffic, and the frequent necessity of working to tides, a rapid turn-round of the small coastal vessels makes just the difference whether a vessel is able to make one or two passages in a given time. At most of the ports, discharging gangs and their gear are not available, and must therefore be carried in the ship. Another outstanding problem is the lack of suitable storage accommodation. Goods are discharged on to the quays or direct into motor trucks for delivery to their destinations. The quays are narrow and no large accumulation either when loading or discharging is possible without blocking the traffic. At present it is the normal custom in most of the ports for a proportion of the discharged goods to be piled at the end of the pier itself, thus slowing down the turn-round of any motor transport used.

Note on Port Names

Many settlements, such as Seyðisfjörður, Ólafsfjörður, Vopnafjörður and Eskifjörður, have acquired the names of the fjords in which they lie. The same name is used without discrimination for both town and fjord. Others are not quite so straightforward. Vatneyri, for example, is the name of the sandspit projecting from the northern shore of Patreksfjörður on which the fishing village is built. The correct name of the settlement is Vatneyri í Patreksfirði to distinguish it from other *vatneyrar* (=lake sandspits), but it is usually referred to either as Vatneyri or Patreksfjörður. The former is more commonly used by the English and the latter by the Icelanders. A similar use of alternative names is also found in many other places, e.g. Búðir or Fáskrúðsfjörður, Búðareyri or Reyðarfjörður, Suðureyri or Tálknafjörður, Suðureyri or Súgandafjörður. The last two illustrate the confusion which may arise in some cases if only the settlement name is given without adding the fjord name. Occasionally doubt may also arise if only the fjord name is given. There are, for example, two fjords on the east coast of the north-west peninsula called Reykjarfjörður.

It is especially the towns built on sandspits (see p. 239) which provide these place-name difficulties. In Siglufjörður a town has been built on a sandspit called Hvanneyri or Siglufjarðareyri. The harbour is called Siglufjarðarhöfn and the town Siglufjarðarkaupstaður. Any of these names may be used, according to the shade of meaning required, but the place is most commonly known simply as Siglufjörður. Another curious case is Ísafjörður, since it is the most notable example of a sandspit town; yet, not only is the fact not indicated in the name, but Ísafjörður (the fjord) is over 30 km. away, the town of Ísafjörður being situated in Skutilsfjörður.

Technical Terms

Many terms used in port descriptions are not clearly enough defined for precise use. In order to clarify the text, the following terms are used only in the senses indicated:

Breakwater: a solid mass of rubble, masonry or concrete, which protects a harbour or anchorage from heavy seas, and alongside which ships cannot lie.

Pier: an open structure, built of wood, iron or reinforced concrete, projecting from the shore. Ships can normally lie alongside or across the head.

Jetty: a solid structure, but otherwise similar in function to a pier. In many small ports the jetty also serves as a small breakwater enclosing the harbour and is quayed on the inner side.

Sloping Jetty: as above, but with a sloping surface leading down to the lowest water level. Sloping jetties afford access to small craft at all stages of the tide, and facilitate the withdrawal of rowing boats from the water.

Quay: a paved space or area devoted to loading or unloading cargo and usually bounded at the water's edge by a wall or wharf so that ships can lie alongside.

Wharf: an openwork structure of piling and framing with a platform, forming the frontage of a water embankment.

Slipway: a prepared surface sloping down into the water, used either for hauling up vessels for repair or for launching newly built vessels.

All the depths mentioned in the text are Low-Water Springs. It must be clearly stated that with few exceptions the duration and degree of accuracy of the tidal observations are not known, and that the depths therefore do not necessarily represent the mean of a series of observations. Measurements of breakwaters, piers, etc., are also only approximate; they are based on conflicting reports, maps and air photographs. Unless otherwise stated, all population figures in this chapter are from the 1940 census.

Note on Tides

The tidal wave from the Atlantic reaches Iceland at the south coast, and then moves clockwise round the island. The average movement of this wave is such that for every hour high water is experienced 80 miles farther along the coast. At new and full moon (spring tides) the crest of the wave, or high water, reaches the south coast about $4\frac{1}{2}$ hr. after the meridional passage. It passes Reykjanes at about $5\frac{1}{2}$ hr., Breiðifjörður at about $6\frac{1}{2}$ hr., Horn at about 8 hr., the middle of the north coast at about $9\frac{1}{2}$ hr., Langanes at about $11\frac{1}{2}$ hr., and Dálatangi at about $12\frac{1}{2}$ hr. From here the velocity of the tidal wave decreases considerably. Berufjörður is passed at about $2\frac{3}{4}$ hr. and Vesturhorn at about $5\frac{1}{2}$ hr. At the islands off this part of the coast, high water is from 1 to 2 hr. later than in the fjords. It is high water at Vesturhorn at about the same time as at Reykjavík, presumably on account of the direct tidal wave from the Atlantic, which is also the cause of the slower advance of the crest of the tidal wave along the east coast as compared with that on the other coasts.

Low tide occurs almost everywhere about $6\frac{1}{4}$ hr. after high tide, though off the south-east coast a secondary low tide occurs simultaneously with the low tide at Reykjavík and the high tide at Langanes.

The tidal streams in the fjords and on the coast turn at about the times of high and low water. At sea, however, they change at different times off different parts of the island. The tidal streams are of considerable strength and are generally much stronger than the drift of water round Iceland, described on p. 88. The tidal streams on the coast and in the offing run sometimes in the same, and sometimes in opposite directions. An exact knowledge of local circumstances arising from the resultant of tidal streams and ocean currents plays an important part in the navigation of these waters. Off promontories and in narrow channels the spring tide stream may reach a velocity of 5–7 knots, but in open coastal waters it seldom exceeds 3 knots.

The range of the tide is largest on the south-west coast and decreases towards the north and east. The range of the spring tide amounts to about $14\frac{1}{2}$ ft. at Reykjavík, about 8–$11\frac{1}{2}$ ft. in the north-west fjords, about 5 ft. in the fjords of the north and east coasts, and about 9 ft. at Vestmanneyjar.

MAJOR PORTS

REYKJAVÍK (Fig. 91; Plates 65, 67 and 68). Admiralty Chart 3201. Lat. 64° 09′ N, long. 21° 57′ W. Population: 38,094.

Reykjavík lies on the northern shore of Seltjarnarnes, a lowlying peninsula which extends north-westwards into Faxaflói. More than half of the total exports and imports of Iceland pass through it and it is the only port of any note in the country. Yet vessels of over 1,500 tons cannot enter the harbour and must anchor in the roadstead outside.*

Seaward approach is made difficult by numerous small islands and reefs which lie to the north of the peninsula. Entrance is made either between the islands of Akurey and Engey, or between Engey and Viðey. The best anchorage for large vessels is between Engey and the harbour, where the roadstead has a depth of over 6 fm. with a sand and mud bottom. Better shelter from the autumn gales can be found in water of from 6 to $6\frac{1}{2}$ fm. off the east and west coasts of Engey. The roadstead provides adequate accommodation for a cruiser squadron and four or five capital ships.

The harbour lies between Örfirisey and the mainland. Stone breakwaters were built in 1913–17 and enclose a water area of about 45 ha. The western breakwater, Grandagarður, is approximately 750 m. long and forms an isthmus to Örfirisey. Protection is given on the east side of the harbour by two separate breakwaters, Norðurgarður and Austurgarður. Between them is an entrance 100 m. (330 ft.) in width, with a depth of 33 ft. at M.H.W.S. and 19 ft. at M.L.W.S. Ships drawing more than 16 ft. cannot enter the harbour with safety. Their cargo must be discharged on to lighters or rafts, but this is not possible in rough weather.

* In cases of necessity, however, during the Anglo-American occupation, ships of 5000 tons have been berthed at the 'Main' and 'Baldur' Quays. They rest on the bottom at low tide.

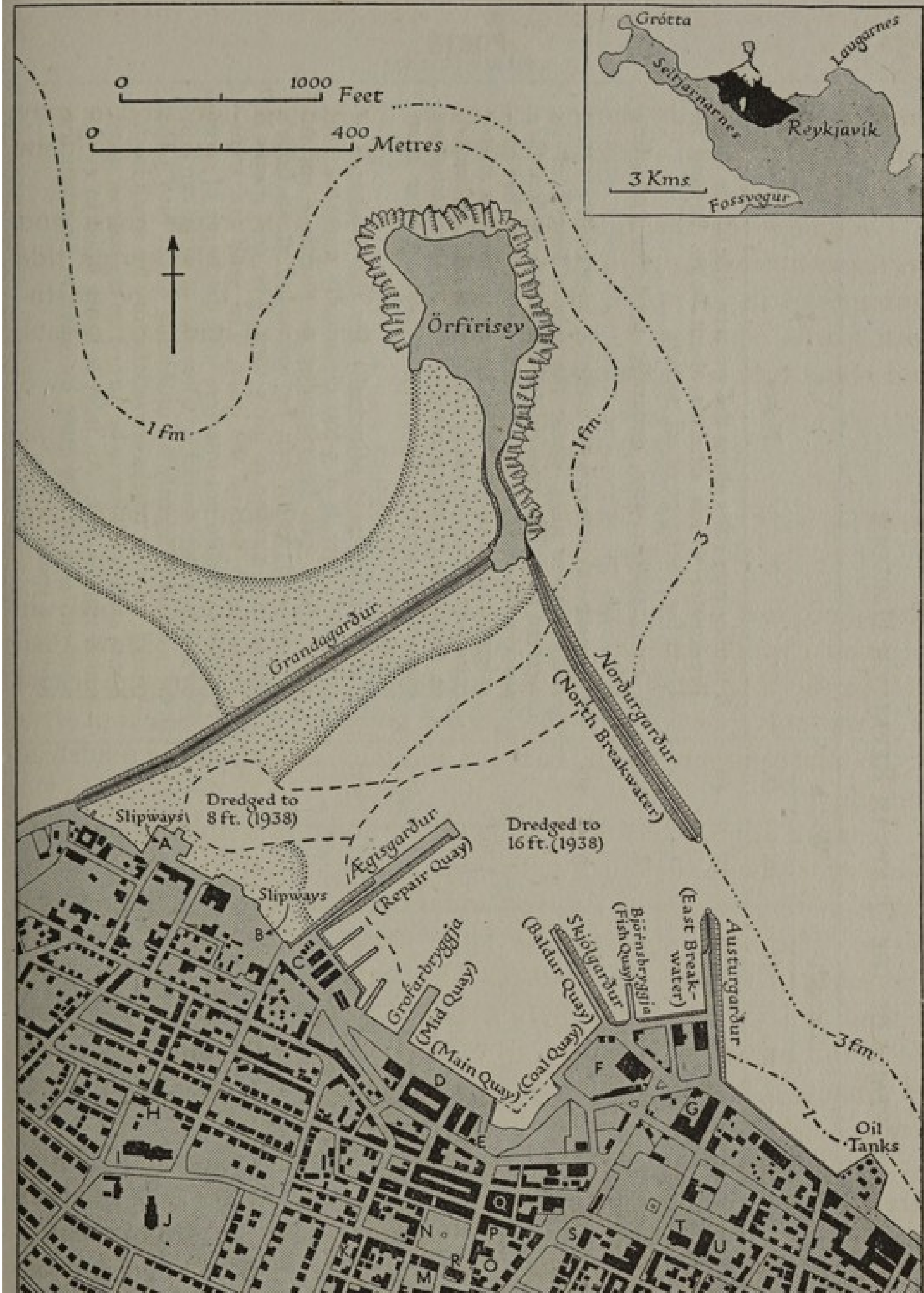


Fig. 91. Reykjavík harbour, 1941. (Names in use by the British occupying forces are given in brackets.) Source: Icelandic surveys corrected from air photographs, 1941. Depths from Admiralty Chart 3201. *A*, Slipways for small fishing boats. *B*, Slipways and Repair Yard (Patent Slipway Co. Ltd.). *C*, Engineering works (Messrs Hamar Ltd.). *D*, Harbour offices. *E*, United Steam Ship Co. *F*, Coal grab and dump. *G*, Ice factory. *H*, Navigation School. *I*, Hospital. *J*, Cathedral. *K*, Salvation Army and Seamen's Home. *L*, Fire Station. *M*, Parliament Buildings. *N*, Telegraph and Telephone Office. *O*, Hotel Borg. *P*, Town Hall Offices. *Q*, Police Station. *R*, Church. *S*, Chamber of Deputies. *T*, National Museum. *U*, National Theatre.

Details of the Quays in Reykjavík Harbour

Icelandic name	Other names	Length m.	Length ft.	Width m.	Width ft.	Notes
Austurgarður	'East Breakwater' Ingolfsgarður 'Batteri Mole'	85	280	12	40	A timber pier runs along the western side of the stone breakwater which extends about 60 m. beyond it. Used for discharge of oil tankers
Björnsbryggja	'Fish Quay' 'Trawler Quay'	52	170	8	26	A small timber pier, generally used for unloading fish
Skjólgarður	'Faxagarður' 'Baldur Quay' 'North Quay'	159	520	9	28	A stone breakwater, with a timber pier built on steel and wooden piles along the whole length of its western side. The east side of the pier is backed by a stone wall, and the pier itself is so narrow that considerable difficulty is experienced in turning motor transport. Cargo must be removed as it is discharged, or complete blockage results. The timber structure cannot be trusted to carry weights greater than about 1 cwt./sq. ft.
?	'Coal Quay'	116	380	11	35	A stone quay used principally for the discharge of colliers. There is a 5-ton electrically operated coal grab which can be extended to plumb a second bottom and which can be converted at an hour's notice into a crane to lift 5 tons. The coal dump is immediately behind the quay. The grab and transporter works do not interfere with discharge of cargo by a ship's own derricks. Clearance of cargo can only be worked efficiently by unloading direct into 3-ton trucks; 30-cwt. trucks are satisfactory for small loads, but as each truck has to be turned on the narrow quay, much time is lost. An inlet is being filled in at the southern end of the quay in order to lengthen the berthing space

?	'Main Quay'	159	520	12	40	Stone quay alongside street. There is adequate space for sorting cargo and some warehouse accommodation across the street
Grofarbryggja	'Mid Quay'	92	300	20	65	Strongly built of stone, concrete and earth in iron shuttering, this jetty serves as the main discharging place in the port. Ships can discharge on both sides and there is also room for a small vessel to berth across the end. The jetty is so narrow that no large accumulation of cargo is possible without blocking the traffic
?	'Sloping Jetties'	56	185	6	20	Between Grofarbryggja and Ægisgarður there are three small sloping wooden jetties each of about the same dimensions. They are suitable for berthing only very small craft such as motor boats
Ægisgarður	'Repair Quay' 'Fish Quay'	145	475	18	58	Stone quay situated at the end of a narrow causeway about 120 m. long. Both sides of the causeway and the east side of the quay have sloping faces against which a ship cannot be berthed. A small vessel can berth across the end of the quay; larger ones along the west side. It is suitable for fish traffic, but not for cargo. The road approach is very narrow

In 1938 the greater part of the harbour was dredged to a uniform depth of 16 ft. at M.L.W.S., while a smaller area in the western part of the harbour was dredged to 8 ft. The sand and mud obtained from deepening operations is used for reclamation work. The depth alongside all quays is 16 ft. at M.L.W.S., but there is a rise to 30 ft. at M.H.W.S., when the quay surfaces are only about 2½ ft. above water level. The range of neap tides is 7½ ft. The soft mud bottom gives good holding ground for the large numbers of trawlers, drifters and motor boats which are normally found in the harbour.

Recent extension work in the harbour has been carried out with the aid of hollow reinforced concrete caissons. They are moulded on shore, launched from a slipway, towed into position and sunk. Later they are filled in to form solid foundations.

Since 1917 the length of quayside for the accommodation of ships has been increased from 240 to over 860 m. The table on pp. 252–3 gives details of the various quays in the harbour, working from the entrance to the shallow western area.

All quays are fitted with electric light, and water is laid on. Other harbour facilities are provided by a small and rather decrepit water boat with a capacity of 50 tons, a small harbour tug of 325 h.p. and numerous lighters of several types. Fuel oil can be taken in at Austurgarður or from tank lighters. Coal supplies, usually up to about 7,000 tons, are available from the dump situated behind the 'Coal Quay'.

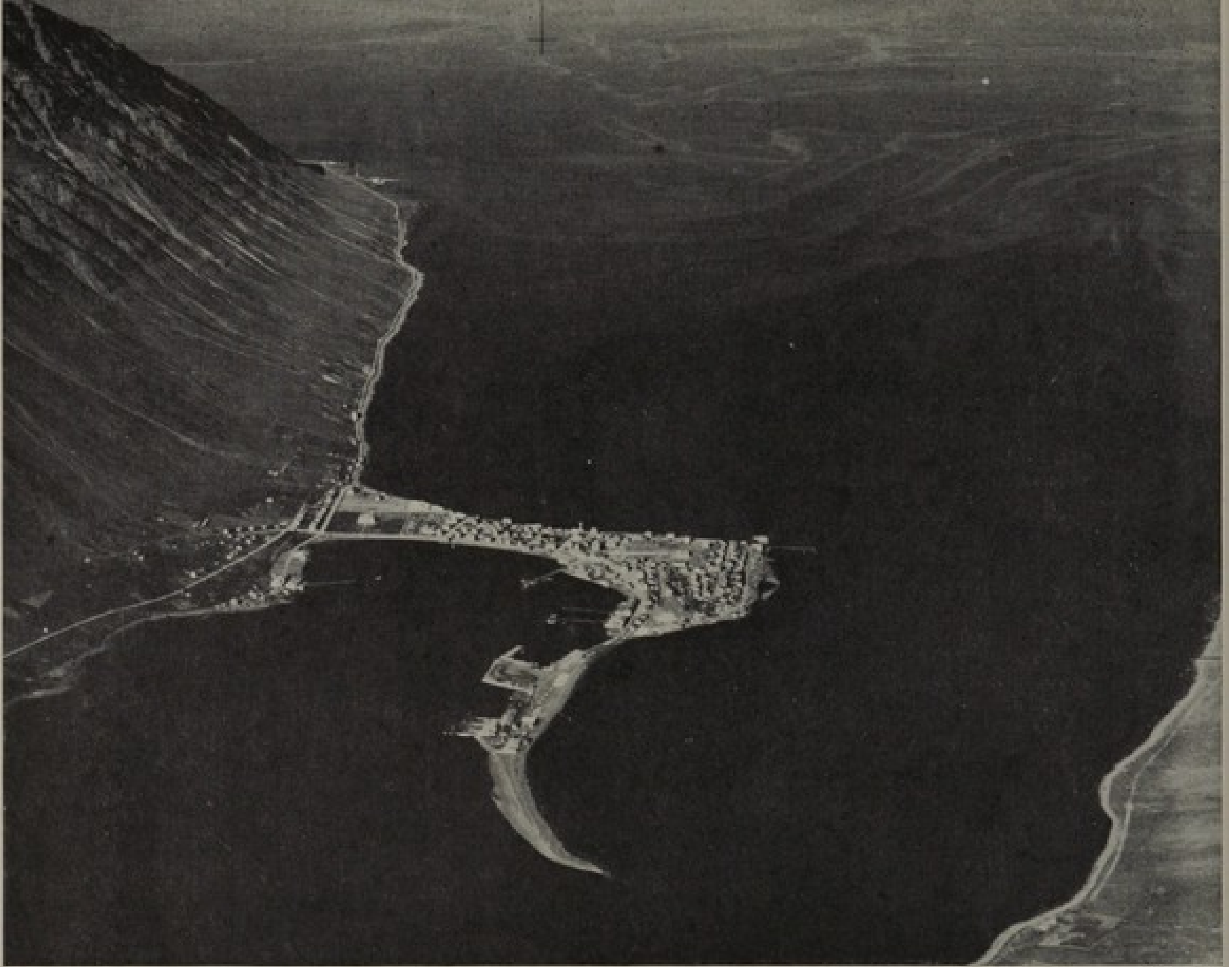
Port Clearance. The electrically operated 5-ton coal grab is the only civil lifting appliance in the port. Except at the 'Coal Quay', vessels must be unloaded with their own derricks. There is scarcely any storage or transit accommodation available on or near the quays, and no covered protection for the discharge of bag cargo in wet weather. In order to overcome these difficulties, the British occupying forces have taken out two mobile cranes (capacity ⅔ and 1 ton). They have also constructed sheds to form a locked storage space of about 16,000 cu. ft. These sheds lie in an enclosed 'transit area' of 2 acres at the eastern end of the 'Main Quay'.

Repair Facilities. There is no dry dock. Three slipways belonging to the Patent Slipway Co. (*Slippfélagið í Reykjavík*) are situated immediately west of Ægisgarður:

	No. 1	No. 2	No. 3
Length of way (m.)	170	141	120
Length of cradle (m.)	58	45	25
Lifting capacity (tons)	1,000	600	150

R.A.F.

Plate 72. Eyjafjörður. The town of Akureyri lies on the sheltered south side of a sandspit near the head of the fjord. The delta at the head of the fjord has advanced considerably in historic times (see Fig. 92 for map).



R.A.F.

Plate 73. Ísafjörður, the largest town in the north-west peninsula, is an important cod-fishing centre built on a recurved sandspit in Skutilsfjörður (see Fig. 95 for map).

R.A.F.

Plate 74. Hafnarfjörður, the third largest township in Iceland, is a cod-fishing centre. There is an excellent road to Reykjavík (see Fig. 94 for map).

Farther west, in the fishing boat harbour, there are additional slipways, suitable only for small fishing vessels. Outside the harbour, vessels up to 1,500 tons may be beached on a sandy bottom on the west side of Örfirisey, where small repairs to the hull can be carried out.

The Patent Slipway Co. is able to deal with most repairs to hulls, boilers and machinery; the air-compressor, oxy-acetylene and electric welding plant possessed by the firm is modern and thoroughly efficient; the machine tools, lathes and planers are old but serviceable. The engineering firm of Messrs Hamar has a good repair shop and can make iron castings up to 25 cwt. and brass castings up to 2 cwt. They are able to undertake forging up to about 6 in. in diameter and 20 cwt. in weight. Steel castings cannot be made. Work is expensive, skilled labour is rather limited, and local stocks of timber, plates, bars, etc., are very meagre.*

The Town. Reykjavík has grown very rapidly since the beginning of this century (see p. 242 and Figs. 86–89). The main part of the town, with its shops and cafés, is near the harbour; a villa district lies round the small lake, Tjörnin, and scattered suburbs now extend across the peninsula to Skerjafjörður and into the surrounding countryside. The lack of local building stone and timber, all of which must be imported from abroad, has limited the architecture to simple forms; the wooden buildings are largely roofed with corrugated iron and are made attractive by the use of brightly coloured paints. They contrast strongly with the more modern constructions of reinforced concrete. Fig. 91 gives the positions of some of the most important buildings in the town.

For road communications see Figs. 121 and 127.

AKUREYRI (Fig. 92; Plates 58, 70 and 72). Admiralty Chart 3001. Lat. 65° 41′ N, long. 18° 06′ W. Population: 5,542.

Akureyri is the most important commercial and trading centre in the north, and next to Reykjavík is the largest town in Iceland. It lies on the sheltered south side of a sandspit near the head of Eyjafjörður, a comparatively narrow fjord some 60 km. long. Both sides of the outer fjord are mountainous, but opposite the island of Hrísey the western shore becomes lower and the hills are separated by wide valleys leading down to the sea.

Polar pack ice sometimes enters Eyjafjörður in the winter, but icebergs become grounded off Oddeyri and never reach the harbour. Otherwise the approach to Akureyri is free from difficulties. The best

* Messrs Hamar have expanded their works considerably since this was written.

anchorage in the outer fjord is found off the south-west point of Hrísey in depths of 11–14 fm.

South of the sandspit, which is called Oddeyri, the fjord is wider and gradually becomes shallower towards the river delta at its head. The area of water between the spit and the delta is called Pollurinn. At the mouth of the river a protective dyke has been built out from the western shore for about 385 m. (1,263 ft.) in order to prevent deposition of sand in the harbour. North of the harbour, protection from waves and swell is given by the sandspit which extends eastwards to within 1 km. of the opposite shore. The northern part of Pollurinn has a depth varying from 10 to 20 fm., and anchorage can be found in all weathers close off the piers on the western shore. In January and February the water south of the 'North Quay' is liable to become frozen to a thickness of 6 in., but a channel is usually kept open so that ships drawing 18 ft. can lie alongside the 'New Pier'.

There are three main quays in the port: the 'North Quay' lies at the south-east corner of Oddeyri, and is more accurately described as a wharf structure of planking on wooden piles in a very poor state of repair. The frontage is about 114 m. (374 ft.) with depths alongside between 13 and 16 ft. The 'Main Quay' is a general name for a stone quay from which two wooden piers extend, partially enclosing a small sheltered harbour, suitable only for vessels up to 100 tons. The stone quay is 116 m. (380 ft.) long and has a depth of 9 ft. alongside. It is backed by a street. The northern arm of this harbour is called the 'Old Pier',* and the sides are made of closely spaced wooden piles. It has been filled in with rock and topped with concrete. There is an outer berthing length of about 73 m. (240 ft.) with depths varying between 14 and 19 ft. The 'New Pier'* (Torfunefsbryggja) forms the southern arm of this small harbour and has a frontage of about 85 m. (279 ft.) with depths alongside of from 14 to 18 ft. Both piers are similar in structure and are in a good state of repair. The 'South Quay' (Innri Hafnar) is made of planking on wooden piles, and although there are depths of 19 ft. alongside, the whole structure is in such poor condition that it is suitable only for discharging small craft. In addition to the facilities given by these quays, there is a new and very shallow rowing boat harbour in the angle made by the sandspit and the mainland. The spring tidal range is $5\frac{1}{2}$ ft., and all the quays stand about 2 ft. above H.W.S.

A hand-worked crane on the 'Main Quay' is capable of lifting

* In Admiralty Chart 3001 and the *Arctic Pilot* the northern arm is called 'New Pier' and the southern arm 'Old Pier'.

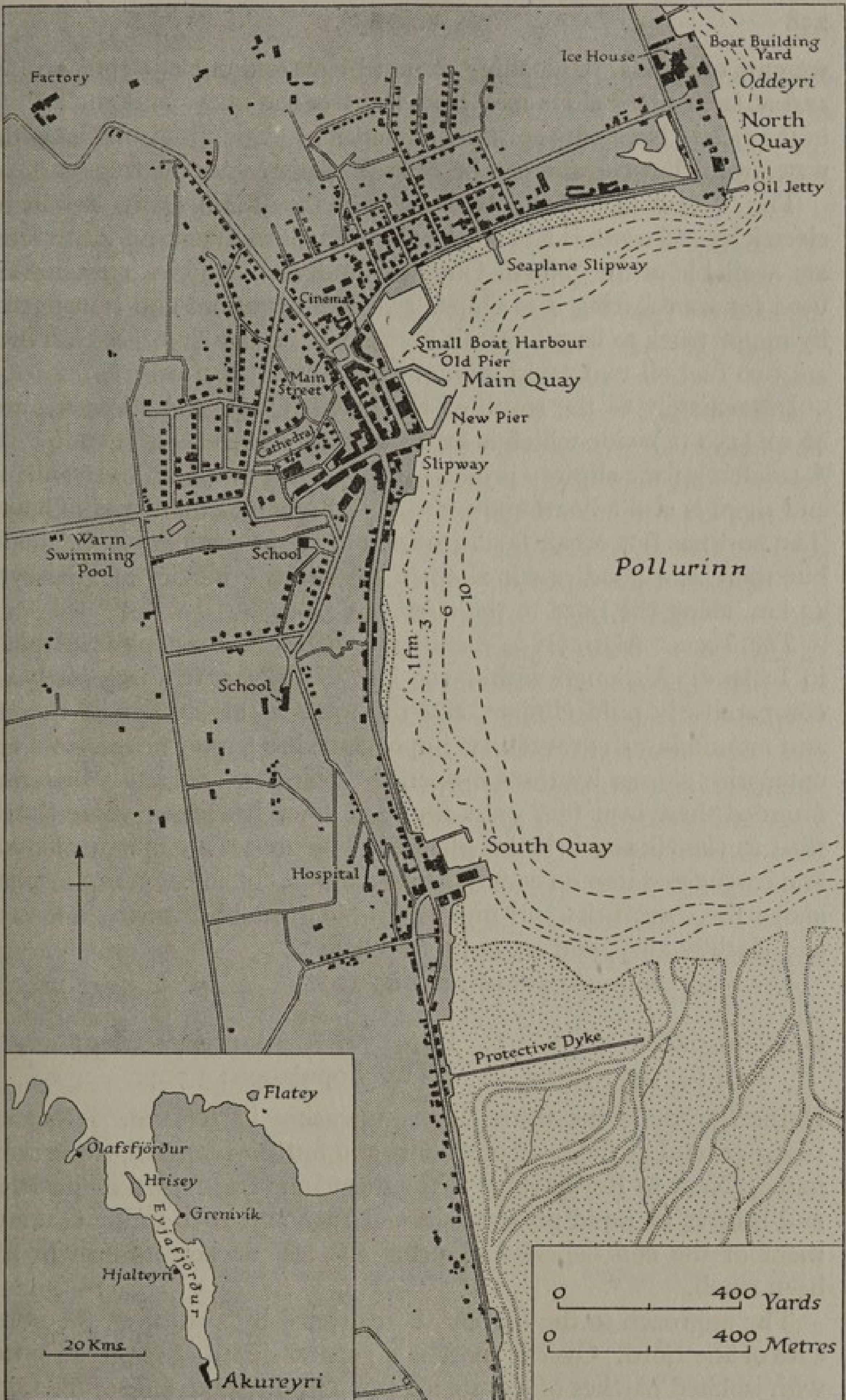


Fig. 92. Akureyri. Based on a town plan published by G.S.G.S. in 1941 (No. 4192). Corrected from air photographs, 1941. Depths from Admiralty Chart 3001.

weights of 2 tons. Unloading cannot be carried out in strong winds, and at such times ships may have to leave the quays and anchor out in the fjord. No storage or transfer accommodation is available on the waterfront, but cargoes can be cleared easily by motor transport.

The 'North Quay' and both piers of the 'Main Quay' are lit by electricity and water is laid on. Coal stocks, normally about 4,000 tons, are available at the 'North Quay'. Handcarts of 4 cwt. capacity are used for transferring it to ships. The coal is bagged and transported by motor truck to larger vessels berthed along the 'New Pier'. There are two fuel oil tanks with a total capacity of 304 tons.

Immediately to the south of the 'Main Quay' there is a slipway 46 m. (150 ft.) wide which is capable of taking vessels up to 100 tons. A small seaplane slipway projects from the south side of the sandspit, and there is also a boatbuilding yard just north of the 'North Quay'. The port has few repair facilities and only light castings can be made, but there is a good repair shop in the herring factory at Hjalteyri, 12 km. along the fjord to the north.

The Town. Akureyri is considered to be the most pleasant place in Iceland. Although within 100 km. of the Arctic Circle, it has a comparatively mild climate, and the town is famous for its flowers and mountain-ash groves. Its importance has largely arisen from the enterprise shown by the Co-operative Farmers' Society which was founded there over fifty years ago. The town has grown more slowly than Reykjavík and is better planned. The houses are mostly of wood and corrugated iron on concrete foundations. In addition to the many shops there are fish- and mutton-freezing establishments, a leather and cloth factory, and six large warehouses.

For road communications see Fig. 123.

HAFNARFJÖRÐUR (Fig. 93; Plate 74). Admiralty Chart 3201. Lat. 64° 04′ N, long. 21° 58′ W. Population: 3,707.

Hafnarfjörður is the third largest township in Iceland. It lies on rising ground at the head of a short and fairly wide fjord of the same name. Next to Reykjavík it is the most important town in Faxaflói, and it owes its rapid growth between 1918 and 1930 to the development of the cod fisheries. During the last decade its growth has been small.

The approach to the harbour is restricted by a shoal on the north side of the fjord. Over it there is a general depth of less than 5 fm. with isolated patches of less than 1 fm. On the south side of the fjord the entrance is further restricted by a spit which projects in a north-westerly direction for about 1 km. A small patch at the end of this spit is visible at low water. East of the spit, shoals extend out from the shore for about 500 m. and there are depths of less than 3 fm.

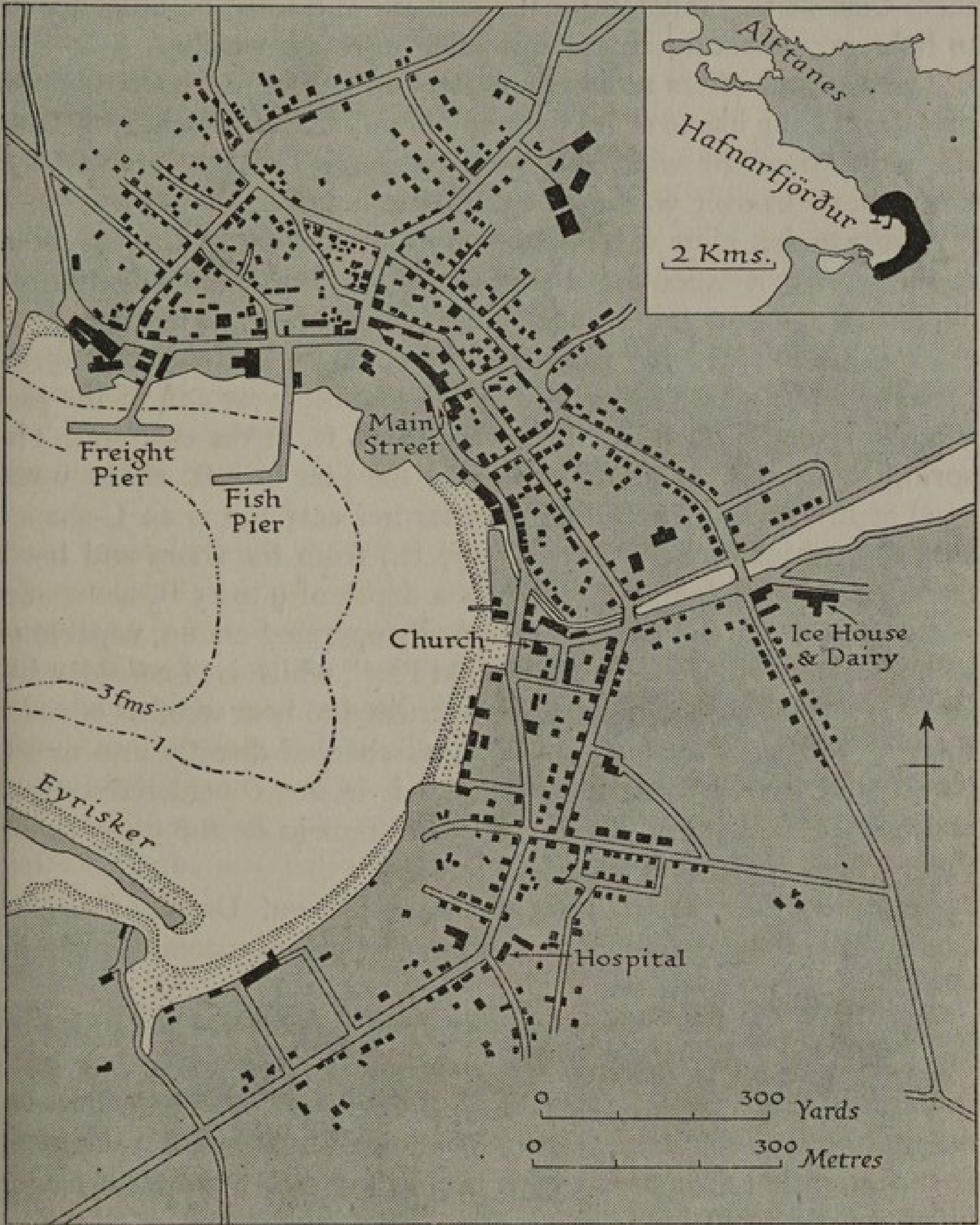


Fig. 93. Hafnarfjörður. Based on a town plan published by G.S.G.S. in 1941 (No. 4191). Corrected from air photographs, 1941. Depths from Admiralty Chart 3201.

Nearer the harbour the south side of the fjord is fringed by a reef, Eyrisker, along which there has been considerable deposition of sand.

In the outer part of the fjord, the uneven and rocky nature of the sea bed prevents good anchorage, but the holding ground improves towards the head of the bay. Fully exposed to strong winds from the west and north-west, the swell and the nature of the bottom make it unsafe for large ships to lie aground at low water. Vessels drawing more than 18 ft. cannot enter the harbour and must be unloaded on to lighters, a most hazardous operation in rough weather.

The harbour offers no better protection from the frequent winter gales, and a tug has to stand by ready to pull larger vessels away from the piers when the wind and swell increase. Ten trawlers and five motor boats of over 30 tons are normally found in the port.

Two wooden piers extend from the north shore of the bay. The more westerly is called the 'Freight Pier' and is a T-shaped structure supported on iron and wooden piles, some of which are loose. It extends 64 m. (210 ft.) from the shore, has a frontage of 125 m. (410 ft.) and a width of 13 m. (43 ft.). At the west end of the pier there is a depth of 18 ft., shallowing to 14 ft. at the east end. The spring tidal range is about 12 ft. and the pier is 5 ft. above water level at H.W.S. The 'Fish Pier' lies farther east and is an L-shaped structure which extends 115 m. (377 ft.) from the shore and has a frontage of 88 m. (289 ft.). There is a depth of 9 to 15 ft. alongside.

On each pier there are two electrically operated cranes, capable of lifting weights of 25 cwt. The 'Freight Pier', which is of considerable age, is far from strong and cannot be trusted to bear weights of more than 1¼ cwt./sq. ft. Cargo is usually discharged directly into motor trucks and driven away immediately; it is not considered safe to allow more than two to three vehicles to remain on the quay at one time. There are several good warehouses.

Both piers have electric light and water laid on. Usually there are coal stocks of about 10,000 tons. Minor repairs to machinery can be effected.

The Town. Hafnarfjörður is built upon lava which has split into blocks of irregular height. In consequence, the town has little uniformity of ground level, and some of the houses, perched on rocks, may tower above their nearest neighbours. Industrial development is almost entirely connected with fishing, and there are factories for filleting fish and making ice.

For road communications see Fig. 121.

VESTMANNAEYJAR (Fig. 94; Plates 69, 75 and 76). Admiralty Chart 2968.

The Vestmannaeyjar are a group of islands lying between lats. 63° 42′ and 63° 28′ N and longs. 32° 45′ and 32° 54′ W. They are all small

Fig. 94. Heimaey, Vestmannaeyjar. Based on Danish 1 : 20,000 map (Copenhagen, 1905). Corrected from air photographs, 1940. Depths from N. P. Kirk and Th. Krabbe, *Timarit Verkfræðingafjelags Íslands*, 1–2 hefti, Bl. xx (Reykjavík, 1922).

and uninhabited, except Heimaey, which has an area of 16 sq. km. and a population of 3,579. The island owes its importance to its closeness to the cod-fishing grounds and to the absence of any good competitive harbours on the south coast.

Heimaey consists of grassy slopes, which rise gently at first and then more steeply to the peak of the extinct volcano, Helgafell. The harbour is in the north-east of the island, where the steep cliffs of Heimaklettur and Stóra Klif protect shipping from north and north-west winds. With a strong east wind, however, it is difficult to enter the harbour or anchor outside, and ships must then anchor close inshore on the west side of the peninsula of Heimaklettur.

All the larger ocean-going vessels have to anchor in the middle of the bay outside the harbour, where there is a depth of 12–16 fm. Cargo and passengers are taken into the inner harbour (Höfn) by lighter or motor boat. Entrance is made from the east between two stone breakwaters which were built in 1914. The entrance is 140 m. (460 ft.) wide.

A narrow shingle isthmus (Eiði) joins the mountains of Heimaklettur and Stóra Klif and forms the northern margin of the inner harbour. Within the harbour there is an average depth of 5–6 ft. and this gives excellent anchorage for small craft except in strong south-east or south-west winds. The main quay, 82 by 55 m. (270 by 180 ft.) is on the southern shore; it is built of stone, with sloping sides. Farther east are two smaller quays of similar construction, each roughly measuring 73 by 11 m. (240 by 36 ft.). There is a depth of 9 ft. alongside all three quays; spring tidal range 9 ft.

The quays are lit by electricity, but there is no water laid on and there are no lifting appliances. Immediately to the west of the largest quay is a slipway, suitable for vessels up to 50 tons. Small engine repairs can be undertaken. About eighty motor boats of from 5 to 100 tons are normally based in the harbour.

The Town. This is known as Kaupstaður and has grown up in haphazard fashion on the south shore of the harbour. Most of the houses are roofed with galvanized iron, and rain water is run from the roofs into underground tanks; no other supply of fresh water is available. Local industries are based almost entirely on cod fishing and its subsidiary trades of curing, salting and icing. There are two fish-curing houses, five ice factories and the largest cod-liver oil plant in the world.

R.A.F.

Plate 75. Vestmannaeyjar, a group of islands off the south coast, from the north-east. Only Heimaey is inhabited (see Fig. 94 for map).

R.A.F.

Plate 76. Heimaey, Vestmannaeyjar, is Iceland's most important cod-fishing centre. The harbour is shallow and larger ships must anchor in the roadstead outside (see Fig. 94 for map).

ÍSAFJÖRÐUR (Fig. 95; Plate 73). Admiralty Chart 2999. Lat. 66° 05′ N, long. 23° 07′ W. Population: 2,836.

Ísafjörður is an important cod-fishing centre and the principal town in the north-west peninsula. It lies on a sandspit which projects from the western shore of Skutilsfjörður, the first of a series of branch fjords on the southern side of the much greater inlet, Ísafjarðardjúp.

The sandspit is about 3 km. from the entrance of Skutilsfjörður. The low narrow tongue of sand extends more than half-way across the fjord and continues almost to the opposite shore as a shoal called Muslingur. The enclosed water, known as Pollurinn, thus forms an almost entirely land-locked harbour. The connecting channel has a very narrow fairway and at low tide is not more than 13 ft. deep. Entry into the harbour is complicated by several factors: the tidal stream continues to run out through the channel until 2 hr. after the tide has begun to rise; strong winds, especially from the south-east, are often experienced; the shoal Muslingur is subject to continuous alteration, and a pilot with local knowledge is required for safe navigation of the channel. Further difficulties of approach are encountered in pack ice which sometimes presses into the fjord in great masses and completely arrests navigation during the finest months of spring and early summer. During especially severe winters, the inner harbour may freeze over.

Shipmasters who do not wish to enter Pollurinn, or who want to find shelter from strong winds, can anchor in Prestabugt, a bay which lies on the north side of the sandspit. In general the depths are less than 3 fm., but on the east side of the bay a shoal is covered by water of less than 1 fm. In the eastern part of the channel, opposite the town, good anchorage can be found in depths of 8–9 fm.

In Pollurinn, holding ground is best in the southern part of the harbour, where there are depths of over 6 fm., but strong winds blowing up and down the fjord may cause trouble. Two or three trawlers, about five motor boats between 10 and 60 tons and about twenty smaller boats are normally found in the harbour. Several piers project into the harbour from the sandspit. Of these, the most important is the 'Main Pier', an L-shaped timber construction built on stout wooden piles. It is well built, with a frontage of about 38 m. (125 ft.) and a width of 12 m. (40 ft.). Ships may have difficulty in berthing alongside, especially in high winds from the south-west. The greatest protection is found on the east side of the pierhead

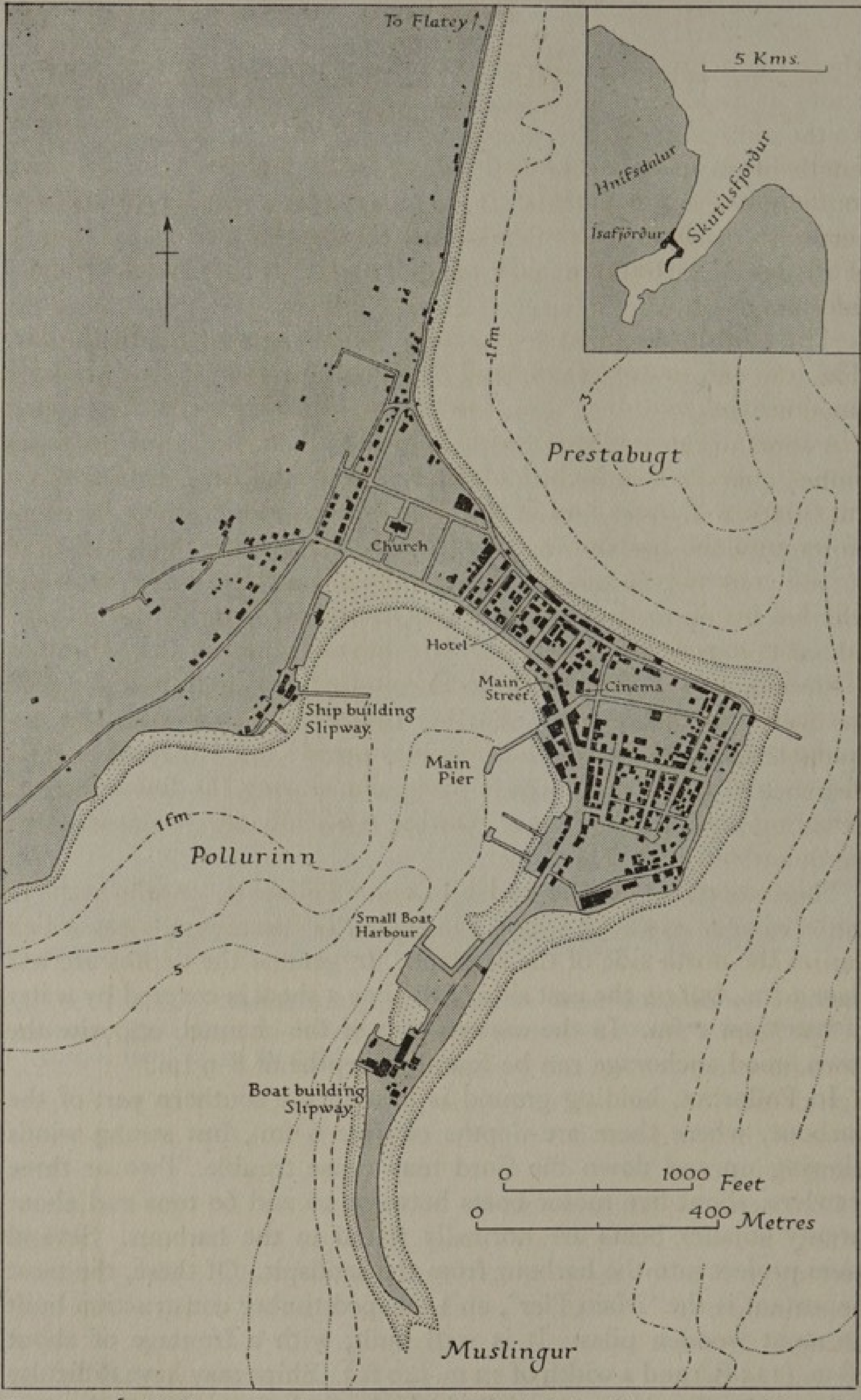


Fig. 95. Ísafjörður. Based on an unpublished Icelandic survey, with major corrections and additions from air photographs, 1941. Depths mainly from Admiralty Chart 2999.

where the depth is 21 ft. A hand-worked crane, with a capacity of 2 tons at a radius of 18 ft. projects 10 ft. from the end of this pier. To the south are two other wooden piers each of which has a berthable length of about 52 m. (170 ft.) and a width of 4 m. (13 ft.). The southern one has a T-shaped head, against which small vessels can berth in a depth of 10 ft. Farther south there is a small boat harbour of modern construction, well sheltered from westerly winds. The sides are of concrete in steel shuttering and are 36 m. (118 ft.), 52 m. (171 ft.) and 56 m. (184 ft.) in length. Larger boats usually berth along the 36 m. wall, where there is a depth of 7 ft. The spring tidal range is 8 ft.

A short distance farther south along the spit there is a rectangular timber quay, with a depth of 18 ft. along its outer or western side, but this is completely exposed to westerly winds. Better shelter can be found along the shorter north-facing wall of this quay, which is 36 m. (118 ft.) in length. Two small wooden piers and several wharves for motor and fishing boats have been built on the western side of Pollurinn.

Electric light is available on all the quays, but only the 'Main Pier' has water laid on. Coal stocks of 2,000–3,000 tons are normally available, and there is storage capacity for 308 tons of fuel oil. The clearance of cargo is by motor trucks which can be driven on to the jetties under ships' derricks. Several large warehouses lie close to the quays.

There are two slipways: the larger is on the west side of the harbour and is capable of lifting vessels up to 80 tons; the smaller is near the south end of the sandspit and is suitable only for small boats. Two machine shops are capable of effecting minor repairs.

The Town. The precipitous nature of the fjord coast has left little room for expansion on the mainland, and the town has a remarkably high density of population (570 people per sq. km.). On the narrow shore of the fjord isolated buildings lie in the shadow of the steeply rising mountains.

Commercial establishments are almost entirely connected with the fishing industry. There are three factories for fish filleting and freezing; others for the production of fish oils and fish meal, and for the canning of fish products and shrimps. There are also drying and salting houses and several large salt depots.

Land communications are very poor. Local roads are passable to motor traffic during summer, but there is no connexion with the main road network of the country. A rough road (see p. 380) leads to

Flateyri and Þingeyri and a short road of slightly better quality runs northwards for 3 km. to Hnífsdalur.

SIGLUFJÖRÐUR (Fig. 96; Plates 71 and 83). Admiralty Chart 3001. Lat. 66° 11′ N, long. 18° 50′ W. Population: 2,833.

The town of Siglufjörður exists only to serve the needs of the fishing industry, and it has grown to be one of the most important herring centres in the world. It lies on a sandspit near the head of a short and narrow fjord of the same name.

The approach is comparatively free from dangers. Good anchorage may be found anywhere within the fjord according to draught, and the inlet provides one of the best refuges for the herring fleet on the north coast of Iceland. The fjord is notorious, however, for the heavy squalls which descend from the surrounding mountains. As in many other fjords on the north coast, pack ice sometimes causes serious hindrance to navigation during winter and spring.

Both in the bay immediately to the north of the sandspit and in the more sheltered waters to the south, depths of less than 3 fm. are found. The bottom is sandy. There is no harbour in the sense of a partially enclosed stretch of sheltered water, but landing facilities on the east and south side of the spit are numerous. In summer, when the herring season is at its height, about 300 vessels operate from the port. In winter there are only about sixty small motor boats.

The 'Main Jetty' is a concrete structure which extends from the north-east point of the spit for 112 m. (368 ft.) and has a width of 12 m. (39 ft.). On the south side there is a depth of 18 ft. Ships cannot berth along the north side, which is protected from wave action by a loose rock apron. The whole jetty serves as a breakwater, not only sheltering but also preventing deposition of sand off the piers to the south. The 'Concrete Quay', situated on the south-east extremity of the spit, has a frontage of 75 m. (246 ft.). A channel 18 ft. deep gives access to water of this depth alongside the quay. A small inlet in the south-west of the spit gives good shelter for small rowing boats. The rest of the waterfront is lined by about forty wooden piers which are used by the herring fleet; these are of slender construction and will not bear heavy weights. Herrings landed on the piers are taken to the factories where they are processed and barrelled. They are then taken in small motor trucks to the 'Concrete Quay' and 'Main Jetty'. About 2,500 barrels can be loaded into a ship in 36 hr.

Up to 10,000 tons of coal are usually stocked at the beginning of

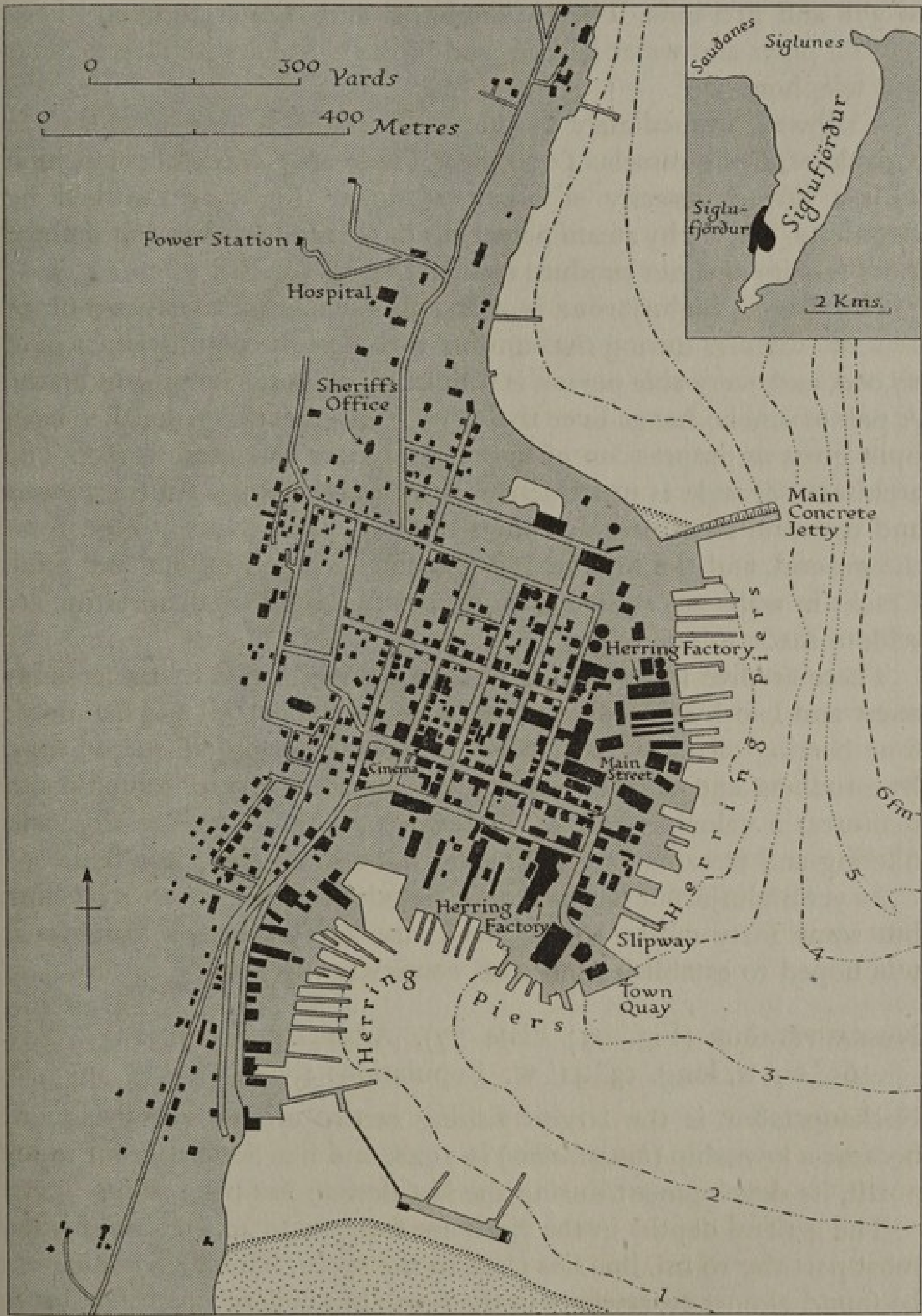


Fig. 96. Siglufjörður. Based on an unpublished Icelandic survey of 1940, with additions and corrections from air photographs, 1941.

the herring season, and there are two fuel-oil tanks with capacities of 378 and 250 tons. The 'Main Jetty' and 'Concrete Quay' have fuel-oil pipes and water laid on, and both are fitted with electric light and telephone.

A slipway, immediately to the north of the 'Concrete Quay', is capable of lifting vessels of 120 tons. There are fourteen cranes, each with a lifting capacity of about $1\frac{1}{2}$ tons. Eight are worked by electricity, and six by steam power. A repair shop is able to undertake most repairs and can produce castings up to 300 lb.

The Town. Siglufjörður is a 'boom town'. The large influx of seasonal workers during the summer increases the population to over 10,000, and every able person is fully engaged in the herring industry. A pall of smoke hangs over the town, and everything that has been built gives an impression of haste, cheapness and carelessness. The architectural style is unattractive—unpainted corrugated iron, wood and concrete structures are often built on piles about $\frac{1}{2}$–1 m. from the ground, and the intervening space is occupied by rats and offal. Cracks in walls are stuffed with seaweed and the small windows are seldom made to open.

There are five large herring factories, three owned by the government and two by the town. They produce herring oil and fish meal; four herring-oil tanks each have a storage capacity of 10,000 tons. By-products and surplus catch are converted into phosphatic fish manures, a valuable part of the export trade. There are also fish-filleting and freezing establishments and several large warehouses.

As yet Siglufjörður has no road connexions with the rest of Iceland, but some forty motor trucks are in use for local work. In 1941 it was hoped to establish such road connexion by 1942.

NESKAUPSTAÐUR (Fig. 97; Plate 77). Admiralty Chart 1535. Lat. 65° 09′ N, long. 13° 41′ W. Population: 1,097.

Neskaupstaður is the largest fishing centre on the east coast. It became a township (*kaupstaður*) in 1928, and like Seyðisfjörður to the north, its development during the last decade has been slow.

The general depths in the fjord are from 20 to 40 fm., and for the most part the 10 fm. line lies close to the shore. Good anchorage can be found almost everywhere in the fjord, but violent squalls are liable to descend from the surrounding mountains. One trawler of 106 tons, two of 60 tons, and about thirty motor boats of over 30 tons normally fish from this port.

In addition to the numerous small piers used by fishing vessels,

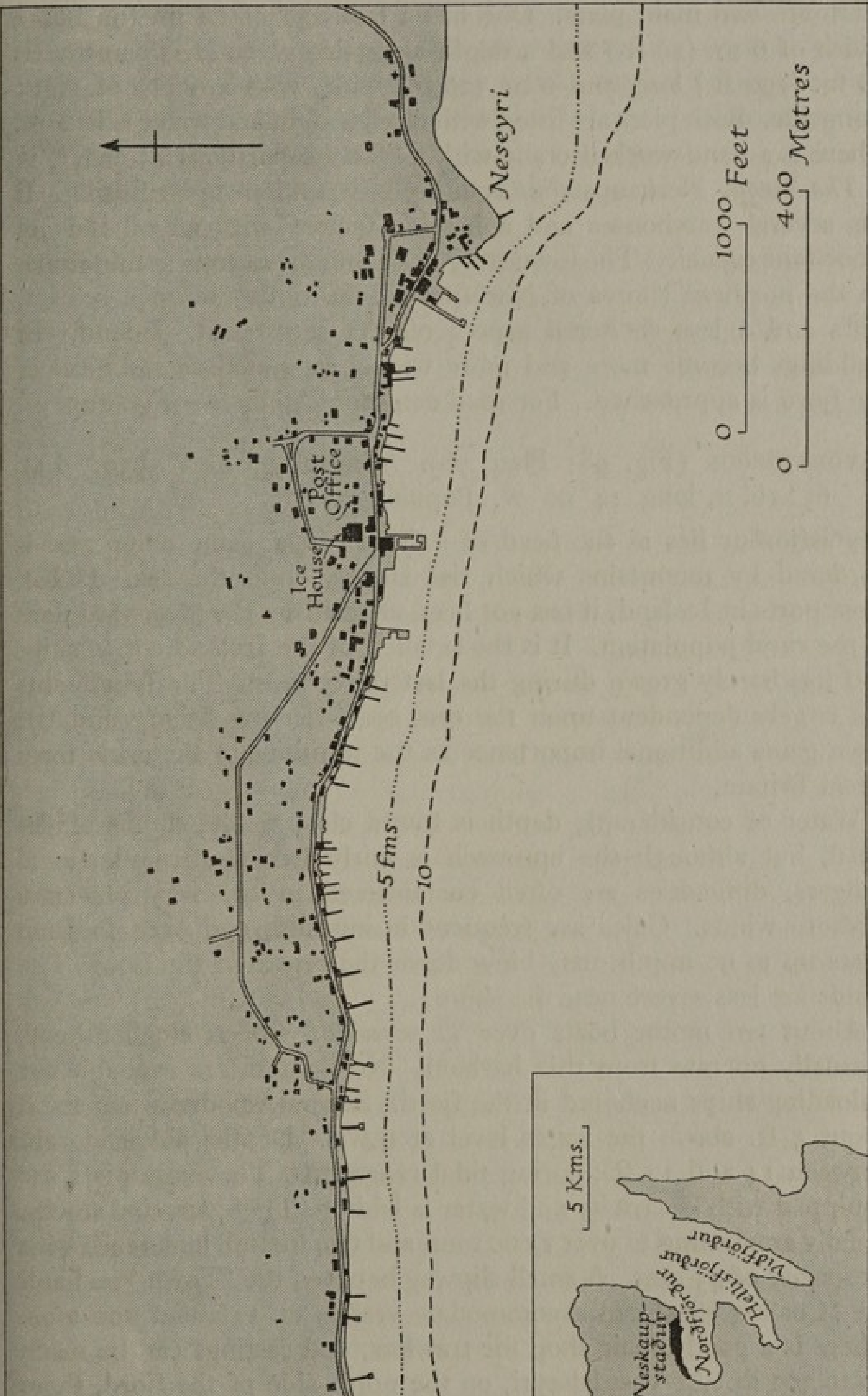


Fig. 97. Neskaupstaður (Norðfjörður). Based on an unpublished Icelandic survey of 1937, corrected from air photographs, 1941.

there are two main piers. One has a frontage of 28 m. (92 ft.), a width of 6 m. (20 ft.) and a depth alongside of 20 ft. The other is 58 m. (190 ft.) long and 6 m. (20 ft.) wide, with a depth of 19 ft. alongside. Both piers are fitted with electric light and water is laid on. There is a hand-worked crane with a lifting capacity of 15 cwt.

The Town. Neskaupstaður is entirely dependent upon fishing. It has several warehouses and a herring factory with an oil tank of 1,000 tons capacity. The town straggles along the narrow gentle slopes on the northern shores of Norðfjörður. Towards the open sea low cliffs and a less sheltered aspect restrict settlement. Inland, the buildings become more and more widely separated as the head of the fjord is approached. For road communications see Fig. 125.

SEYÐISFJÖRÐUR (Fig. 98; Plate 78). Admiralty Chart 3330. Lat. 65° 16′ N, long. 14° 00′ W. Population: 903.

Seyðisfjörður lies at the head of a fjord of the same name and is bordered by mountains which rise steeply from the sea. Unlike most ports in Iceland, it has not been affected by the townward drift of the rural population. It is the smallest of the Icelandic townships and has barely grown during the last thirty years. The inhabitants are largely dependent upon the east coast herring fishery and the town gains additional importance as the terminus of the cable from Great Britain.

Water of considerable depth is found close to the shores of the fjord, but although the approach is fairly free from navigational dangers, difficulties are often encountered in the very powerful offshore winds. Gales are frequent in autumn, and even in June gusts up to 90 m.p.h. may blow down the centre of the fjord. The winds are less severe near the shore.

About ten motor boats over 12 tons and fifteen smaller boats normally operate from this harbour. No lighters are available for unloading ships anchored in the fjord. Several wooden piers stand about 5 ft. above the water level at H.W.S. Depths alongside are between 14 and 17 ft.; spring tidal range 5 ft. The main piers are equipped with electricity and water is laid on. There are coal stocks, usually amounting to over 1,000 tons, and two fuel-oil tanks each with a capacity of 45 tons. A small slipway between the 'Town Pier' and the 'Coaling Pier' can accommodate vessels up to about 100 tons. There is a good repair shop for trawlers, and castings can be made up to 300 lb. At Vestdalseyri, on the north side of the fjord, there is a small and very decrepit wooden pier.

The Town. The houses are mostly built of wood or corrugated iron on concrete foundations, and are scattered for a considerable distance along the south side of the fjord. Seyðisfjörður is a fish-filleting and freezing centre, and also has a herring-oil factory with a tank of 500 tons capacity.

For road communications see Fig. 125.

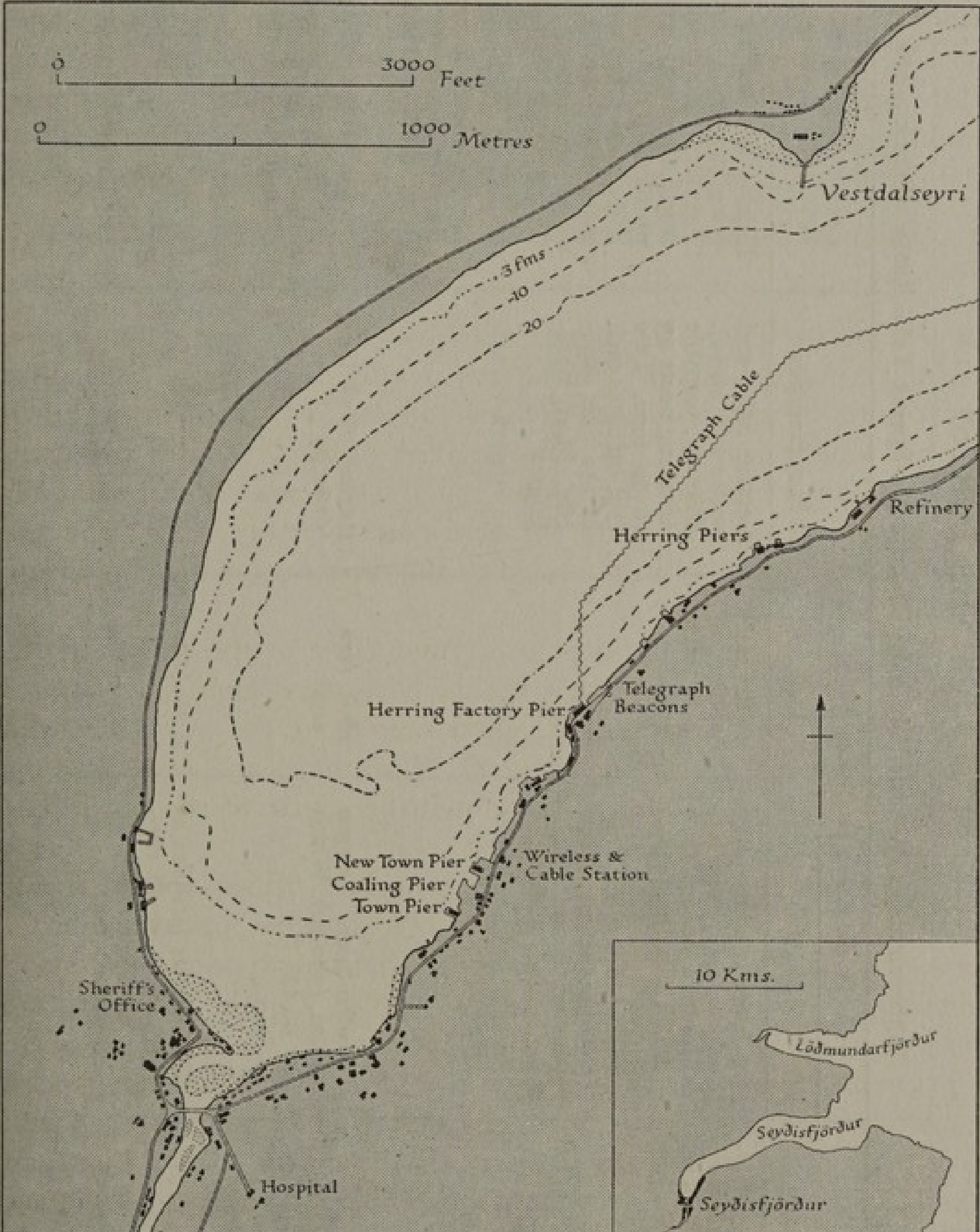


Fig. 98. Seyðisfjörður. Based on an unpublished map prepared by the Hydrographic Department of the Admiralty, corrected from air photographs, 1941. Depths from Admiralty Chart 3330.

MINOR PORTS*

(Abbreviations: Ad.Ch. = Admiralty Chart; S.R. = Spring Tidal Range where known)

Port	Berthing facilities: Berths	Berthing facilities: Depths	Port facilities	Notes
Akranes Lat. 64° 18′ N Long. 22° 06′ W Population 1,905 Plate 32	(*a*) Main concrete jetty on east of peninsula. Frontage 82 m. (270 ft.). Width 8 m. (27 ft.) (*b*) Small wooden pier also on east side (*c*) Concrete jetty and wooden pier on west of peninsula. Both *c.* 46 m. (150 ft.) by 6·5 m. (21 ft.)	26 ft. (sea end) 4 ft. (shore end) 9 ft.	Electric light and water laid on (*a*). Slipway, capable of taking boats up to 70 tons. Two fuel-oil tanks each of 150 tons capacity. Many warehouses	Fishing and trading centre on long low-lying peninsula north of Hvalfjörður in Faxaflói. Innumerable reefs make seaward approach difficult, but give some protection from open sea. In fair weather ships up to 1,500 tons can berth alongside main jetty; cannot do so in high winds from south-east, south or south-west. Thirty motor boats up to 40 tons normally operate from harbour. Several fish-salting houses; two fish-freezing plants; herring-meal factory; slaughterhouse; freezing house for mutton. Town has more than doubled in size during last 20 years
Bíldudalur Lat. 65° 41′ N Long. 23° 36′ W Population 349 Ad.Ch. 2999 Plates 19 and 41	Wooden pier. Length 92 m. (300 ft.). Width 11 m. (36 ft.)	18 ft. (sea end)	1 crane of $1\frac{1}{2}$ tons capacity	On west shore of small bay in Arnarfjörður. Anchorage has very poor holding ground. Ten fishing boats under 12 tons normally operate from harbour
Blönduós Lat. 65° 39′ N Long. 20° 20′ W Population 436 Ad.Ch. 2977	No harbour facilities as yet, but a small concrete jetty is in course of construction	6 ft. (1940)	—	On low undulating ground on east side of Húnafjörður. Important as a trading station in a prosperous farming district, but has little value as a port. Slaughter-house and mutton-freezing plant. No harbour and no shelter from northerly

* For road communications see pp. 369–83 and Figs. 120–129.

				winds. Roadstead served by small open boats which can be drawn up on to exposed beach. Landing difficult in winter and approach made dangerous by submerged reefs. In calm weather vessels can anchor anywhere in Húnafjörður, according to draught
Borðeyri Lat. 65° 13′ N Long. 21° 09′ W Population 55 (1935)	No piers	—	—	Small collection of houses on sandspit on west side of Hrútafjörður. Farming centre with freezing plant for mutton. Ships of 2,000 tons can anchor within 90 m. of shore and landings can be made from small boats. Sheltered waters of fjord often freeze in winter and pack ice has been reported at southern end of Hrútafjörður
Borgarnes Lat. 64° 32′ N Long. 21° 55′ W Population 608	Wooden and iron pier, with berthing length of *c.* 27 m. (90 ft.). Built on a small island (Stóra Brákarey) which is connected to mainland by concrete bridge. Under favourable conditions ships up to 1,800 tons can use pier	5 ft.	No lifting appliances except a small ship's davit. One warehouse. Coal stocks usually *c.* 100 tons	On narrow peninsula on north side of Borgarfjörður. Approach up fjord is one of the most dangerous and difficult in Iceland owing to shallow water, numerous skerries and submerged reefs; also a strong current of 5–6 knots in fjord. In winter drift ice occasionally provides an additional obstacle. Vessels proceeding to Borgarnes usually obtain a pilot at Reykjavík. For ferry service to Reykjavík see p. 382. Anchorage is very exposed to south and south-west winds. Village is about 500 m. from pier. Main occupations depend chiefly on farm produce and to a less extent on fishing. Large dairy produce and canned milk factory; also a slaughterhouse

MINOR PORTS (*continued*)

Port	Berthing facilities: Berths	Berthing facilities: Depths	Port facilities	Notes
Búðareyri Lat. 65° 02′ N Long. 14° 13′ W Population 343 Plate 46	(*a*) T-shaped wooden pier of flimsy construction. Frontage 18 m. (60 ft.). Width 8 m. (25 ft.) joined to mainland by pier 91 m. (300 ft.) long and 5 m. (16 ft.) wide	15 ft.	Several warehouses	Farming village mainly built on sandspit near head of Reyðarfjörður. High mountains rise steeply from sea on each side of fjord. Only local craft are one boat of 22 tons and another of 10 tons. Care must be taken to avoid a shoal near the T-shaped pier. This pier will just take a 30 cwt. motor truck. There is a slaughter-house and freezing plant for mutton. (Map: G.S.G.S. 4189, 1 : 25,000, published 1940)
	(*b*) Wooden pier, 700 m. east of sandspit; 15 m. (50 ft.) by 24 m. (78 ft.)	12 ft.		
Búðir Lat. 64° 56′ N Long. 14° 02′ W Population 539 Plate 47	(*a*) Wooden pier, Length 30 m. (100 ft.). Frontage 13 m. (42 ft.). Very shaky and unsuitable for landing heavy stores	18 ft.	Electric light on (*a*). No lifting appliances. Several warehouses	Fishing centre and trading station near head of Fáskrúðsfjörður. Lies on north shore, from which mountains rise abruptly. Good anchorage can be obtained off village in depths of 3–12 fm. It is possible to berth alongside piers in any wind
	(*b*) Eight subsidiary piers	15 ft.		
Dagverðareyri Lat. 65° 45′ N Long. 18° 10′ W Population ?	(*a*) Wooden pier. Length 82 m. (270 ft.). Width 6·5 m. (21 ft.)	15 ft. (sea end) 6 ft. (shore end)	No lifting appliances	A herring factory 9 km. north of Akureyri. All three piers are suitable for berthing vessels across the end
	(*b*) Two other small piers			
Djúpavík Lat. 65° 57′ N Long. 21° 30′ W Population ?	(*a*) L-shaped wooden pier. Longer arm 46 m. (150 ft.).	19 ft. (sea end) 0 ft. (shore end)	Electric light and water laid on (*a*). No lifting appliances except for conveyor on (*c*).	In south-west corner of Reykjarfjörður, a branch fjord in north-west Húnaflói. Good shelter in fjord from north winds, but ships must move from piers in strong east winds. Largest privately owned
	Shorter arm 30 m. (100 ft.)	10 ft.		

	(*b*) Small wooden pier suitable for motor boats (*c*) Wooden pier. Length 46 m. (150 ft.)		Usually about 1,000 tons of coal. Repair shop for factory and trawlers. Several warehouses	herring-oil and meal factory in Iceland. Built in 1935, deals with about 30,000 tons of herrings each year. Three concrete fish-oil tanks; two with a capacity of 1,250 tons each, the other of 1,500 tons. Village consists of some twenty houses for factory workers and two large communal dwelling houses for temporary workers. Herring boats discharge alongside (*c*) which is fitted with electric herring conveyor running to factory. Pony track to Hólmavík, closed in winter, provides only land communication
Djúpivogur Lat. 64° 39′ N Long. 14° 18′ W Population 246 (1935) Ad.Ch. 1636 Plate 50	Pier suitable only for small craft	9 ft. (sea end)	—	Fishing and farming village at head of an inlet on south side of Berufjörður. Entrance to inlet is narrow and rock-strewn, but there is good anchorage in outer roadstead, depth 7–8 fm. (clay bottom), and in 2–3 fm. in cove itself. A few 10-ton motor boats are based on the harbour. Inhabitants sometimes suffer from lack of fresh water as the catchment area is small and there are no rivers. A freezing house for mutton and fish. No land communications except by pony over the mountains
Eyrarbakki Lat. 63° 52′ N Long. 21° 09′ W Population 603 Ad.Ch. 2733 Plate 56	Two concrete jetties. Length 91 m. (300 ft.). Width 8 m. (25 ft.)	Only deep enough for vessels up to 30 tons	No lifting appliances	Fishing and farming village on reef-bound coastline, with flat country extending inland for a considerable distance. Water supply from wells. There is no harbour. Approach is hazardous at all times and impossible in strong onshore winds. Heavy swell causes surf out to about 2 km. from the shore. Anchorage is not good, and vessels over 500 tons must anchor at least 3 km. from the shore

MINOR PORTS (*continued*)

Port	Berthing facilities		Port facilities	Notes
	Berths	Depths		
Eskifjörður Lat. 65° 04′ N Long. 14° 02′ W Population 671 Plate 45	(*a*) Wooden pier 'Tulinius', in fair condition. Berthing length 30 m. (100 ft.) (*b*) Wooden pier, berthing length 33 m. (110 ft.). Not strong, but possible to berth alongside in any wind (*c*) Numerous minor piers, suitable only for small craft	20 ft. 17 ft.	Electric light and water laid on (*a*); electric light only on (*b*). No lifting appliances. Several warehouses	On north shore of a branch fjord from Reyðarfjörður. Approach is easy, but anchorage is not very good owing to sudden variations in depth. Surface waters freeze only in exceptionally cold winters, but pack ice enters fjord in severe 'ice years' and fishing vessels have to be hauled up the beach in front of the town. Fish-salting business
Flatey Lat. 65° 22′ N Long. 22° 55′ W Population 165 (1935)	—	—	—	A small island in north-east part of Breiðifjörður. Trading station is on north-west side and is the only one in northern Breiðifjörður. Innumerable reefs and islets make navigation in inner part of fjord dangerous. Good anchorage can be found in depths of 8–9 fm. but exposed to north-west winds. Small craft obtain complete shelter in depths of 2–3 fm. in bay on south side of Hafnarey
Flateyri Lat. 66° 03′ N Long. 23° 31′ W Population 440 Ad.Ch. 2999 Plate 36	(*a*) Wooden pier on east side of spit head Length 91 m. (300 ft.). Width 27 m. (90 ft.) (*b*) Wooden pier on mainland to east of spit, 37 m. (120 ft.) by	18 ft. 18 ft.	No lifting appliances. Small repair shops. Several warehouses	Village built almost entirely on a shingle spit on north side of Önundarfjörður. General depths in fjord about 12 fm., but holding ground is not good and there are gusty offshore winds. Best anchorage is in depths of 8–9 fm. in sheltered bay formed by spit. Village almost wholly

	55 m. (180 ft.). For use of herring factory			dependent upon fishing; has fish-filleting and freezing house, a herring-oil and meal factory. There is a disused whaling station. Road to Ísafjörður open only in summer
Grímsey Lat. 66° 33′ N Long. 18° 00′ W Population 119 (1935) Ad.Ch. 2978	Small wooden sloping pier in Sandvík. Length 27 m. (90 ft.)	—	—	An island, 5 km. long and 1·6 km. broad, lying just over 40 km. north of Iceland. Landing is difficult except in calm weather. Very shallow bay called Sandvík on west coast; not possible for boats with a draught of more than a few feet to come alongside, even at high tide. Main occupations are fishing and fowling. (Map: 1 : 30,000, published in *Geogr. Journ.* 1935, p. 144)
Gríndavik Lat. 63° 49′ N Long. 22° 31′ W Population ?	(*a*) Wooden pier. Length 55 m. (212 ft.). Width 10 m. (33 ft.)	2 ft. (S.R. 13 ft.)	No lifting appliances	Village 13 km. east of Reykjanes lighthouse. A narrow channel with maximum depth of 5 ft. connects outer harbour with a smaller inner harbour. The bed of the latter is of sand. Pier is on west side of outer harbour; protected by a breakwater. Fish- and mutton-freezing establishments
Hesteyri Lat. 66° 20′ N Long. 22° 53′ W Population 77 (1935) Ad.Ch. 3000	(*a*) Wooden pier. Frontage 37 m. (120 ft.) (*b*) Lightly built wooden pier in a poor state of repair	18 ft.	—	On west side of Hesteyrarfjörður, a branch fjord of Jökulfirðir. Average depth of fjord 15 fm. Suitable anchorage for large ships; shelter from north-west, north and north-east winds. Pack ice sometimes sets into Jökulfirðir, but is kept out of Hesteyrarfjörður by tidal streams and currents. Head of fjord freezes in winter, but anchorage is usually free. Herring factory which can deal with 2,000 barrels a day—has a herring-oil tank with a capacity of 1,300 tons

MINOR PORTS (*continued*)

Port	Berthing facilities: Berths	Berthing facilities: Depths	Port facilities	Notes
Hjalteyri Lat. 65° 51′ N Long. 18° 12′ W Population 101 (1935) Plates 33 and 84	(*a*) Main pier, platform 29 m. (90 ft.) by 20 m. (65 ft.), joined to mainland by an arm from either end (*b*) Herring Pier. Length 55 m. (180 ft.). Width 9 m. (30 ft.) (*c*) Three subsidiary piers	— 18 ft.	Repair shop with forge, drilling machine and several lathes, *c.* 3,000 tons of coal at beginning of herring season. Electric light and water laid on to (*a*) and (*b*). Elevator on (*a*) for unloading herring	Large, modern and important herring-oil and fish-meal factory on west side of Eyjafjörður; two herring-oil tanks each holding 1,800 tons, two similar tanks in course of construction. Occupations based entirely on herring industry
Hnífsdalur Lat. 66° 07′ N Long. 23° 08′ W Population 313	Concrete jetty 1 km. south of village. Length 24 m. (80 ft.). Width 7 m. (23 ft.). Not suitable for ships longer than 30 ft.	9 ft. (sea end) 2 ft. (shore end) (S.R. 5 ft.)	Electric light and water laid on. No lifting appliances. Several small warehouses and sheds	Village of some fifty houses in small cove 4 km. north of Ísafjörður. High mountains on south and west, but exposed to winds from north-east, east and south-east. Good anchorage 1 km. from small jetty in depths of 30–35 fm. Ships can berth alongside jetty in any wind except very strong south and south-east winds. People mainly dependent on fishing. Fish-freezing and salting business
Höfn Lat. 64° 14′ N Long. 15° 12′ W Population 226 (1935) Ad.Ch. 1535 Plate 53	Four wooden wharfs. The best is on Álögarey	7 ft. Off other three varies from 4 to 7 ft. (S.R. 7 ft.)	No lifting appliances. Several warehouses on mainland and islands	Fishing station on a long low peninsula in Hornafjörður. The fjord is largely filled with deltaic deposits and there are a number of small rocky islands. The sand-banks are intersected by glacier torrents and sheets of shallow open water that vary in size according to the state of the tide and to melting conditions on the inland glaciers. The fjord is well sheltered from the open sea by two long low tongues of sand, separated by an entrance only

				20 m. wide. Strong currents of from 4 to 10 knots always run outwards. Only one narrow channel leads from fjord entrance to anchorage near the village. Approach from sea very difficult owing to shallow water, heavy swell and isolated rocks; a pilot is essential. Harbour consists of narrow sounds between islands; depth varies between 3 and 30 ft.; holding ground is good between Mikley and Álögarey
Hólmavík Lat. 65° 42′ N Long. 21° 43′ W Population 327	(*a*) Strong wooden L-shaped pier. Long arm 76 m. (250 ft.). Short arm 30 m. (100 ft.) (*b*) Small sloping jetty for motor boats	20 ft. (sea end) 0 ft. (shore end) 20 ft. (uniform)	Water laid on to (*a*) from reservoir: liable to freeze in winter. No lifting appliances. Small repair shop for fishing boats	Prosperous trading centre on west shore of Steingrímsfjörður. Good anchorage in 17–18 fm. in all winds except from east. Occupations mainly fishing and farming; very fertile land near by. Small fish-freezing factory; large co-operative store
Hrísey Lat. 65° 59 N Long. 18° 21′ W Population 316	Three wooden piers	15 ft.	Several warehouses	Small island in Eyjafjörður. No sheltered harbour, but good anchorage in 11–14 fm. Settlement at south end of island; dependent on fishing and farming. Small cod-liver oil factory
Húsavík Lat. 66° 02′ N Long. 17° 20′ W Population 1,002 Ad.Ch. 2978 Plate 42	Wooden pier with concrete surface. 100 m. (328 ft.) long with a broader wooden extension. Length 64 m. (210 ft.). Width 10 m. (33 ft.)	16 ft. (sea end) 0 ft. (shore end) 20 ft. (uniform along frontage)	Electric light and water laid on pier. No lifting appliances. Several warehouses	Prosperous fishing centre on east side of Skjálfandi. Approach requires care owing to submerged reefs. Good anchorage in bay in 5 fm. Eight motor boats of about 12 tons normally operate from harbour. Four 1,000-ton ships can lie alongside pier at same time, but impossible to berth in strong winds from south-west, west and north-west; heavy swell swamps pier. Herring-oil factory which can handle 700 barrels of fish a day; three small herring-oil tanks, ice and fish-filleting factory; salting business. Was of some importance in sixteenth century as export centre for sulphur from Mývatn district

MINOR PORTS (*continued*)

Port	Berthing facilities		Port facilities	Notes
	Berths	Depths		
Hvammstangi Lat. 65° 24′ N Long. 20° 58′ W Population 310	Stone jetty. Length 30 m. (100 ft.). Suitable only for small motor boats	6 ft.	Electric light and water at shore end of jetty. Hand-worked crane, capable of lifting ½ ton. Small repair shop for motor boats. No warehouses	Market town for Viðidalur and Vatnsdalur, on east side of Miðfjörður. Anchorage in 15 fm. 360 m. south-west of jetty; holding ground is rock, described as 'good', but untenable in north winds. Six scows are available for discharge of cargo
Keflavík Lat. 64° 00′ N Long. 22° 33′ W Population 1,551 Plate 55	(*a*) Main wooden pier on iron-faced piles. Frontage 46 m. (150 ft.). Width 14 m. (45 ft.) (*b*) Stone jetty 7 m. (23 ft.) by 64 m. (210 ft.). 5 ft. concrete wall on east side (*c*) Small wooden pier (*d*) Small stone jetty (*e*) Three wooden (?) piers in bay to north	18 ft. (average) 22 ft. (sea end) 15 ft. (shore end) (S.R. 10 ft.)	Water and electric light laid on (*a*) and (*b*). No lifting appliances. Fuel-oil tank 500 tons capacity. *c.* 200 tons of coal usually stocked. 14 warehouses	Important fishing centre in small bay on east side of Miðnes, the promontory marking southern extremity of Faxaflói. Good anchorage in clay and sand in middle of bay, except with strong winds from south-east, east or north-east. Local pilot essential to approach piers owing to dangerous rocks. Ships up to about 3,000 tons can berth alongside main wooden pier, except in winds from south to north-east. Trawlers and fishing boats up to 200 tons can berth alongside stone jetty in any wind. Pier (*c*) and jetty (*d*) are unimportant and are suitable only for small craft. Twenty-five motor fishing boats of 20–30 tons normally operate from harbour. Factories for freezing and filleting, fish meal, salting and curing. Water supply from artesian wells
Kópasker Lat. 66° 17′ N Long. 16° 27′ W Population *c.* 70 Ad.Ch. 2978	Wooden pier. Length 43 m. (140 ft.). Width 4 m. (13 ft.). Suitable only for small motor boats	10 ft.	—	Farming and fishing centre on flat ground on east side of Axarfjörður. Anchorage is shallow and not easy to find; always unsatisfactory in bad weather, impossible in strong north winds. Mutton-freezing establishment deals with 16,000 carcasses annually. Road communication to Húsavík and Raufarhöfn is seldom open in winter

Ólafsfjörður Lat. 66° 04′ N Long. 18° 39′ W Population 736	(a) Pier on south side of bay, of concrete blocks joined by timber balks reinforced by iron girders. Length 30 m. (100 ft.). Width 3 m. (10 ft.). Exposed (b) Wood and concrete pier. Length 15 m. (50 ft.)	11 ft. (sea end, and along south side) 9 ft. (sea end)	No lifting appliances. Slipway immediately north of main pier. Capable of taking ships up to 50 tons. Small repair shop	Fishing centre in Ólafsfjörður, a branch fjord from Eyjafjörður. Anchorage is in 6½ fm. in middle of bay, about 1·5 km. north-west of pier (a); good holding ground in hard sand. Long low swell even on calm days, heavy surf with winds above force 4 from north-east, north or south-west; anchorage then inadvisable. Work has been started on a breakwater from Brimnes to protect piers from north-east winds. The town has grown rapidly in importance; large and well-equipped herring-barrelling factory; ice house; small cod-liver oil factory, connected to village by rail track; fish-salting establishment in north-west of bay; fox farm. Many modern concrete houses. No road communication with other towns; mountains rise steeply on both sides of fjord
Raufarhöfn Lat. 66° 27′ N Long. 15° 56′ W Population 218 (1935) Plate 34	(a) Two main wooden L-shaped piers; both have frontage of 15 m. (48 ft.) (b) Four other wooden piers	15 ft. and 12 ft.	Herring boats alongside inner main pier are unloaded by small cranes into elevator. c. 2,000 tons of coal in June. Fuel-oil tank capacity 1,000 gal. Small repair shop. Large warehouse used for fish meal	Herring fishing centre on lowlying eastern side of Melrakkasljetta. Anchorage in 5½ fm. outside harbour. Entrance is shallow; requires local knowledge. Impossible to enter in strong north or north-east winds. Large vessels cannot turn round at high water without grounding. Considerable silting of harbour; depths alongside piers vary in winter when dredging is not in progress. Channel to piers, 200–300 ft. wide, is being dredged to 16 ft. Entire industry of town dependent upon large herring-oil and fish-meal factory owned by government. Has its own electric power plant and three herring-oil tanks with total capacity of 5,000 tons. Water supply from wells. Normal local craft six to eight motor boats, but during herring season harbour is crowded

MINOR PORTS (*continued*)

Port	Berthing facilities: Berths	Berthing facilities: Depths	Port facilities	Notes
Sandgerði Lat. 64° 03′ N Long. 22° 43′ W Population ?	(*a*) North jetty. Length 184 m. (605 ft.). Width 10 m. (32 ft.) at shore end, 7 m. (22 ft.) at sea end (*b*) South jetty. Length 160 m. (525 ft.). Width 7 m. (22 ft.)	0 ft. (shore end) 8 ft. (sea end) 0 ft. (shore end) 6 ft. (sea end) (S.R. 8 ft.)	No lifting appliances. Electric light and sea water laid on. Normally *c.* 20–30 tons of coal. Fuel oil up to 11,000 gal. in barrels near quay. Fuel-oil tank, 500 gal. capacity. Seven warehouses	Fishing village on west side of Miðnes, south-west of Faxaflói. Small harbour formed by reefs to south and west, submerged at high water, and to north by two parallel concrete jetties, 22 m. apart. Anchorage in harbour suitable for ships up to 75 tons; twenty-five mooring buoys. Normal local craft about thirty-five 20- to 30-ton motor boats. Possible to berth alongside jetties at all times except in strong winds from north-west, west and south-west. Seasonal fluctuation in population due to cod fishing in winter. Refrigerating, salting and packing houses; cod-liver oil factory
Sandur Lat. 64° 55′ N Long. 23° 53′ W Population 434	Quay along landward side of harbour: often swamped at high tide	3 ft. (S.R. 9 ft.)	No lifting appliances. No electric light. Three warehouses	Fishing centre on north-west point of Snæfellsnes. Approach difficult owing to reefs; vessels of any size can anchor about 1 km. from shore in gentle offshore winds; impossible in bad weather. Very small harbour sheltered by concrete breakwaters; depth at entrance 6 ft. suitable only for boats up to 10 tons. Normal local craft seventeen motor boats of 3–5 tons. Small cod-liver oil factory. Nearest road is at Ólafsvík, 8 km. to east
Sauðárkrókur Lat. 65° 45′ N Long. 19° 40′ W Population 959	(*a*) New stone and concrete breakwater. Length 168 m. (550 ft.). Width 8 m. (27 ft.)	—	Electric light and water laid on (*b*). Several small warehouses	Farming and fishing centre in south-west of Skagafjörður. Harbour gives good shelter in any weather. Breakwater about 1 km. north of town; longshore drift in

	(*b*) L-shaped jetty extending from inner side of breakwater (*c*) Wooden pier	18 ft. 19 ft.		fjord is building up a shoal on its seaward-facing side. Normal local craft twenty small motor boats. Dairy; slaughter-house; mutton-freezing, fish-filleting and fish-freezing establishments
Skagaströnd Lat. 65° 49′ N Long. 20° 20′ W Population 324 Ad.Ch. 3001	(*a*) Stone breakwater. Length 110 m. (360 ft.). Width 18 m. (60 ft.) (*b*) Two wooden piers extending from sheltered east side of breakwater	16 ft. (sea end) 12 ft. (end of outer pier) 4 ft. (end of inner pier)	No lifting appliances. Warehouse 46 m. (150 ft.) by 18 m. (60 ft.) just inshore of inner pier	Fishing port in small bay on east shore of Húnaflói. Harbour unprotected from south; partially protected on west by breakwater. Depth in outer harbour 12 ft.; in inner harbour 3–4 ft. Fish-freezing factory (the only building with electric light), ice house
Stokkseyri Lat. 63° 50′ N Long. 21° 04′ W Population 469	Small wooden (?) pier	6–12 ft.	—	Trading station, of little importance, having similar coastal features to neighbouring town of Eyrarbakki. Very exposed to wind and swell. Considerable decline in population since 1920
Stykkishólmur Lat. 22° 43′ N Long. 65° 05′ W Population 656 Ad.Ch. 2240 Plate 66	(*a*) Z-shaped wooden pier partly on wooden piles, partly on concrete blocks (*b*) Smaller wooden pier east of (*a*)	17–20 ft. (along outer arm)	Warehouse on small rocky islet, half way along pier	Most important place in Breiðifjörður; trading station on south shore of fjord. Approach dangerous because of innumerable reefs and islets. Although sheltered anchorage in 9 fm. is found between island of Súgandisey and mainland, the holding ground is poor. Larger ships find better holding ground in 15 fm. east of island, but better anchorage is more exposed to north-east winds
Suðureyri Lat. 66° 08′ N Long. 23° 32′ W Population 362	?	?	?	Flourishing small town on south shore of Súgandafjörður. Base for large number of small herring drifters; submerged sandspit across fjord mouth prevents large vessels from entering

MINOR PORTS (*continued*)

Port	Berthing facilities		Port facilities	Notes
	Berths	Depths		
Svalbarðseyri Lat. 65° 44′ N Long. 18° 05′ W Population 37 (1935)	Wooden pier. Length 34 m. (110 ft.). Width 3 m. (10 ft.), strongly built	6 ft. (sea end)	—	Farming centre on sandspit on east shore of Eyjafjörður, 6 km. north-east of Akureyri. No offshore dangers. Formerly one of largest herring centres in Iceland, but has been completely eclipsed by development of Djúpavík and Raufarhöfn. Rich pastureland in neighbourhood. Two slaughterhouses; freezing house for mutton; leather manufacture. Water has to be fetched in carts from wells
Sveinseyri Lat. 65° 37′ N Long. 23° 50′ W Population ? Ad.Ch. 2999	Wooden pier. Length 61 m. (200 ft.). Width 12 m. (40 ft.)	18 ft.	30 ft. slipway for whales: several steam winches. Normally *c.* 2,400 tons of coal. Large warehouse	Whaling station at head of Tálknafjörður—only one which has operated in Iceland during last 25 years (for details see p. 321). Activities suspended during war. No other occupations; normally about forty to fifty men were employed. Anchorage in bay in depths of 7–12 fm.
Vatneyri Lat. 65° 35′ N Long. 23° 59′ W Population 724 Ad.Ch. 2999 Plate 35	Wooden pier 37 m. (120 ft.) by 30 m. (100 ft.), strongly built	20 ft.	1½ ton crane worked by petrol motor. Electric light and water laid on. Several well-built warehouses. Machine shop capable of minor repairs	Prosperous trading station and fishing centre on sandspit on north shore of Patreksfjörður. Ships can berth alongside pier in all but south and south-west winds, when good anchorage can be found in sandy bay on opposite side of fjord. Sheltered anchorage in 8–9 fm. in bay east of spit. Normally two trawlers and fifteen to twenty motor boats operate from the harbour. Fish-meal, fish-oil and freezing factories. Ice factory under construction
Vík Lat. 63° 25′ N Long. 19° 00′ W Plate 54	None	—	None	Most southerly settlement on mainland: south of Mýrdalsjökull. Farming centre; two slaughterhouses, co-operative store.

Population 232 (1935)				No harbour or facilities of any kind. Shore of steeply shelving black sand. Shallow water out to 550 m. from shore and any wind from east, south or west produces very heavy surf. Ships anchor about 1 km. from beach in offshore winds. Landing extremely hazardous with other winds
Vopnafjörður Lat. 65° 45′ N Long. 14° 50′ W Population 250 (1935) Ad.Ch. 2978	Small stone jetty. Length 9 m. (30 ft.), suitable only for small boats	5 ft. (sea end)	—	Fishing and farming centre near head of fjord of same name. Approach difficult and narrow, passing between numerous submerged reefs and islets. Fjord notorious for mountain squalls which are more violent near shore than in mid-fjord. Anchorage in 2–3 fm. about 250 m. from shore; some shelter given by small island, but unsafe in strong winds from north and north-east. Mutton-freezing plant; co-operative store. Water from wells, sometimes scarce
Þingeyri Lat. 65° 53′ N Long. 23° 28′ W Population 375 Ad.Ch. 2998 Plates 38 and 39	T-shaped wooden pier on sheltered east side of spit. Length 33 m. (110 ft.). Cross-head has frontage of 11 m. (36 ft.) in poor repair	22 ft.	Fitted with rail track to repair shop. Electric light and water laid on. Excellent repair shop. Crane capable of lifting $1\frac{1}{2}$ tons. Several warehouses	Fishing village on sandspit on south side of Dýrafjörður. Has been used for many years by British trawlers, owing to exceptionally good repair facilities; three lathes (one with a 9 in. bed and a 6 in. throw), drilling machine, mechanical saw, shaping machines, smithy, foundry capable of making castings up to 300 lb. Probably the second best repair shop in Iceland. Good anchorage off pier, according to draught. Normal local craft two trawlers and about twelve 10-ton motor boats. Fish-curing, freezing and filleting factory. On opposite side of fjord a rough road leads to Ísafjörður, but this is only open for motor transport in summer

MINOR PORTS (*continued*)

Port	Berthing facilities		Port facilities	Notes
	Berths	Depths		
Þórshöfn Lat. 66° 11′ N Long. 15° 20′ W Population 185 (1935) Ad.Ch. 2978	(*a*) Small stone jetty (*b*) Wooden pier. Protected from west by stone breakwater and suitable only for small craft	—	—	Fishing and farming centre on east side of Lónafjörður, a branch of Þistilfjörður. Easy approach, but anchorage impossible in strong winds from north, north-west or west. Larger vessels must anchor in 4½ fm. about 1 km. south of village. Normal local craft six 10-ton and several smaller motor boats. Mutton-freezing factory and co-operative store. Good road towards Raufarhöfn, not yet completed

R.A.F.

Plate 77. Neskaupstaður, a township in Norðfjörður, is the most important fishing centre on the east coast. Part of the long narrow Mjóifjörður appears in the distance. In the fjord regions there is little flat land for settlement (see Fig. 97 for map).

R.A.F.

Plate 78. Seyðisfjörður, in east Iceland. The telegraph cable from Great Britain lands here. The fjord valley shows the characteristic form resulting from glacial erosion (see Fig. 98 for map).

Chapter XII

AGRICULTURE

Soils and the Extent of Farming: Estates and Land Tenure: The Development of Agriculture: Cultivation: Crops: Livestock and Livestock Products: The Farmer's Year: Reafforestation: Eider-Duck Farming: Co-operative Societies: Organization and Research

Soils and the Extent of Farming

The soil all over the country has a fairly uniform constitution, being derived almost without exception from basic igneous rocks. On the highlands and in the neighbourhood of the glaciers there is little organic matter. Nearer sea level the stratum of humus increases in thickness and in many places is more than a metre deep. Decomposition of the basalts is slow, and glacier detritus, volcanic ash and wind deposits commonly build the loose superficial material. In some districts there is serious soil erosion by wind (see p. 56).

Analyses of the soil constituents soluble in hydrochloric acid show a high content of iron oxide and phosphate and a low content of calcium carbonate. Figures for substances in the rivers (in grams per 5,000 l. of water) compared with Danish rivers are as follows:

	Danish rivers	Hörgá	Eyjafjarðará	Hvítá (Borgarfjörður)	Hvítá (Árnessýsla)	Þjorsá
Potash (K_2O)	10–15	13·50	11·50	11·00	12·5–17·5	11·0–15·5
Phosphate (P_2O_5)	0·6–1·0	1·05	5·00	4·35	1·5–3·5	5·6–19·5
Lime (CaO)	100–700	33·02	35·00	41·50	21–37	49–82
Nitrogen (N)	15–20	1·37	4·65	1·35	4·9–14·1	4·6–6·5

An effect of the poverty in lime is seen in the extremely thin shells of the fresh-water animals.

In spite of the poor quality of the soil and the uncertain weather conditions, farming has been the chief occupation of the Icelanders since the time of the first colonization. Formerly it constituted almost their only means of livelihood, but in recent years fishing, commerce and other industries have developed to such an extent that, in spite of the increased population, the number of those who live by farming is considerably less than it was a generation ago.

Iceland has an area of 10,285,000 ha., three-fifths of which are uninhabited. The highlands are largely infertile, but some areas are used as mountain pasture for sheep and horses, which in spring are driven inland and left to graze untended during the summer months. The total area of inhabited land amounts to about 3,800,000 ha. Of this only 40,000 ha. are cultivated. Of the rest some 80,000 ha. are birch 'forest', and some 3,500,000 ha. are rough grazing grounds, mostly unfit for cultivation.

The main agricultural districts are shown in Fig. 99.

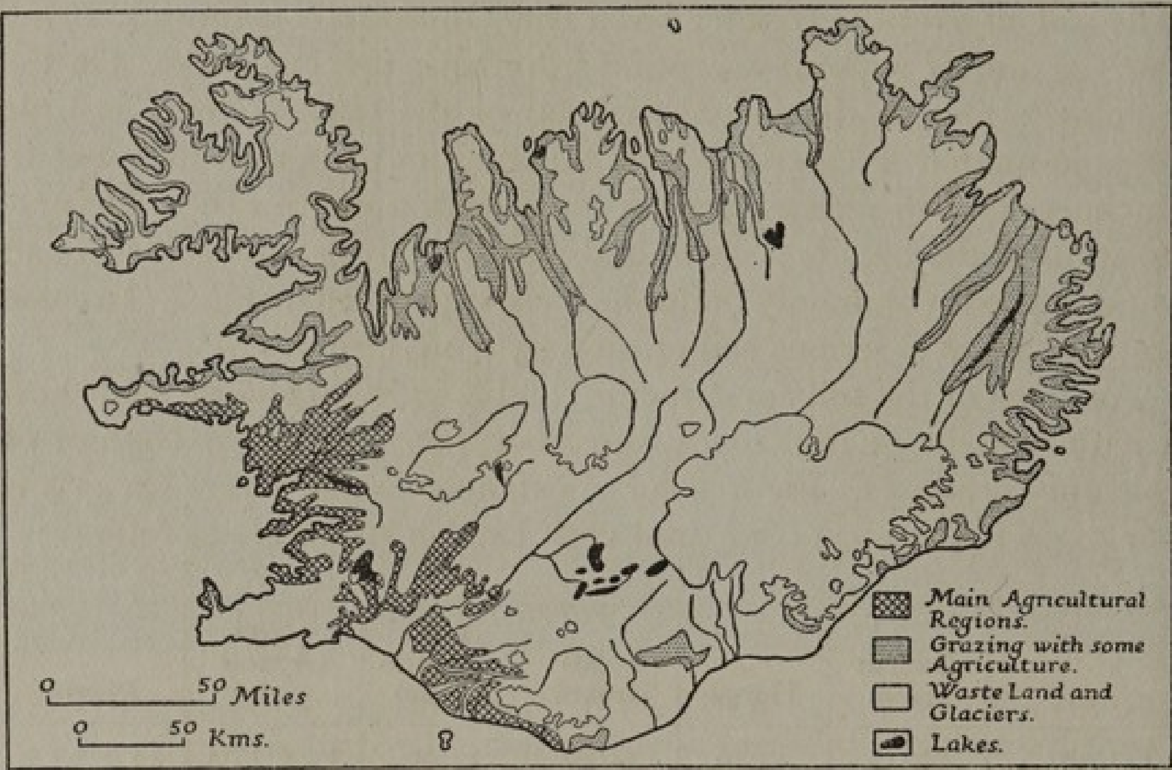


Fig. 99. Main agricultural districts.

Estates and Land Tenure

According to the census of 1930 the number of farmers in Iceland was then 6,600, with an additional 500 who carried on farming as a subsidiary source of income. The country is divided into 6,200 farms, some of which are parcelled out among two or more farmers.

Icelandic farmhouses are usually isolated, standing within the boundaries of their own land. Sometimes two or three farmhouses are built together and the estate is parcelled out between them. The farms average about 500–600 ha., but most of this area is uncultivated land with little vegetation. The average cultivated area per farm is about 6 ha., and that of irrigated hay meadows about 30 ha. As the uncultivated tracts are so extensive in comparison with the cultivated, the value of a farm does not depend on its size, but on the quality of the soil. While it is known that the total area of manured homefields (see p. 291) is near 32,000 ha., and that of vegetable gardens about 500 ha., meadowland, 'forests' and rough grazings have not yet been precisely mapped.

A general survey of land values is made every 10 years. The last survey (1930) showed land and buildings valued at Kr. 46,777,000. The average value of a farm is thus a little over Kr. 7,000.

During the last two centuries there have been marked changes in land ownership. In 1695 only forty-seven farms out of a total of 4,058 belonged to Icelanders; the rest being owned by king and church. In the middle of the eighteenth century about half of the inhabited lands were either national estates, church lands or farms owned by the bishops' sees. Towards the end of the eighteenth century and during the first decades of the nineteenth century all farms belonging to the sees and a great many of the national estates were sold to private owners. In 1905 the government was authorized to sell all national estates, and in 1907 all church lands. About 83 % of the farms are now privately owned, the rest being state property (10 % church lands, 6 % national estates, and 1 % owned by public funds and municipalities).

About 48 % of the farmers are now freeholders; the remainder are tenant farmers. Of the latter about 60 % are tenants of private persons and 40 % rent public lands. With the rise in purchasing power, the number of freeholders is increasing. In 1850 only 17 % were freeholders, while in 1910 their number had risen to 37 %.

THE DEVELOPMENT OF AGRICULTURE

The community in saga times was an agricultural community, but until the end of the nineteenth century there was little planned cultivation of the soil. About 1845 a number of societies were formed with a view to promoting agriculture by levelling, draining and irrigation. At first these societies were small local organizations, but in 1887 they began to receive annual government grants in proportion to the improvement work carried out during the previous year. In 1893 there were ninety such societies receiving government support, and by 1916 their number had grown to 159. The war of 1914–18 caused many of them to suspend activities, but after 1920 the movement regained its former importance, and there are now about 216 societies of this kind, covering almost every parish in the country. Little real progress was made until 1923, when the Improvement of Estates Act raised the grants. These grants, which in 1887 totalled Kr. 6,000, gradually rose, and in 1920 they amounted in all to Kr. 30,000. In 1925, when the Improvement of Estates Act came into force, they had risen to Kr. 143,000 and in 1935 to Kr. 588,000. The act was revised in 1936, the grants being apportioned more fairly according to the needs of the individual estates.

The major achievements resulting from these measures are outlined in Appendix VII, tables 1 and 2. It will be seen from these tables that cultivation did not begin on a large scale until the Improvement of Estates Act came into force. Since 1925 more has been accomplished in single years than previously in decades.

The act of 1936 provided for the establishment of new farms on unoccupied land and for the formation of farming colonies on co-operative principles. Under this act the government is authorized to assist the greatest possible number of people to obtain farms in the undeveloped areas where animal husbandry and agriculture can be their chief occupations. Grants are not repayable, the full value being handed down in due course to the farmer's successors.

Various government funds are available for the assistance of farmers. The Farmers' Bank of Iceland (*Búnaðarbanki Íslands*), operated by the state, was established by an act of the *Alþingi* in 1929. Its chief business is to make loans for various enterprises connected with agriculture. Until the formation of this institution the farmers had no access to capital and were thereby handicapped in developing progressive agricultural and housing measures. In addition to general banking, the Farmers' Bank arranges mortgages and loans, and has two special funds at its disposal:

The Agricultural Fund (*Ræktunarsjóður*) was established in 1925, its object being to promote agriculture and contribute to the improvement of rural housing. The Building and Colonization Fund (*Byggingar- og landnámssjóður*) was established in 1928 in order to increase the number of farms in the country and to maintain those already in existence. This aim is achieved by granting loans and by building new farms on lands owned by the state or purchased by it for that purpose.

A special Crisis Fund (*Kreppulánasjóður*) was established in 1935 with the object of granting loans to farmers to pay off their old debts, provided creditors would abate their unsecured claims to an extent which would enable the farmers to re-establish their farming on a sound basis. Loans from this fund were made only during the period between 19 June and 31 December 1935. In all, 2,844 farmers were enabled to liquidate their debts and make a fresh start.

The amount expended by the Treasury on agriculture has increased enormously during the past 60 years—from Kr. 2,400 in 1876 to Kr. 1,837,000 in 1935. In spite of the fact that a large number of agricultural workers have gone over to other occupations since the close of the nineteenth century (see Fig. 84), the total production has increased. Table 4, Appendix VII, summarizes the main changes that have occurred since 1900.

The results of the government agricultural policy may be measured by the following figures of the increase in production between 1900 and 1934: pork 168%, other meat 50%, milk 84%, wool 69%, vegetables 180%, eggs 2,300%.

Cultivation

Most farms have a homefield (*tún*), hay meadows, home pastures and mountain pastures (see Plate 81). The *tún* is cultivated land, most frequently situated around the farm buildings and enclosed by turf walls. In former times it was hummocky and was cultivated only to the extent that manure was spread on it once a year. To-day the *tún* is generally cultivated either by special hummock-extracting machinery (*þúfnabanar*) or by ploughing. The growth of hummocks, due to frost action (see p. 56 and Plate 80), prevents the use of mowing machines in most of the natural hay meadows. Many of them have therefore been levelled by two different processes. *Þaksléttur* is old cultivated land where the tufts and hummocks have been levelled after the turf has been cut off, ploughed and manured, and then re-covered with the turf. *Sáðsléttur* is newer meadowland which has been levelled and ploughed and then sown with grass. A great deal of grass is still cut by hand scythe, especially in the distant meadows, and most of it is still brought home as bundles slung across the backs of horses. The hay meadows are usually surrounded by wire fencing, beyond which lie the pasture lands.

Drainage and irrigation work has been undertaken on a large scale in the south-western lowlands. In the region bordering the Hvítá in Árnessýsla, the water from the river is led by canals and drains to flood an area of about 11,500 ha. belonging to 166 farms.

The resultant mud deposits support a hay crop which can be cut by machine, but the value of this somewhat costly experiment is much debated.

Crops

There are records in the sagas of the sowing of corn, but the climate of Iceland is not suitable for cereal crops. In recent times, grain (chiefly barley) has been grown experimentally; it scarcely ripens, even in the finest summer, although it can be used as fodder.

Hay. All farming in Iceland is based on the cultivation of grass. The hay from the homefield is used for dairy cows and only for other cattle if there is an adequate supply. When horses and sheep are unable to graze in winter, they are fed on a different type of hay which grows in the unlevelled meadows. During the last 40 years the area of homefields and the yield of homefield hay has been almost doubled, while the yield of meadow hay has remained about the same. With good manure (stable manure and fish refuse), the homefields yield two or three crops each summer.

The task of drying the hay and storing it is not easy in such a wet climate. A method has been quite extensively adopted for preparing 'sour hay' (*súrhey*), which is not dry, but withstands mould and does not develop heat. The storage of dry hay in silage barns is rapidly being more widely adopted.

Vegetables. Near some of the towns and coastal villages where the soil is sandy considerable quantities of potatoes are grown, and, in south Iceland especially, almost every farm has a small plot where potatoes and turnips are raised. The potato crop has increased four-fold since 1900, but still the output does not satisfy the home market and about one-third of the country's requirements have to be imported. In 1936 the *Alþingi* passed an act to encourage production by granting subsidies (for 1936–8) to those growers who increased their output of 1935; by fixing a minimum price; by establishing a state wholesale business in potatoes; and by reserving for the state the sole right of importing foreign potatoes.

During the past few years considerable interest has been taken in foreign research carried out with a view to producing a variety of potato capable of resisting frost. Some of the varieties introduced into Sweden from South America have been tried in Iceland, but without any positive results. On the other hand, the more general experiments with various types of potatoes have led to definite progress, both as regards quality and quantity. The potato harvest has been as follows in the last few years:

	Metric tons		Metric tons
1930	3,631	1938	6,500
1935	4,605	1939	11,600
1936	8,437	1940	6,400
1937	6,500	1941	c. 12,000

Rhubarb and black currants are grown in comparatively large quantities, and cabbages and carrots in small quantities, but there is still a definite shortage of fresh vegetables. Wild bilberries (*blá-ber*) and crowberries (*kræki-ber*) are everywhere gathered for human consumption.

Hot-houses. Hot-house cultivation, especially of tomatoes, has increased very considerably in Iceland during the last 10 years, and at present some 12,000 sq. m. of land are under glass—chiefly in the neighbourhood of hot springs. The springs at Álafoss, which yield hot water to Reykjavík (see p. 333), are also used locally for horticultural and market gardening. In many places hot-water pipes have been buried in the soil, and the cultivation of potatoes and pot herbs has been improved thereby, as the plants are not so liable to the effects of summer frosts.

The number of flowers and vegetables which can stand the rather bleak Icelandic summer is very limited, and this branch of agriculture is receiving increasing attention. The village of Hveragerði, about half-way between Reykjavík and Stokkseyri, has sprung up in a hot-spring region during the last 10 years, and the community of 300–400 inhabitants is almost entirely occupied with hot-house agriculture. The largest group of about a dozen hot-houses is owned by the State Agricultural College (*Garðyrkjuskóli*). This college, which was founded in 1938, has at present 12–16 pupils. It is planned to increase the area under glass, and borings have been made near a hot spring in the immediate vicinity to a depth of 50 m. The existing source of hot water, a 25 m. boring farther down the valley, is sufficient for present purposes and delivers water at a temperature of 85° C. Flowers, tomatoes, grapes and cucumbers are among the chief products of the college, but a private horticulturalist has been able to produce such exotic fruits as bananas by the addition of electrical heating in her hot-houses.

Livestock and Livestock Products

According to the official statistics the numbers of livestock in 1939 were as follows:

Sheep	593,785
Cattle	37,412
Horses	52,545
Goats	1,600
Poultry	78,000
Silver foxes	3,300
Other fur-bearing animals	2,500

Further details are summarized in Appendix VII, tables 3 and 4.

Sheep. In proportion to the number of inhabitants, Iceland has more sheep than any other country in the northern hemisphere. There are six to each person, whereas in Bulgaria, which comes next, the average is only 1·5 per person.

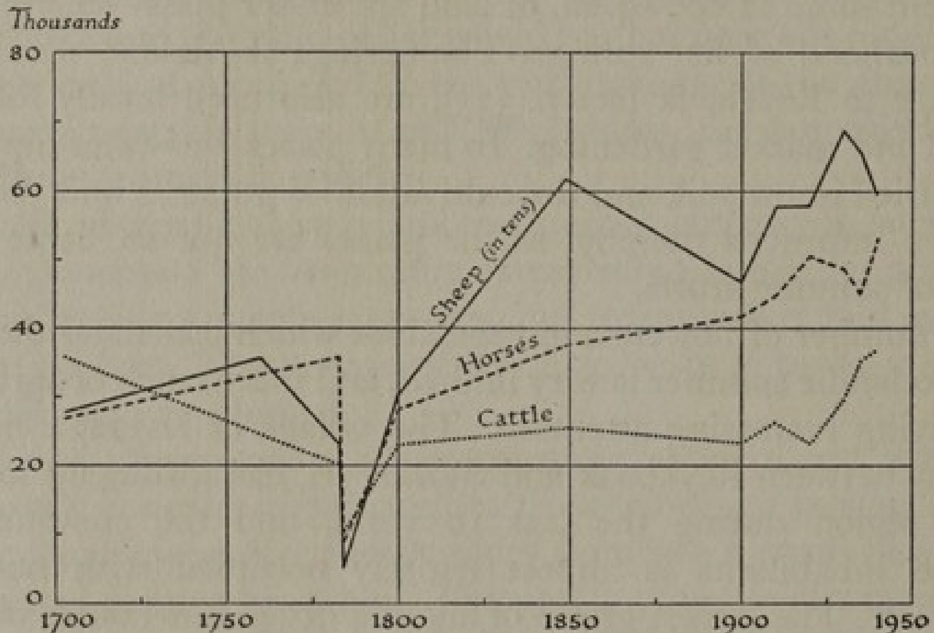


Fig. 100. Number of sheep, horses and cattle, 1703–1939. The number of sheep has been divided by 10. Note the decrease caused by the eruption of Laki in 1783. Compiled from data collected by A. G. Eylands, *Tidsskrift for Landøkonomi*, pp. 120–3 (Copenhagen, 1938).

The rearing of sheep has always played an important part in Icelandic husbandry, but in hard times, when the hay reserve has been insufficient for winter feed, the flock has often been considerably depleted. Owing to the destruction of the pastures during the eruptions of Laki in 1783, the number of sheep fell to about 50,000, but by 1800 it had reached its former level of about 300,000 (see Fig. 100).

The Iceland sheep is of Norwegian origin and is of the breed most common in northern Europe (*Ovis brachyura borealis* Pall.). It is comparatively small, with long flowing wool, and is a hardy animal. There are eight sheep-breeding farms in the country, and these keep selected stocks which are sold to the farmers. Some years ago attempts were made to improve the stock by crossing with foreign breeds. Unfortunately the attempt resulted in a mysterious sheep disease, and no further attempt at crossing has been made.

The traditional household management in Iceland has been a form of home industry where each farm has had to be self-supporting. In former times this depended chiefly on utilizing the meat, entrails, skin, wool, milk and in some measure the dung of the sheep. Less attention is now being paid to the milk and the foods prepared from it, and more to the wool and fat lamb meat, which is exported in the autumn in a fresh or frozen condition. The emphasis is being placed on sales in foreign markets, since a large variety of goods is imported.

During the summer the sheep from a town or district graze untended in the mountains. Towards the end of September they are driven into large corrals (*réttir*), and sorted out by their owners, before being driven home for the winter. A very large number of men and horses are encamped in the mountains during these sheep-herding weeks, and the ancient games and sports are revived. Sheep culture and everything connected with it still constitutes a conservative and conserving element in Icelandic rural life, for it has adapted itself to modern requirements less than the raising of other domestic animals.

Cattle. The number of cattle is now considerably lower than in former centuries. From the time of the colonization until about 30 years ago little was done to improve the stock by rational breeding. At present there are in Iceland about 100 cattle-breeding and inspection societies with a membership of about 2,300 farmers who own about 11,000 cows. The societies select animals for breeding purposes, keep records of fodder and milk, and measure butter-fat content of the milk. About one-third of all the cows are now owned by the cattle-breeding societies.

The meat is of rather poor quality. The average annual milk production per cow is estimated at 2,400 kg., though a few may yield over 4,000 kg. A preliminary investigation shows that the butter-fat content averages between 3·5 and 4%.

The cattle, like the sheep, were formerly obliged to spend a large part of the year out in the open. They suffered considerably from this treatment, and after the middle of the nineteenth century this perennial grazing was gradually discontinued with the increase in the production of hay. Each farm has its cow sheds, and in many localities the animals are given unripe grain and other nourishing fodder in addition to hay.

Dairy Produce. Milk is used either directly for human consumption, or for the making of butter, cheese and *skyr*. *Skyr* is an Icelandic speciality somewhat like Bulgarian *yogurth* or Iranian *sgirr*. It is a type of home-produced, semi-liquid, sour curds, which has a high food value and vitamin content. It was formerly very widely used as a food throughout Iceland, but is now being replaced more and more by imported foods. *Skyr* is eaten with cream and sugar; it must never be eaten with alcohol as the mixture causes painful flatulence. It is also used as a preservative for meat, fish and vegetables.

Butter making has been considerable, both at the farms, and, more recently, at the co-operative dairies (see p. 305). The butter made at the dairies is mostly sold to the towns, while that produced at the farms is consumed at home. If insufficient, it is supplemented by margarine from the factories which have lately been established. In recent years an increasing quantity of cheese has been made for export. The canned milk industry now fully satisfies the home market, whereas, before 1932, considerable quantities of canned milk were imported.

In 1934 a law was passed respecting the treatment and sale of milk. The country is divided into price-equalization regions, and milk producers are forbidden to sell milk or milk products outside their respective regions. The retail price of milk is fixed by local boards, while a board of seven government officials manages the marketing throughout the country.

Horses. Compared with the number of inhabitants, horses are more numerous in Iceland than in any other European country; more than one to every three persons. The main reason for this is that, until recently, horses have been almost the only means of overland communication. In some districts they are also reared for export, but this trade has dropped considerably in recent years (from 3,229 in 1910 to 475 in 1935). There are about fifty horse-breeding societies for improving both the treatment and the breed of horses. Some notes on these hardy animals, which cannot be too highly recommended for transport purposes, will be found on pp. 384–6.

Goats. These are found almost exclusively in Þingeyjarsýsla. They are decreasing in numbers, and there are now less than half the total recorded in 1930.

Poultry. Chicken farming has increased greatly during the last few years, and domestic fowls have about doubled their numbers since 1930. The wild ducks and geese of Iceland have suffered very seriously from the indiscrimate taking of their eggs. It appears that the most promising method of protecting these birds is to establish chicken farming on a more extensive scale.

Fur-bearing animals. Since about 1930 fox farming has become popular in Iceland. The high prices fetched in the European market have encouraged many farmers to enter the fur trade, but it is doubtful whether this activity is compatible with eider-duck farming (see pp. 299–303). The difficulty facing the fox farmer is to provide sufficient food. It is lawful to take gulls, puffins, guillemots, cormorants, shags and gannets for this purpose, but there is no reason to suppose, in spite of the protection laws, that the eider ducks, with other protected species, escape the general slaughter.

Reindeer. The environment of Iceland is well suited for reindeer (*Rangifer tarandus*), and four attempts have been made to introduce them. Eleven were brought to Rangárvallasýsla as early as 1771, but none of these survived. In 1776, 23 brought from Finland were established on Hvaleyri in Hafnarfjörður. Descendants of this herd survived in the Reykjanes peninsula until about 1920. In 1783 a small herd was taken to Vaðlaheiði in Eyjafjörður. These increased and spread over Þingeyjarsýsla, but 'disappeared' a few years ago. In 1787 the last attempt was made to introduce reindeer into Múlasýsla. Descendants of this herd still exist in a wild state in the north-eastern plateau, and numbered about 100 in the autumn of 1939.

The introduced animals thrived and increased rapidly in numbers. They began to compete with the sheep in the limited pastures and were therefore unpopular with the farmers who obtained permission to kill them. Hunting restrictions were gradually relaxed by laws of 1798 and 1817, and in 1849 unrestricted permission was given to hunt reindeer of both sexes and of all ages. This policy never allowed the herds to become firmly established. In 1939, however, the *Alþingi* gave complete protection to all reindeer, and the numbers are likely to increase again. It is still hotly debated whether they should be kept in enclosed reserves. Experiments are being conducted with a small herd near Þingvellir, apparently with a view to rearing reindeer as domestic animals.

Many of the farmers are able to supplement their incomes from other sources, such as eider-duck farming, salmon fishing, sealing (hair seals), and fowling (sea birds).

The Farmer's Year

The monthly weather reports published in Iceland include notes on the dates on which the various activities of the Icelandic farmer's year begin and end. It is the custom to draw up averages for the whole country, although there is often a considerable difference in the dates, for example, of planting potatoes in spring or of stabling the cattle in autumn between the milder south and the more snowy north-west. Broadly it may be said that cattle stay out-of-doors for 4–5 months (late May to early October) and find their own grazing from early June onward. Sheep graze freely for 7 months and often more; horses for much the same length of time. In some years both sheep and horses have remained out until January or even February near the south coast. Lambs are born in May or June, and are brought in at various dates in late autumn, depending on the locality and the season; the yearlings are turned out some time between the end of February and late April, although it is still necessary to feed them until some time in April or early May. It has already been pointed out (see p. 109) that great variations occur in the amount of snow-free pasture in winter, especially near the south and west coasts.

Work in the hay fields generally begins towards the end of April or early in May. Mowing is begun from late in June to mid-July and continues for about 10 weeks. The last hay is carried towards the end of August or in some places early in September; soon after this cattle must again be fed, though in favourable circumstances they may stay out until late in October.

Potatoes are planted from late May or early June and are taken up in mid-September. Occasionally planting has been tried in April with success.

The frost-free period in the milder parts of Iceland is commonly from early May to late September. The last snowfall of spring generally comes early in May, the first of autumn early in October. The last 'snow-cover' of spring is generally to be expected late in April, the first in autumn coming late in October. The Icelandic farmer's year is therefore largely devoted to saving as much hay as possible in the cool summer and feeding it to his stock through the long but variable winter, during which his sheep at least may still find a good deal of pasture.

J. H. Reynolds

Plate 79. Hvanneyri in Borgarfjörður. The building on the right is one of the two agricultural schools in Iceland.

L. Hawkes

Plate 80. Grass hummocks (*þufur*) in the *tún* at Eydalir in Breiðdalur. These hummocks, due to frost action, are very common in Iceland; their development makes grass cutting difficult.

V. Sigurgeirsson

Plate 81. A typical Icelandic farm at hay-making time. The dwelling house is built of concrete in the modern style, while the outbuildings are of the old type, thatched with turf. Most farms have a cultivated homefield (*tún*), hay meadows, home pastures and mountain pastures.

Reafforestation

Formerly there were only birch forests in Iceland. Efforts are now being made to grow other trees. There are at present about 80,000 ha. covered with birch, most of the trees being merely scrub $\frac{1}{2}$–2 m. in height. In areas which have been fenced, the birches exceed 2 m., particularly at Hallormsstaður in the north-east, where 600 ha. of birch, fenced there in 1905, have now grown to a height of 11 m. Some 2,500 ha. of birch forest have been fenced since 1938.

Attempts are being made to grow Norwegian pine and Alaskan spruce. The pine seeds have been obtained from forests north of Trondheim, and the seeds of the Sitka spruce from Valdez in Alaska. The climatic conditions at Valdez and at Eyrarbakki are almost identical. The method employed is to plant the spruce and pine seeds under birch trees, which afford protection until the young conifers begin to grow. With very few exceptions the cultivation of foreign trees has only proved successful when the planting has been carried out under the protection of birch trees, and the latter are cut down as soon as the new trees have become firmly established. It appears, therefore, that all waste land must first be planted with birch to prepare the way for other trees.

The work of reafforestation is in the hands of a Director of Forestry, who has a staff of four assistants. Various kinds of trees have been tested out in experimental plots as part of a scheme to reclaim as much as possible of the barren grounds. The most interesting experimental plantations are at Akureyri, where trees up to 7 m. in height are flourishing. There are government plantations in the neighbourhood of Reykjavík at Elliðavatn and Fossvogur. The farmers are not always anxious to own woodland. Some believe that the forest 'pulls the wool off the sheep' when they are grazing. However, an increasing number of Icelanders are demanding a systematic forest culture, and in 1930 a Forest Protection Society (*Skógræktarfjelag Íslands*) was formed. In 1941 the Director of Forestry started a vigorous campaign to make the public conscious of the necessity for preserving and extending the forests. This is especially important as a measure to combat soil erosion (see p. 56).

Eider-Duck Farming

In no country in Europe is the eider duck (*Somateria mollissima*) more abundant or of greater economic importance than in Iceland.

Owing to the special character of this industry, and because no adequate description of it is available elsewhere, the following account is more detailed than that of other farming activities.

The eider nests in large colonies in suitable areas (Fig. 101). The most usual nesting sites are small islands offshore, but the bird adapts its nesting habits very readily to its environment. Along the flat, open coast of north-east Iceland, the favourite sites are islands in the fresh-water or brackish lagoons which are a feature of this part of the coast, and which are separated from the sea by narrow storm

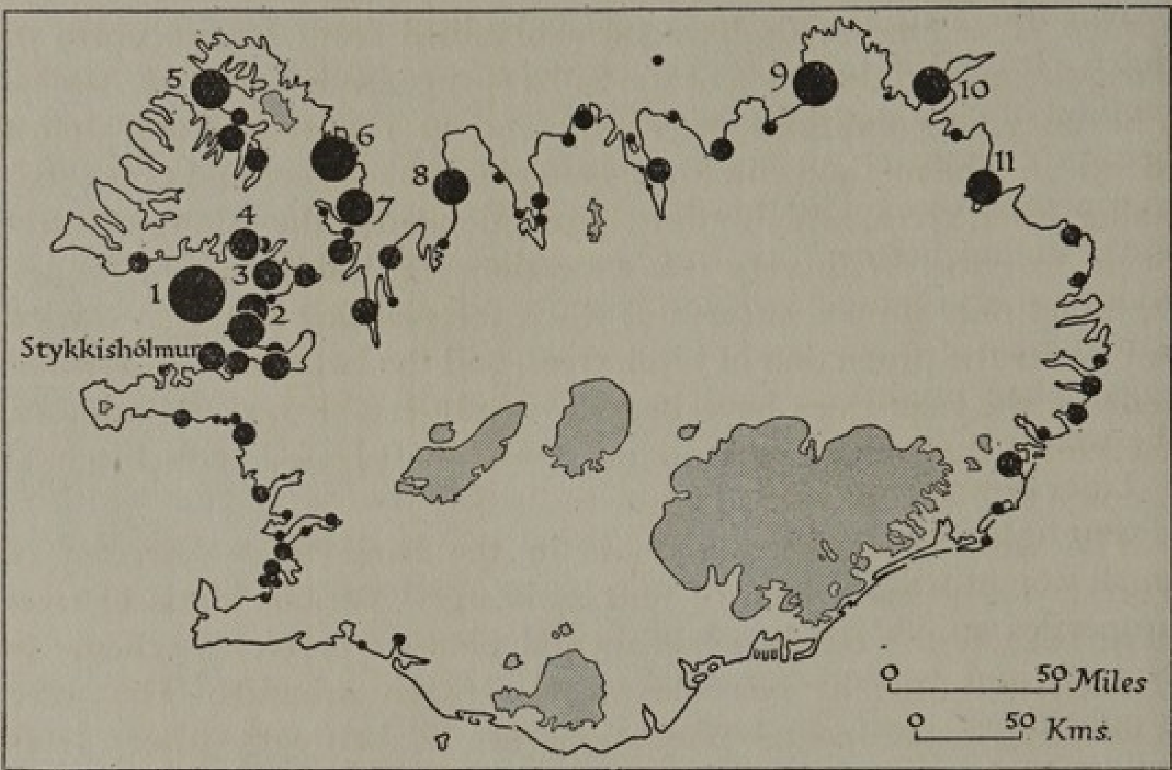


Fig. 101. Eiderdown collection areas. The areas of the circles are proportional to the quantity of down collected in a typical year (1936). The main centres are numbered as follows: 1, Flateyjar. 2, Klofnings and Skarðs. 3, Reykhóla. 4, Múla. 5, Snæfjalla. 6, Árnes. 7, Kaldrananes. 8, Vindhælis. 9, Presthóla. 10, Sauðanes. 11, Vopnarfjörður. Based on figures in *Hagskýrslur Íslands*, No. 98 (Reykjavík, 1938).

beaches. In north-west and west Iceland the majority of the colonies are situated on the rocky islets and beaches. Very few ducks nest along the south and south-east coasts of the island. The size of the breeding grounds varies widely, and may, in the course of a few years, be subject to considerable fluctuations. In 1914 Sauðanes in Þingeyjarsýsla contained 10,000 pairs, but most of the colonies are much smaller than this.

Throughout its range, the eider is an early nester. In Iceland, eggs are usually laid towards the end of March, but owing to the systematic removal of eggs by the farmers, the breeding season continues for a considerable length of time. The nest itself is usually a mere scrape or hollow in the ground, and is not very bulky. It consists of a little dry grass or seaweed, with an abundant warm lining of down which the duck plucks from her breast.

It is certain that the exploitation of the eider duck for its down has been carried on since very early times by the Norse peoples. As early as 1281, the Icelandic *Jónsbók* had forbidden the killing of eider under certain conditions. Records from the seventeenth and eighteenth centuries show that a considerable trade had by that time grown up. This trade appears to have been entirely in uncleaned down. It was not until the early seventeenth century that a successful method of cleaning down was invented, and a century later before it became customary to export clean down only. Until quite recently, the method of exploitation has remained substantially the same as in the eighteenth century, but rising prices have led some farmers to adopt a short-sighted policy in order to obtain big returns. The down is naturally of much greater importance than the eggs, although the eggs, when preserved, form a staple diet for many farmers during the winter.

Eider down is undoubtedly the warmest known form of bedding. It is very light indeed and clings together in a remarkable way. A very small weight will fill a pillow or quilt satisfactorily, and its insulating properties are very high owing to the quantity of air held in it. In Norway and Iceland the usual form of bedding consists merely of a light down quilt, encased in a washable sheet similar to a large pillow case. Very few of the 'eiderdowns' found in most British households to-day are filled with genuine eider down. About 2–3 kg. of down are required to fill such a quilt, and the cost of the down alone, even if bought on the spot from the farmer, would to-day be about £6. The cost of a genuine eiderdown in England (1939) would be not less than £15. However, genuine eider down is now being used extensively as a filling for light-weight sleeping bags, and it is likely to find an increasing market for this purpose.

Icelanders distinguish two types of down—*þang-dúnn* and *gras-dúnn*. *Þang-dúnn* is taken from nests with a foundation of seaweed, and contains small jagged bits of material which are difficult to extract. This somewhat decreases its value. *Þang-dúnn* is peculiar to those colonies situated on rocky islets and coasts. *Gras-dúnn* is cleaner and therefore more valuable, since it comes from colonies situated on grassland or marshes.

The method of cleaning down regularly employed since about 1775 is still used with very little modification to-day. A square frame is made of stout pieces of wood, and strings or leather thongs are stretched harp-like across, 1–2 cm. apart. They are adjusted to a fair tension. The frame is then held horizontally by two people who each grasp a pointed piece of wood to stroke the strings. A heap of down is placed in the centre of the frame and the stroking process begun. The down is gradually vibrated through the strings, and while the coarse feathers and rough pieces fall to the ground, the down remains hanging in a loose ball. The frame is then reversed and the process repeated. It takes a long time to clean even a small quantity properly, and a whole family may be occupied all winter in cleaning their down. The average annual yield on a large farm is anything up to 150 kg., but on a small farm it is rarely above 25 kg. Before the down is cleaned, it is gently heated, or, more frequently, laid out in the sun for a few days. This dries and, in the case of artificial heating, sterilizes the down, for it must be perfectly dry before cleaning.

At Stykkishólmur, on the west coast, is situated the only down-cleaning 'factory' in the country. This consists of a large shed with half a dozen frames set up against the wall on one side, while along the other side is placed a specially constructed baking stove. This contrivance is made of metal and has many shelf drawers like a large incubator. The temperature can be regulated to dry the down without damaging it. A number of girls are employed by the local co-operative society to work full time in the factory. The society buys uncleaned down from the farmers of the surrounding district, cleans it in the factory at an economical rate, and exports large quantities each year. So far, no machinery has been employed in place of manual labour. It is probable that more of these factories will be set up in the future.

During the latter part of the nineteenth century, eider farming expanded considerably owing to the greatly increased demand for down in European markets and the high prices which were being offered. Every effort was made by the farmers to enlarge existing colonies and to establish new ones. As a result of the measures adopted to protect and encourage the birds, the number of colonies grew from 116 in 1805 to 258 in 1914. In the same period the down production was increased by 360%.

The production of down has varied considerably in the course of the last two centuries. Statistics will be found in Appendix VII, Table 5. It will be seen that since 1928 a decline has set in. The demand for eider down has continued to increase, and the price has risen steadily since about 1905; in 1938 it was three times as much as in 1905—Kr. 63 as against Kr. 21 per kg. In spite of the high prices that farmers are able to get to-day, they are unable to increase their output because the number of breeding eiders in Iceland is rapidly decreasing. One duck will give between 12 and 18 g. per year. Estimating the amount as 12 g. there were in 1928 about 357,000 breeding ducks, and in 1938 about 232,000. These are, of course, minimum figures and by no means accurate, but they show that during the 10 years between 1928 and 1938 the number of breeding ducks decreased by some 125,000.

This decline in numbers may be attributed to three causes: first, a considerable increase in the number of greater black-backed gulls, which prey on the young ducks; secondly, over-exploitation of the ducks and careless management of the breeding grounds; thirdly, a great increase in illegal shooting and netting of the birds for food for the rapidly expanding fox farms. If appropriate measures are taken at once, there is no reason why the output of down could not be permanently raised to its former level, and Icelanders will undoubtedly give their support to the preservation of their most ancient industry and their best-loved bird.

Co-operative Societies

When the last of the Danish trade monopolies was annulled in 1854, the Icelandic merchants began to compete successfully with Danish firms. Shortly after this, Jón Sigurðsson, the greatest Icelandic statesman of modern times, advocated that the farmers 'band together to buy and sell' in order to improve their standard of living. This was the germ of the co-operative idea, but the first societies formed were joint-stock companies, and failed in their object because the merchants soon gained control of them.

It was not until 1882 that the first real co-operative society was established. The farmers of Þingeyjarsýsla organized for the purpose of marketing their sheep and other products in England and purchasing what they needed there in return. This society, which covered a large district, was made up of smaller groups. Each group appointed one of its members to collect the farmers' orders for supplies and at the same time obtain from them a promise to deliver a certain number of sheep in payment. These orders were sent to the headquarters of the society at Húsavík. From there arrangements were made with a wholesale firm in England to charter a ship and furnish the required goods. When the ship arrived, the farmers brought their sheep and other products to Húsavík to be sent to England by the same ship. If a farmer delivered more produce than was needed to pay for the goods he had ordered, he could either receive the value in cash or bank it with the society.

The society was able to pay the farmers a higher price for their products and to buy goods for them at a lower price than they could obtain from the local merchants. The success of this venture resulted in the rapid formation of similar societies in all the most important farming regions of the country. The merchants tried to meet this competition, and succeeded in some places in regaining the trade, largely because the business methods of the societies were rather complicated.

In 1902 the Federation of Icelandic Co-operative Societies (*Samband Íslenzkra Samvinnufélaga*) was formed. At first its activities were devoted entirely to propaganda, speakers being sent to the various farming communities. In 1906 a new impulse came into the movement. Hallgrímur Kristinsson, a young Icelander who had studied the methods of the Danish co-operatives, took charge of a small society at Akureyri. Instead of collecting orders from the farmers, he opened a store where they could obtain what they needed against the delivery of a stipulated number of sheep in the autumn. Non-members could deal with the society, but of course they did not share in the profits distributed to members at the end of the year—dividends proportional to the amount purchased. The Akureyri society soon became the largest in the country and all the others rapidly reorganized on the same principle.

Gradually most of the societies joined the federation. In 1915 it opened a wholesale office which now markets all the products of the societies and supplies them with consumer goods. This office is in Reykjavík, and there are branch offices in Copenhagen and Leith. For some years there was also an office in Hamburg, and, in April 1940, a new branch was opened in New York. In 1939 there were in the federation forty-six societies with a total membership of 14,000. Since each member may be said to represent a family of four, this means that practically half the population is connected with the co-operative movement.

In 1937 the turn-over of the federation was Kr. 25,600,000. It is thus by far the largest single business concern in Iceland. It controls the entire export of frozen mutton and about 90% of the total meat export. It controls about 80% of the wool export, and between 80 and 90% of the total export of agricultural products. It handles about 20% of the total imports, including most of the agricultural machinery. In addition to its wholesale activities, the federation operates a woollen mill, a clothing factory, a tannery and glove factory, a soap factory, and several other plants.

The federation has not ceased to pursue its original aim of spreading co-operative ideals. It publishes a monthly magazine, *Samvinnan* (=Co-operation), which is the most widely circulated periodical in the country. Since 1917 it has run a co-operative school (*Samvinnuskólinn*) offering a two-year course to train young people for service in its enterprises. About twenty-five students now take the leaving certificate annually. In 1920 the federation founded an auditing office for the co-operative societies.

Most of the local societies are situated in coastal towns and often their buildings occupy the best sites. Many of them own slaughter-houses and freezing plants, and some of them also have dairies and creameries supplied with the most modern equipment. The co-operatives encourage the farmers to improve the quality of their products by grading them and paying better prices for the best wares.

The Federation of Icelandic Co-operative Societies has, therefore, four main activities:

(1) The supply of information, auditing and instruction.
(2) The sale of Icelandic products.
(3) Acting as agent and wholesaler of imported goods.
(4) Maintaining factories.

Outside the federation there are several smaller co-operative societies. The most important application of the co-operative idea in recent years has been among the fishermen (see p. 323). In Reykjavík and several other towns co-operative building societies have been established (see p. 342).

The Icelandic co-operatives combine a consumers' society, a producers' society and a lending society. The clash of interests which arises in co-operatives of other countries between consumers and producers has in this way been avoided. Except for the credit allowances which are made, the present-day Icelandic co-operatives follow approximately the Rochdale system as devised in England. The principles are:

(1) Open membership and ownership, regardless of race, nationality, politics or religion.
(2) Each member casts one vote, regardless of his investment.

(3) Limited returns on capital, and return of gains to members through annual dividends.
(4) Regular provision of funds for the promotion of new ideas, for educational work, and for the building up of reserves.
(5) Cash trading at market prices.

Iceland's consumer refund averages 8%, and is as high as any in Europe. Dividends are paid in cash, though about 50% of each member's bonus is put into an endowment fund which is paid out in a lump sum when old age or retirement changes the economic status of the member.

It is possible in Iceland to obtain every requirement through a co-operative society. Goods are sold to member and non-member alike. The movement is now well established and has close connexions with the Scandinavian Co-operative Wholesale Society, which is regarded by some as a possible model for a general international intertrading association. It is urged by the promoters that this type of co-operation provides a solution of the industrial problem by showing capital as a hired yet contented servant. One interesting result of the system in Iceland is that many farmers carry on their business largely by exchange of goods without any cash transactions.

Organization and Research

The chief farmers' society is the Agricultural Association of Iceland (*Búnaðarfélag Íslands*), which was founded over a hundred years ago. In 1935 it had a membership of 2,600. The object of the association is the promotion of agriculture and allied industries, by research and experimental work, money grants, and guidance. The association also deals with all matters connected with the reclamation of sandy wastes. It employs a number of expert advisers in large-scale cultivation, horticulture, market gardening, livestock breeding, fox farming, fish hatching, irrigation and drainage work, and matters concerning farm machines and agricultural implements. It runs an experimental station at Samsstaðir in Fljótshlið and a vegetable research station at Laugarvatn. It has experimented with fodder for milch cows and sheep, and with the growing of various types of grain. The association sees to the carrying out of agricultural laws and inspects most agricultural work subsidized by the treasury, from which it receives an annual grant. It is, therefore, really a government department, though it was built up from the farmers' agricultural societies (see p. 289). There are now about 216 parish agricultural societies which form joint unions comprising one or more judicial districts. At present there are ten such unions which take the lead in all large-scale improvements. They elect representatives to the Agricultural Council (*Búnaðarþing*) in which is vested supreme power in all matters concerning the Agricultural Association. The council meets every two years in Reykjavík, and is made up of twenty-five representatives who prepare the estimates for expenditure and elect the director and governing board of the association.

Mention has already been made of the various societies which have been formed for the purpose of promoting the rational breeding and rearing of livestock. These also employ experts to advise the members, and are supported by annual government grants.

In addition to the State Agricultural College at Hveragerði (see p. 293), there are two agricultural schools, one at Hvanneyri in Borgarfjörður (Plate 79) and the other at Hólar in the north. Both are supported entirely by the state; they have model farms and accept from forty to fifty students for two-year courses. The University recently established a research laboratory, one department of which is to work directly for the benefit of agriculture.

In 1903 the Northlands Culture Society (*Ræktunarfélag Norðurland*) started an agricultural experimental research station at Akureyri, and this has continued to do useful work until the present day.

Chapter XIII

FISHERIES

General Features: Fishing Seasons and Fishermen: The Cod Fishery: The Herring Fishery: Subsidiary Fisheries: The Preparation and Sorting of Fish: Whaling: Public Institutions in the Service of the Fishing Industry: Regulations affecting Fishing in Territorial Waters.

General Features

Sea fishing is one of the principal industries of Iceland. The fishing grounds extend all round the island, out to and slightly beyond the 200 m. depth contour (Fig. 102). There are marked differences, both local and seasonal, in the hydrological conditions round the coast. Reference to Fig. 54 (showing ocean currents) and to Figs. 55 and 56 (showing surface temperatures of the sea) will be sufficient to give a general picture of the main changes which influence the fisheries.

The fauna off the south and west coasts is North Atlantic or Boreal, whilst off the north-east and east coasts it is Arctic. Off the north-west coast, where the hydrological conditions are mixed, the fauna is intermediate.

Many of the most important food-fishes spawn in the warmer waters off the south and west coasts, whilst their fry, together with the plankton organisms upon which they feed, drift along with the currents to the north-west, north and east coasts. They remain there, feeding on the enormous swarms of small crustaceans, until they are mature, and then move back to the warmer waters for spawning. After spawning they revisit the colder waters in search of food.

The productivity of the different fishing grounds varies according to the season of the year; those to the south-west and west of the island being most profitable in the early months, those to the south and south-east in May and June, and those to the north and north-east in the summer, particularly in July and August. In the late autumn and early winter, fishing takes place principally on the north coast.

The catch consists chiefly of cod (*þorskur*), though considerable quantities of coal fish or saithe (*ufsi*) and haddock (*ýsa*) are also obtained. There is a very important summer catch of herring (*síld*) along the north coast, and a lesser one in the spring in the neighbourhood of Faxaflói. Many other species of commercial importance are

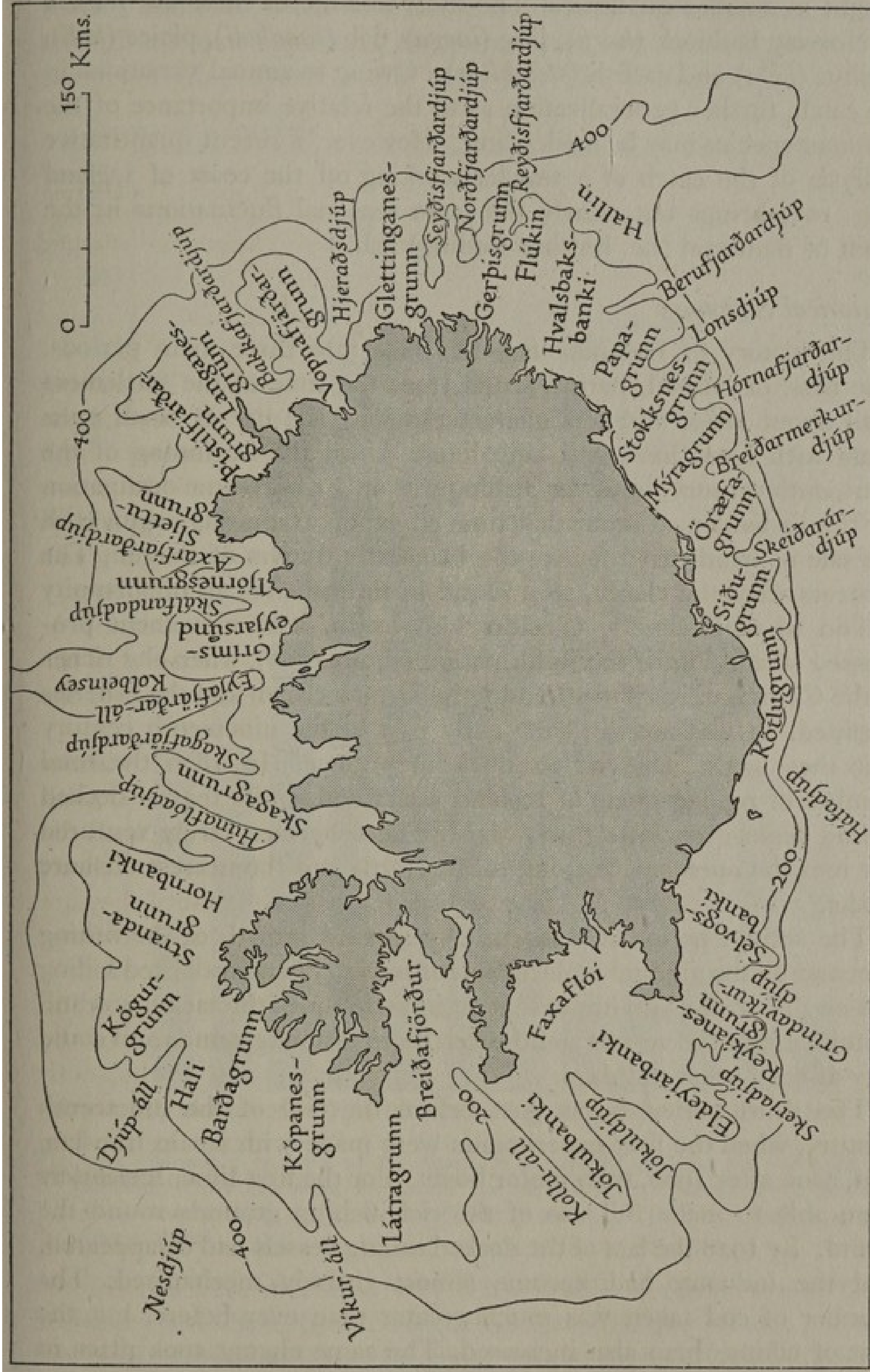


Fig. 102. Fishing grounds. The 200 m. and 400 m. submarine contours are shown. Based on information supplied by the Icelandic government.

caught in smaller quantities. The most notable of these are redfish or Norway haddock (*karfi*), ling (*langa*), dab (*sandkoli*), plaice (*koli*), halibut (*lúða*) and catfish (*steinbitur*). Owing to annual variations in the catch, further generalization as to the relative importance of the different species may be misleading. However, a recent quantitative analysis of the catch of a trawler working off the coast of Iceland (Fig. 103) brings out clearly the main seasonal fluctuations in the catch of demersal (i.e. bottom feeding) fish.

Historical Summary

The history of Icelandic fisheries falls into three main periods. The first, or coastal, period lasted from the time of the settlement until about 1880, and was characterized by the use of small open boats with hand lines and long lines. Until the beginning of the fourteenth century, however, fishing was only a part-time occupation for the Icelanders. About that time an export trade was begun with the sale of wind-dried fish to the Hanseatic traders of Bergen. The pioneers were the clergy, who found in the fisheries an opportunity to add to their already considerable wealth. The movement progressed steadily until the Reformation (about 1550), when the riches of the Church were confiscated by the Danish crown and the fisheries declined. It was not until the early part of the nineteenth century that they again achieved national importance. In 1876 the total number of rowing boats in Iceland was 3,208, while that of decked sailing vessels was only thirty-eight. The fishermen rarely ventured out into the open sea, keeping to the fjords and the nearest offshore banks.

The second period was marked by a rapid growth of the fishing fleet and by the gradual replacement of rowing boats by decked sailing vessels. There was no improvement in technique; the tackle was still primitive, but the vessels could reach more distant grounds and could stay at sea for several days.

The third period began just before the end of the nineteenth century, when the first experiments were made with steam trawlers, and, soon after 1900, with motor boats. For the first time, Icelanders were able to make full use of the rich fishing grounds round the island. By 1928 the last of the decked sailing vessels had disappeared, and the industry had become almost entirely mechanized. The number of cod taken was much greater than ever before, but the cost of taking them also increased. The same change took place in the herring industry. Until the beginning of the twentieth century herring had been taken only in the fjords, and even there on a small scale, but a new apparatus, the purse-seine net, made it possible to capture herring shoals in the open sea. The financial returns from

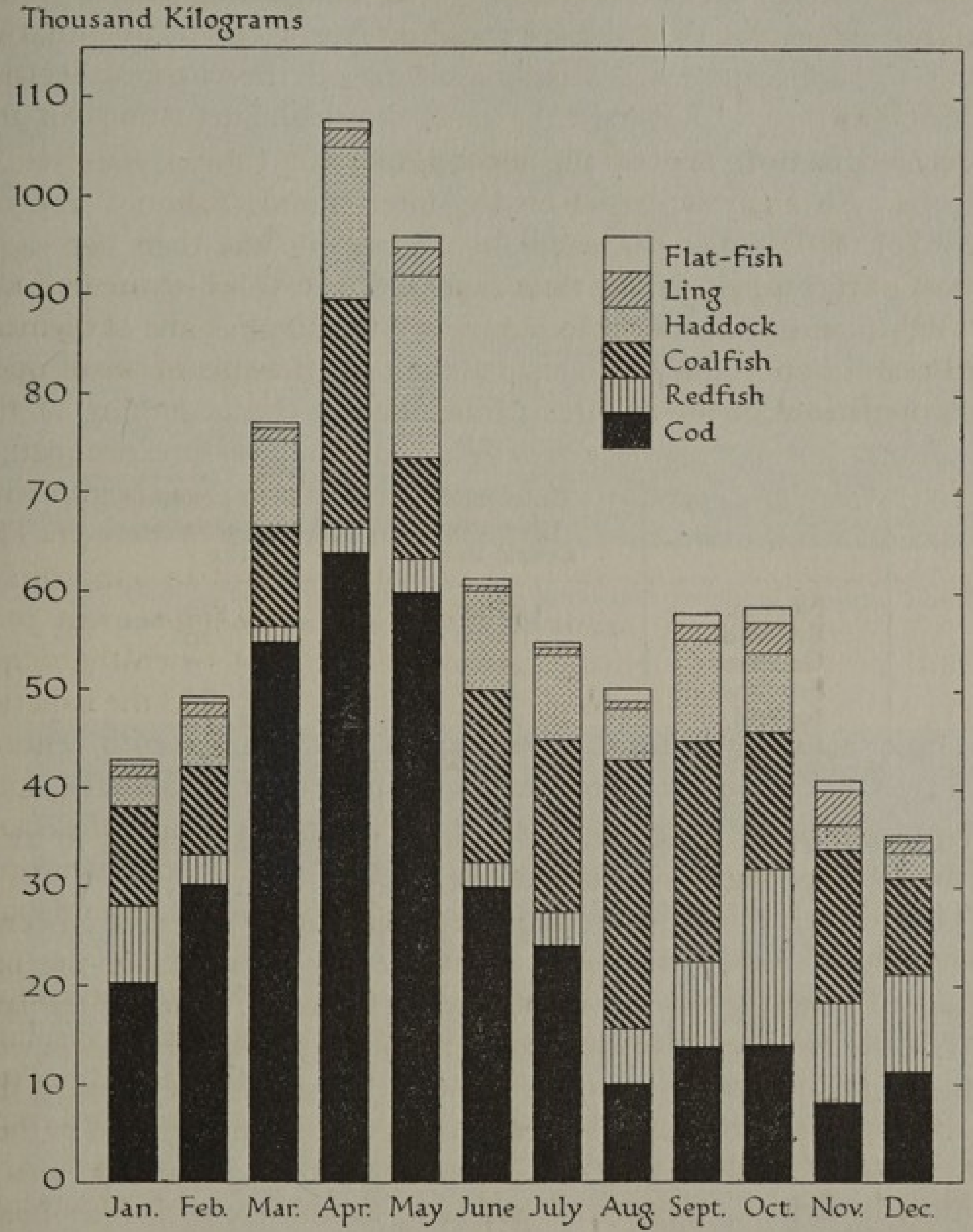


Fig. 103. Monthly analysis of the catch of a trawler working off the coast of Iceland. Only the most important species are shown. Source: J. le Gall, *Revue des Travaux de l'Office des Pêches Maritimes*, Tome III, Fasc. 3, p. 351 (Paris, 1930).

the fisheries have increased very considerably in recent years; first, because plants have been constructed for extracting oil and making fish-meal, and second, because more varied methods of curing have been adopted. As a result of increasingly efficient organization, the fishing industry in Iceland is becoming concentrated in a few main ports—thus following a phase of development which has already occurred in Britain and France.

Details of the composition and growth of the fleet since 1905 are given in Appendix VIII, tables 1 and 2.

Production

Iceland is now one of the most important fishing countries in Europe. An analysis, based on the international fisheries statistics for 1935, shows that the catch by Icelanders was then per capita almost seven times greater than that of Norway, which ranked first in total quantity. In order to appreciate the significance of the 1935 statistics it is necessary to consider the total production in terms of the populations of the countries concerned:

	Total catch (thousand metric tons)	Catch per head of population (kg.)
Norway	1,046·6	370
England	729·9	20
Germany	468·9	7
Scotland	279·7	32
Iceland	266·1	2,315
France	264·0	11

In recent years Icelandic waters have produced from 17 to 21 % of the total fishing output of Europe.

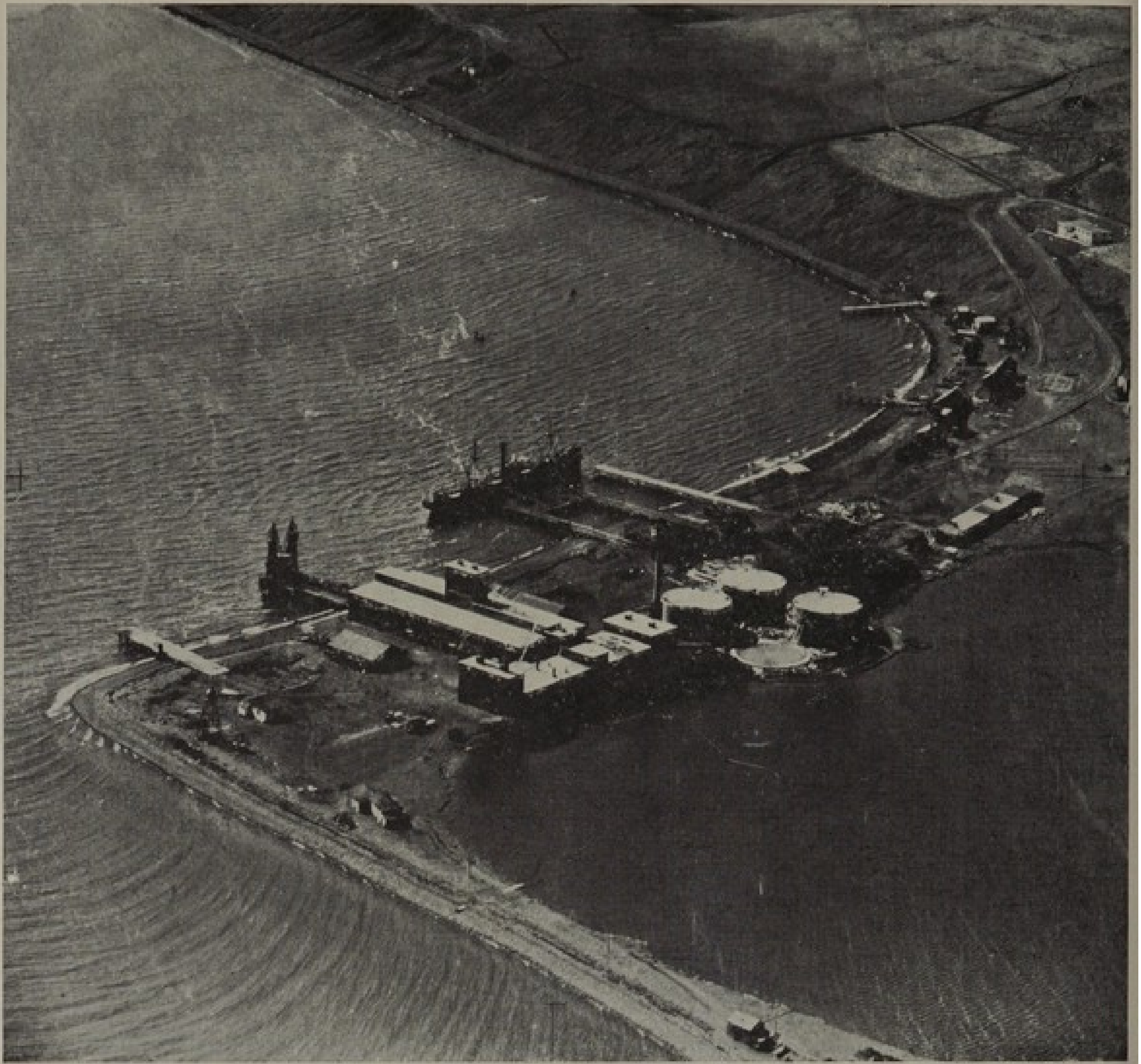
The lucrative fishing on the Icelandic banks has never been a monopoly of local fishermen. Almost every year during the past century foreign vessels have actively participated. During the later part of the nineteenth century large numbers of French vessels were engaged in the fishing off the coast of Iceland. It is estimated that in 1876 approximately 4,500 French fishermen were stationed in these waters, and that their total catch amounted to 12,300 metric tons of split cod. British, German, Dutch and Scandinavian fishing boats, especially trawlers, also visited the banks at this period. The French competition was especially harmful, since France had previously been an important market for Icelandic cod.

Although strongly opposed to the activities of these foreigners, Icelandic fishermen for many years remained virtually passive, and it was not until 1907 that they began to employ modern and well-equipped trawlers of their own. In order to check foreign competition a law was passed in 1922 which prevented foreign ships from

J. Y. Macdonald

Plate 82. Sun-cured cod ('klipfish') is an important article of export. The fish are split and laid out on large areas of flat stones.

Plate 83. Herring barrels waiting for export at Siglufjörður, one of the most important herring-fishing centres in the world.



R.A.F.

Plate 84. A modern herring-oil and meal factory at Hjalteyri, with a capacity of 9,000 hectolitres (200,000 gallons) of herring every 24 hr. (see also Plate 33).

entering Icelandic ports to prepare, pack and ship their catch; they were also forbidden to fish within territorial waters (see p. 323). These restrictions did not apply to Danish and Faroese ships, whose catch, however, was small. In 1932 the necessity of finding a foreign market for salt meat led to a special treaty with the Norwegians, who were permitted to sell a limited quantity of herring direct to Icelandic factories. This quantity corresponded with the value of salt meat exported.

The chief participants in Icelandic fishing during the last decade have been British, Icelanders and Germans so far as demersal fish were concerned, whilst the herring fishery has been carried on mainly by Icelanders and Norwegians, and to a lesser extent by Swedes and Finns. In 1937, the last year for which the statistics prepared by the International Council for the Exploration of the Sea are available, the percentages of the total catch of demersal fish taken in Icelandic waters by the principal participating countries were: Great Britain 39·4 %, Iceland 30·1 %, Germany 22·3 %. The corresponding percentages of the total catch, including herring, were: Iceland 48·0 %, Great Britain 26·2 %, Germany 14·9 %.

The total quantity of demersal fish taken by British fishing vessels on the Icelandic grounds and landed in Great Britain during the years 1934–8 was as follows (to the nearest thousand hundredweight or thousand metric tons):

	Cwt.	Metric tons
1934	3,499,000	178,000
1935	3,686,000	187,000
1936	3,490,000	177,000
1937	3,606,000	183,000
1938	3,236,000	164,000

In addition to the British catch, the Icelanders themselves landed considerable quantities of fresh, dried and wet-salted fish in Great Britain, either from fishing vessels or cargo boats. These quantities are given below:

	Fresh fish cwt.	Dried fish cwt.	Wet-salted fish cwt.	Total	
				Cwt.	Metric tons
1934	260,000	18,000	58,000	336,000	17,000
1935	223,000	39,000	99,000	361,000	18,000
1936	243,000	24,000	101,000	368,000	19,000
1937	204,000	9,000	96,000	309,000	16,000
1938	232,000	18,000	188,000	438,000	22,000

A large proportion of the wet-salted fish exported from Iceland to the British Isles has been further processed and re-exported to the Mediterranean countries, the West Indies and South America.

Fishing Seasons and Fishermen

The fishing seasons vary greatly in length for the offshore and inshore fisheries. All the steam trawlers and the majority of the motor vessels are operated throughout the year, while the length of the fishing season for the small motor boats and rowing boats may vary from a few weeks to six months or even more, according to the locality.

In 1938 the number of men and boys actually engaged in fishing from Icelandic ports was 6,410, distributed among the various types of vessels as follows: decked vessels, 3,863; small motor boats, 2,162; rowing boats, 385.

The development of the fisheries is the main reason for the migration of the people from the rural districts to the fishing stations and villages on the coast (see pp. 231–4). Recent statistics are not available, but the number of people dependent on fishing and its various subsidiary industries up to and including the year 1930 was:

Year	1880	1901	1920	1930
No. of persons	8,700	9,000	18,700	24,300
% of population	12	11	20	22

The Cod Fishery

Early in January cod begin to gather for spawning in the warm waters off the south and south-west shores of Iceland. From that time until the end of April nearly the whole Icelandic fishing fleet is engaged in cod fishing in this area. Many of the young fish complete their development on the spawning grounds, but the bulk of them are carried by the currents in a clockwise direction round the north and east coasts, where they reach maturity in the colder water before returning again to the spawning grounds. When the spawning is over, the fish again spread round the island in search of food, mainly to areas off the north-west, north and east coasts, where they are followed by the fishing boats.

Cod is by far the most important fish and is so common that Icelanders often refer to it simply as *fiskur* (=fish). About three-fifths of the total yearly catch of cod is taken during the 'winter fishing season' (January to May).

Techniques differ according to season and locality. Icelandic steam trawlers, which range between 300 and 400 gross registered tons, are modern power vessels equipped with otter trawls. Most of them are fitted with radio telephony, echo-sounding and direction-finding devices. While at work, the trawl is usually hauled about once an hour. During the hauls the crew sort the catch according to species and size. Every effort is made to obtain catches for which a market is waiting and to prepare the fish to meet the demands of the markets in which they will be sold. Continuous radio contact

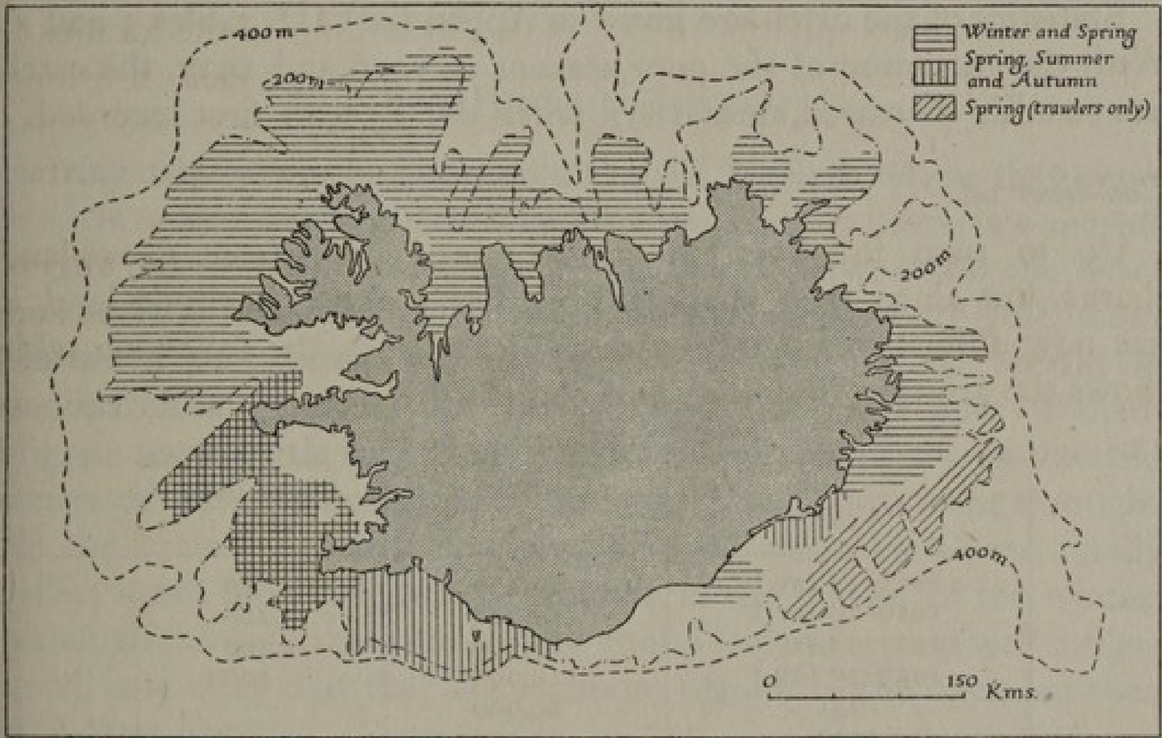


Fig. 104. Main cod-fishing banks. Trawlers visit all shaded areas; smaller vessels work in the areas nearest to their home ports. Sources: (1) *Handbuch der Seefischerei Nordeuropas*, Bd. v, Heft 4, p. 21 (Stuttgart, 1930). (2) J. le Gall, *Revue des Travaux de l'Office des Pêches Martimes*, Tome III, Fasc. 3, p. 274 (Paris, 1930). (3) Information supplied by the Icelandic government.

is kept both with the shore and with other trawlers, and market reports are broadcast so that the catches may be landed at the right market on the right day.

Long-line fishing has a very different technique. Whether steam-ships or motor boats are used, the main work consists of baiting the hooks, since many thousands of them are put into the water at one time. In the neighbourhood of Vestmannaeyjar, 200,000 large cod have been caught in a single day by this method. In exceptional cases there may be a fish on more than half of the hooks on a single line, which may be over 6,000 m. long.

Expressed as percentages of the total catch, the quantities landed during recent years by the various types of vessels have been as follows:

	1934	1935	1936	1937	1938
Trawlers	39·1	39·3	41·0	34·9	38·8
Other decked vessels	39·3	42·1	37·1	40·8	36·8
Motor boats of less than 12 tons	21·6	18·6	21·9	24·3	24·4
Totals	100	100	100	100	100

Statistics of the catch are given in Appendix VIII, tables 3 and 4. With the exception of the poor seasons in 1936 and 1937, the catch has steadily increased since 1897, when details were first recorded.

Cod-liver oil

Up to 1900 fish-liver oil was obtained only from Greenland sharks, but since then shark fishing has steadily declined, and it has now almost completely ceased. By contrast, the following table shows the growing importance of cod fish-liver:

Year	Cod liver hl.	Shark liver hl.
1911–15 (av.)	26,100	4,800
1916–20 (av.)	14,200	5,200
1921–25 (av.)	84,300	1,200
1926–30 (av.)	119,900	300
1931	89,600	—
1932	99,000	—
1933	119,300	—
1934	111,700	—
1935	109,607	—
1936	81,700	—
1937	83,800	—
1938	102,700	—

Several kinds of oil are prepared from cod liver, medicinal oil (containing vitamins A and D) now forming about 90 % of the total output. In 1928 trawler crews began cooking the fresh liver catches on board by high-pressure steam, with the result that the output of medicinal oil increased considerably. Fish-oil producers formed associations in various places; in Reykjavík the Iceland Steam Trawlers Cod-Liver Oil Union (*Lýsissamlag Íslenzkra Botnvörpunga*) was formed, and in 1930 a factory was built with modern equipment for cold-filtering fish oil. The oil could then be exported in a consumable state. At the same time the direct sale of oil to the United

States was started, whereas previously nearly all of it had been handled by Norwegian fish-oil merchants. At Vestmannaeyjar a Cod-liver Union was established by the fish producers, and another factory was built with machinery for preparing medicinal oil, industrial oil, and cod-liver meal.

Since 1935 redfish have also become important as a source of medicinal oil. Previously this species had always been thrown back into the sea when caught with other fish, but it was then found that the oil from redfish livers was very rich in vitamins, and that the redfish themselves could be processed for oil in the herring factories.

The Herring Fishery

Herring are extremely common all round Iceland, where they grow to a size unknown elsewhere. There are two distinct races: one spawns in early spring (March–April) off the south coast, while the other spawns in summer (July–August) in the area off the south-east, south and south-west coasts. After spawning, many of the fish remain on the spawning grounds, but, like the cod, the great bulk of them migrate northwards to feed on the swarms of crustaceans in the cold waters off the north coast. They remain off the north coast throughout the summer; then they spread over the outer banks and finally collect again on the spawning grounds in the middle of the winter. Although the movements of herring round Iceland are not well understood, it is clear that they are far more regular in the open sea than in inshore waters.

In spring small quantities of herring are caught in many places round the coast, especially in the neighbourhood of Faxaflói. When the fish begin to move north at the end of June, the ships follow them, and the cod fishing is neglected. From that time until the middle of September practically all the shipping of Iceland as well as some hundreds of foreign ships are gathered together off the north coast. The main catch is taken in July and August. The herring are chiefly caught in purse-seines or drift nets, which are carried in specially designed boats. The net is laid around the herring shoal when it is seen rising towards the surface of the sea, and is then contracted at the bottom so that the shoal is imprisoned. Often 400–500 barrels of fish are caught in one operation. The herring are then baled up out of the net into the ship, the process being repeated until the ship is full.

The herring are thin in the early part of summer, often not more than 9–10 % of fat, but they fatten very quickly until by August they often have as much as 20 % of fat. Early in the summer all the herring caught are taken to factories, where they are used for the manufacture of oil and meal. From July onwards the best-quality fish are salted, and they are then prepared in various ways to meet the differing demands of foreign markets (see Appendix VIII, tables 5 and 6).

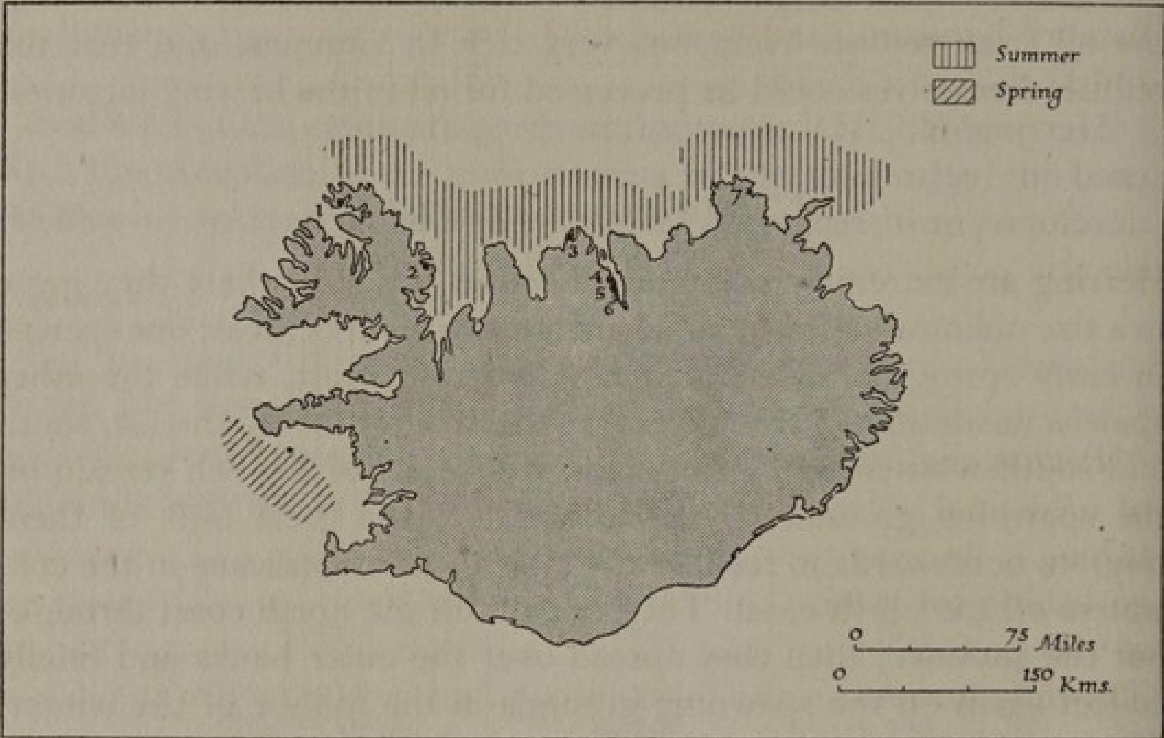


Fig. 105. Main herring-fishing areas. The most important activity takes place within the shaded area off the north coast from July until September. In Spring, small quantities of herring are caught locally at many places round the coast, especially in the neighbourhood of Faxaflói. Dots indicate the positions of the most important herring-oil factories. (1) Hesteyri, (2) Djúpavík, (3) Siglufjörður, (4) Hjalteyri, (5) Dagverðareyri, (6) Krossanes, (7) Raufarhöfn. Based on data supplied by the Icelandic government.

Expressed as percentages of total catch, the quantities landed during recent years by the various types of vessels have been as follows:

	1934	1935	1936	1937	1938
Trawlers	14·2	12·4	24·6	32·6	24·8
Other decked vessels	81·7	82·6	73·0	64·3	72·8
Boats of less than 12 tons	3·3	4·4	2·1	2·4	2·0
Land-seines	0·8	0·6	0·3	0·7	0·4
Totals	100	100	100	100	100

The annual catch has been very variable (see Appendix VIII, table 6). Up to 1927 most of the herring caught used to be salted for export. In that year the catch was much greater than usual, and a large proportion was sold to factories to be used for the manufacture of herring oil and herring meal. More factories were built for this purpose, and there has been a remarkable increase in production during the last 10 years. In 1938 there were sixteen herring-oil factories in Iceland, capable of extracting oil and meal from about 4,000 metric tons of herring in 24 hr. The most important factories are located at Hesteyri, Djúpavík, Siglufjörður, Hjalteyri, Dagverðareyri, Krossanes and Raufarhöfn. There are also many smaller ones round the coast for the production of fish meal only.

Herring oil is still exported in a crude state, but refined fish oil is used in Iceland for the manufacture of margarine and soap. The development of refineries will become possible only when sufficient electric power is available at the herring stations.

Subsidiary Fisheries

Redfish and Flatfish. The growing importance of redfish as a source of medicinal oil has already been mentioned. When the winter cod fishing is drawing to a close at the end of April, some of the trawlers go fishing for redfish until the herring season opens. Others begin at once to fish 'on ice' and sail with their catch to European markets. Trawling for redfish also takes place in the autumn when the herring season is over. While the trawlers are taking redfish, many small boats are engaged in seine-net fishing, mainly for flatfish. The greater part of the catch of these boats is filleted and 'quick frozen' (see p. 320), while some of it is also exported frozen in boxes.

Shrimps. Shrimp canning was first tried in 1935. It was so successful that in the following year a factory was built for this purpose at Ísafjörður. By 1938 the output had risen to 170,300 kg. Another shrimp factory has since been erected at Bíldudalur, and it is considered that this industry has great possibilities for future development.

Salmon. For many years there has been a small-scale commercial exploitation by netting the salmon rivers. Statistics show that the annual catch has varied from 9,700 to 21,000 fish. Salmon are likely to be of greater importance to the country as an attraction for tourists who visit Iceland for rod fishing. Salmon are very common in most of the rivers in the south-west, north and north-east parts of the island, but they are not found in the numerous rivers on the south and east coasts between Þórsá and Lagarfljót, nor in the small rapid rivers of the north-west peninsula. The richest salmon rivers are the Hvítá (both rivers of this name in the south-west and their tributaries), Elliðaá (near Reykjavík), Haffjarðará (on the south side of Snæfellsjökull), Bjargós (flowing into Miðfjörður), and Laxá (near Húsavík). The season for river fishing normally lasts for about three months, beginning in either May or June. The inland waters of Iceland cannot be angled without permission, and even for fishing in the lakes and streams up in the highlands it is necessary to obtain a licence from the farmer who owns the land.

The Preparation and Sorting of Fish

All salted fish prepared for foreign markets must be sorted by official sorters into standard grades. The inspector of fish curing and fish selection (*Fiskimatsstjóri*) controls all fish sorting in the country.

The old method of curing cod and other related species consisted simply of prolonged drying of the split and gutted fish (Plate 82). The product obtained is known as 'stockfish' (*harðfiskur* or *skreið*). The bulk of the catch, however, is now prepared with a view to foreign markets, and is mainly exported fully cured, though part of it is also put on the market half-cured or even wet salted. The fully salted and dried cod, known as 'klipfish', have their heads, intestines and the greater part of the spinal column removed before they are landed. They are then thoroughly dried in the open air. Of late, artificial drying has increased considerably, especially in the winter months, and a number of well-equipped fish-curing houses have been built in Reykjavík and elsewhere.

From October to January the trawlers are engaged in ice fishing and sell their catches in England and (formerly) Germany. The quick freezing of fish is a comparatively new method in Iceland, and it is rapidly developing. The countries which purchased most fresh fish from Iceland previously received it carried on ice. Since the fish lay on ice for a long time before they were frozen, the consumers were rather mistrustful of frozen fish. Freezing houses have now been built in many places in Iceland, so that it is possible to freeze the fish on the same day as they are caught. This method has led to an increased demand.

Details of the total export of fish from 1933 to 1940 are set out in Appendix IX, table 5.

Whaling

From about 1880 until 1915 the Norwegians carried on active whaling operations in Icelandic waters. In 1906 they had twelve whaling stations—seven situated on the north-west peninsula and five on the east coast. As a result of this hunting, the whales became so scarce that they were given complete protection from 1915 until 1935, and the shore stations were closed down. The species captured were mainly Fin whales, Blue whales and Humpback whales, but a few Sei whales and Sperm whales were also taken. Between 1914 and 1930 hunting of the Lesser Fin whale, by harpooning from motor boats, was carried on in some of the fjords on the north-west and north coasts. The total catch during this period was, however, only about 200 whales.

In 1935 a Norwegian whaling station (Kópur Ltd.) was established at Suðureyri in Tálknafjörður. This has been the only whaling station operating in Iceland since 1915. It is equipped with a slipway for whales, twelve pressure boilers and eight open tanks for trying out blubber, as well as a factory for the production of meat meal and bone meal. Details of the catch are available only for the first four years of operation:

	1935	1936	1937	1938
Fin whales	25	72	56	113
Blue whales	2	5	1	9
Sperm whales	—	7	21	20
Humpback whales	—	—	1	—
Sei whales	1	1	—	5
Totals	28	85	79	147

Public Institutions in the Service of the Fishing Industry

The Ministry of Industries and Commerce has wide powers. These include the supervision of the seaworthiness of ships, the sorting of fish and fish products, the construction of harbours, the improvement of landing places, and all other activities of the state for the benefit of the fishing industry.

The Fisheries Association of Iceland (*Fiskifélag Íslands*), established in 1911 with a view to encouraging salt- and fresh-water fisheries, receives an annual state grant, and has branches throughout the country. It prepares weekly and fortnightly reports on production, and provides information about the fisheries of neighbouring countries which are in competition with Iceland. The Association issues the monthly journal *Ægir*, the only fishing periodical published in the country, as well as a nautical almanac for fishermen. It also conducts fishery research, investigates industrial problems, and arranges short courses in navigation and the handling and operating of motor boats.

The Icelandic Fish Industry Board (*Fiskimálanefnd*), established by the government in 1934, is composed of seven members appointed by the following organizations: the Ministry of Industries and Commerce, the Federation of Labour Unions, the Association of Trawler-owners, the Fisheries Association, the Union of Icelandic Co-operative Societies, the National Bank of Iceland and the Fishing Trade Bank. A manager may also be appointed to attend to the daily business of the board. The activities of this board cover a wide field; it effects trial sales of Icelandic fish in new markets, organizes experiments to find new methods of catching and preparing fish, sends trial shipments of fish prepared by new methods to foreign markets, and initiates and encourages any measures that seem likely to benefit the industry.

No fish may be sold or exported without the sanction of the Minister of Industries and Commerce. Exceptions may be made, however, in the case of small shipments of cured or uncured salt fish to be sent to places outside normal Icelandic markets. The minister grants export licences to the Union of Icelandic Fish-Producers (*Sölusamband Íslenzkra Fiskframleiðenda*), which commands about 65 % of the total yield. The minister has placed in the hands of the Fish Industry Board the distribution of export licences for all kinds of roe and fish except herring. The board arranges the disposal of exports in accordance with the import permits of the marketing countries.

In 1934 the Herring Industry Board (*Síldarútvegsnefnd*) was created with the same field of activities for the herring fisheries as is assigned to the *Fiskimálanefnd* with respect to other kinds of fish. It also inspects and directs the curing of herring, and fixes minimum prices.

The Herring Factory Board (*Síldarverksmiðjunefnd*) operates the herring-oil factories belonging to the state. It fixes the price of herring and redfish sold to the factories and undertakes the sale of their products.

The Fisheries Fund (*Fiskiveiðasjóður Íslands*), founded in 1930, has its capital provided from the balance of an earlier fund and from a tax levied on all exported fish products. The fund is managed by the

Fishing Trade Bank. Loans are granted on favourable terms to enable fishermen to purchase vessels of under 50 tons, or to establish factories in connexion with the fisheries. These loans are divided between the various parts of the country in proportion to the number of boats in each locality. A subsidiary fund for the relief of motor-boat owners was established in 1935.

In a number of localities boats are owned by co-operative societies of which the crews are members. Owing to a succession of bad years for the industry as a whole, these fishermen's co-operatives have not yet been very successful, but significant progress in this field may be expected in the future.

Regulations Affecting Fishing in Territorial Waters

The maritime jurisdiction of Iceland, so far as the fisheries are concerned, was fixed in 1903 by a treaty between Denmark and Great Britain concerning the prosecution of fishing outside the territorial waters round Iceland and the Faroe Islands. According to this treaty, Iceland's territorial waters extend three nautical miles from the most outlying islets and rocks visible at low water. In bays the limit was defined as a straight line drawn across the bay, as near to its entrance as possible, at the first point where its width does not exceed ten nautical miles.

The main body of laws respecting fishing in Icelandic territorial waters is comprised in acts of 1933 and 1935, by which earlier legislation was repealed. Trawling is prohibited in territorial waters; the use of seine-nets is prohibited between 1 January and 31 August, and also during the whole of December each year. Special regulations apply to various stretches along the coast.

Until 1918, fisheries inspection in Icelandic waters was carried out by Danish patrol vessels. By the Act of Union of 1918 it was agreed that the inspection should continue to be carried out by Denmark under the Danish flag 'until Iceland decides at her own expense to take over partly or wholly the fisheries inspection within her territorial waters'. Shortly afterwards the Icelanders purchased their first inspection vessel, a small steamer called the *Þór*. Later, this service was extended, and was combined with the salvage service round the coast. At the outbreak of war in 1939 the Icelandic government had three armed patrol vessels, the *Þór*, *Óðinn* and *Ægir*, and a number of motor boats which had special parts of the coast assigned to them. The Icelanders had thus largely taken the inspection into their own hands, but the Danish government continued to send a patrol vessel to Icelandic waters until the occupation of Denmark by the Germans in April 1940. Since that date the fisheries inspection has been entirely taken over by the Icelandic government. Most of the expenses of this service are defrayed by the fines for illegal trawling in territorial waters and by the proceeds from the sale of forfeited catch and fishing gear. Special maritime courts have been set up to deal with all legal cases connected with shipping.

Additional Note

It seems likely that the new methods of artificial drying recently developed in Great Britain and the U.S.A. may have a considerable influence on Icelandic fisheries. Although dehydrated canned fish is still inferior in texture, flavour and nutritional value to fresh or frozen fish, it is undoubtedly more suitable than 'klipfish' for consumption by the industrial populations of other countries. In addition to providing a more acceptable product for export, the use of these new methods, which are particularly suited for lean fish such as cod and haddock, prevents waste during periods of glut.

Chapter XIV

INDUSTRIES AND PUBLIC UTILITIES

Introduction: Electrical Power: The Reykjavík Hot-Water Supply System: Coal Gas

Introduction

Iceland possesses few natural resources, and many of the chief necessities of life, such as grain, timber and iron, must be imported. From the earliest times imported commodities have been exchanged mainly for farm produce, and farming has always been of the greatest importance in the national economy of the country. But, as there was little surplus production for export, and as the amount of shipping was limited and sailing was full of risks, the population had to depend almost entirely on local resources. For these reasons Icelandic industries in early times were more varied than at a later date. The growing of grain, the working of iron and salt, the dressing of skins, and the making of woollen goods were diligently carried on. Some of these occupations disappeared as soon as conditions became favourable to increased imports, although woollen and skin industries have been revived to some extent in recent years.

The future prosperity of the country will depend mainly on the fisheries, and to-day the only factories of major significance to the export trade are those connected with this industry; they include refrigerating plants, factories for canning, for the manufacture of herring meal, herring oil and cod-liver oil. In recent years the increased processing of fish has to some extent been due to difficulties in the sale of salt fish in the Mediterranean countries. The growth of some branches of industry has similarly arisen from the stringent import restrictions which have had to be imposed, primarily on account of the shortage of foreign exchange. Much of the industrial activity has been exclusively for the domestic market, but there is every likelihood that the fish industry will continue to thrive to such an extent as to be able to compete successfully in foreign markets.

Other industries have developed on only a very small scale. At present the factories are confined to such manufactures as the following: clothing (especially oilskins and working clothes), woollen and leather goods, shoes, gloves, margarine, dairy products, biscuits, sweets, coffee substitute, chicory, near beer, mineral waters, candles, soap, fishing lines, fishing snoods, steel drums, wooden barrels and packing cases.

There is now an increasing tendency for government legislation to encourage the construction of assembly plants and the production of manufactured goods from imported raw materials. In 1931 an act was passed providing rebate of customs duties on materials for industrial enterprises, in cases where competitive foreign articles carried no import duty or less duty than that of the raw materials. New industries gained further government support in 1935. Those firms which manufactured goods not previously made in Iceland, and those which used new methods or materials, were exempted from state and municipal taxes for three years. There is now no excise duty on any industrial product except such luxuries as confectionery, beer, and mineral waters.

The following production details of some of the articles manufactured in 1938 and 1939 are sufficient to indicate that the scope of the factories is still comparatively small:

	1938	1939
Biscuits (metric tons)	340	352
Margarine (metric tons)	1,515	1,411
Soap (metric tons)	509	535
Washing powder (metric tons)	106	237
Cleaning and polishing materials (metric tons)	52	60
Candles (metric tons)	23	23
Prepared paints and varnishes (metric tons)	—	444
Shoes (pairs)	111,300	132,000
Gloves (pairs)	—	21,700
Wooden packing cases (number)	96,300	176,000
Wooden barrels (number)	68,100	83,800
Steel drums (number)	25,600	30,900
Near beer (litres)	196,215	205,025
Malt extract (litres)	112,153	118,741
Mineral waters (litres)	392,131	405,006
Chocolate (kg.)	97,595	85,998
Sweets (kg.)	86,216	85,920

Source: *Statistical Bulletin*, vol. 9, nos. 5 and 6 (Reykjavík, 1940).

The tourist industry may be mentioned here, as it offers great possibilities for future development. The Icelandic government takes a special interest in tourist travelling facilities, and a State Tourist Bureau, usually known by the contracted name *Statourist*, was set up in 1936 for the purpose of spreading knowledge about the country both at home and abroad. The unique scenery and saga associations of Iceland are likely to attract an increasing number of foreign visitors;

it is estimated that about 8,000 visited the country in 1936, the latest year for which figures are available.

There is no shipbuilding apart from the construction of small motor boats at Reykjavík, Akureyri, Ísafjörður and Keflavík.

Electrical Power

Iceland possesses almost unlimited resources in water power, and the last two decades have witnessed considerable development of its utilization for generating electricity. Although the first power station was built in 1902, almost the whole development has taken place since 1918 (see Fig. 106). The present position (1940) may best be summarized in tabular form:

	Hydro		Diesel or steam		Wind		Total	
	No.	Capacity kW.	No.	Capacity kW.	No.	Capacity kW.	No.	Capacity kW.
Public utility plants	17	14,338	21	1,278	0	0	38	17,616
Private generators	271	1,946	89	2,383	10	7	370	4,336
Private generators (24 V. or less)	22	8	0	0	167	28	189	36

Apart from the major power stations operated by the government, many farms possess small private plants. For example, in the farming district of Vestur-Skaftafellssýsla there are forty-one hydro-electric generators, producing 318 kW. in all, while in the same district there is only one diesel-electric plant. In recent years a large number of wind-driven generators have been erected. Most of these are small, 100–200 W., or even less; some are larger, up to 1,200 W. These generators are used chiefly for lighting and for charging wireless batteries, the latter being a serious problem in isolated localities. The largest are used for household equipment such as electric kettles and irons; the smallest, 24 V. and under, are used solely for charging batteries.

Several industries have their own power stations, which in small villages are often tapped for local lighting. About twenty factories, nearly all of them connected with the herring fishery, are able to supply electricity to houses in their immediate neighbourhood. The larger villages and townships all have state-owned power stations.

Reykjavík. The capital obtains its supply partly from the Elliðaá at Ártun, 5 km. distant, and partly from the river Sog at Ljósafoss, 45 km. distant.

The Ártun station was erected in 1920–1, producing 1,032 kW. from two units of 500 and 1,000 h.p. respectively. Since then the dam at Ártun has been raised and storage has been increased by the construction of a dam at Árbær and a reservoir at Elliðavatn. Further

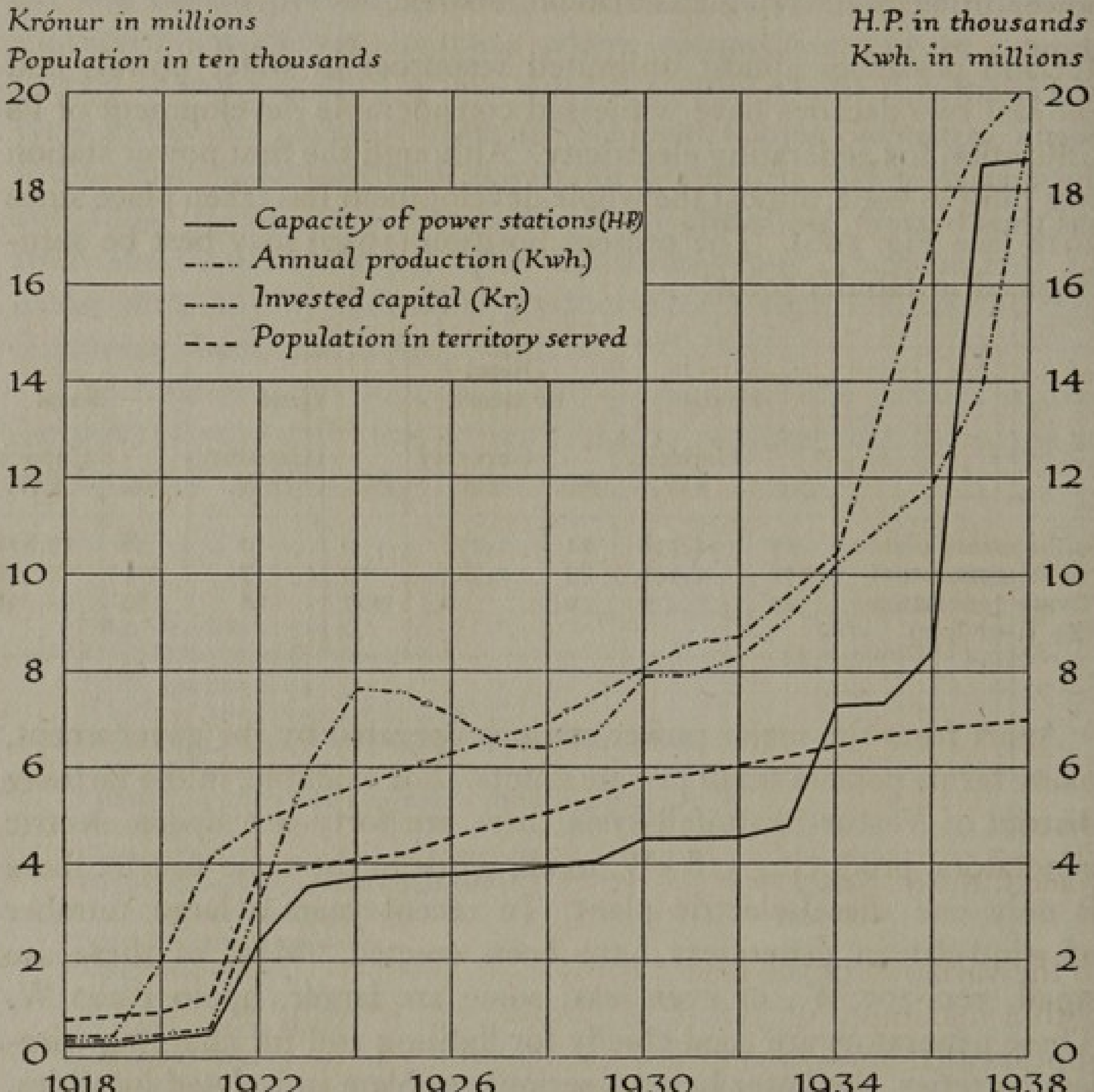


Fig. 106. The development of electricity, 1918–38. Source: *Iceland, 1918–1938*, pp. 32–3 (Ísafoldprentsmiðja H/F, Reykjavík, 1938).

units have been installed and the maximum output is now 3,160 kW. The power is transmitted to the town at a voltage of 6,000 and is then transformed at twenty-seven sub-stations down to the supply voltage of 220. The resources of the Elliðaá were fully developed by 1933, but they were inadequate, and in view of the steadily increasing population of Reykjavík (31,500 in 1933, 38,094 in 1940) a further source of power had to be found.

The Sog, the outflow of Þingvallavatn, flows south over many rapids and falls, and through two small lakes (Úlfljótsvatn and Álftavatn) before joining the Hvítá. The conservation effect of Þingvallavatn, a lake of 83 sq. km. which receives most of its water from sub-surface streams and seepage, results in a remarkably even discharge throughout the year (Fig. 107). It is therefore very favourable for power utilization. At the outlet of Úlfljótsvatn there are rapids of about 4 m. head. About 1 km. farther down the river are the falls of Ljósafoss, with a total head of about 13 m. A dam (Plate 64) has been constructed across the river just above the falls, thereby raising the surface of Úlfljótsvatn 0·8 m. above its former level. A reservoir has thus been created sufficient for the flow regulation corresponding

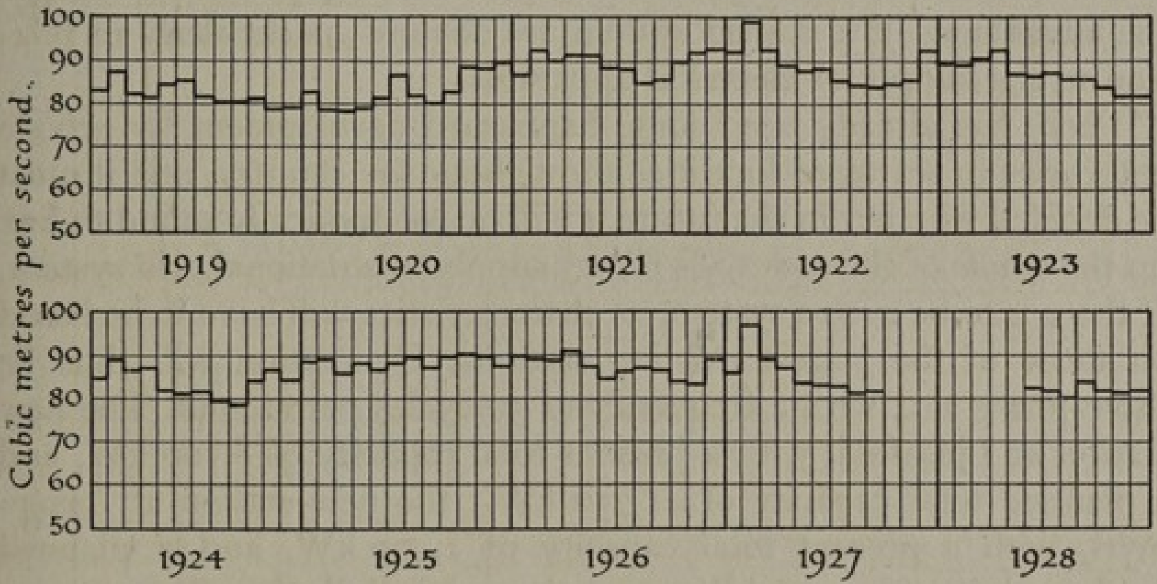


Fig. 107. Average monthly discharge records of the Sog. Source: A. B. Berdal and J. Nissen, *Report on Development of Ljósafoss in Sog...*, p. 9 (Oslo, 1934).

to the variation of the load during 24 hr. Two turbo-generators, each with a maximum output of 4,350 kW., are now in operation, and it appears that the demand is such that there is no reserve of power. The current is conveyed by a single three-phase overhead transmission line through a transformer station at Ártun.

Provision was made for five generating units in all at Ljósafoss, and it is now proposed to proceed with the installation of the third unit to provide an increase in capacity of over 4,000 kW. This will suffice for Reykjavík for a considerable time.

The Sog flows through the largest tract of farm land in the country, and within reach are Hafnarfjörður, Eyrarbakki, Stokkseyri, Akranes, Vestmannaeyjar, and Reykjanes. Plans have been worked out to supply all these districts from the station on the Sog, and thus to provide electricity for more than half the population of Iceland. The network has already been extended to Hafnarfjörður, Álftanes, Álafoss and Vatnsendi.

Akureyri. The Laxármýri power station (Laxárvirkjunin), about 40 km. east-north-east of Akureyri, is situated on the Laxá which flows from Mývatn. Here again the conservation effect of a large lake has been utilized. The station was completed in 1938, and the scheme provides for the eventual installation of two turbo-generator units, each of about 1,500 kW. capacity. One unit is in operation, and it is now proposed to proceed with the installation of the second.

Future Development

For the future development of hydro-electric power in Iceland the advantages of a unified system are obvious, particularly in relation to the supply of electrical apparatus.

There has already been some haphazard development by private enterprise in scattered localities throughout the country, and it must be decided whether in the future it will be economically sound to link up the whole of the country's power supply in a national grid system. If there is to be such a system, its characteristics will have to be based on those of the largest existing stations. Generation will thus be three-phase a.c., with a frequency of 50 cycles per second. The new station at Ljósafoss, with a present total capacity of 8,700 kW. and a planned total capacity of 21,750 kW.; the new station at Laxármýri, with a present total capacity of 1,500 kW. and a planned total capacity of 3,000 kW.; and the original Reykjavík station at Ártun, with a total capacity of 3,160 kW., all have these characteristics and could therefore be linked together as the nucleus of a national grid. The transmission voltages of these three stations are 60, 30 and 20 kV. respectively. Before they could be linked a common transmission voltage would have to be agreed upon, and the necessary transforming and switching gear installed.

The other stations in the country are all of relatively small capacity, and it is likely that in the event of a national grid system being operated they will be used as emergency stations only.

The existing public stations (Fig. 108) can be divided into five groups as indicated in the table opposite:

Group I. The three main generating stations as outlined above.

Group II. Small three-phase a.c., 50-cycle, 220 V. systems. All electrical equipment supplied by these could be directly connected to a national grid, and a change-over would be comparatively simple.

Public Generating Stations in Iceland. (*For localities see Fig.* 108)

Group	Serial no.	Locality	Total generating capacity kW.	Source of power	Nature of supply	Supply voltage
I	1	Sogfoss (Ljósafoss)	8,700 (projected 21,750)	Hydro	3-phase, a.c., 50~	3 × 220
	2	Laxármyri	1,500 (projected 3,000)	Hydro	3-phase, a.c., 50~	3 × 220
	3	Ártun	3,160	Hydro	3-phase, a.c., 50~	
II	4	Ísafjörður (Hnífsdalur)	750	Hydro	3-phase, a.c., 50~	3 × 220
	5	Blönduós	250	Hydro	3-phase, a.c , 50~	3 × 220
	6	Siglufjörður	425	Diesel and Hydro	3-phase, a.c., 50~	3 × 220
	7	Akureyri	375	Diesel and Hydro	3-phase, a.c., 50~	3 × 220
III	8	Seyðisfjörður	145	Hydro	3-phase, a.c., 50~	3 × 208/120
	9	Bíldudalur	40	Hydro	1-phase, a.c., 50~	220
IV	10	Akranes	100	Diesel	d.c.	220
	11	Vatneyri (Patreksfjörður)	30	Hydro	d.c., 3-wire	2 × 220
	12	Flateyri (Önundarfjörður)	10	Diesel	d.c.	220
	13	Suðureyri	7	Diesel	d.c.	220
	14	Bolungavík	26	Diesel	d.c.	220
	15	Suðavík	12	Diesel	d.c.	220
	16	Hvammstangi	16	Diesel	d.c.	220
	17	Sauðárkrókur	42	Hydro	d.c., 3-wire	2 × 220
	18	Hofsós	8	Hydro	a.c.	220
	19	Dalvík	9	Hydro	d.c.	220
	20	Hrísey	12	Diesel	d.c.	220
	21	Húsavík	50	Hydro	d.c., 3-wire	2 × 220
	22	Kópasker	9	Diesel	d.c.	220
	23	Neskaupstaður	58	Diesel	d.c.	220
	24	Búðareyri (Reyðarfjörður)	195	Hydro	d.c., 3-wire	2 × 220
	25	Búðir (Fáskrúðsfjörður)	85	?	d.c., 3-wire	2 × 220
	26	Vík (Mýrdal)	100	Hydro	d.c., 3-wire	2 × 220
	27	Vestmannaeyjar	248	Diesel	d.c.	220
	28	Stokkseyri	11	Diesel	d.c.	220
	29	Eyrarbakki	29	Diesel	d.c.	220
V	30	Borgarnes	52	Diesel	d.c.	110
	31	Stykkishólmur	24	Diesel	d.c.	110
	32	Þýingeyri (Dýrafjörður)	8	Diesel	d.c.	65
	33	Hólmavík	4	Diesel	d.c.	110
	34	Ólafsfjörður	15	Diesel	d.c.	110
	35	Eskifjörður	26	Hydro	d.c., 3-wire	2 × 110
	36	Höfn (Hornafjörður)	10	Diesel	d.c.	65
	37	Selfoss (Ölfusábrú)	10	Diesel	d.c.	110
	38	Keflavík	63	Diesel	d.c.	110

Group III. This consists of two systems which may possibly be convertible to a standard grid. The first of these, at Bíldudalur, is a single-phase a.c., 50-cycle system, generating at 220 V. and transforming up to 2,500 V. The second, at Seyðisfjörður, is a three-phase a.c., 50-cycle system, generating at 3,000 V. stepped down to $3 \times 208/120$ V.

Group IV. This consists of those systems other than three-phase a.c., 50-cycle, but with a supply voltage of 220. The conversion of these to a national standard would involve considerable replacement of equipment, but certain domestic apparatus such as lighting and heating might be retained unchanged.

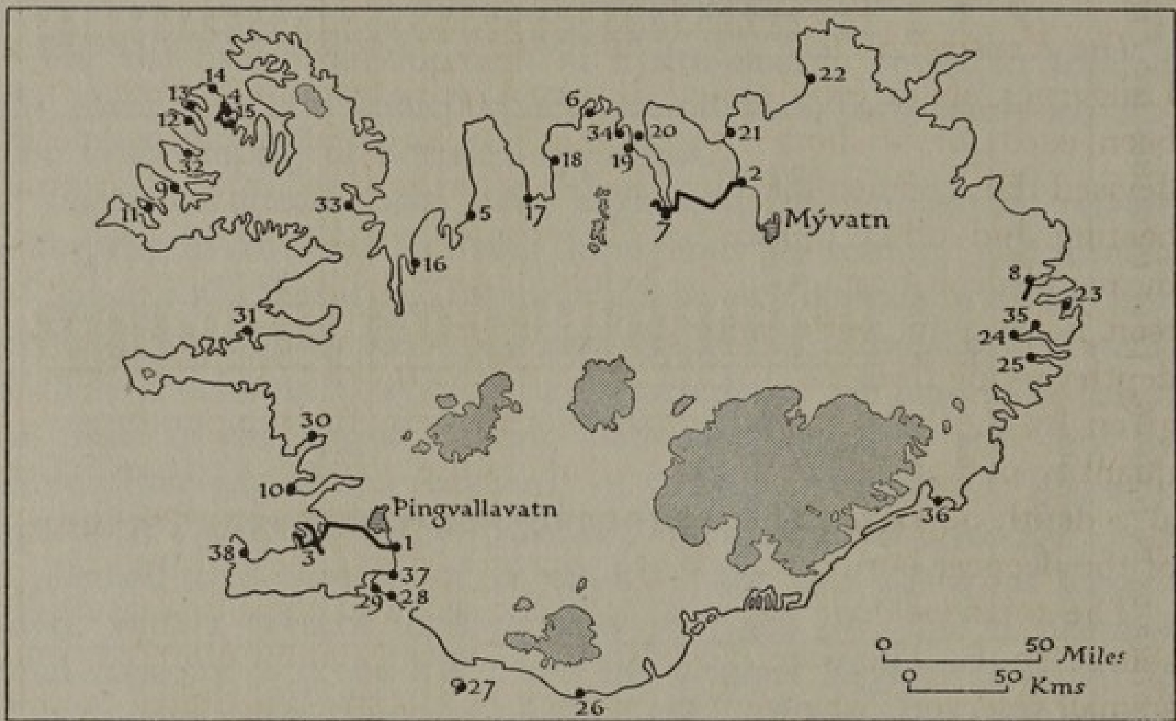


Fig. 108. Electrical generating plants and high tension lines, 1940. The serial numbers refer to the table on p. 331. Source: War Office.

Group V. In these, conversion to a national standard would involve an almost complete replacement of all equipment.

The principal cost of a national grid system is in the building of the hydro-electric stations and the main transmission equipment. In Iceland, three main stations with an adequate potential capacity for the whole country already exist. The organization of local supply would be a matter of little difficulty and comparatively small cost, but the replacement of local equipment where necessary to conform to a national scheme would arouse considerable opposition. However, if any national scheme is to go forward, it is important that further equipment installed by private enterprise should conform as closely as possible with the requirements of a planned scheme.

It is considered by those responsible for the Sog power station that at present it would be unprofitable to organize general distribution of electricity to the rural districts except those which lie on the direct route of transmission lines to towns and villages. The distances are too great and the population is too scattered. If the supply districts outside Reykjavík are given sufficient aid by the government, there is no reason why the radius of the network should not eventually be extended to reach every town in the country.

The Reykjavík Hot-water Supply System

The Existing System. The hot springs, Þvottalaugar, situated on Laugarnes, about 3 km. east of Reykjavík, have from time immemorial been used for washing and bathing. In 1930 Icelandic engineers devised the scheme of leading the hot water into the town for central heating and other purposes. The supply was increased 50 % by means of deep borings in the neighbourhood of the springs. Fourteen holes 4 in. wide were drilled during the years 1928–30, the depth varying from 20 to 246 m., with an average of 114 m. The results given by the holes varied greatly both as regards temperature and quantity of water. The highest temperature was 95° C. from water at a depth of 84 m. The temperature of the ground at the bottom of the deepest boring was 98° C., but no water appeared there.

The total yield of water is 15 l. per sec. and its temperature at source 87° C. The water flows from the springs and bore holes into a small reservoir, whence it is pumped by electric centrifugal pumps through one 7 in. steel pipe to the town, where branches lead off to the various buildings. The main pipe-line is buried in the ground, insulated with expanded cork granules and protected by a thin covering of concrete and asphalt board. The pipes are joined together with welded sockets and with expansion joints at 50 m. intervals. When pumping is in full force the water cools 2–3° C. on its way to the town. The total length of piping, excluding that leading into the houses, is about 5 km. This supply has now functioned for ten years; it serves seventy-two houses and institutions, including the largest hospital in the country, two elementary schools, a swimming hall, and an open-air swimming pool.

The water is fed directly into the central heating system of the houses, where it cools by 30–40° C. in the radiators, the water then being used for baths, washing, etc. Some of the houses are in direct connexion with the swimming hall, to which their supply is finally delivered at a temperature of about 30° C.

The water is considered to be beneficial for bathing, as it contains various salts not found in the ordinary water and is slightly radioactive. The water is alkaline and neither corrodes the pipes nor deposits incrustation inside them.

Extension of the System. Plans to supply hot water to the whole town have been drawn up by the Danish engineering firm of Messrs Højgaard and Schultz, who have raised funds for the enterprise and undertaken its execution. Work was begun in 1939 and is continuing.

The source of the new supply is the hot-spring area of Reykjalaug, near Álafoss, 17 km. east of the town. The supply from the springs has been more than doubled by borings. Drilling commenced in 1933 and twenty-eight holes have been made, varying in depth from 135 to 621 m. All holes except one have yielded water, the hottest one yielding 23 l. per sec. with a temperature of 98° C. The combined delivery of water now attainable is 240 l. per sec., and its average temperature is 87° C. Borings are still being made.

From borings and springs the hot water will run by gravity along collecting pipes into a common reservoir. From the reservoir the water will be pumped by electric centrifugal pumps through two 13 in. pipes up to a hot-water reservoir at Öskjuhlið, a hill just south of the town. To begin with, five tanks of reinforced concrete will be built with a capacity of 1,000 tons each, but later it is proposed to increase their number to eight. From the tanks, two 16 in. pipes will lead down into the town, where pipes will branch off into each street, and from the street mains pipes will enter each house. The diameter of these street 'mains' will vary from 1 to 18 in. and their total length will be over 40 km. The whole pipe system, excluding the house pipes, will be about 76 km. The town system is calculated for 500 l. per sec., but there will also be a pumping station near the tanks to increase the pressure of water during hours of maximum consumption.

To accommodate variations of temperature there will be expanding joints in the pipes at suitable intervals, and, for the same reason, the house systems will be joined to the street mains by pliable piping. All the main pipes will be insulated with insulating materials of Icelandic origin, chopped turf and pumice, but outside the insulating layer there will be a trough for protection. The double feed pipe will lie in a single trough and mainly above ground, but the street mains will be dug down into the pavements. The house leads will, on the other hand, be mostly insulated with glass-wool round which will be a protecting layer of bitumen. When the consumption is greatest, the fall of temperature between the source and the most distant house is not expected to exceed 5° C. It may be mentioned that there will be little additional expenditure on domestic plumbing, as 80 % of the houses in Reykjavík already have central-heating systems.

The new hot-water system is, as mentioned above, intended to heat the whole town, but not the outlying suburbs. Altogether, some 3,000 houses will be affected. About 15 % of the heat will go to baths, laundries, etc., but for these purposes the water which has already passed through the radiators of the houses will be used.

The inhabitants of Reykjavík expect great things from this heating system, as in addition to the economy effected it will be more convenient and cleaner. Instead of lighting the central-heating furnace, a tap will merely have to be turned to obtain instantly whatever heat is desired. The pall of smoke which often hangs over the town in winter will disappear, and perhaps each home will have its own hot-house where flowers and vegetables can be grown. Reykjavík will be unique—the only town warmed by the heat of the earth's interior.

Coal Gas

Coal gas, dependent upon imported coal, is available only in Reykjavík, where there are 2,805 subscribers. There is one container with a capacity of 1,500 cu.m. The maximum output is 4,000 cu.m. per day, and at present the average daily consumption is 2,600 cu.m. There seems to be little future for this enterprise, since power can be provided more cheaply by electricity and heating more cheaply from thermal springs.

Chapter XV

SOCIAL LEGISLATION

Introduction: Workmen and Employers: Wages and the Cost of Living: Housing and Rent: Social Insurances: Note on Alcohol and Prohibition

Introduction

Four main factors have led to a fairly comprehensive system of social legislation in Iceland:

(1) the rapid industrialization of the country during this century;
(2) the growth of urban centres;
(3) the repercussions of the war of 1914–18;
(4) the Act of Union with Denmark in 1918.

As late as 1910 more than half the people in Iceland were dependent for their livelihood upon agriculture. Their needs were simple and were met largely by farming and occasional fishing. There were fewer farm labourers than tenant farmers and land owners, a fact due in part to the small labour demands made by pastoral farms and in part to the Icelandic inheritance laws. By these, children inherit equally. No distinction is made between male or female, eldest or youngest; nor, in contrast with Britain and the United States, can a man dispose of more than one-quarter of his property by bequest.

In proportion to the number of employers there was a much larger labouring class in the fishing industry than in farming. But here too there was little distinction between employer and worker, and it was not until the introduction of the steam trawler that differences became pronounced. The rapid growth of an industrial working class is made clear by the census returns for 1910 and 1930. The figures include not only the workers but their dependents:

	Agriculture		Fisheries		Industry		Commerce and transport	
	1910	1930	1910	1930	1910	1930	1910	1930
Employers	26,672	27,153	2,039	3,179	1,526	3,442	3,278	4,440
Employees	16,739	11,850	13,851	20,216	2,414	12,843	2,753	11,295
Total	43,411	39,003	15,890	23,395	3,940	16,285	6,031	15,735

During this period the total population was increasing rapidly; more and more people were leaving the country for the towns; the comparatively self-sufficient life of the pastoral farmer was being replaced by a life dependent on money paid for specialized work in the ports; needs were growing and a demand for higher wages was inevitable. Class distinctions and class struggles began to show themselves as one of the attendant evils of industrialization. Workers and employers each formed unions to look after their interests, and membership grew rapidly when war conditions brought discontent over wages. The townward drift of the people and the difficulty of importing building materials caused housing problems. Moreover, before 1918, political agitators were fully occupied with the struggle for national independence. With the achievement of this object they turned their attention to internal problems. Comprehensive legislation now covers most of the social problems of Iceland.

Workmen and Employers

Workers' Associations. The first workers' society was a sailors' union, founded in 1894 by deep-sea fishermen; their dangerous occupation, among other things, unifying them in a demand for greater security. Legislation followed in 1903 when an inspection of the condition and seaworthiness of ships was made compulsory. For the first ten years of the union's existence its growth was small and membership was limited to fishermen living in Reykjavík. A printers' trade union was formed in 1897 and a union of unskilled workers was established in 1906. Membership of these organizations remained small until the outbreak of war in 1914, when the rise in prices, not immediately followed by a rise in wages, gave an impetus towards unity. In 1916 the Federation of Labour Unions (*Alþýðusamband Íslands*) came into being. It worked in close collaboration with the Socialist Party, which for the first time was able to elect a representative to the *Alþingi*. The following table, to which must be added

Type of Union	Within the Federation		Outside the Federation	
	Unions	Membership	Unions	Membership
Unskilled labourers (men)	19	3,558	8	?
Unskilled labourers (women)	4	617	1	?
Sailors' Unions	5	1,313	4	?
Skilled workers	2	135	8	?
Total	30	5,623	21	*c.* 800

Source: *Árbók Hagstofu Íslands*, p. 90 (Reykjavík, 1930).

six socialist societies with a total of 322 members, gives the strength of the Federation in January 1930. Within the last few years its growth has been even more rapid. In 1936 it included eighty-three unions, with a total of 12,300 members.

Employers' Associations. The first employers' union, like that of the deep-sea fishermen, was formed in 1894 by the owners of decked fishing vessels; but with the gradual change over to steam power the association weakened and was finally dissolved. Its place was taken in 1916 by the Association of Trawler Owners (*Félag Íslenzkra Botnvörpuskipaeigenda*), which has subsequently become the most powerful part of a central organization of owners' unions (*Landssamband Íslenzkra Útvegsmanna*). This, in its turn, is the strongest section of the Employers' Association of Iceland (*Vinnuveitendafélag Íslands*), established in 1934.

Strikes and Lockouts. Disputes between worker and employer were never acute until after 1914, when there was a rapid rise in the cost of living. Strikes and lock-outs, which had been almost unknown, became common and increasingly severe, but little action was taken by the *Alþingi*, except to forbid civil servants to strike. Labour troubles continued in an even more violent form after the war. In 1925 the government appointed a Public Mediator, whose term of office was to run for three years, and whose duty it was to arbitrate between workers and employers if there was threat of serious dispute.

The appearance of a working class in Iceland is so recent a feature that the need to protect its interests by legislation did not arise until this century. It is significant that it was not until 25 years after the act of 1903 providing for the inspection of ships, that a similar act was passed providing for the inspection of factories and land machinery. The chief aim of both laws is to protect the lives and health of the workers by seeing that machinery, in particular the steam boiler, is safe for use.

Wages and the Cost of Living

The payment of wages in cash was made compulsory in 1902, a further act of 1930 enforcing a weekly payment. Under this second law it was also made easier for workers to sue employers for arrears of wages. Until 1915 there was a barely perceptible wage increase, and what little there was came far below the rise in commodity prices. After the formation of the Federation of Unions in 1916, wages increased more rapidly, but it was not until 1921 that wages and cost of living reached the same comparative level as in 1914.

Comparison of prices is best seen in Figs. 109 and 110. In the first few months of the war foodstuffs showed the biggest price increase, but by 1915 the rise in light and fuel prices had surpassed all others.

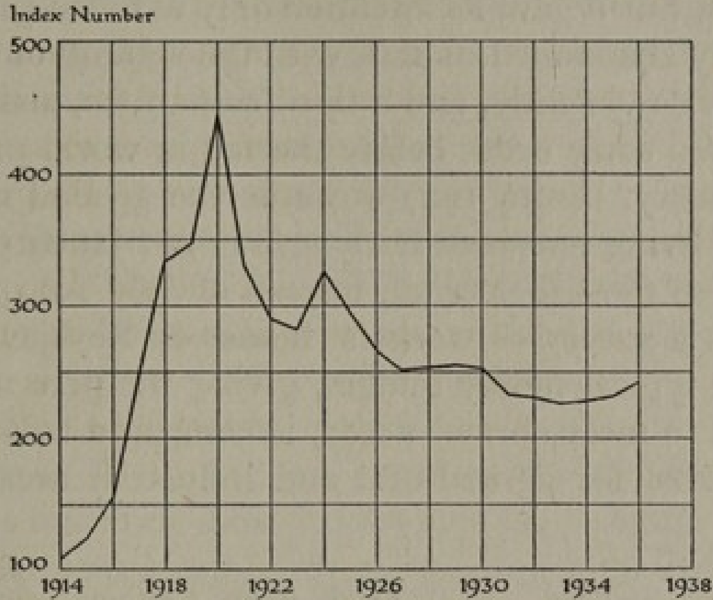


Fig. 109. Changes in the cost of living in Reykjavík, 1914–36. Constructed from general index numbers for October of each year (July 1914 = 100). Compiled from statistics in Þ. Þorsteinsson, *Iceland, 1936*, p. 122 (Reykjavík, 1936).

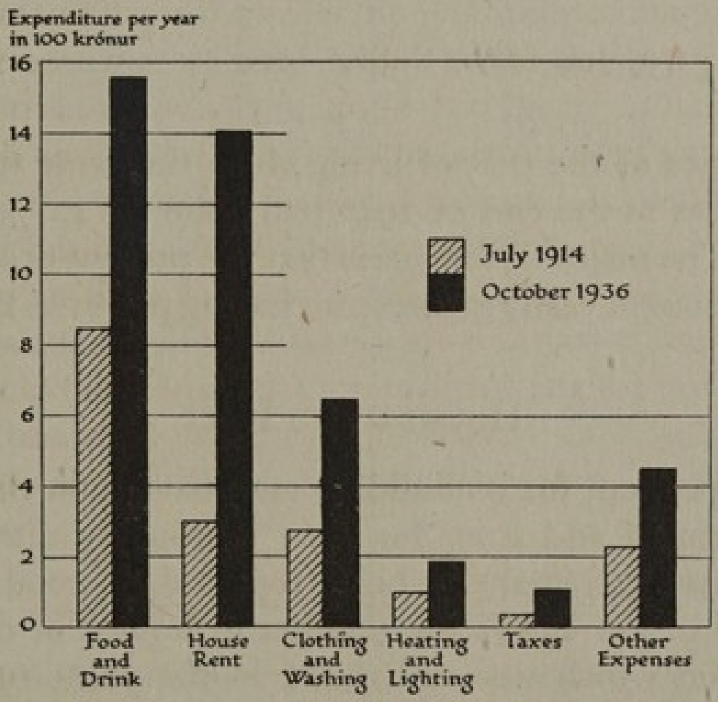


Fig. 110. Comparative average expenditure of a family of five in Reykjavík, 1914 and 1936. Compiled from statistics in *Report on Economic and Commercial Conditions in Iceland*, p. 29 (London, Dept. Overseas Trade, 1937).

Some attempt was made by the government to check the alarming rise. A price regulation committee was set up in the autumn of 1914, but no maximum prices were put on goods until December 1915, and the committee was dissolved late in the following year.

Unrestricted submarine warfare and the complete dependence of Iceland upon imported fuel forced up the price of coal to ten times its pre-war value. Another committee was formed, with the power to restrict prices, but it gave its attention only to home-produced goods and eventually abandoned its task with the signing of peace. Prices continued to rise violently, and a third committee, acting with more vigour, restored some order before the fall in world prices made its work unnecessary. From 1927 onwards the general index number of the cost of living remained fairly stable, but January–March 1939 is now taken as the base period, instead of July 1914. The revision was based on a survey of workers' homes in Reykjavík. The composition of a typical family budget, giving the percentages of total income spent to meet normal needs, is compared below with corresponding figures for agricultural and industrial areas in England and Wales:

	Date	Food	Rent	Clothing	Light and fuel	Sundry expenses
Reykjavík	Jan.–March 1939	44·2	18·2	16·6	7·3	13·7
Agricultural England & Wales	Oct.–July 1937–8	48·4	8·3	9·1	8·6	25·6
Industrial England & Wales	Oct.–July 1937–8	40·1	12·7	9·5	7·6	30·1

Recent statistics of the cost of living show the same trend as in the last war. Prices at the end of 1940 had gone up 42 % over the new base period. The major difference is that the present occupation of the country has brought vastly greater purchasing power to the Icelanders.

Housing and Rent

Iceland is dependent for its building materials upon the importation of timber, cement and iron, for even in country districts the turf and stone houses (*torfbæir*) are being replaced by wood and concrete. The table on p. 341 shows the number of houses of different types of construction which were inhabited in the years 1910, 1920 and 1928.

In the 10-year period 1910–20 the total increase in the number of houses was quite small. The rise in labour costs and the increased prices of imported building materials, due to the difficulties of sea transport during the war, rapidly sent up the cost of house construction (see Fig. 111). Meanwhile there was scarcely any increase in rents from 1914 to 1916, and throughout the war the rate of increase was not comparable with the high level reached in other prices. Rents had tripled by 1920, despite a special act of 1917 forbidding any unnecessary alteration in price. The general result was a decrease in building to little more than half of the 1914 figure.

Building material	1910	1920					1928
	Whole country	Reykjavík	*Kaupstaðir* (townships)	*Verslunarstaðir* (trading stations)	Rural districts	Whole country	Reykjavík
Stone or concrete	371	351	144	148	414	1,057	902
Wood	4,488	1,095	1,078	1,250	1,732	5,155	1,219
Mixed materials	—	—	—	—	—	—	109
Turf, etc.	5,354	13	41	250	4,658	4,962	—
Not known	—	—	9	21	60	90	—
Total	10,213	1,459	1,272	1,669	6,864	11,264	2,230

Source: *Árbók Hagstofu Íslands*, p. 91 (Reykjavík, 1930).

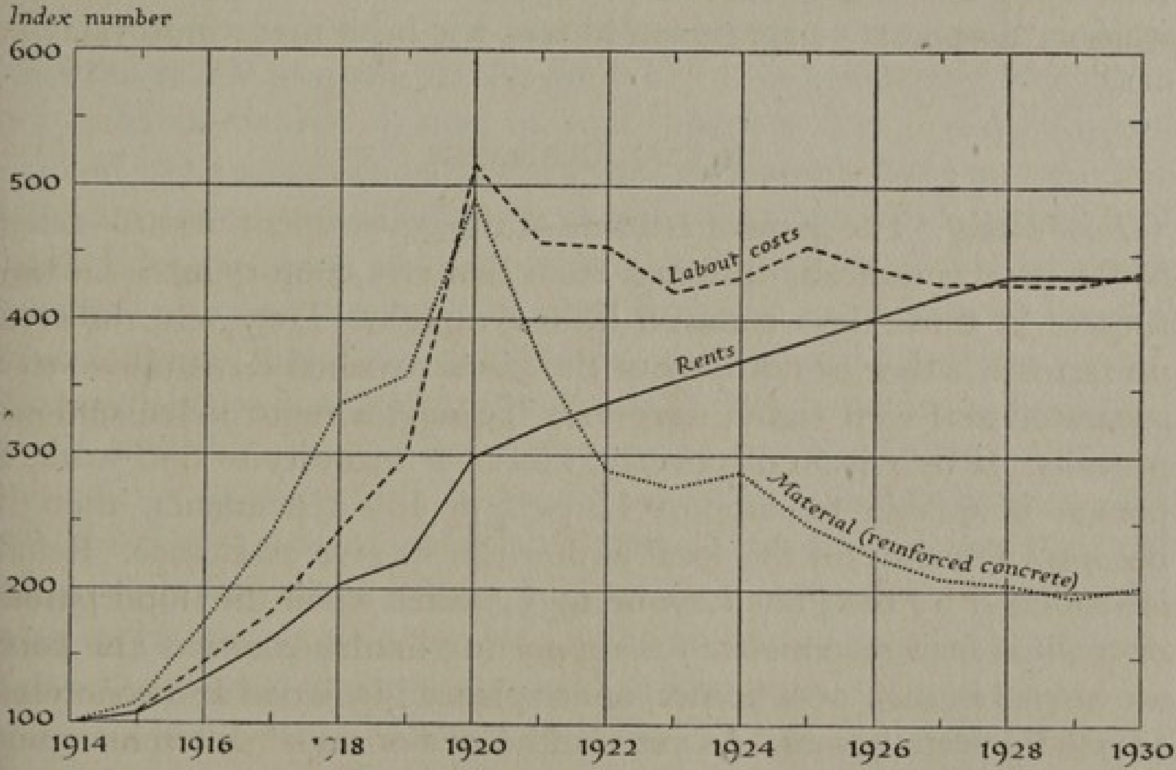


Fig. 111. Variations in building costs and rent in Reykjavík, 1914–30. The curves are based, not on actual costs in *krónur*, but on variations of cost in relation to an index number (July 1914 = 100). Based on statistics in *Árbók Hagstofu Íslands*, pp. 85, 88 (Reykjavík, 1930).

Moreover, the population in the capital was growing steadily and the municipality, faced with the problem of an increasing homeless population, built communal huts large enough for twenty families. These were insufficient to meet the needs; outhouses and dwellings, unfit for human occupation, were then used. In 1929 an act was passed forbidding the use of such dwellings unless they came up to certain hygienic standards. Those which were inhabited at the time of the act could remain so, but each year the worst of them were to be closed.

A steady drop in the prices of building materials set in about 1920 and continued until 1927, when they were only 1·75 times the 1914 level. Rents, on the other hand, continued to increase until they balanced or surpassed the rise in building costs. By 1927 the population of Reykjavík had increased by 69 % over pre-war days, and the great demand for houses coupled with the high rents gave an impetus to building. Even so there is still serious overcrowding, despite new building schemes, and in many cases whole families have to live in one room. In several towns co-operative building societies have built single and semi-detached houses, for which the interest and instalment payments together amount to less than private rentals. An interesting and highly successful experiment in the construction of workers' co-operative apartment houses has been made in Reykjavík.

Social Insurance

Poor Relief. The present attitude of the government towards relief of the poor is radically different from that of a century ago. Unfortunates in those days received little sympathy. They were billeted on farms whether or not they or the farmer wished it; families were separated and civil rights were lost. To-day, a more social outlook prevails. If by reason of poverty, illness or inability to find work, a person is unable to support himself or his dependents, then it becomes the duty of the local authorities to give assistance. Relief is regulated by the Poor Law of 1935, under which the local parish or town is held responsible for supporting hardship cases. The poor are helped in their own homes, or are placed in charitable institutions or good private homes. As yet workhouses or poor houses have not been built. Those receiving such help must do any work which is set, provided that they are in a fit state of health, but there is no loss of civil rights and families can no longer be separated without their consent. Allowances are looked upon as loans, to be repaid when possible, except for those made to the support of orphans, the children of widows, or to people over 60 years old. When parishes and towns have to face heavy relief burdens, the state meets part of the cost. On an average about 25 % of the total expenditure by local authorities goes towards support of the poor. In 1930 there were 1,168 persons receiving public assistance.

Old-Age Pensions. Since the poor laws of last century left many people destitute, funds for the relief of the aged were set up in 1890 in all towns and parishes. Domestics and unskilled workers between the ages of 20 and 60 made small voluntary contributions, and pensions were later given to poor people over 60. This help proved insufficient to be of any real value, and in 1909 a new act was passed which made subscriptions compulsory for all men and women between the ages of 18 and 60. The state subsidized the fund, but still the pension was too small. Both subscription and subsidy were increased in 1917 and yet again in 1933. By the end of 1934 the fund amounted to Kr. 1,600,000, and 50,000 people (43 % of the population) were insured.

The Social Insurance Act of 1936 brought big changes. By its terms it became compulsory for every Icelandic subject between the ages of 16 and 67 to pay premiums into a general pension fund (*Lífeyrissjóður Íslands*). The amount to be paid varies with locality; thus the yearly payment in a town is Kr. 7, in a village of more than 300 inhabitants Kr. 6, and in rural districts Kr. 5. In addition, 1 % of the assessable part of each contributor's income goes into the fund and an annual state grant of Kr. 150,000 will be made until 1986. Civil servants, school teachers and midwives have their own pension schemes and are exempted from the provisions of the act. So too are all those who were 60 or over when the act was passed. When the fund is sufficiently well established, pensions will be paid to all contributors who reach the age of 67. The full amount will not be paid if there is an income from other sources which exceeds one-third of the pension. In this case a graded deduction is made. Meanwhile, old people who are in need, or any persons between the ages of 16 and 67 who are entitled to invalidity pensions, are supported on a scale fixed by the local authorities.

Accident Insurance. More than three-fifths of all accidental deaths in 1931 were due to drowning, and it is not surprising that insurance against accidents was first started amongst fishermen. The comprehensive Social Insurance Act of 1936 embodied almost unchanged the laws already in force. By an act of 1903 insurance was made compulsory for all sailors on decked vessels. In 1909 and again in 1917 the scope of the legislation was widened to cover sailors on all but two-oared boats; compensation in the event of death was increased, and disability insurance was introduced for injuries which led to permanent incapacity. By a further act of 1925 (with later additions and amendments) accident insurance was made to cover practically all wage earners except farm labourers. Under this law, benefits in the form of daily payment during illness, incurred as the result of an accident, were to be paid whether or not the incapacity was of a permanent or temporary nature. In 1928 both compensation for loss of life and disablement payments were again increased. To-day, the compulsory insurance of Icelanders is divided into two types—the Seamen's Department and the Industrial Department. Those outside the limits of these compulsory schemes may be insured by themselves or their employers. Expenses for insurance are met by the employers, except for fishermen in rowing boats or motor boats of less than 5 tons, for whom the state pays 30 % of the premiums. Compensation is paid on the following basis:

(1) An insurance of Kr. 5 a day is paid when 10 working days are lost, the payments beginning 1 week after the injured person has ceased to receive wages. Although the allowance continues until recovery or until a decision regarding permanent incapacity has been reached, the maximum term of payment for any one accident is 6 months. Meanwhile, full payment is made for medical aid and hospital expenses, or, in the case of out-patients, three-quarters of the amount spent on medicine is given free.

(2) Lump payments of Kr. 6,000 are made for permanent disability, and proportionately less sums for partial disablement.

(3) If the accident causes death within a year, compensation is paid to the nearest relative. Kr. 3,000 is paid to a widow or widower and further sums are paid for the support of children or other dependents.

Sickness Insurance. A Sickness Benefit Society, the first of its kind in Iceland, was formed in the capital in 1909. State aid was given to any such societies after 1911, and by 1935 twelve clubs, with a total membership of some 5,000 people, were receiving financial help. In the following year insurance against sickness was made compulsory for all town-dwellers between the ages of 16 and 67. Only those suffering from lingering illnesses were exempted, and these were to be given free treatment in hospitals or sanatoria, the state paying four-fifths of the cost and the local community the balance. In rural areas benefit societies can be formed if it is the wish of the majority of ratepayers. Few country districts have as yet taken advantage of this state help.

Every member has to contribute to the funds of the society, but only those with a taxable income below Kr. 4,500 are entitled to benefits from it. Premiums are low, since the state and municipality equally share half the costs, provided that this aid does not exceed Kr. 9 per head. Benefits cover members and their children, and include full medical aid and hospital treatment for indoor patients. Three-quarters of the costs to out-patients are paid by most insurances. In addition to all this, daily relief is given in cash on a scale varying with the size of the family.

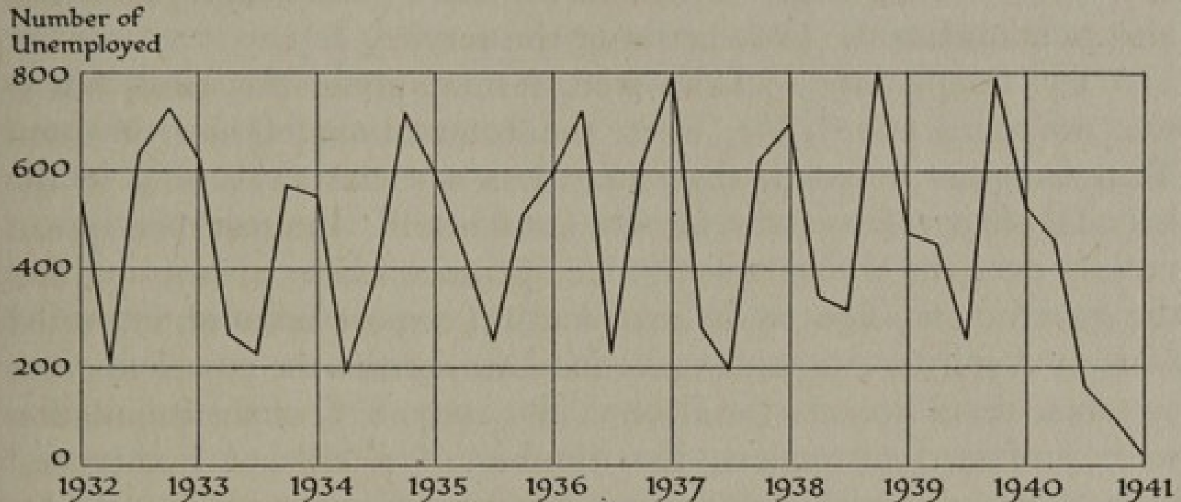


Fig. 112. Unemployment in Reykjavík, February 1932 to February 1941. The graph has been constructed from statistics for the 1st day of February, May, August and November each year. Source: *Statistical Bulletin*, Vol. x, No. 2 (Reykjavík, 1941).

Unemployment Insurance. The temporary nature of much of the unemployment in Reykjavík is typical of a land where the chief occupations are seasonal (see Fig. 112). There is indeed a labour shortage during the summer months when the herring season off the north coast coincides with the hay harvest. Within recent years, however, world market difficulties and restrictions on trade generally have brought unemployment as a permanent feature of the social system. Distress has been lightened by state and municipal expenditure on relief work and by the setting up in 1935 of labour exchanges. Trade unions which have established funds for their unemployed members are entitled by the Social Insurance Act of 1936 to receive public aid. As no union has yet established such a fund the provisions of the act remain theoretical.

Since 1940 unemployment has virtually disappeared with the extra work brought by British and American occupation.

Note on Alcohol and Prohibition

In a land of fishermen and farmers where the weather is frequently cold and damp, it is not unnatural to find brandy (*brennivín*) looked upon as a valued stimulant and medicine. Shortly after 1850 the annual consumption per head in terms of pure alcohol was over 3 litres. Men, women and children made brandy their common drink; each traveller carried his bottle and almost every loft had its keg or firkin. Not only was it brought to church for use by the congregation but also to stimulate the preacher after the service.

A few temperance societies were formed about this time, but it was not until after 1884, when the International Order of Good Templars was founded, that there was a social awakening to the harmful effects of excessive alcohol upon health. Interest then spread rapidly over the whole country. Temperance lodges sprang up, and the government, slow to do anything but impose taxes on imported wines and spirits, eventually gave local authorities the power to grant or refuse retail licences for alcohol. By 1907, 8 % of the population were professed teetotalers, the number of retail and innkeepers' licences had diminished and many districts were completely 'dry'.

The movement towards total prohibition steadily developed, and at the general election in 1908, 60 % of the voters wanted temperance. Legislation followed slowly. By the end of 1915 the sale of intoxicants was prohibited, whereupon the medical, technical and scientific professions demanded unlimited alcohol for professional uses. Smuggling, too, was more common than usual; intoxication was seen frequently in the towns, and on coastal steamers and visiting luxury liners the degree of drunkenness was staggering.

Foreign economic pressure came after the war. Spain, and to a lesser extent France, were the chief importers of Icelandic salt fish, and prohibition in the northern countries (Norway and Finland had followed Iceland's example) destroyed their wine market. Strong protest was made by Spain, and in 1922 the *Alþingi* was forced to lift the ban. Wines of less than 21 % alcohol (by volume), which excluded only certain sherries, were allowed into the country. Their importation and sale were placed under the State Monopoly of Wines and Spirits (*Áfengisverzlun Ríkisins*), which set up a wine shop in every town.

In country districts domestic brewing was started, and there were many opportunities for drinking, great ingenuity often being shown by the people in obtaining intoxicating substitutes. The open law-breaking encouraged the anti-prohibitionists to attack the remaining restrictions, and since the Good Templars had dwindled in numbers once their object had been achieved, the fight was successful. In a 1933 plebiscite 58 % of the voters were in favour of abolishing the prohibition law, and repeal followed in 1935. At the same time the state kept its monopoly and imposed restrictions on the sale of spirits. Thus shops were allowed to remain open only for a few hours each day and sales could only be made to adults on a cash basis. In every town and village a committee, with a government appointed chairman, was set up to advise the people against alcohol. Moreover, that part of the prohibition law which prevented the importation of ale and beer above an alcohol strength of 2·5 % (by volume) was kept in force. This has created considerable difficulties since the occupation by British troops in May 1940, and there have since been changes in policy, none of which is entirely satisfactory.

Figures showing the average alcohol consumption per head are misleading, since only part of the consumption can be entered in official statistics. Moreover, there are few temperate or 'average' drinkers. Consistent with the Icelandic tendency to extremes, certain sections of the community are given to excessive sobriety, others to excessive indulgence.

Chapter XVI

FOREIGN TRADE

Growth of Trade: Imports and Exports: Commercial Policy: Summary: Trade Conditions since 1939

Growth of Trade

From the time of the Settlement until the thirteenth century the Icelanders themselves traded in European markets, but after the Union with Norway in 1262 Icelandic trade was taken over by the Norwegians. When Norway was itself united with Denmark in 1397 the rulers of this joint kingdom imposed restrictions that gave a monopoly of Icelandic trade to the merchants of Bergen. However, these restrictions were not rigorously enforced, and, throughout the

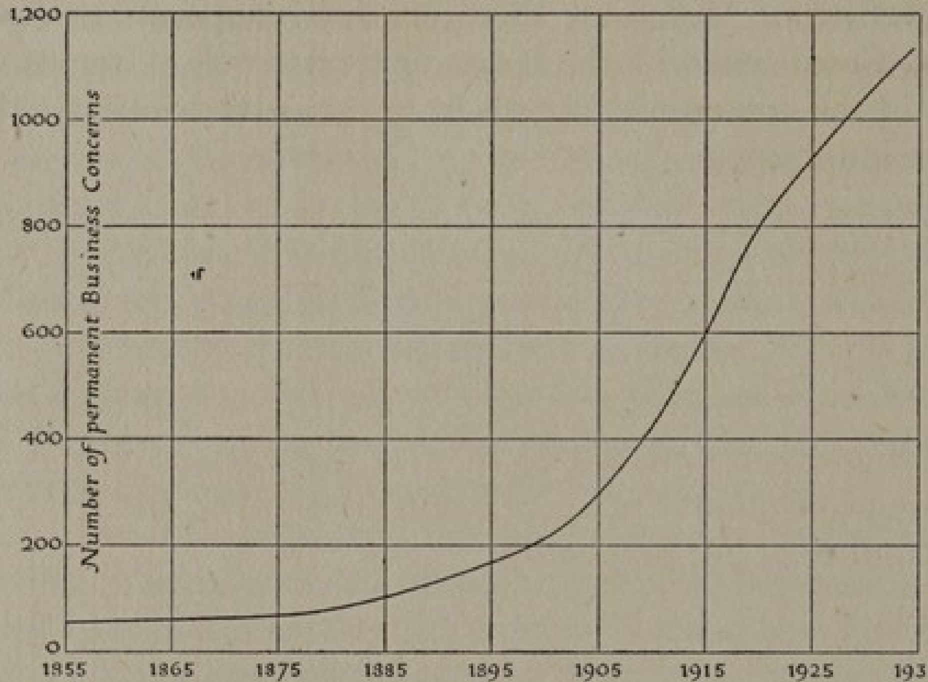


Fig. 113. Growth in the number of permanent business concerns in Iceland, 1855–1934. Data from Þ. Þorsteinsson, *Iceland, 1936*, p. 87 (Reykjavík, 1936).

fourteenth and fifteenth centuries, the greater part of Icelandic trade was carried on by English and Hanseatic merchants. In 1602, however, Denmark established a complete monopoly in Iceland. This policy was continued until 1787, when trade was granted to all subjects of the King of Denmark, but not until 1854 was the Icelandic trade opened to all nations. Since that year, business in Iceland has grown, gradually at first, but very rapidly in recent years. Fig. 113

shows the increase in the number of permanent business concerns in the country between 1855 and 1934, and illustrates the marked expansion during the present century.

By the Act of Union between Iceland and Denmark in 1918, a Danish subject may establish a permanent business in Iceland and yet reside in Denmark, whereas this concession is not granted to other nationals unless they are resident in Iceland, in which case their businesses are classed as native concerns. In 1855 more than 50% (or 32 in number) of the business houses in Iceland were owned by persons residing in Denmark; by 1934 the figure had fallen to less than 0·4% (or 4 in number). At first, the Icelanders themselves were engaged only in retail business, but during and after the war of 1914–18 they played an increasing part in foreign trade. In 1912 there were only 15 native wholesale dealers and commission agents in Iceland; in 1934 their number had risen to 84.

Compared with the total population (120,264 in 1939) the foreign trade of Iceland is larger than that of most other countries. The import and export values (in krónur) per capita may be seen from the following summary:

	Imports	Exports	Total
1896–1900	78	91	169
1901–1910	123	149	272
1911–1915	209	258	467
1916–1920	587	529	1,118
1921–1930	603	648	1,251
1931–1935	413	433	846

These high figures are due to the fact that Iceland, having a very limited range of natural resources, must depend on foreign trade for a great number of her necessities.

Imports and Exports

The import or export values for a given year or of a particular commodity must always be considered in relation to price level. In many cases where the total value for one year as compared with another appears to have increased, the figures for quantity or weight will show a decrease, or *vice versa*. Fig. 114 shows two pairs of curves for Icelandic trade from 1914 to 1938. These are plotted from index numbers, taking the year 1914 as equal to 100. The dotted lines show the index of volume of exports and imports, and are computed from statistics of the total value of trade, corrected to eliminate the variable factor of price level. The continuous lines show the fluctuations in price level, taking an average of imported or exported goods respectively. The index of volume for any given year multiplied by the index of price level for that year will give the index of total value of exports or imports.

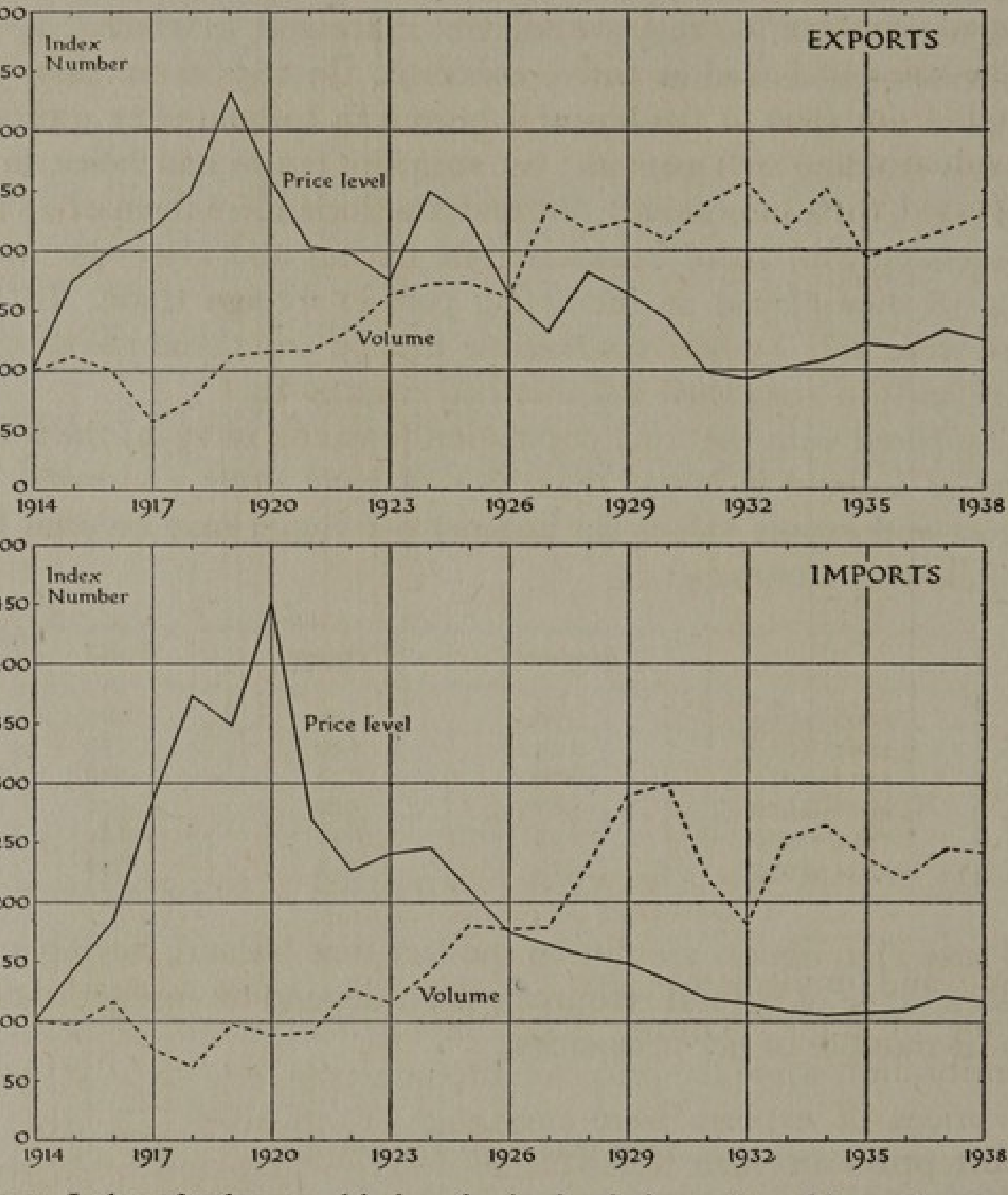


Fig. 114. Index of volume and index of price level of exports and imports, 1914–38 (1914=100). Data from *Hagskýrslur Íslands, Verslunarskýrslur* (Reykjavík, 1930–38).

From these curves it will be seen that the drop in the quantity of total trade in 1917 coincides with the extension of unrestricted submarine warfare during the last war. During that year imports fell to three-quarters of their quantity in 1914, and in 1918 they fell further, to about three-fifths of the 1914 figure. In the case of some of the individual commodities such as coal and wheat, the decrease was even greater, and rationing had to be introduced for some commodities for a short time.

Up to 1930 trade reflected the growth of population (see Fig. 81), for, although hindered during individual years by world events or internal policy, it showed a general increase in spite of violent price fluctuations. After 1930 the volume of imports was controlled by the planned economy of the Icelandic government.

The value of Icelandic trade, expressed as averages over five-year periods from 1896 to 1940, is shown in Fig. 115, and the values for individual years from 1931 to 1940 in Fig. 116. The increase during the period 1916–20 was due more to a general rise in the price level

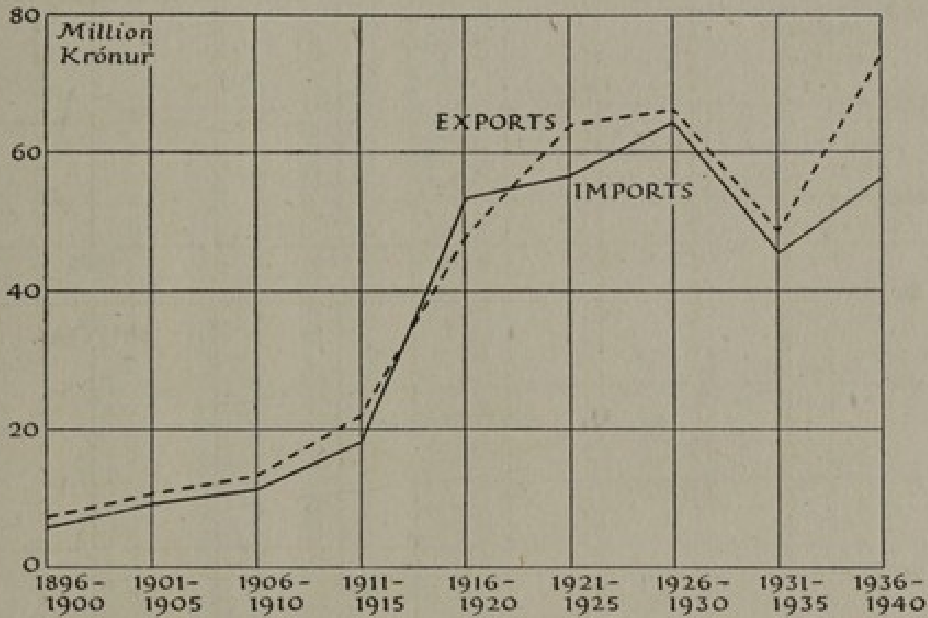


Fig. 115. Average value of imports and exports for 5-year periods, 1896–1940. Data from Appendix IX, table 1.

during and immediately after the war than to an increase in the volume of trade. During 1920 imports decreased somewhat in quantity; but, while the prices of import articles rose to great heights the prices of exports were declining. Compared with 1913–14, import prices in 1920 were, on an average, four and a half times higher, while export prices were only two and a half times as great. This anomaly, coming at the same time as an abnormally large purchase of ships, caused a large deficit in the balance of trade.

The effect of the world depression is shown by the drop in the total value of trade after 1930, which was due both to decreased trade and to lower prices. In 1931 the price of export goods fell more rapidly than that of imports, and from that date the values are complicated by world economic trends.

Statistics of the chief groups of imports and exports are given in

Appendix IX, tables 1 and 2, and of the most important articles of import and export in tables 3 and 4. From these it will be seen that during the last two decades fish and fish products have formed more than 80% of the total value of exported goods, whereas the imports cover a much wider range of commodities. The increase in exports up to 1930 was chiefly a result of the increased capacity of the fishing fleet. The chief agricultural products are mutton, wool and hides, but the increased production after 1925 has to a great extent been absorbed within the country itself. Before about 1930 all meat for export was salted, but since the establishment of state-owned refrigerating plants, the greater proportion has been shipped frozen.

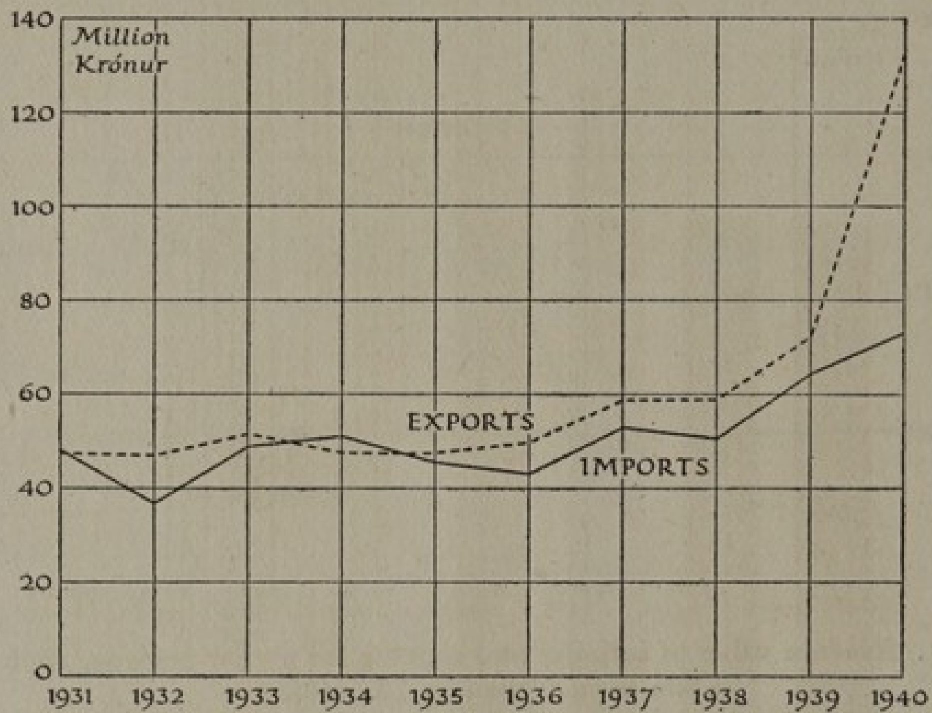


Fig. 116. Value of imports and exports, 1931–40. Data from Appendix IX, table 1.

The relative importance of particular groups of imports have shown periodic fluctuations, but the ratio between goods for production and those for consumption has changed fairly consistently. This is shown for the period 1935–8 in Fig. 117. The increase in capital goods in proportion to consumable goods is a natural result of the change which is taking place in the occupational life of the country, more goods for consumption now being produced at home. This natural trend has been accentuated by state restrictions on certain imports.

The lack of coal and other mineral resources has necessitated imports for both domestic and industrial use. Formerly the agricultural population was content to use peat and sheep manure as fuel, but with the better transport facilities and the improvement of purchasing power, a much greater demand for coal has been created. The increased use of motor transport has necessitated the import of petroleum and benzine, while the fishing fleet, which consists of steam trawlers and motor vessels, is dependent on imported coal and oil. As new industries develop, the need for fuel will increase further, but it seems likely that this will be satisfied by the development of hydro-electric power, and that the natural hot-water supplies will be increasingly used as heating for industry and domestic pur-

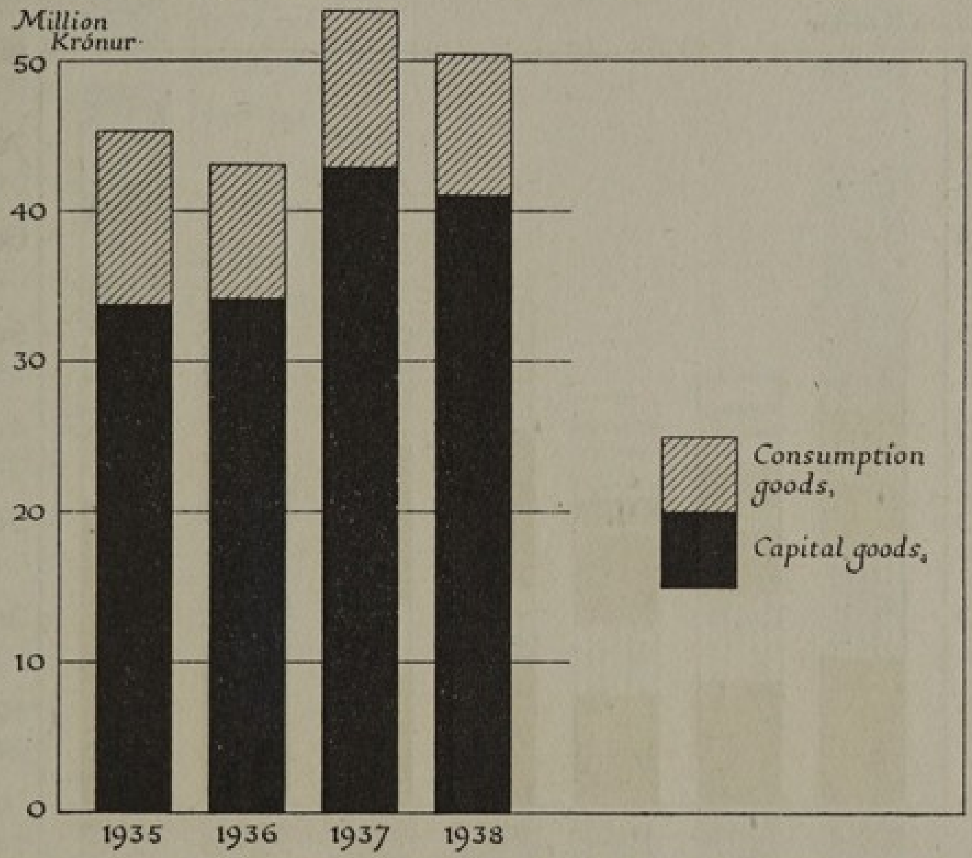


Fig. 117. Goods for consumption and capital goods imported into Iceland, 1935–8. Compiled from data in *Hagskýrslur Íslands*, No. 104, *Verslunarskýrslur*, pp. 10–11 (Reykjavík, 1940).

poses. Building materials for the modern Icelandic houses have to be imported, as well as timber and machinery. As practically no grain is grown in the country, a considerable amount is imported, and large quantities of vegetables have still to come from abroad, although the home production is likely to increase. Other imports cover a wide range of foodstuffs and manufactured goods.

Up to the beginning of the twentieth century Iceland was commercially dependent on one or two foreign countries. In 1900, 90% of the imports came from Denmark and Great Britain, and 60% of the exports went to them. After the war of 1914–18 Icelandic commerce became more diffuse. Owing to the disruption of shipping lines, trade with the United States increased, but decreased with the gradual resumption of normal shipping lines. It is again increasing during the present war.

In 1933, 80·7% of the imports came from Great Britain, Denmark, Germany and Norway, while only 32·2% of the exports went to them: 55·4% of the exports (largely 'klipfish') went to the Catholic countries of Spain, Italy and Portugal, but only 5% of the imports came from those countries. The foreign trade of Iceland was not,

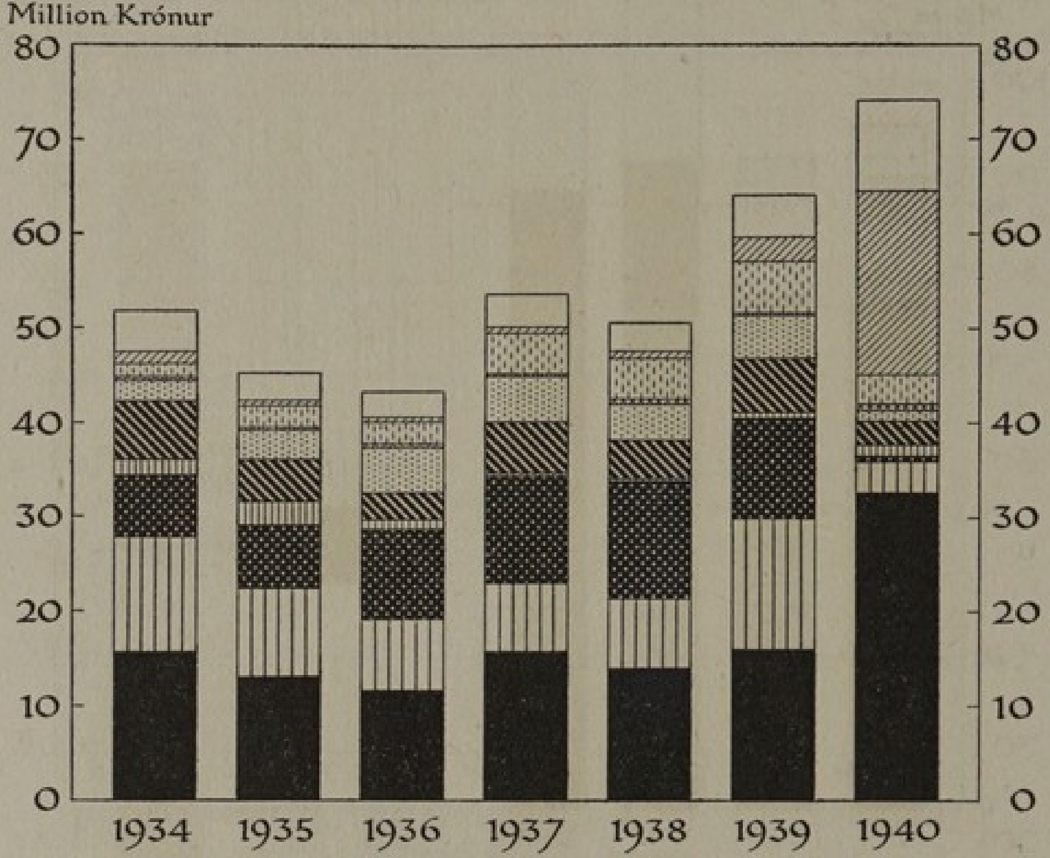


Fig. 118. Value of imports into Iceland from foreign countries, 1934–40. For key see Fig. 119. Data from Appendix IX, table 6.

therefore, 'balanced' as regards individual countries. As a result of the world depression and of the decrease in importing power, there was a general tendency for European countries to seek reciprocal trade. Such a policy was bound to have an adverse effect on a country like Iceland which has a very limited range of exports. In 1934 Spain restricted the importation of 'klip-fish' and demanded a trade agreement with Iceland.* Italy demanded a similar trade agreement in 1935. The Spanish Civil War of 1936–9 put a further restriction

* The prohibition law in Iceland had been revoked in 1922, as far as wines were concerned, in order to satisfy the Spanish merchants, and so keep open the Spanish market to Icelandic fish. In 1935 the prohibition was altogether abolished.

on Icelandic trade, and exports to Spain fell from 28·8% in 1933 to 1% in 1937, and those to Italy from 12·3% to 5%. The value of trade with the principal foreign countries for the period 1934–40 is shown in Figs. 118 and 119.

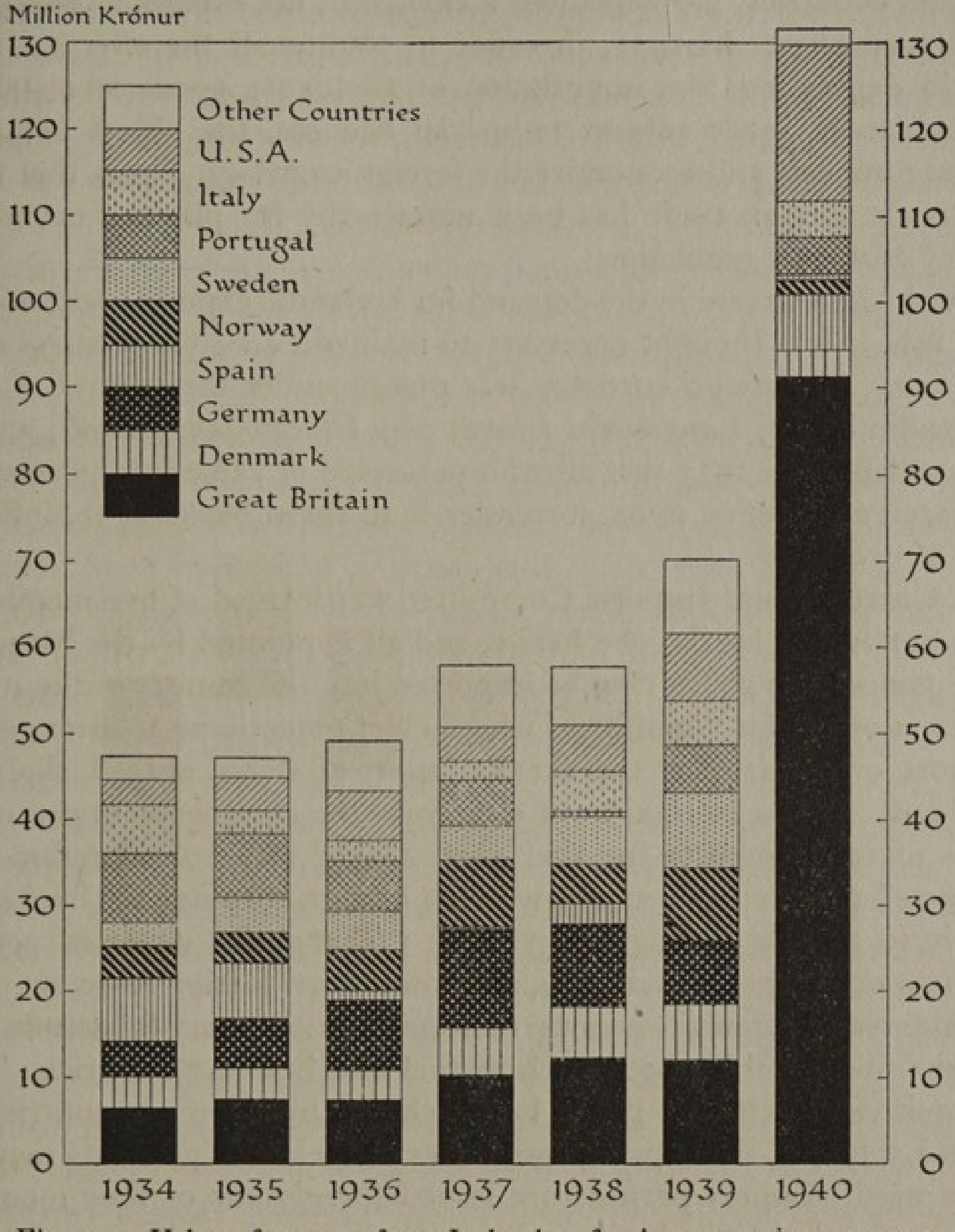


Fig. 119. Value of exports from Iceland to foreign countries, 1934–40. Data from Appendix IX, table 7.

Commercial Policy

In 1930 the world depression began to show its effect on Iceland's foreign trade. The need for foreign currency became pressing, and in 1931 there was a marked deficit in the balance of trade, for exports fell enormously in price during that and the following year. Since then there has again been a rise in the prices of export goods; but at the same time the attempts made by various countries to restrict the importation of Iceland's chief export goods, and the necessity of agreeing to the quota principle in her economic agreements with foreign countries, has expedited a change in her economic policy.

Organization. In 1931, in order to counteract the effects of the world depression, the importation of all luxury goods was strictly forbidden or made subject to special licences, the object being to reduce imports and economize the foreign currency. From that time Icelandic foreign trade has been noteworthy for planned economic policy and state regulation.

With the decrease in the demand for Icelandic exports, particularly salt fish, it was thought necessary to maintain a stricter control over imports. All foreign currency was placed under the control of two Icelandic banks, *Landsbanki Íslands* and *Útvegsbanki Íslands*, and it was ordained in 1933 that all who possessed or came into possession of foreign currency must surrender it to these banks at the official rate of exchange.

A Currency and Imports Committee was formed of five members, two nominated by the two banks, and all appointed by the Minister of Finance. No goods may be imported into the country without the permission of this committee, whose chief object is so to arrange the import of goods that the accumulation of debts abroad shall be avoided. At the beginning of each year the committee draws up a plan of total imports for that year, taking into consideration the expected requirements and how much foreign currency the banks are likely to acquire during that year in exchange for exported goods. Obligations to pay instalments and interest on foreign loans are also considered. Preference is given to imports of necessary foodstuffs and other indispensable goods such as fuel and building materials. The committee directs that goods be purchased in specified countries in such a way that the export possibilities of Icelandic products may be fully used. Import permits are issued for periods of four months, but, as the committee has to forecast the extent of production and the sale of exports (chiefly products of the cod and herring fisheries), the permission granted is only conditional on there being sufficient foreign currency in hand when the payment has to be made. Hence the currency and import permit does not imply either state responsibility or a guarantee that the banks will transfer the amount owing on the date when the payment falls due.

It should be emphasized that these far-reaching import restrictions have been introduced as a necessary expedient. They were intended to counteract the difficulties which Iceland had to face in international trade, particularly in the salt-fish market, up to the outbreak of war in 1939. They were also intended to protect as far as possible the purchasing power of the Icelanders. As a result of these restrictions, and of the foreign debts incurred by Iceland, trade with certain countries, with which Iceland had an unfavourable balance of trade up to 1935, became more evenly balanced than before. At the same time the restrictions caused the purchase of certain kinds of goods to be more closely bound, or to be transferred, to specific countries.

State Monopolies. A distinctive feature of Icelandic trade is the part played by the state monopolies. These were first introduced towards the end of the war of 1914–18. When, owing to world conditions, trade became difficult, the state undertook the purchase of some of the more indispensable imports, which were then sold to the merchants and co-operative stores. This resulted in the government stores (*Landsverzlun*) which continued to operate until 1927 when only the state monopoly of wines and spirits was left. Other state monopolies have since been created, each with the sole right of importing goods within its sphere of activities. In 1941 there were five state monopolies operating in Iceland covering the following goods: tobacco, wines and spirits, wireless apparatus, motor cars and spare parts, and vegetables.

Tariffs. The duties which have gradually been imposed on imported goods were at first levied almost exclusively as a means of revenue and not for the purpose of protecting Icelandic produce. They were, therefore, placed only on luxury goods. When the law prohibiting the importation of spirits became operative in 1912, import duties were levied on almost all kinds of imported goods, to make good to the treasury the loss of the spirit tax. In 1924, owing to the unfavourable rate of the króna, taxes on all imported goods, except grain, were increased by 25%, a measure which has been renewed and still, to some extent, remains in force. In the same year an *ad valorem* duty of 20% was imposed on various articles on which a goods tax was already payable, but this duty has been repeatedly altered. In 1935 a new *ad valorem* duty, in addition to the one already in force, was imposed on various kinds of goods, to the amount of 2, 5, 10, or 24% of the cost price. This tax had the definite object of curtailing the import of luxuries. In 1940 a new customs tariff, based on combined weight and *ad valorem* duties, came into operation. Besides the taxes levied on imported goods, there is also an *ad* *valorem* duty of 1·5% on all Icelandic export goods, except farm produce. Herring meal, fish offal and herring used for the herring-meal and herring-oil industry, on which a duty by weight is payable, are exempted from *ad valorem* rates.

The Co-operative Movement. The co-operative movement has been discussed elsewhere (pp. 303–6), but no survey of Icelandic trade would be complete without some reference to it. In 1910 the Federation of Icelandic Co-operative Societies began to help its members in the sale of products abroad. The opening of branch offices in Copenhagen and Leith, and more recently in New York, has greatly extended the scope of activities. In 1936 the Federation sold Icelandic goods to the value of Kr. 11,459,723, of which the value of Kr. 10,531,538 was exported. The chief articles exported by the Federation are mutton (frozen and salted), sheep skins, wool, guts, offals, fish (hard, salted, dried and chilled), salt herring and salmon, skins and hides, horses, eiderdown and cheese. In 1936 the sale of imported and other purchased goods amounted to Kr. 7,969,320.

In 1917 the merchants of Iceland established a Chamber of Commerce (*Verzlunarráð Íslands*), with headquarters in Reykjavík, which has set up a court of arbitration in commercial and shipping affairs. The Mercantile Agency (Address: Pósthússtræti 2, Reykjavík) has been established under the protection and supervision of the Icelandic Chamber of Commerce, in order to furnish Icelandic and foreign firms with reliable commercial information and to assist in the recovery of debts.

Summary

The main facts relevant to the foreign trade of Iceland prior to the present war appear to be as follows:

(1) Owing to the size of the population the market offered to foreign exporters is small, but it is larger than the population would indicate on account of the lack of natural resources. Almost everything required, excepting fish, fish by-products, and certain agricultural produce, has to be imported either in the shape of raw materials or of finished products.

(2) The capacity of Iceland as an importer is limited to the extent of her ability to find external markets for her exports. Difficulties have arisen owing to import restrictions in force abroad, to the Spanish, Italian and German demands for evenly balanced trade, and especially to the Spanish Civil War, since Spain was formerly the most important market for Icelandic fish.

(3) The shortage of foreign exchange has necessitated, where possible, the production of goods in Iceland itself. This has been marked by an increase in the import of capital goods and raw materials over that of consumable goods. There has also been a curtailment of imports from countries whose exports to Iceland are greater than their imports from Iceland.

(4) The government monopolies and the extent of the co-operative movement are distinctive features of Icelandic trade.

Trade Conditions since 1939

The outbreak of war in 1939 and the subsequent occupation of Iceland by British and American troops have created an 'artificial' economic situation. Some of the diversions in trade may outlast the war, but at present they must be considered as purely temporary, and the rapid rise in export and import prices is a result of the exceptional conditions.

Up to 1940 over 60% of Iceland's foreign trade had been with Scandinavia, central Europe, and the Mediterranean countries. Trade with Germany and Poland ceased during the last months of 1939, and, with the exception of a small export of salted herring to Sweden, the Scandinavian market was closed in April 1940 after the German occupation. Even before the British occupation of Iceland on 10 May 1940, all trade with countries at war with Great Britain had become impossible. Trade with the Mediterranean countries, except with Portugal and to some extent Spain, stopped when Italy declared war on England in June 1940. Practically all Iceland's foreign trade is now therefore with Great Britain, Canada and the United States.

Figures for the value of exports in 1940 are nearly double those for 1938, while the value of imports rose by nearly 50%. With the exception of cod-liver oil to the United States, dried fish to Spain and Portugal, and a small quantity of salted herring to Sweden, all Icelandic exports were taken by Great Britain in 1940, the value of exports to Great Britain being greater than the total value of all Icelandic exports in 1939. This very marked rise is due partly to increased prices. The greatest increase in exports has been in fresh fish (frozen or on ice), which has to a great extent taken the place of the export of 'klipfish' and wet-salted fish. In 1940 the tonnage of fresh fish exported was six times as great as in 1938, while, owing to increased prices, the value was as much as twelve times as great.

With greatly increased purchasing power resulting from increased prices for exports and from the money obtained by the Icelanders from the British army, there has been a natural demand on the part of some sections of the community for a higher standard of living involving increased imports. At the same time both shipping and supply difficulties tend to reduce imports and consequently internal prices have risen enormously. The government is facing grave domestic political difficulties in meeting this situation.

When Great Britain occupied Iceland the British government promised to assist her economy. When later Great Britain's own supply situation made it difficult to meet requirements of the island from British sources, discussions with the United States were initiated in order to see what joint measures could be taken. Since the United States had also undertaken to assist Iceland's economy, a solution was rapidly reached, and it was arranged that the United States should take over the responsibility for supplying the main bulk of Iceland's requirements. The necessary dollars for purchases in the United States were to be acquired by Iceland, in part as a result of the United States occupation, but principally by the United States taking over the purchase of Icelandic exports to Britain and charging them to the British account as Defence Aid under the Lease-Lend Act. After 27 November 1941 all payments by Britain for Icelandic products have been paid into a Suspense Account which will eventually be transferred to the United States debit.

The sterling balances at present held by Iceland in London will remain available for such purchases in the sterling area as Iceland continues to make and for the repayment of existing loans.

Chapter XVII

FINANCE

Coinage and Rate of Exchange: State Finance: Urban and Rural Finance: Banks: Insurance

Coinage and Rate of Exchange

The Icelandic monetary unit is called a *króna* (pl. *krónur*) and is divided into 100 *aurar* (sing. *eyrir*). The National Bank of Iceland (*Landsbanki Íslands*) issues notes for 5, 10, 50 and 100 krónur, and there are 1 eyrir, 2, 5, 10 and 25 aurar pieces, and 1 króna and 2 krónur pieces. The export of Icelandic notes is prohibited.

Before the war of 1914–18 the Icelandic króna was equivalent to the Danish, Norwegian and Swedish krone, and the relation between it and the English and American monetary units was then as follows: £1 = 18·16 krónur; 1 dollar = 3·73 krónur. With the fluctuations caused by the war in the currencies of various countries, the Icelandic krónur followed the Danish krone up to the beginning of 1920, while from the latter half of that year to the middle of 1922 it was quoted, though not officially, independently of the Danish krone and at a lower rate. In June 1922, when foreign currencies began to be officially quoted in Reykjavík, a pound sterling was equivalent to 26·50 krónur, and a United States dollar to 6·03 krónur. From October 1925 to March 1939 the relation of the value of the Icelandic króna to the £ was unaltered (£1 = Kr. 22·15), but this value was not stipulated by law. By a law of 4 April 1939 the Icelandic króna was devalued by 22%, and the rate of the £ raised to Kr. 27·00. This rate was unaltered until September 1939. A law of 18 September 1939 provides that when the rate of the £ expressed in dollars falls below 4·15, then the value of the Icelandic króna shall be adjusted to the dollar instead of to the £ at the proportion of $ 4·15 = Kr. 27·00. As a result of this, the rate of exchange of the £ to the króna decreased from September 1939 to June 1940, when it was decided that the official quotation of the dollar in the open market in London should be used as a basis of exchange, instead of the quotation of the £ in the open market in New York. Since then the rate of exchange of the króna has been Kr. 26·22 to the £. For rough purposes 1 króna may be taken as equivalent to 8½*d.*, and Kr. 6·50 to 5*s.* or $1.

State Finance

In 1871 the finances of Iceland were separated from those of Denmark. It was not, however, until three years later, by the constitution of 1874, that the *Alþingi* was granted control of Icelandic finances, and the first budget was framed for the financial year 1876. Up to that time the finances of Iceland had been in the hands of the Danish government.

In 1871 Denmark agreed to pay Iceland an annual grant to be reduced by a fixed yearly amount until it had come down to Kr. 60,000. This grant was looked upon as a repayment of Icelandic money which had gone into the Danish treasury. In 1918, when Iceland was acknowledged as an independent state, this grant was discontinued and Iceland undertook to pay her share of the Civil List. At the same time two million krónur were paid out of the Danish treasury and made into two separate funds of a million krónur each; one managed by the university of Reykjavík, the other by the university of Copenhagen. The object of both funds is to further intellectual intercourse between Denmark and Iceland, to promote Icelandic research and science, and to support Icelandic students.

Revenue and Expenditure. After Iceland had achieved financial independence, the budget was for a number of years carefully framed, with a small surplus each year which gradually accumulated into a Reserve Fund. State loans were unknown up to 1908, but as the government became engaged in public undertakings, the revenue and expenditure rapidly increased. The percentage distribution of revenue and expenditure in 1876 and 1935 was as follows:

Revenue

	1876 %	1935 %
Taxes	17·9	32·1
Customs	32·1	45·1
Post, telegraphs and telephones	−1·0	3·4
Monopolies	—	15·3
Annual contribution from Denmark	32·1	—
Other revenues	18·9	4·1
Total	100·0	100·0

Expenditure

Administration and the *Alþingi*	35·8	17·6
Public health	13·4	6·0
Communications	—	18·6
Church and education	32·1	13·2
Science, literature and art	2·7	1·4
Industrial affairs		17·7
Social affairs	—	8·1
Pensions and allowances	11·2	1·8
Interest on national debt	—	9·8
Other expenditure	4·8	5·8
Total	100·0	100·0

In 1876 the revenue amounted to Kr. 296,000, and the expenditure to Kr. 187,000, while in 1939 the figures were Kr. 19,931,000 and Kr. 19,378,000, and in 1940 Kr. 26,500,000 and Kr. 21,600,000. To meet the steadily increasing expenditure, taxes and customs duties have been considerably raised, while during recent years the state monopolies have provided additional revenue.

Among the taxes, those on income and property are by far the most important, and in 1939 yielded Kr. 2,082,000. Five-sixths of this amount came from income tax, which is divided into a tax on personal income, and a tax on the profits of corporations.

The income tax is graduated. In 1937 the tax on the first Kr. 1,000 of assessable income was 1%; on the next Kr. 1,000 2%; 5% on the third, 7½% on the fourth, 10% on the fifth, 15% on the sixth, 20% on the seventh, 30% on the eighth, 31% on the ninth, 31½% on the tenth, 32% on the eleventh, and then gradually rising by 1% up to 44% of any portion exceeding Kr. 28,000. Allowances are made for families according to whether the place of residence is the country, a town, or the capital.

Companies also pay tax on a graduated scale. Before the tax is assessed upon a company's profits, a deduction of 5% is allowed on the paid-up capital and one-half of the amount is passed to the Reserve Fund. On the other hand, companies are not allowed to deduct from their profits dividends paid to shareholders, if these exceed 5%. This tax, therefore, represents a double taxation, as dividends are also taxed on the shareholders. In 1937 the tax on co-operative societies was at a rate of 8%, but of 10% on all profits amounting to Kr. 7,000 or more. Purchasing and other co-operative societies are allowed to deduct from their profits the interest on their capital, one-half of the sum passed to the Reserve Fund, and the amount which they either pay over to their members or place to their credit at the end of the year. One-half of the supertax on incomes of Kr. 6,000 or more goes to the municipal or district funds where the tax is levied.

The property tax is also graduated, but no tax is paid on a property of less value than Kr. 5,000. The tax upon real estate is payable on the assessed property value on the basis of assessments made every 10 years. Tonnage dues (Kr. 1·50 for each registered ton in 1935) are imposed on all ships of over 5 tons burden registered in Iceland. Light dues are imposed at the rate of Kr. 1 per ton (1935) on all ships arriving in Iceland from abroad, except tourist ships which pay 20 aurar per ton (1935). Men-of-war and vessels seeking harbour in distress pay no light dues.

A tax on motor vehicles is applied exclusively to the maintenance of the roads. This is partly a direct weight duty imposed on private cars, passenger cars and motor bicycles, partly an import duty on tyres and tubes, and partly a tax on petrol.

There is also an entertainment tax, imposed with a view to raising funds for building a national theatre; a legacy duty, a restaurant tax, and various legal and stamp duties. Some articles, when produced within the country itself, are subject to an excise duty equal to a certain fraction of the customs duty payable on these commodities if imported from abroad.

Customs duties have constantly been raised as a means of increasing the revenue since 1912, when a general tax was levied on almost all imports. In 1939 they amounted to about Kr. 10,000,000, including the taxes on exported goods (Kr. 680,000).

The postal service has often shown a considerable deficit due to the small population and the difficulty of communications. On the other hand, the telephone and telegraph services have had a considerable yearly surplus.

State loans were practically unknown in Iceland up to 1908, when a loan of half a million krónur was negotiated for the construction of telegraph lines; and in 1909 a loan of 1½ million krónur was taken up for the purpose of buying bank bonds. Since then other loans have been raised for constructing roads and harbours, or defraying the expenses of other public undertakings. During the war of 1914–18 loans had to be raised to buy ships to ensure the importation of supplies, and for other measures made necessary by the war. At first these loans were placed exclusively in Denmark, but since 1916 some of them have been raised in Iceland, while since 1921 the largest loans have been negotiated in England. The increase during the last war is seen from the following table, which shows the size of the national debt at the end of certain years from 1910 to 1940:

	National debt 1,000 Kr.	National debt per head of population Kr.
1910	2,572	30
1917	19,404	212
1920	15,188	160
1921	25,547	268
1929	29,850	280
1930	40,031	370
1931	39,393	359
1932	40,578	364
1933	39,958	352
1934	41,938	365
1935	46,770	404
1936	46,945	402
1937	46,639	396
1938	47,161	397
1939	56,648	471
1940	55,200 (estimated)	455 (estimated)

A considerable portion of the national debt is lent out to financial institutions or employed in buying bank bonds, and the banks have to pay their share of the annual interest and instalments. Thus the treasury is liable for less than two-thirds and acts only as guarantor of the remaining part of the debt.

The national debt on 31 December 1939 was made up as follows:

	Kr.
Internal loan	3,596,104
Danish loan: on account of treasury	770,011
Danish loan: on account of purchase of bank bonds	6,536,647
United Kingdom loan	34,281,776
Various debts	7,011,994
Debts of the national telegraphs and telephones, the government herring factories, the state broadcasting station and the government shipping service	4,451,921
Total	56,648,457

Urban and Rural Finance

The municipal funds in the urban districts and the parish and district funds in the rural districts are derived from a number of sources. Rates are high and are graded according to general financial status. Revenue is also derived from municipal undertakings and property, and from rents for municipal lands. By far the greatest expenditure is on poor relief, which accounts for about 25 % of the total. Education and public utility services account for the rest. The local debt is greater in the towns than in the parishes or districts (*sýslur*) and has increased during the last 20 years.

Banks

Before Iceland achieved financial independence, money transactions were very little known in the country and foreign merchants were the chief lenders. After 1874 various measures were taken by the legislature to stimulate productive effort and trade, the most important being the founding of a bank. The bad years following 1880 made this step so urgently necessary that in 1885 a law was passed to establish a national bank.

There are at present three banks in Iceland: the National Bank of Iceland (*Landsbanki Íslands*) which began business in 1886, the Fishing Trade Bank of Iceland (*Útvegsbanki Íslands*)* and the Farmers' Bank of Iceland (*Búnaðarbanki Íslands*), both formed in 1930. All three banks have their headquarters in Reykjavík, and the two first have four branches in various parts of the country. All three banks were established by special acts of the *Alþingi*, under which they enjoy certain privileges.

The issue of banknotes in Iceland was regulated by an act of the *Alþingi* in 1928, granting the exclusive right of issue to the National Bank of Iceland. Following this act the bank became an independent state-owned institution, operating through three financially separate departments: the Issue Department, the Savings Bank Department, and the Hypothec-Mortgage Department. The national treasury is liable for all engagements made by the bank.

The main purpose of the Fishing Trade Bank of Iceland is to support fishing, industry and commerce, while that of the Farmers' Bank of Iceland is to support farming and facilitate the financial transactions of those engaged in productive farming operations. Both banks administer funds for the relief or improvement of conditions among the fishing and farming populations. (For further details see pp. 322 and 290.)

Savings Banks. The first savings bank in Iceland was founded in 1870. In 1911 there were thirty-four, and in 1934 their number had increased to fifty-six, and the total deposits had increased from

* The *Útvegsbanki Íslands* took over the assets and liabilities of the Bank of Iceland (*Íslandsbanki*), established in 1905.

Kr. 1,363,000 to Kr. 10,561,000. The savings banks do not as yet play a very important part in the economic life of the country.

Insurance

Marine Insurance. The Mutual Insurance Company of Icelandic Fishing Vessels (*Samábyrgð Íslands á fiskiskipum*) was founded in 1909 and was the first marine insurance company of Icelandic origin. It is a mutual company covering the insurance of all kinds of fishing vessels and including their catch and gear. In 1918 the Icelandic Marine Insurance Company (*Sjóvátryggingarfélag Íslands*) was formed. This is a joint-stock company, insuring against any maritime risks and including, since 1925, fire insurance and, since 1934, life insurance. The Icelandic Steam Trawlers Mutual Insurance Association (*Samtrygging íslenzkra botnvörpunga*) was formed in 1923. It is a mutual company which insures steam trawlers and other steamships engaged in the fishing trade.

Fire Insurance. The Icelandic Fire Insurance Company (*Brunabótafélag Íslands*) was established by an act of the *Alþingi* of 1915. It is a mutual company backed by the treasury, and undertakes the insurance of houses in towns (except Reykjavík) and villages, and all dwelling houses outside towns and villages where insurance of houses is compulsory. In Reykjavík the insurance of houses against fire has been compulsory since 1874, and according to a contract all houses are insured with a foreign fire insurance company.

Life Insurance. Apart from the Icelandic Marine Insurance Company mentioned above, there is no Icelandic company or institution which transacts general life assurance business. Before 1937 there were six foreign companies in Iceland (three Danish, two Swedish and one Norwegian), but in 1937 and 1938 respectively the two Swedish institutions transferred their stock of Icelandic policies to the Icelandic Marine Insurance Company. The domestic share of all life insurance policies in force has, therefore, increased from 7·6 % at the end of 1936 to 55·3 % at the end of 1938. Two funds have been established to provide pensions to officials employed in public service. In 1919, when an amendment to the act respecting salaries to civil servants was passed by the *Alþingi*, the right to pensions from the state was abolished. To take the place of this the Civil Service Pension Fund was formed, to which the state made a grant of Kr. 50,000, the fund to be kept up by the premiums paid by the civil servants. In 1921 the Elementary School Teachers'

Pension Fund was established on approximately the same lines. In 1936 these two funds amalgamated as the Pension Fund of Iceland (*Lífeyrissjóður Íslands*).

Liability Insurance. Every owner of a motor vehicle must insure with some insurance company or institution considered as sound by the government.

Before the war there were about twenty foreign insurance companies with branches in Iceland. These are chiefly for fire, marine, and life insurance.

Social Insurance. This has been dealt with fully on pp. 342–5.

Chapter XVIII

COMMUNICATIONS AND TRANSPORT

Introduction: Land Communications: Sea Communications: Air Communications
The Distribution of Petroleum Products

INTRODUCTION

Transport in Iceland has developed along lines somewhat different from those in any other European country. This has been due partly to isolation and partly to the great physical contrasts existing within such a small area. The populated region forms a ring round the uninhabited interior. Consequently, Icelandic transport mainly falls into three categories: (1) land transport along the coast and across the coastal plains, (2) sea transport round the island and to foreign countries, and (3) air transport. The problem of providing adequate communications for the small but widely scattered population is particularly difficult and controversial, but it is perhaps in this field that the most sweeping changes in the material development of Iceland are taking place.

LAND COMMUNICATIONS

Roads

Road transport in Iceland is a comparatively recent development. Until the end of the nineteenth century there were hardly any bridges in the country; wheeled vehicles were almost unknown and all inland transport was by pack horses over bridle paths. In 1884 a Norwegian expert in road building was engaged to organize the construction of proper roads. Ten years later the *Alþingi* undertook the expense of building roads between the chief towns, and the administration of road transport was placed in the hands of a civil engineer. From that date road making has progressed rapidly. This may be seen from the following figures for yearly expenditure on roads and bridges:

	Thousand krónur		Thousand krónur
1876–1893 (av.)	23	1934–1935 (av.)	1,766
1894–1903 (av.)	107	1936	1,637
1904–1913 (av.)	150	1937	1,910
1914–1923 (av.)	431	1938	1,827
1924–1928 (av.)	789	1939	1,859
1929–1933 (av.)	1,553		

Successive governments have been fully aware of the importance of developing inland communications. The numerous unfordable rivers have necessitated an extensive bridge-building programme, for it was realized at an early stage that a single bridge could bring a whole region out of isolation. The first considerable bridge in Iceland was constructed by British civil engineers, across the Ölfusá. The bridge was about 75 m. in length and was built in 1890. Several other bridges of this type were then built, but when road development necessitated still more bridges, the iron suspension type was found to be too expensive. In the following years a number of fixed iron bridges supported on piers of masonry were built (Plate 91), but since 1907 almost all bridges have been made of reinforced concrete (Plate 92). The progress made with this work may best be summarized in tabular form:

Bridges more than 10 *m. long, constructed between* 1890 *and* 1929

Length in m.	1890–1900		1901–10		1911–20		1921–29		1899–1929		
	C.	M.	C.	M.	C.	M.	C.	M.	C.	M.	Total
10– 20	—	—	2	3	20	1	43	6	65	10	75
20– 30	—	1	1	3	12	2	17	4	30	10	40
30– 50	—	1	—	1	8	—	5	6	13	8	21
50–100	—	1	1	1	2	1	10	—	13	3	16
100–200	—	1	—	1	—	—	3	—	3	2	5
200–300	—	—	—	1	—	—	—	1	—	2	2
Total	—	4	4	10	42	4	78	17	124	35	159

C. = reinforced concrete; M. = metal.
Source: *Árbók Hagstofu Íslands*, p. 65 (Reykjavík, 1930).

The Road Act of 1894 classified Icelandic roads into four categories. They are defined as follows by the Director of the Statistical Bureau of Iceland:

(1) *High Roads* (sometimes called National Roads), i.e. main roads built and maintained entirely at the expense of the state.

(2) *Provincial Roads* are built across provinces where the traffic is greatest. They are paid for by the provinces concerned, except in so far as they may be made carriageable, in which case grants from the state are allowed up to one-half of the cost. A part of the total expenses of road making is refunded by the state to those provinces which levy a special road tax on their inhabitants. The higher the rate levied, the larger is the grant from the treasury.

(3) *Parish Roads* are minor roads which are only of local importance. They are paid for by the parishes.

(4) *Mountain Roads* are those which run across mountain tracts and upland regions. They are mostly ill-defined bridle paths, but stone cairns have been erected along them at the expense of the state.

It is important that these four categories should not be taken as indicating the actual surface condition because good and bad stretches alternate on all the roads. The main obstacles to transport in Iceland are the rivers. There may be a perfectly good road between unbridged rivers, or alternatively, good bridges with very bad roads between them. Furthermore, a road which is good on one day may not be good on the following day. The amount of water in the rivers

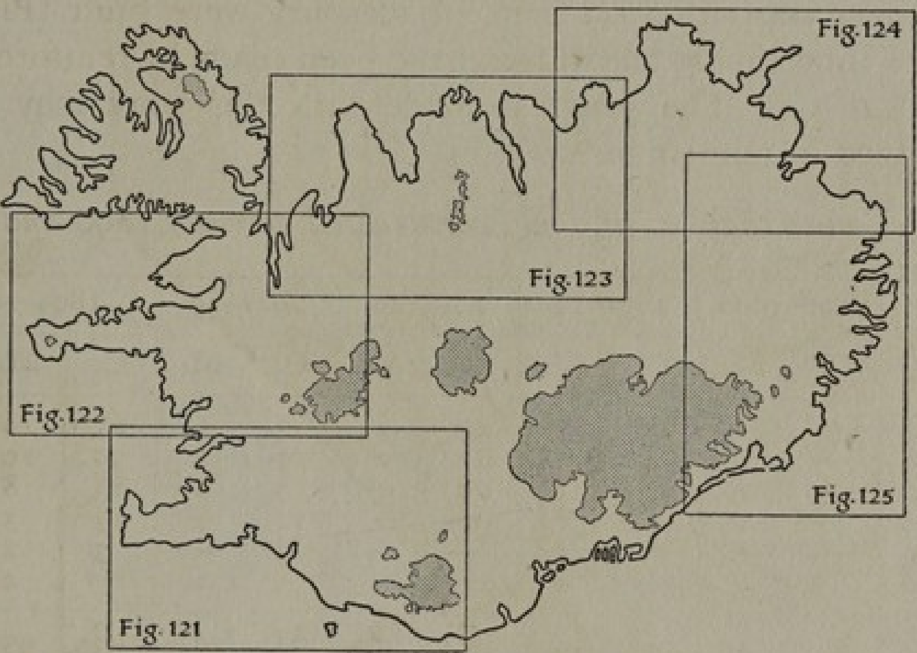


Fig. 120. Key to show the relative positions of the separate road maps (Figs. 121 to 125). Owing to the lack of roads in the north-west peninsula, on the central plateau, and along the south-east coast between Vatnajökull and the sea, no separate road maps of these areas have been prepared.

varies considerably with the weather, and some of the rivers are continually changing their courses; they may wash away parts of a road, or wash gravel and rocks over it, or flow beside a bridge instead of under it. These changes take place remarkably quickly, especially in the districts where the rivers flow from glaciers. It is thus essential to have information which is not more than a few hours old before stating the condition of many roads. With the good telephone system which exists in Iceland this information is not difficult to obtain.

In 1936 the total length of 'roads' was about 4,400 km., of which about 2,800 km. were considered fit for motor transport. Considerable improvement works have been carried out since these figures were published. Nearly all the motorable roads are in the

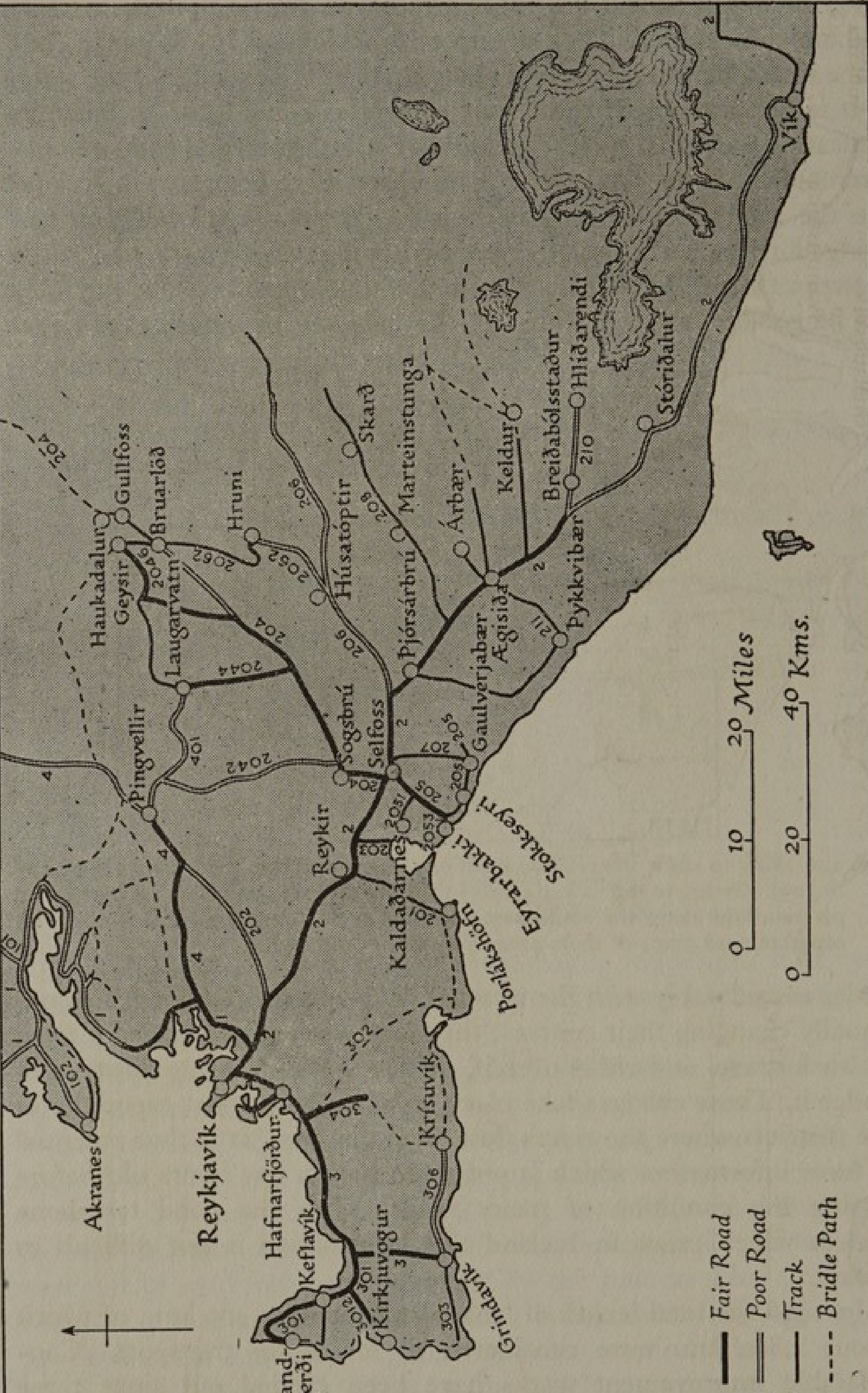


Fig. 121. Roads: south-west.

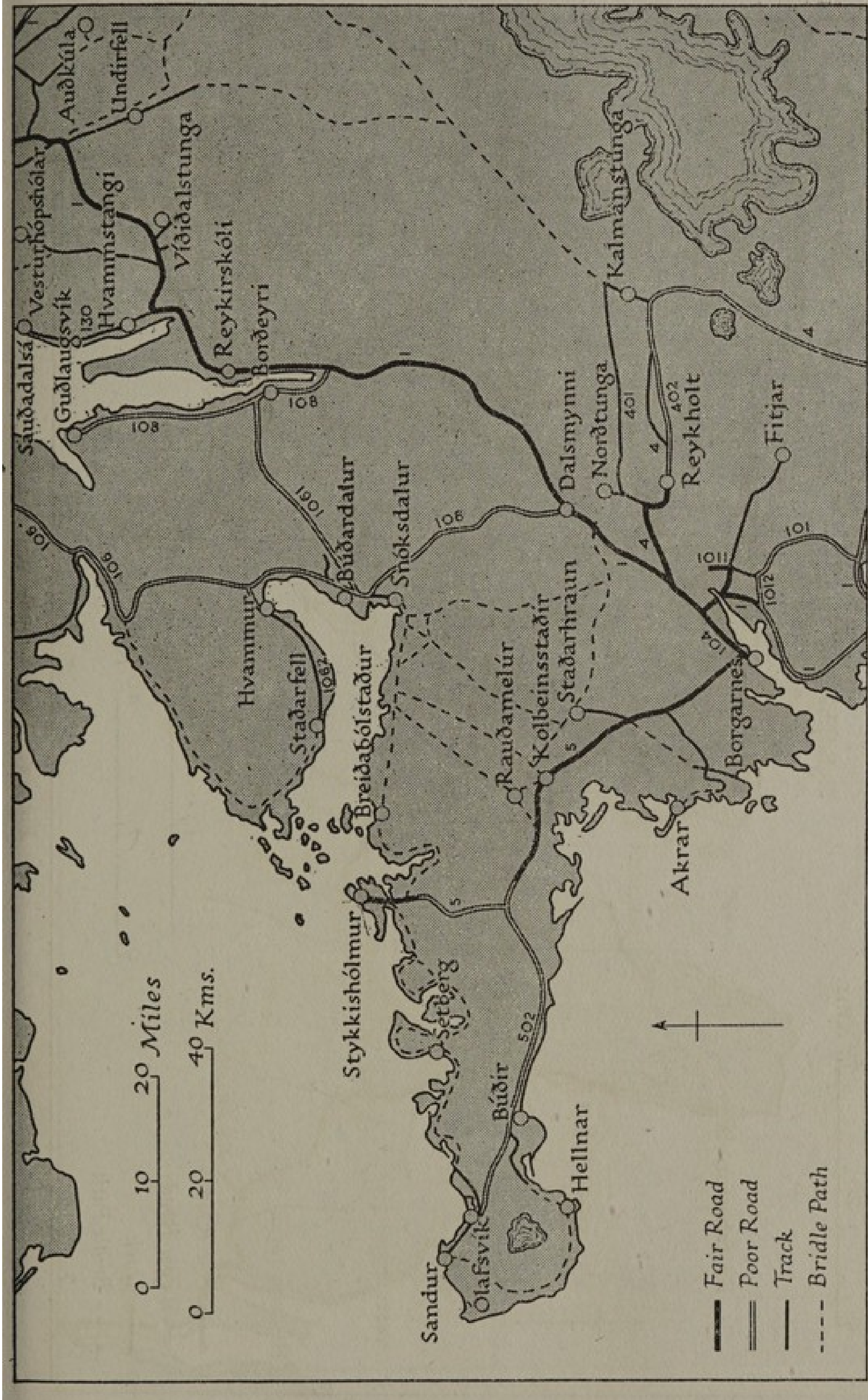


Fig. 122. Roads: mid-west.

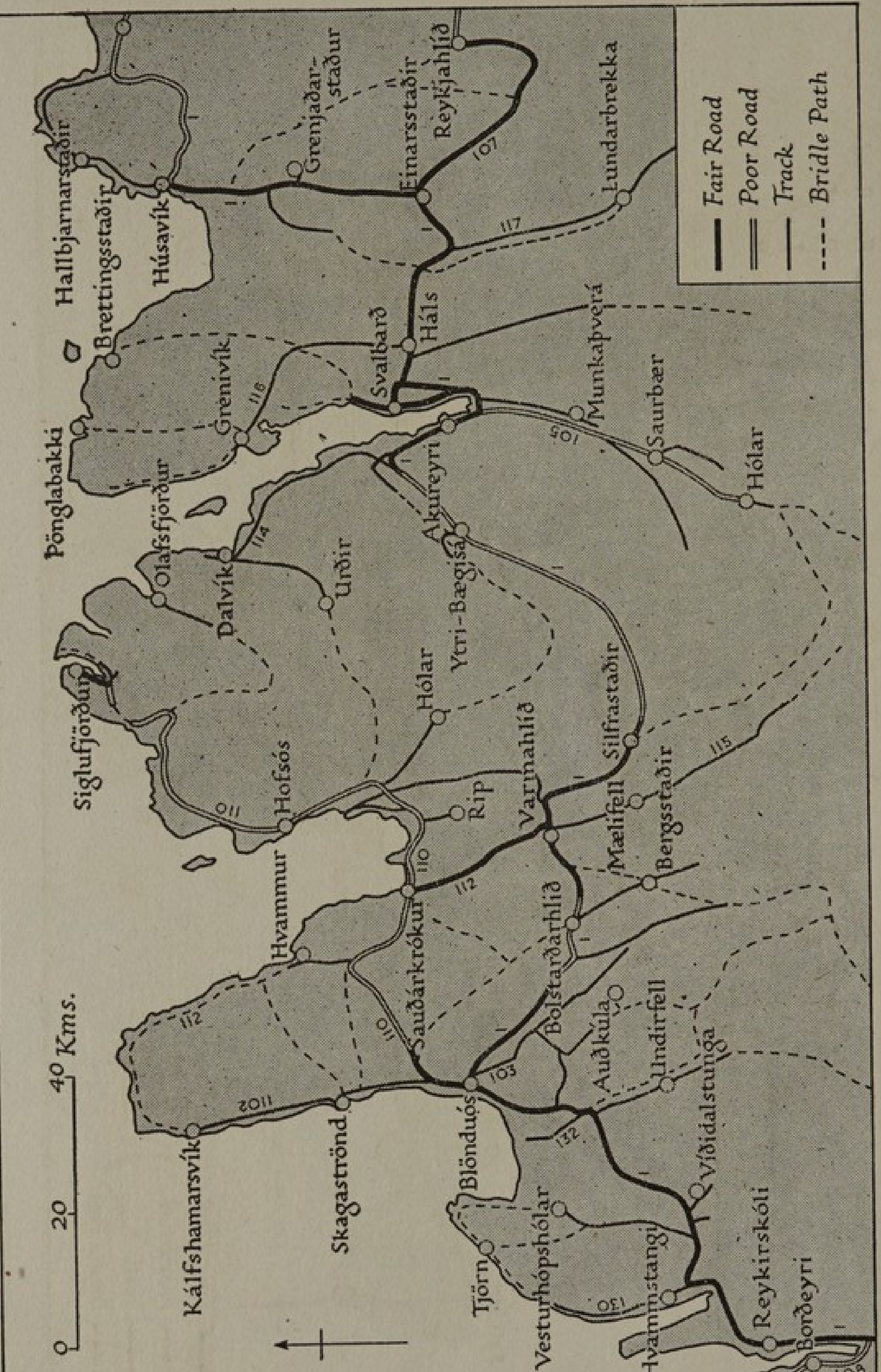


Fig. 123. Roads: mid-north.

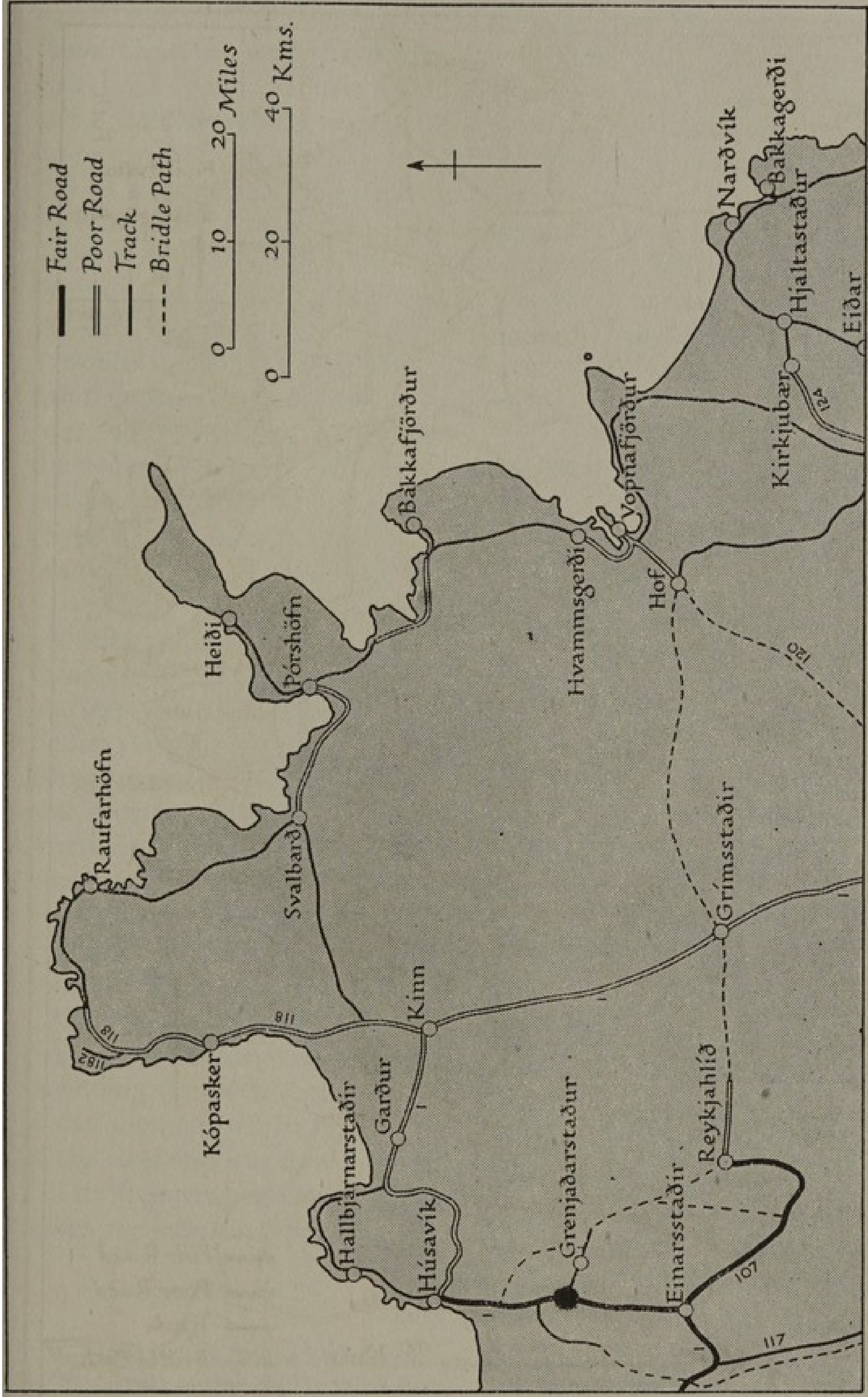


Fig. 124. Roads: north-east.

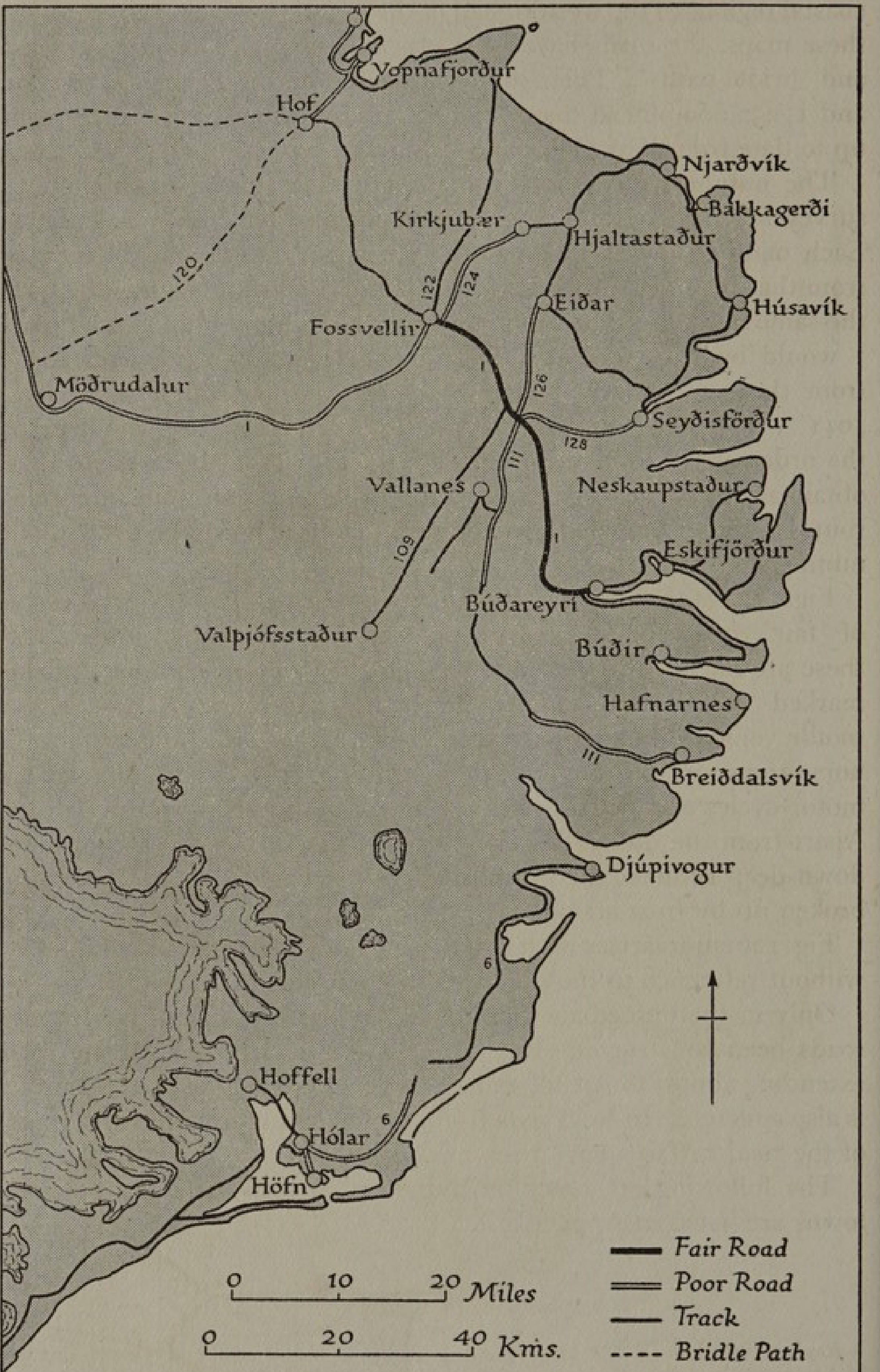


Fig. 125. Roads: east.

coastal regions of the western half of the island (see Figs. 120–126). In these maps, the roads have been classified as 'fair', 'poor', 'tracks' and 'bridle paths'. Their routes are based on the Danish 1:100,000 and 1:250,000 official maps, and the classification has been brought up to date from War Office and Admiralty reports of 1940 and 1941.

The numbers given to the roads are those of a British military survey made in 1940. The system appears to have been as follows: Each main road was given a single number. Each branch turning from that main road was then given a hundred number starting with the same number as the original main road. Thus a branch road from 1 would be 101, 102, or 108, and not 11, 12, or 13. Branch roads from these secondary roads were given a thousand number, e.g. 1011, 1012, 1013, etc. All branch roads from say 203 would be of the order 2031, 2032, 2036, and so on. It has not been possible to obtain a copy of the original numbering key, and some quite important routes in the accompanying maps have therefore had to be left without numbers.

Figs. 121–125 show only the quality of the roads. The usual width of 'fair' roads is 4–5 m., with a surface of unscreened gravel. All these are likely to be passable to motor vehicles in summer. Roads marked 'poor', and many of the 'tracks' are at times passable to motor vehicles, but most of the 'bridle paths' are suitable only for horse transport. Throughout the island, progress is very difficult for motor cycles and pedal cycles owing to the boulders and deep ruts. Apart from the difficulties caused when the surface is washed away down deep runnels, the gravel roads in the highlands are constantly broken up by frost action.

Fig. 126 summarizes what is at present known of seasonal conditions, without reference to the quality of the surface or the width.

Only in the immediate vicinity of Reykjavík have really adequate roads been constructed (Fig. 127). There is a good concrete road extending almost to Ártun, and a portion of the road to Hafnarfjörður is also concrete. In Reykjavík itself, and in several other towns, many of the road surfaces have been macadamized.

The following are notes on individual roads. Distances between towns are listed in Appendix X.

South Coast

Reykjavík to Vík (Route 2). Usually passable to motor traffic in winter, but the highlying part of this road west of Reykir (over Hellisheiði) is sometimes blocked with snow. The lowlying country east of Reykir has many rivers which may change

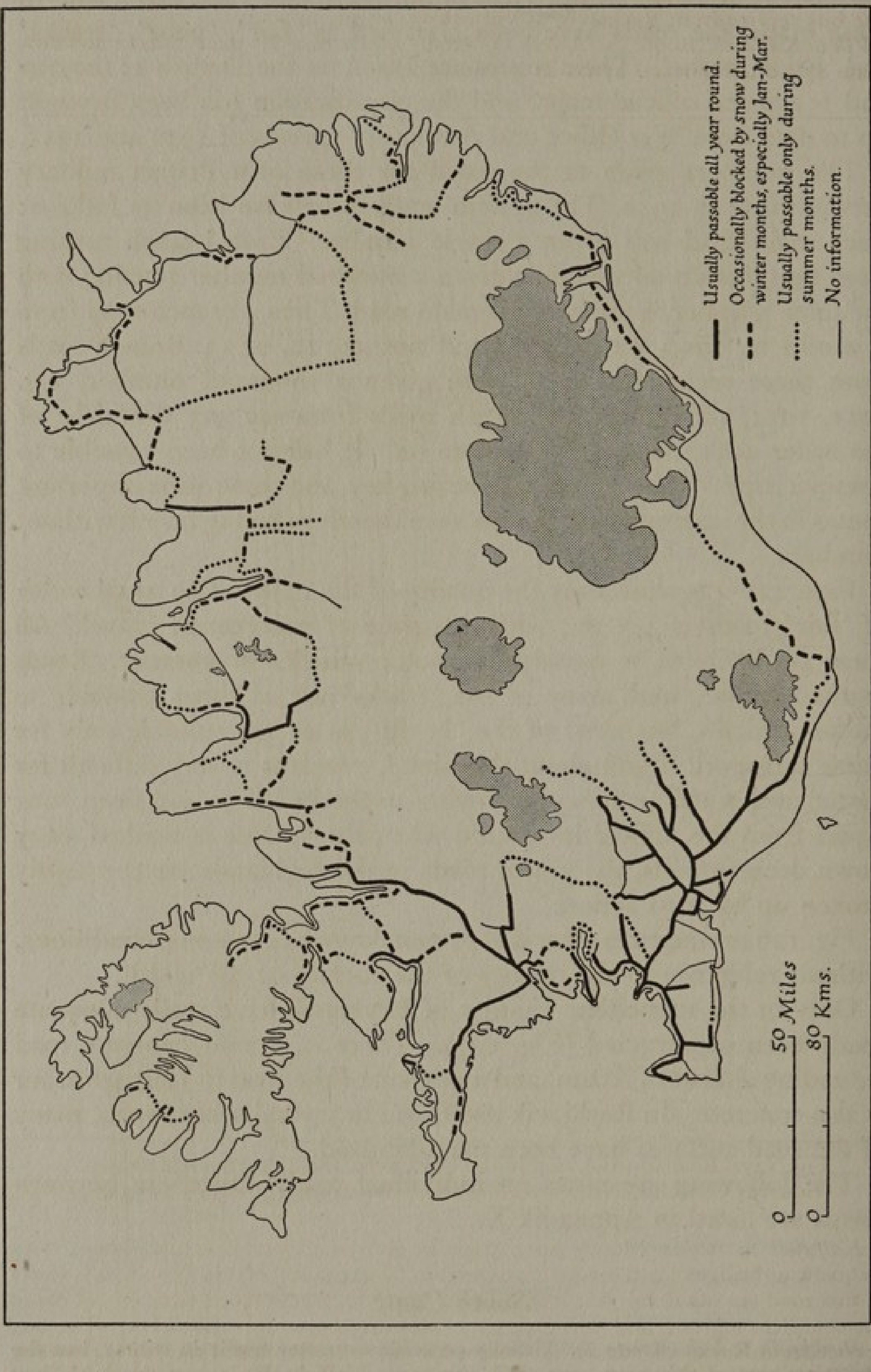


Fig. 126. Roads: seasonal conditions as known in 1940. Only the more important roads are shown. Source: War Office.

their courses, especially south of Mýrdalsjökull. There are, however, good bridges. The bus service from Reykjavík to Vík usually begins in May.

Vík to Kálfafell (Route 2). A very uncertain road across flat sandy wastes and lava (Plate 87); often blocked by rivers in winter.

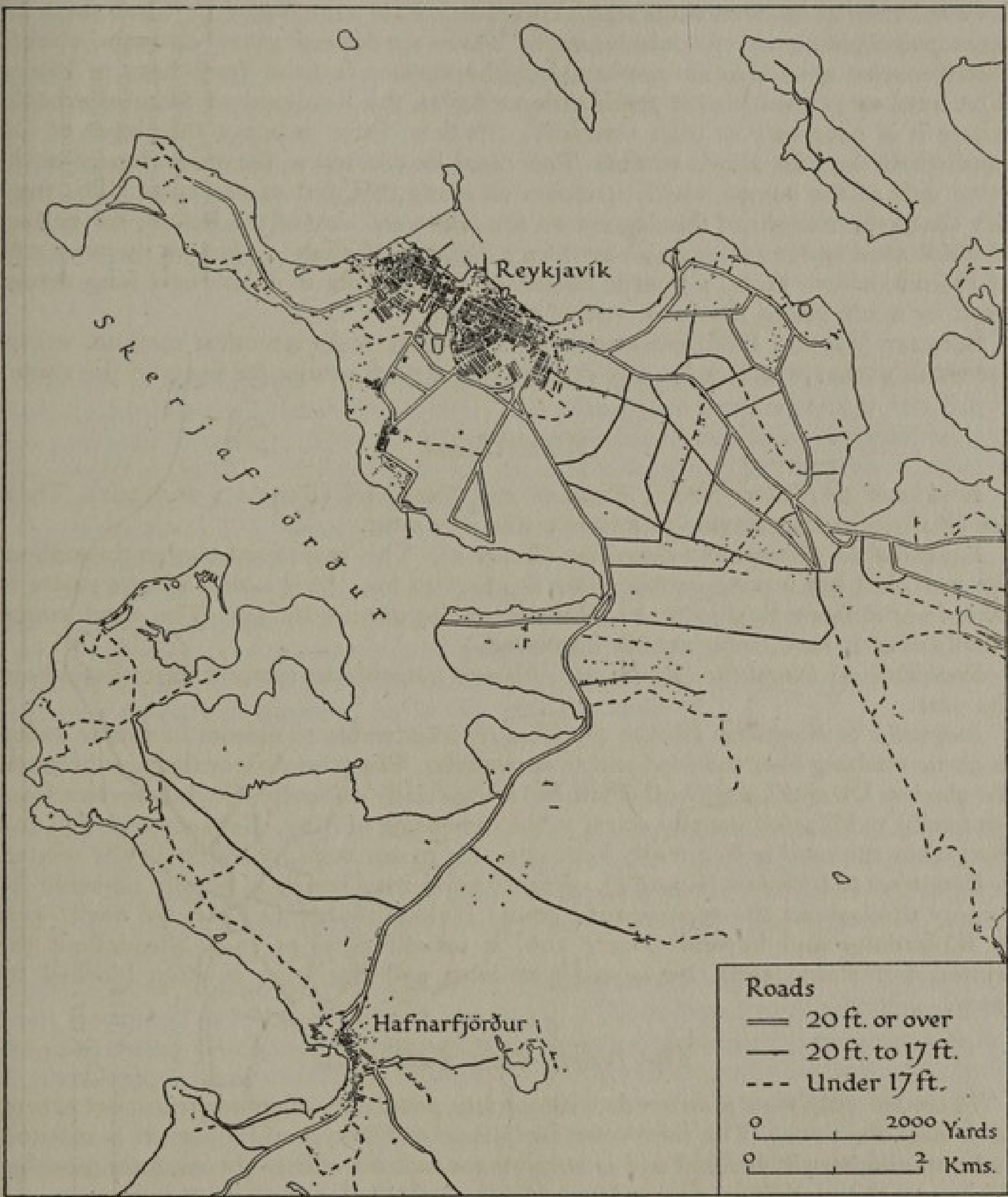


Fig. 127. Roads in the vicinity of Reykjavík. Bridle paths not shown. Source: G.S.G.S. No. 4186, *Reykjavik and Hafnarfjörður*, 1 : 25,000.

Kálfafell to Höfn. Mostly an extremely poor road across sandy desert, with frequent unbridged swift rivers flowing from Vatnajökull (Plates 27 and 52). Parts of this road are made up, but it is believed that only one motor truck has yet made the complete journey, and that under exceptionally favourable conditions. The bus service from Reykjavík runs in summer as far east as Kirkjubæjarklaustur. Between Skeiðarásandur and Kvisker there are several streams from the glacier, and local guides are necessary. There is little difficulty for ponies, but the changing streams over the sands and gravels sometimes provide serious difficulties even for local guides. At Jökulsá á Breiðarmerkurjökull the glacier comes very close to the sea. Here, two powerful streams must be crossed (only very leaky rowing boats were available in 1937), or a detour must be made over the glacier. Eastwards, there is a good motor-able road to Kálfafellstaður, and the rivers are easy to cross. The Kolgrimá is crossed by a substantial modern single-span concrete bridge near Skálafell. Then there are open gravel plains with fordable streams. There are difficult gravel and sand-choked distributaries near Heinabergsvötn, but the surface is good from here to Flatey. The track next passes over grasslands as far as the headland of Skinneyjarhöfði, where it is necessary to turn seawards. Shallow water covers a thin layer of soft mud which overlies a firm surface. This must be crossed to the storm beach on the outer side of the lagoon which stretches all along this part of the coast. The track lies along the margin of this lagoon on the landward side of the beach; the surface of black sand and gravel is quite hard for a distance of about 13 km. to the west side of Hornafjörður. Here, a boat is necessary for crossing to Höfn, or a long detour must be made round the inner end of the fjord.

Between Vík and Höfn sea transport is the only really practical method, except for small parties which must rely on riding and pack ponies for parts of the route.

West Coast

Reykjavík to Hafnarfjörður, Keflavík and Sandgerði (Routes 3 and 301). These are all main roads passable to motor traffic in winter.

Reykjavík to Akranes and Borgarnes (Route 1). This coast road is open throughout the year, but has a poor surface after the first 40 km. It is nearly always easier to take freight from Reykjavík to Akranes or Borgarnes by sea. The road round Hvalfjörður is now being greatly improved.

Reykjavík to Þingvellir (Route 4). Always passable to motor traffic throughout the year.

Þingvellir to Borgarnes (Route 4). Usually impassable to motors in winter owing to rivers washing over the road and to snowdrifts. The stretch over the pass between the glaciers Ok and Langjökull (Plate 86) is especially difficult. The bus service from Þingvellir to Húsafell usually starts at the beginning of May. Between Húsafell and Borgarnes the road is frequently kept open for motor traffic throughout the winter.

Borgarnes to Blönduós (Route 1). A fairly good road which is usually passable for motors throughout the winter, runs across Holtavörðuheiði. The road north-west to Búðardalur and beyond (Route 106) is usually clear of snow throughout the winter, but Route 1061, between Búðardalur and Borðeyri, is often blocked by snow.

The North-west Peninsula

There are only very poor roads without any possibility of motor transport except in or near the towns. The road from Ísafjörður to Flateyri and Þingeyri is reputed to be the highest in Iceland and is suitable for motor traffic in the summer months. This, and the road from Ísafjörður to Súgandafjörður, are of great importance to the fisheries during the summer months (see p. 239). The coastal farms are linked by ill-defined bridle paths which are suitable only for ponies.

North Coast

Blönduós to Varmahlið (Route 1). Usually passable to motors in winter, but rivers sometimes run over the road.

Varmahlið to Akureyri (Route 1). Very poor surface, but in winter this road is usually passable by motors for the first 20 km. In most years motor traffic over Öxnadalsheiði is stopped by snowdrifts and rivers at the end of October, and the road is closed until about the middle of May. The last 30 km. towards Akureyri are nearly always clear of snow, but are liable to flooding.

Blönduós to Akureyri (Route 110). A more northerly road via Sauðárkrókur and Dalvík. The mountainous region west of Dalvík is impassable to motors, even in summer.

Akureyri to Húsavík (Route 1). The main obstacle is the high ground between Akureyri and Háls. In winter the snow is frequently very deep, but the road is usually kept open for motor traffic throughout the year. The road is rather narrow between Háls and Einarsstaðir, but from there to Húsavík it is always open and is one of the best in Iceland.

Einarsstaðir to Reykjahlíð (Route 107). Probably open all through the winter unless there is very heavy snow.

Kinn to Kópasker (Route 118). Nearly always closed throughout most of the winter. North of Kópasker towards Rif the road is very poor, even in summer.

East Coast

Húsavík to Seyðisfjörður (Routes 1 and 128). A very rough route via Grímsstaðir, Möðrudalur, Fossvellir and Egilstaður. It is passable to motors in summer, but is always closed in winter. Most of this route is snow-covered from September until May every year. West of Seyðisfjörður there is a long narrow wooden viaduct of slender construction across the Lagarfljót.

Seyðisfjörður to Eskifjörður (Routes 128 and 1). Motorable road in summer, but nearly always difficult in winter.

Eskifjörður to Höfn (Route 6). There are only very rough bridle paths between Eskifjörður and Djúpivogur. To the south the road is mostly impassable to motors, even in summer. The surface is best between Djúpivogur and Höfn, but the worst rivers have not yet been bridged. Sometimes the rivers present serious difficulties to pony transport in summer, especially near Stafafell.

The Central Highlands

Most of the bridle paths in central Iceland are very unreliable, some being indistinct throughout most of their length; they traverse very rough country, and are marked only by occasional cairns. There are no west to east tracks or bridle paths across the centre of the island, but three main bridle paths run across the central highlands from south to north.

Route across Sprengisandur between Höfsjökull and Vatnajökull. For the road from Reykjavík to Þórsá (Route 2), see p. 379. From Þorsá to Skarð (Route 208) the road is very rough indeed, but it is passable to motor traffic in summer. Farther north it becomes impassable for motors, even in summer, and pony transport must be used. Deep snow is likely to be found in winter, and especially between Höfsjökull and Vatnajökull the country is uninhabited and extremely desolate. This bridle path joins up with the track southwards from Akureyri to Hólar. This northern stretch may be clear of snow throughout the winter, but it is always difficult for motors. It is only possible to cross the river Skjálfandafljót from Mýri to the parallel road to Svartárkót (Route 117) by boat.

Route between Langjökull and Hofsjökull. From Reykjavík to Gullfoss there are two main roads running to the north and south of Þingvallavatn. If Hellisheiði is free of snow in winter, it is possible to motor throughout the year via Reykir and Sogsbrú to Gullfoss (Routes 2 and 204). The northern road from Reykjavík to Þingvellir (Route 4) is passable throughout the year, and it is usually possible for motors to continue eastwards to Geysir in winter. The track from Geysir to Gullfoss is only passable for motors in dry weather. North of Gullfoss motors can reach Hvítárvatn (Route 204) in summer, but not in winter. North of Hvítárvatn the track is only passable to pony transport in summer, and it is possible to take any of the three routes from Hveravellir to Blönduós, Sauðárkrókur or Hólar. The eastern route along Vatnahjallavegur is only motorable in summer from Hólar to Akureyri.

Inland Route west of Langjökull. For the road from Reykjavík to Húsafell (Route 4), see p. 380. The bridle paths northward from Húsafell, via Kalmanstunga and Arnavatn, are only passable for pony transport in summer.

It must be emphasized that freight transport to any coastal area in Iceland is nearly always easiest by sea. The above notes on the state of roads cannot be precise owing to the continually changing conditions.

Motor Transport

The first motor vehicles were brought to Iceland in 1913. The number increased rapidly, and by 1925 there were more than 400. In 1940 the number of registered Icelandic motor vehicles was 2,225 (835 motor cars, 1,120 trucks, 120 buses and 150 motor cycles). Most of these vehicles are registered in Reykjavík.

A regular passenger service is maintained in summer between the main towns, but in winter this is largely suspended owing to the heavy snowfall in the mountains. There are at present about thirty fixed routes on which government-licensed motor buses normally run. Two types of services are maintained between Reykjavík and Akureyri, a distance much the same as between London and Newcastle. These are:

(1) The 'Regular' which is entirely by bus, and requires about two 12 hr. days for the journey.

(2) The 'Express', which is by boat from Reykjavík to Borgarnes and thence by bus to Akureyri. This takes from 15 to 17 hr.

From about 1 June to 1 October there is a single daily service each way between Akureyri and Reykjavík, but the opening and closing dates of the bus season are determined by weather conditions. The express buses operate daily in summer, but three times a week when the road begins to deteriorate. The regular buses operate on four days a week. Each bus has a seating capacity of from 18 to 21. The law requires a second bus if there is one more passenger than seats on any day. Passenger buses also carry baggage and mail, but freight goes by motor truck.

Reykjavík has a privately owned internal bus service known as *Strætisvagnar Reykjavíkur.* It owns about twenty single-deck buses.

W. Heering

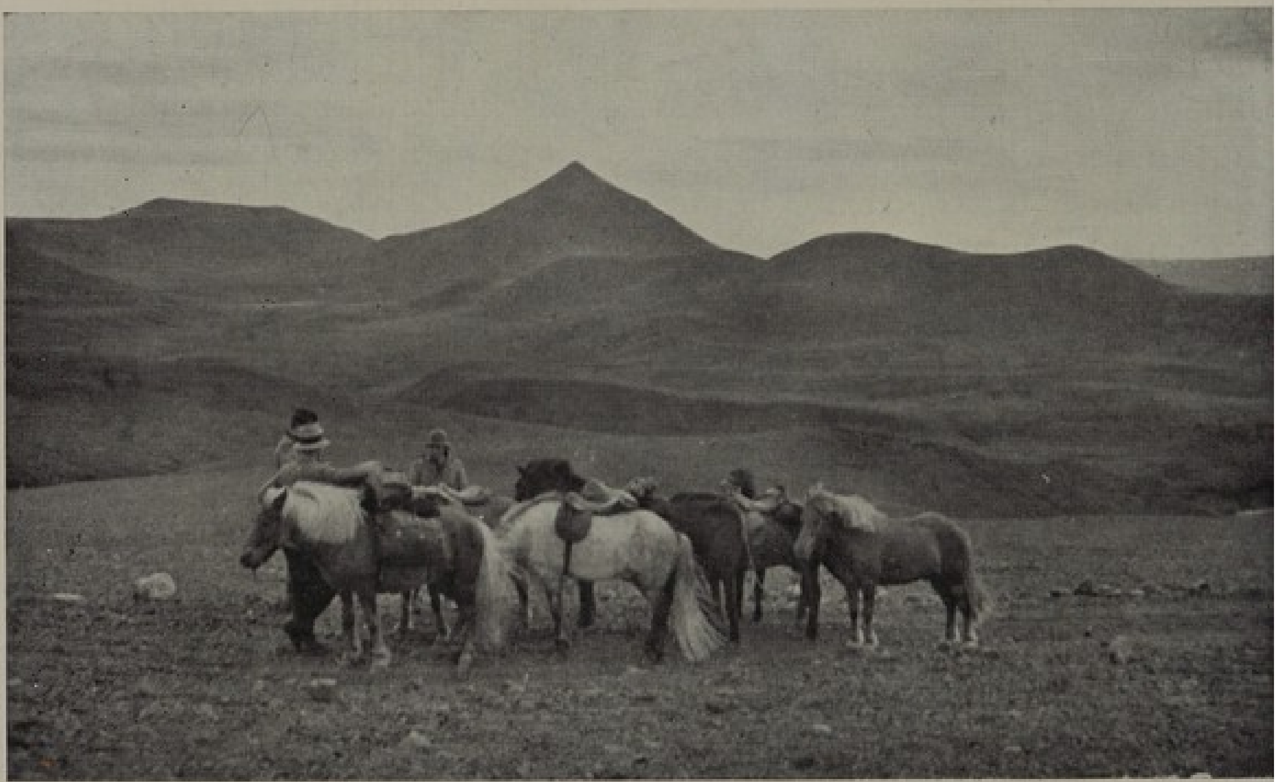
Plate 85. A typical bridle path. The deep ruts are pony tracks and cannot be used by wheeled vehicles.

B. B. Roberts

Plate 86. Road from Þingvellir to Kalmanstunga, between Langjökull and Ok (see p. 380, Route 4).

M. H. Donald

Plate 87. The main coastal road through the Laki lava field (see p. 379, Route 2). The irregular *apalhraun* surface of the lava, extruded in 1783, is now covered with moss and lichen.



M. H. Donald

Plate 88. Until recently, ponies have provided the only means of inland transport. Although largely replaced by motor vehicles in the settled districts, they are still indispensable for travel in the interior and for crossing braided glacial streams.

Owing to the poor condition of the roads, motor transport in Iceland takes very much longer than for corresponding distances in Britain. The strain on drivers is also much greater. Chains have to be used extensively to overcome the difficulties of snow and sand, maximum anti-freeze protection has to be given, and even then the water system has to be carefully watched. Icing of the windscreens is also a problem, and is overcome on some vehicles by de-icers, made of flexible tubing, which carry hot air from the engine to the windscreen. During the summer months dust is often a major problem. Many road surfaces consist of lava fragments, and wear on tyres is considerable. Under such conditions, four-wheel drive vehicles have been found extremely useful; those in use are of many different types, the most frequent for trucks being Ford (39 %) and Chevrolet (34 %), and for passenger cars Ford (22 %), Chevrolet (15 %) and Studebaker (11 %).

Railway Projects

There are at present no railways in Iceland. In 1927 a Norwegian company initiated a project for a railway about 100 km. long from Reykjavík, eastwards to Þingvellir, Selfoss and Þórsá. Preliminary surveys have also been made with a view to building a railway, 60 km. in length, from Reykjavík through the southern lowlands. The first of these projects was provisionally accepted by the *Alþingi*, but in 1928 the plan was deadlocked and it is uncertain when the question will be reopened. The improved motor roads from Reykjavík are cited by some as sufficient reason for not proceeding with any railway scheme under present conditions. The Icelandic poet and philologist, Benedikt Gröndal, once said that railways were 'unpoetic' and therefore have no place in Iceland. The hope is widely expressed that the country will omit this phase in the history of communications.

Postal Services

Although the postal service has always been under government management, most of the inland mail was carried by pack horse until the war of 1914–18. Horse-drawn mail coaches were then introduced on the principal mail routes, but these are now rapidly being replaced by motor vehicles. At intervals along these routes are post offices from which local posts are despatched to the surrounding districts. Many of the local posts, and also some of the mail vans on the main routes, have to be suspended in winter. With the improvement of the coastal steamship services, the mails are to an increasing extent being sent by sea. The mail facilities between some of the ports and the interior are still very unsatisfactory, but, except in winter, even the most isolated parts of the country are now reached at least once a fortnight. In localities where there are regular bus services, mail is in many cases delivered daily.

Note on Icelandic Ponies

Ponies have been the chief means of land transportation in Iceland since the time of the original settlement. Everybody rides in Iceland. The children learn the art very early by riding the ponies bare back to pasture, or by sitting on an extra one that follows the pack ponies when returning from the fields with hay. The old people do not readily give up riding. The use of ponies for drawing vehicles has always been limited, but when employed as pack animals they are often compelled to perform very arduous work. Baggage, lumber, logs and telephone poles must still frequently be transported over rough country and across torrential streams with the help of these extremely hardy and sure-footed animals.

In many of the more remote parts of Iceland little attempt has been made on the large-scale Danish maps to distinguish between bridle paths in constant use and routes which have perhaps only a historical significance and are marked at intervals with cairns. On the former, it is not difficult to travel 30 km. a day with ponies. On the latter, 12 hr. toil may result in only about 10 km. progress.

The following are brief notes on Icelandic ponies:

Cost. In peace time a riding pony costs about Kr. 400 and a pack pony about Kr. 260. These are spring prices; in autumn they are lower.

Size. Smallest 11 hands; average about 12·2; maximum about 14 hands. A convenient length of girth is 70 cm. (27 in.) from buckle to buckle (see Plates 88, 89 and 90).

Age. Icelandic ponies are usually not considered fit to work until they are 5 years old; they are then worked until at least 20 years old. If worked before 5 years old they are not so strong in later years. After 5 years it is extremely difficult to estimate age by their teeth.

Loads. On roads an average pony can carry 100 kg. (220 lb.) about 60 km. a day. In rough country about 80 kg. is the maximum, and loads exceeding 50 kg. should, if possible, be avoided. The animals travel better as the day advances, usually being sluggish for the first 15–20 km. and requiring hourly halts. Weights can, of course, be greatly increased if the ponies are used as haulage instead of pack animals.

Saddles. The pack saddles used in Iceland are of the same size and shape as those used by the British army in India, but they are inferior in several respects. The load is divided into two equal parts so that it can be carried on both sides of the animal in bags, bundles or boxes. The saddles have wooden side bars with roughly made iron arches, and are fitted with hooks to take the load; they also have double web girths with leather girth straps and cruppers. Beneath the wood of the saddle there is a protective 'pannel' on each side. In their most primitive form, these pannels consist of compact layers of turf, though more usually they are made of canvas stuffed with hay or horsehair. Small top loads are sometimes carried, but they are not popular with the Icelanders.

Cruppers. These are essential both for riding and pack ponies, breast plates being unnecessary in either case. The standard Icelandic type of crupper is far more convenient than the English one, being made to buckle round the tail instead of loop over it. The tails are very long and bushy and the ponies use them continuously to brush off the abundant biting flies; they should on no account be shortened as has sometimes been done with exported animals.

Shoes. Icelandic ponies have well-shaped feet with big frogs, unlike the contracted 'boxy' feet so typical of British ponies of similar size. Under normal conditions in Iceland, shoes are of two types, used in about equal quantities. One type is forged locally during the winter months; the other is mass-produced and imported from Scandinavia. Shoeing is rather rough and ready. Four nails have proved adequate to hold on a shoe, but the nails wear out before the shoe, and the same shoe usually has to be nailed on a second time. Icelandic pony shoes have large calkins which give a good grip on the rough lava blocks, and prolong the life of the shoe by about 50 %. The wear and tear in lava deserts is considerable. About 300 km. of such desert travelling will wear out any set of shoes, and they will require a new set of nails after the first 150 km. If prepared to waste approximately half the nails used, inexperienced men can learn to shoe these ponies in one lesson.

Feeding. Iceland ponies are very thrifty and are quite capable of working over 24 hr. without food. They can perform hard work for long periods on a ration of 12 lb. of hay per day. Maximum endurance is obtained with 7 lb. hay and 3 lb. oats, given in three feeds. More than 3 lb. of oats a day may lead to laminitis, and the ponies may become uncontrollable. In Iceland, where the pasture is rather poor, 7 hr. grazing in 24 provides them with sufficient nourishment. They are accustomed to drink every hour and will always do so if given an opportunity; they can, however, go without water for long periods (20 hr.) if necessary.

Docility. Icelandic ponies will usually stand if reins or head rope are trailed; horse holders should not be necessary. The ponies stand quietly in the field type of rope horse lines, but these are seldom used in Iceland because the sandy soil will not hold pickets, posts or pegs. A large number of animals can, if necessary, be enclosed in a small space with very little risk of injury by kicking. Owing to their docile character, the most convenient way to catch them is by the tail.

The Icelandic hobble is made up of 60 cm. of plaited rope, with a 10 cm. loop at one end and a toggle made of a sheep's cannon bone spliced in at the other. This is quite satisfactory, but wears out quickly. It would probably be better to use leather pastern shackles with buckles, joined by 25 cm. lengths of 5 cm. rope. In hobbles, these ponies can jump low walls and canter faster than a man can run, but they are usually easy to catch.

Trains of up to eight pack ponies require only one man to guide the front animal; the others are tied from the rear cross-piece of the saddle to the head of the following pony. Icelandic ponies have such insensitive skins that rope is perfectly satisfactory as material for bridles and halters.

SEA COMMUNICATIONS

From the time of the settlement until about the year A.D. 1000 the Icelanders owned enough ships to provide suitable communications with other countries. During the eleventh century the number of vessels began to decline and trade slipped more and more from home control. After 1200 most of the traders, captains and shipowners recorded in connexion with sailings were Norwegian. At this time there was little direct communication with any other country, and Norwegian ships continued to be the main source of communication until the fourteenth century. During the next 200 years the English and Germans came in increasing numbers to trade, and largely replaced the Norwegians. From 1602 until 1787, however, trade was

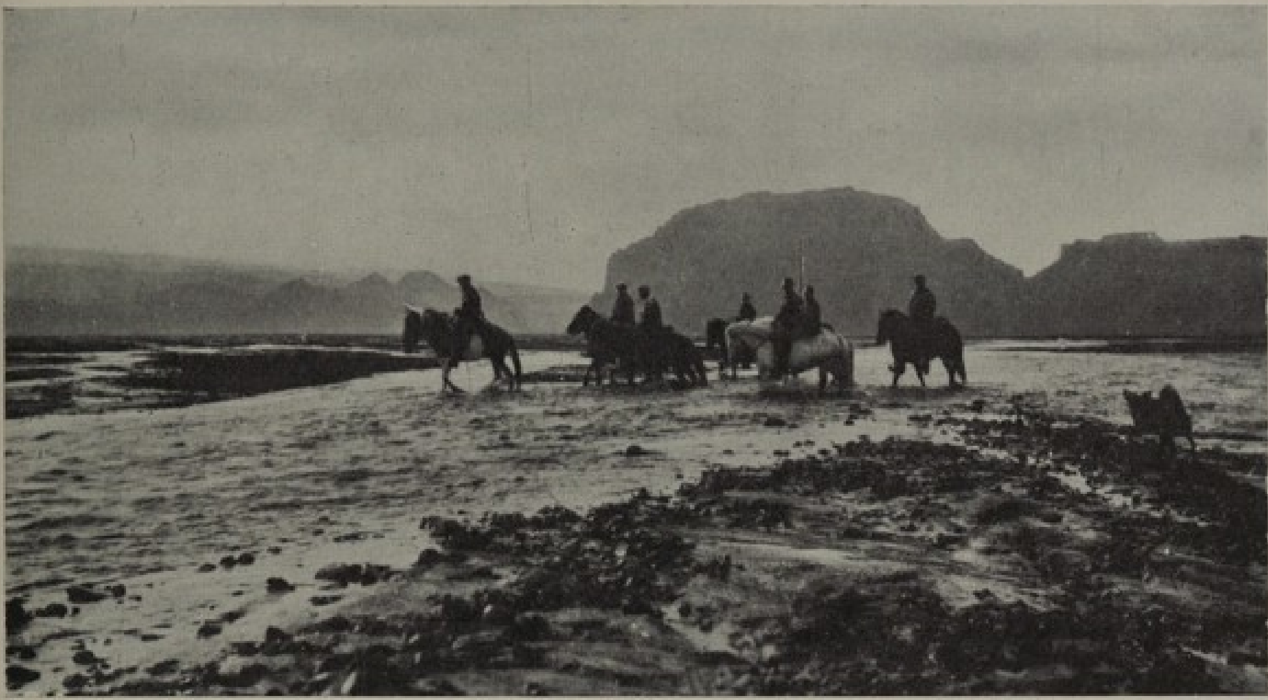
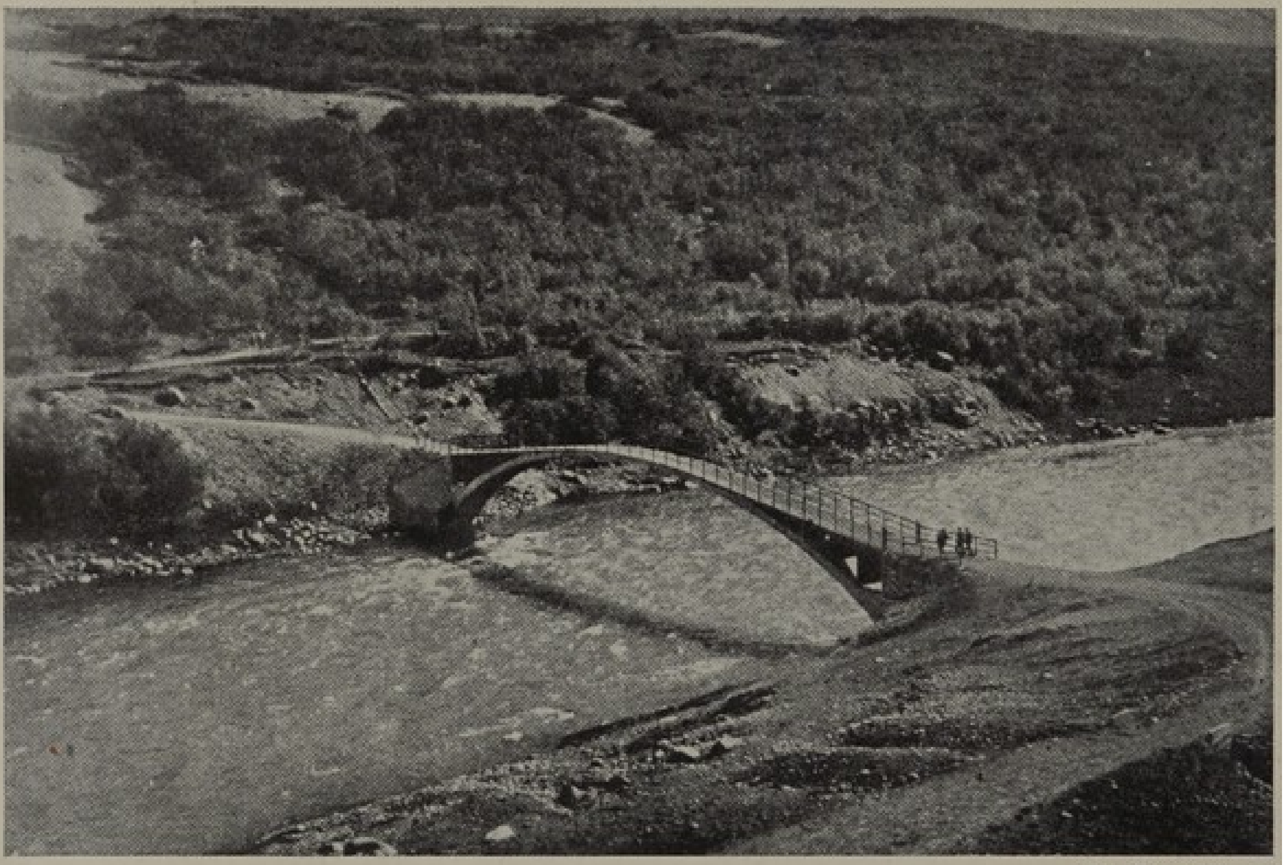


Plate 89 Ponies crossing a river in Mýrdalssandur.

Plate 90. Iceland ponies.

M. H. Donald

Plate 91. Iron bridge over the Skjálfandafljót below Goðafoss.



V. Sigurgeirsson

Plate 92. A birch-covered slope in Fnjóskadalur. Most of the bridges built in recent times are of reinforced concrete.

restricted to a few Danish concessionaries; then it was made free to all Danish subjects. In spite of the restrictions there is evidence that sporadic non-Scandinavian trade persisted during the closed period. Not until 1854 were the ports thrown open to the ships of all nations.

Several factors have influenced the development of modern Icelandic shipping. Of the three main companies operating in 1939, one was Danish, one Norwegian and one Icelandic.

The United Steamship Company of Copenhagen instituted a service between Denmark and Iceland in 1866. This was continued with three ships until 1870, when the Danish government assumed control. During the years 1876 to 1914 the company again maintained the service, in co-operation with the Danish government, although from 1880 to 1914 little was carried beyond passengers and mail. Until 1940 this company maintained a service with one ship every three weeks between Copenhagen and Iceland. This ship called at Leith and Thorshavn on both the outward and homeward voyages.

The Bergen Steamship Company sent its first ship to Iceland in 1908. In 1913–14 the company made an agreement with the *Alþingi* that it would keep two ships plying between Iceland and Norway. Both of these ships were sunk during the war of 1914–18. The company then suspended sailings until 1919, when they resumed service with one cargo and passenger vessel, which called at Reykjavík and Thorshavn every fortnight. Since 1925 another ship of this company has maintained a service from Oslo and Bergen to the east and north coasts of Iceland and to Reykjavík.

At the end of the nineteenth and the beginning of the twentieth century, one man, Thor E. Tulinius, a wholesale merchant of Copenhagen, played an outstanding part in the development of Icelandic shipping. He owned many tramp steamers and chartered others. Through his initiative the Thore Steamship Company was founded in 1903. This company acquired many ships which sailed between Iceland and Europe, and, in addition, it maintained three smaller vessels for coastal service round Iceland. The company was enterprising and flourished for a while, but in 1913 financial difficulties compelled it to suspend activities.

The Icelanders came to realize more and more that it was unsatisfactory to depend almost entirely on foreigners for their communications with other countries. With the outbreak of war in Europe the problem became acute, and in 1914 the Iceland Steamship Company (*Eimskipafélag Íslands*) was formed in Reykjavík with financial assistance from Icelanders in Canada and U.S.A. This company carried on voyages to America between 1915 and 1920. At the end of the war the American service was discontinued, and regular sailings have since been made to Leith, Hull, Hamburg, Copenhagen and Antwerp. Despite great difficulties, the company has made steady progress, and in 1939 it possessed six vessels: *Gullfoss* (1,414 gross registered tons), *Goðafoss* (1,542 g.r.t.), *Brúarfoss* (1,579 g.r.t.), *Dettifoss* (1,604 g.r.t.), *Lagarfoss* (1,211 g.r.t.), and *Selfoss* (775 g.r.t.). All of these, except the cargo ship *Selfoss*, are combination passenger-and-cargo ships. The sailings of these ships have combined local coastwise and foreign services, and, until the outbreak of war in 1939, a weekly service was maintained between Iceland and Great Britain.

The duration of a voyage to Iceland depends on the route used. The usual times to Reykjavík are as follows: from Hull about 5 days; from Bergen about 4 days; from Leith 3½–4 days; from Copenhagen direct, about 4½ days; from Copenhagen with one or two days' stop at Leith, 6–7 days; from Hamburg with one or two days' stop at Hull, 7–8 days. From any of the above ports to the first port of call on the east coast of Iceland, the voyage is usually about a day shorter.

The establishment of the Icelandic Steamship Company was both opportune and fortunate. Without her own domestic service it is doubtful whether Iceland could have secured necessities during the later part of the war of 1914–18. As a war-time emergency measure, the *Alþingi* purchased three ships in 1917. One of these was stranded in 1923, and later the other two were sold. A new ship replaced the first of these, and in 1927 this was the only ship owned by the government. In 1930 the government established its own shipping office (*Skipaútgerð Ríkisins*) for two coasting steamers which have since called regularly at about sixty points round the coast. Until 1939 one of these boats, *Suðin*, used to make seventeen, and the other, *Esja*, ten trips a year round Iceland. Owing to the severe conditions, this service frequently had to be suspended in the middle of winter. During June, July and August, when the Iceland Steamship Company's boats were fully commissioned, the *Esja* was usually withdrawn from the coastwise schedule and plied between Reykjavík and Glasgow to assist with the British tourist traffic. The *Esja* was sold in 1939, and in the same year a modern Danish-built motor-ship of the same name, designed for coastal work, replaced her. In addition to the *Suðin*, the government then owned ten smaller vessels which were used for local transport in fjords and bays.

Several small steamship companies have been founded in Iceland with freighting as their object: the Reykjavík Steamship Company, founded in 1932, operates two ships which have been sailing to the Mediterranean countries, Great Britain, northern Europe, and America. The Ísafold Steamship Company, founded in 1933, owns one ship which was used on a Mediterranean service. The Skallagrímur Steamship Company, of Borgarnes, maintains a regular service between Reykjavík and Borgarnes. The Akureyri Co-operative Society handles considerable freight transport. Since 1935 one of its ships has made seven to ten voyages each year between Iceland and other countries.

The Icelandic merchant fleet (of ships above 12 gross registered tons) consisted, in 1940, of 78 steam vessels totalling 29,382 tons, and 348 motor vessels totalling 12,773 tons. There are also a very large number of smaller craft, especially motor boats, which are almost all engaged in the fisheries (see pp. 308–24). The number of passenger vessels belonging to Iceland is, however, still insufficient to satisfy requirements; in the summer there has for many years been a shortage of passenger accommodation for tourists who wish to visit the country.

The increase in the tonnage of ships visiting Iceland from abroad (including Icelandic vessels) may be seen from the following table, which gives yearly averages for the periods indicated:

	No. of ships	Total tonnage		No. of ships	Total tonnage
1787–1800	55	4,366	1891–1895	331	54,376
1801–1810	42	3,531	1896–1900	368	70,218
1811–1820	33	2,665	1901–1905	385	92,101
1821–1830	54	4,489	1906–1910	384	132,308
1831–1840	82	6,529	1911–1915	413	146,210
1841–1850	104	7,664	1916–1920	320	199,810
1851–1860	133	11,388	1921–1925	337	140,595*
1861–1870	146	13,991	1926–1930	363	239,078
1871–1880	195	20,716	1931–1935	330	241,700
1881–1885	149	36,445	1936	348	256,881
1886–1890	264	46,202	1937	351	243,494

* Owing to a misprint in the original statistics this figure may not be correct.

Sources: (1) *Árbók Hagstofu Íslands*, p. 61 (Reykjavík, 1930). (2) *Hagtíðindi*, p. 44 (Reykjavík, 1936). (3) *Íslands Addressebog*, p. 49 (Reykjavík, 1940).

Up to the present time the shipowners' business in Iceland has not been very lucrative, and there is much debate and uncertainty about the method of developing this type of transport. Some consider that the coastal service must be divorced entirely from overseas communication. If this should happen, it will be difficult for the coastal lines to satisfy the increasing demand for rapid and frequent transportation between the ports. People are no longer willing to wait weeks for passage, as they have often had to do up to the present, unless they had a motor boat at their disposal. In the commercial centres there are motor boats everywhere, but serious inconvenience is caused by the lack of adequate harbours along a large part of the coast. This deficiency has been felt in the steamer traffic, and it has become increasingly evident in recent years with the more frequent attempts to serve isolated coastal farms. The steamers must often anchor at a distance from the shore, and the passengers and freight have to be brought to land in rowing boats. This causes a considerable delay. It is impossible to maintain any definite schedule; a steamer may lie at anchor sounding blasts on the whistle for hours, before the passengers on board can be certain whether any of the people on the neighbouring farms intend to take advantage of the rare opportunity offered.

Since the coastal traffic cannot yet be satisfactorily run to a reasonably fixed time-table, it is not difficult to understand why some Icelanders ignore the whole steamboat problem, like the railway problem, and advocate the development of road and air transport.

AIR COMMUNICATIONS

Aviation in Iceland

Interest in the development of aviation is considerable, since, in spite of progressive road-making projects during the last decades, there is not yet a nearly satisfactory road network.

In 1919 and 1920 some experiments were made with a small aeroplane, but the results did not prove very successful. In 1928, however, the Aeronautical Society of Iceland (*Flugfélag Íslands*) was founded and operated for four years. A four-seater plane was hired from a foreign company for transport between Reykjavík and various places on the coast. During the summer of that year 26,000 km. were covered, and 500 passengers carried. The following spring two four-seater seaplanes were hired; a total of 56,000 km. were flown, and 1,110 passengers were carried. Some mail was also conveyed by air. In the next two years the distances covered were increased, but the number of passengers decreased, because greater emphasis came to be placed upon long-distance flying. From 1929 to 1931, during the herring season (mid-June to mid-September each year), one of the seaplanes was employed to locate herring shoals and report them to the fishing fleet. In 1930 the *Alþingi* passed an act creating the Iceland Aircraft Fund (*Flugmálasjóður Íslands*), which provided that while a plane was so engaged, every ship fishing by purse-net had to contribute to the fund in proportion to its catch. A series of bad seasons, with resulting complaints from the fishermen, caused the withdrawal of the tax in 1932. Without this support the *Flugfélag* could not meet operating expenses, and it went out of business.

During the International Polar Year, 1932–3, the Dutch government sponsored an expedition to Reykjavík. Two Fokker planes were used for systematic aerological observations. During the year, 330 flights were made on 261 days, and the observations made during this period provided extremely valuable information about flying conditions in Iceland.

In 1938 the Aeronautical Society of Akureyri (*Flugfélag Akureyrar*) was organized for the purpose of summer flying in a five-seater Waco. Although this society had a regular route—Reykjavík–Siglufjörður–Akureyri—it also provided a taxi service, and would fly to any point where business offered. Operations showed such a profit that the society continued its flights during the winter of 1938–9. Its success, and that of planes owned by private individuals, is of great importance to Iceland, for aviation assures a dependable service that can quickly reach the most isolated towns and farms. Patients can be taken to hospitals, and doctors can reach patients who cannot be moved.

Transatlantic Flying

It is only 800 km. from Scotland to Iceland, and from there to Greenland less than 350 km. When the United States Army aviators touched at Iceland on their flight round the world in 1924, the idea naturally arose that the island could be a suitable stage for flights between Europe and America. This idea was strengthened by the British Arctic Air Route Expedition to Greenland in 1930–1, and especially by Marshal Balbo's air fleet which took the route via Iceland and flew in one stretch from Reykjavík to Labrador in 1933. At this time several aviators made Iceland a stage in the flight between Europe and America, touching also at Greenland. Among these was the German, Wolfgang von Grönau (in 1930, 1931 and 1932), Colonel Lindberg (a survey flight for Pan-American Airways in 1933), and the Englishman, John Grierson (in 1934). In 1932–3 H. G. Watkins, who had organized the British Arctic Air Route Expedition, again took an expedition to East Greenland to investigate flying conditions for Pan-American Airways. In 1936 this company obtained permission from the Icelandic government to make flights both to Iceland and within the island itself, together with the right to establish landing places and other constructions connected with aviation. No progress was made with this work during 1937 and 1938, as had been stipulated in the agreement, and the permission was then withdrawn.

The German Luft-Hansa, which had for a time assisted the Icelanders to maintain communications by air within the country, sent a commission to Reykjavík in March 1939 to arrange with the Ice-

Fig. 128. Proposed Arctic air route.

landic government for aviation rights. In 1931 the Luft-Hansa had obtained a partial promise that up to January 1940 it would have the same right of flying to Iceland as any other foreign company. When the commission came in 1939 it immediately learned that the right of Pan-American Airways had lapsed, and that no foreign company had aviation rights in Iceland; the promise made to the Luft-Hansa had been cancelled, and such rights would not for the time being be granted to any foreign company. The commission therefore returned to Germany without result, but it had emphasized that the Luft-Hansa was planning to undertake flying to Canada and to experiment with regular flights from Germany to Iceland. In view of the international situation which by that time had arisen in Europe, the Icelanders had no faith in these proposed communications by air.

In 1939 the possibility of establishing an arctic air route was still being debated. It seemed that organization difficulties would outweigh any technical difficulties, and the southerly ocean route was more favoured. The shortest route, given by the great circle (see Fig. 128), will doubtless be used in the future. Although difficulties due to weather conditions may lie in the way of maintaining regular flights between Europe and America by way of Iceland, it is certain that flying from Iceland to America, with or without touching at Greenland, is perfectly easy with modern aeroplanes. The strategic importance of Iceland as a base from which planes can maintain a close watch on the movements of shipping in the North Atlantic has been well demonstrated during the present war.

THE DISTRIBUTION OF PETROLEUM PRODUCTS

Supplies of petroleum products are sent mostly in tankers from the Dutch West Indies (Curaçao and Aruba) and occasionally from Britain. Total sales of petroleum products in Iceland in recent years have been as follows:

	Metric tons		
	1938	1939	1940
Gasoline:			
Aviation spirit	40	21	48
Benzine (motor spirit)	5,831	5,822	6,113
White spirit (mainly for paints, thinners, etc.)	70	78	94
Kerosine (paraffin)	2,588	2,879	2,678
Gasoils:			
(*a*) Gasoil (mainly for the fishing fleet)	9,189	12,019	14,362
(*b*) Diesel oil (mainly for passing vessels)	1,226	1,295	1,805
Lubricating oils and greases	750	825	*c.* 880
Bitumen (asphalt)	90	—	—
Total	19,784	22,939	25,980

Companies operating

Hlutafélagið Shell á Íslandi (Shell Subsidiary Company).

Oliuverzlun Íslands H/F (Agents for the Anglo-Iranian Oil Company).

Hið Íslenzka Steinoliuhlutafélag (agents for the Standard Oil Company of New Jersey).

Nafta, a small concern, which before the war imported cargoes of gasoline in bulk from the continent, but is not selling at present, having run out of stocks.

In addition, there are two Fishermen's Co-operative Societies, at Keflavík and Vestmannaeyjar respectively, which each have a tank, and imported gasoline independently before the war, but which now purchase their requirements from the major companies under long term contracts.

The Vacuum, Wakefield, and some smaller lubricating-oil marketing companies operate in Iceland through agents.

Distribution

All cargoes arriving by ocean-going tankers are discharged into the Shell Company's main installation in Skerjafjörður, south-west of Reykjavík. Products are stored at this depot for all three companies. Apart from this, Shell has a number of small tanks round the coast, all used for gasoil except one tank at Akureyri which is used for benzine. Some of these small tanks are leased to the B.P. (Anglo-Iranian Oil Co.) The B.P. installation is in Reykjavík harbour, and is at present used only for the storage of gasoil, which is transported in lighters from the Shell installation in Skerjafjörður. The Standard Oil Co. has only one tank, on Viðey, an island north-east of Reykjavík.

From the main installations at Skerjafjörður and Reykjavík gasoil is transported to the small tanks round the coast in Shell's small motor lighter, *Skeljungur*. This lighter also carries gasoil and other products in drums, but drums are also sent by coastal vessels of the Iceland Steamship Company. Benzine (motor spirit) for coastal places is all shipped in drums, except to Akureyri, where it is shipped in bulk by the *Skeljungur*. The tank at Akureyri is used for storing both Shell and B.P. benzine. Kerosine for coastal places is all shipped in drums by the *Skeljungur* and other coastal vessels. There are no small kerosine tanks round the coast.

The various products are further distributed as follows:

Gasoline is transported from Shell's main installation in Skerjafjörður and from the benzine tank at Akureyri in tank lorries or in drums carried on lorries. The gasoline is distributed from service stations at Reykjavík and from petrol pumps up country (see pp. 396–7).

Kerosine is supplied by tank lorries to shopkeepers who have small kerosine pumps. It is delivered to the farming community in drums.

Gasoil is largely supplied to the fishermen's motor board, which takes the oil either from the tanks or in drums.

Lubricating oil is all imported in drums or other packages and is distributed over the country by sea and overland. Motor oil is distributed from service stations and at petrol pump sites. Lubricating oils for the use of the fishing fleet are sold in drums.

Storage Tanks and Petrol Pumps

The table below gives details of the coastal storage tanks. The products stored are indicated as follows: g = gasoil, b = benzine k = kerosine, a = aviation spirit, s = settling tank, t = service tank.

Locality	Approx. capacity (metric tons)	Owner
Skerjafjörður	4,800 (*g*), 3,800 (*b*), 2,000 (*k*), 1,000 (*a*), 100 (*s*), 60 (*t*), 60 (*t*), 60 (*t*), 60 (*t*)	Shell
Reykjavík	800 (*b*)	Nafta
	550 (*g*), 550 (*g*), 550 (not in use), 550 (not in use)	B.P.
Viðey	1,000 (*g*)	Standard
Akureyri	330 (*b*), 200 (*g*)	
Njarðvík	100 (*g*)	
Akranes	175 (*g*)	
Ísafjörður	235 (*g*), 100 (*g*)*	
Siglufjörður	60 (*g*), 60 (*g*)*	Shell
Seyðisfjörður	60 (*g*), 60 (*g*)	
Neskaupstaður	60 (*g*), 60 (*g*)	
Eskifjörður	60 (*g*), 60 (*g*)	
Fáskrúðsfjörður	60 (*g*), 60 (*g*)	
Vestmannaeyjar	800 (*g*)	Fishermen's Co-operative
	235 (*g*), 100 (*g*)*	Shell
Keflavík	500 (*g*)	Fishermen's Co-operative

* Shell tank leased to B.P.

Petrol pumps are situated along the chief roads (see Fig. 129). Shell has installed only 1,000 gal. underground tanks; most of those belonging to B.P. have a capacity of 500 gal., but some hold 300 gal. It will be seen from the key to Fig. 129 that the three main companies distribute throughout the island in competition with each other. In Reykjavík the companies have a number of service stations; Shell (two), B.P. (three), Standard Oil Co. (one), and Nafta Co. (one).

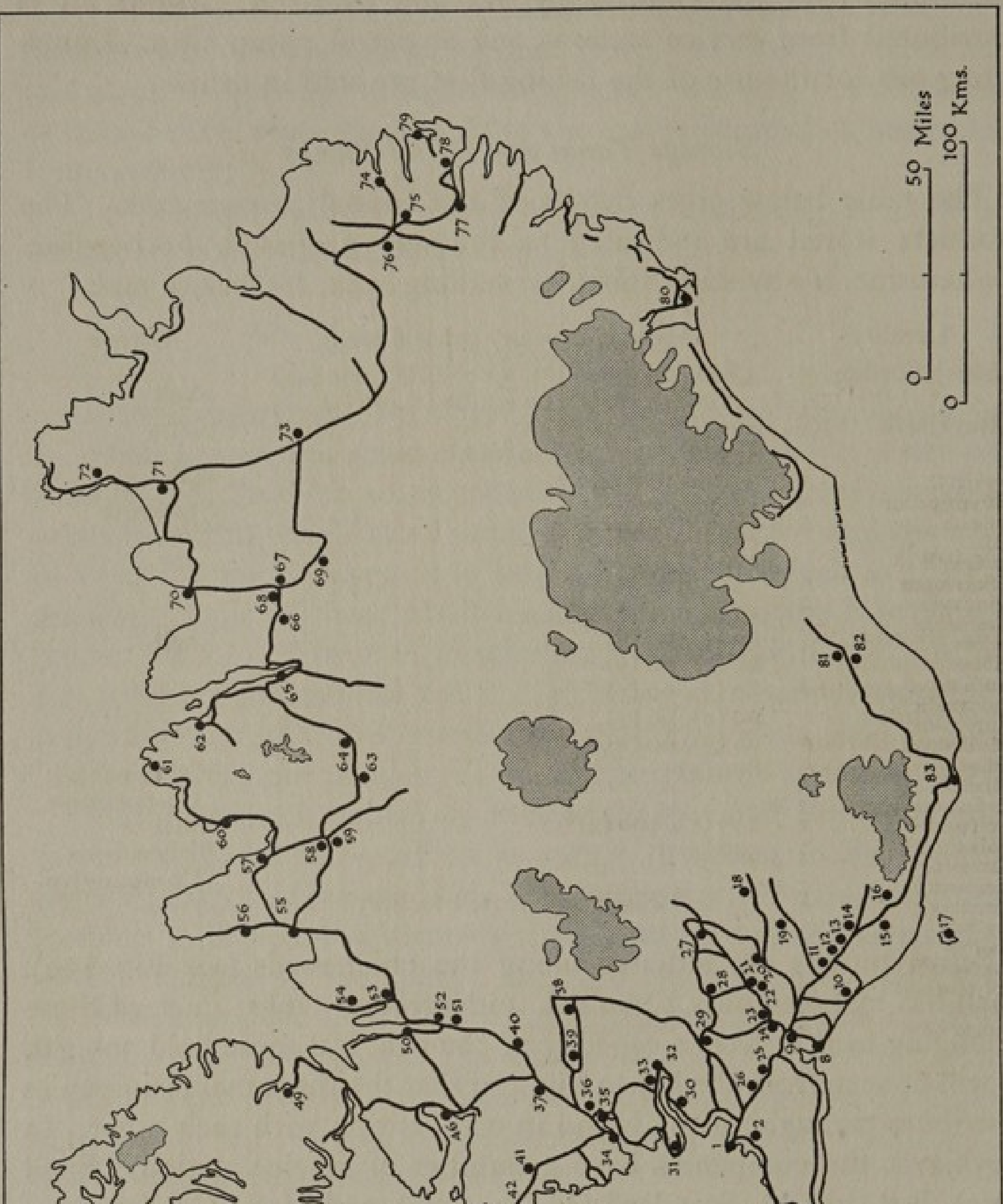


Fig. 129. Location of petrol pumps, 1940. Data supplied by Shell Co.

Key to Fig. 129. B.P. (A), Shell (B), Standard (C).

1.	Reykjavík	A	B	C
2.	Hafnarfjörður	A	B	C
3.	Keflavík	A	B	C
4.	Hof			C
5.	Sandgerði			C
6.	Kirkjuvogur	A		
7.	Grindavík	A	B	
8.	Eyrarbakki	A	B	
9.	Selfoss	A	B	C
10.	Miðkot			C
11.	Rauðilækur	A		
12.	Gaddstaðir		B	
13.	Djúpidalur			C
14.	Stórólfshvol	A		
15.	Dalssel	A		
16.	Seljaland	A		
17.	Vestmannaeyjar	A	B	
18.	Asólfsstaðir	A		
19.	Múli	A		
20.	Húsatóftir		B	C
21.	Sveinavatn		B	
22.	Minniborg	A		
23.	Sogsbrú	A		
24.	Alviðra			C
25.	Hveragerði			C
26.	Kolviðarholl			C
27.	Einholt	A		
28.	Laugarvatn	A		
29.	Þingvellir	A	B	
30.	Eyri			C
31.	Akranes	A	B	C
32.	Þyrill		B	
33.	Ferstikla	A		
34.	Borgarnes	A	B	C
35.	Ferjukot	A	B	
36.	Svignaskarð			C
37.	Hraunsnef	A		
38.	Húsafell	A		
39.	Reykholt	A	B	
40.	Fornihvammur	A	B	
41.	Grund		B	
42.	Grof			C
43.	Eiðhus	A		
44.	Ólafsvík		B	
45.	Stykkishólmur	A	B	C
46.	Búðardalur	A		C
47.	Flateyri	A		
48.	Ísafjörður	A	B	C
49.	Holmavík	A	B	
50.	Borðeyri	A	B	
51.	Grænumýrartunga	A		
52.	Staður			C
53.	Stori Ós		B	
54.	Hvammstangi	A	B	
55.	Blönduós	A	B	C
56.	Skagaströnd	A		
57.	Sauðárkrókur	A	B	
58.	Varmahlið	A		
59.	Viðimýri		B	
60.	Hofsós	A		
61.	Siglufjörður	A	B	
62.	Dalvík	A		
63.	Ytri-kot		B	
64.	Bakkasel	A		
65.	Akureyri	A	B	
66.	Fossholl	A		
67.	Breiðamýri		B	
68.	Einarsstaðir	A		
69.	Álftagerði	A		
70.	Húsavík	A	B	
71.	Ferjubakki		B	
72.	Kópasker	A		
73.	Grímsstaðir	A		
74.	Seyðisfjörður		B	
75.	Egilsstaðir	A		
76.	Ekkjufell		B	
77.	Reyðarfjörður	A	B	
78.	Eskifjörður	A	B	
79.	Neskaupstaður	A	B	
80.	Höfn	A		
81.	Kirkjubæjarklaustur	A		
82.	Hólmur	A		
83.	Vík	A	B	

Chapter XIX

SIGNAL COMMUNICATIONS*

Introduction: Telephones and Telegraphs: Radio

Introduction

Owing to her isolated position and her widely scattered population, Iceland has always taken a great interest in world development of communications. The invention of the telephone, and later of wireless, has contributed more than almost anything else to the welfare of the people.

In 1854 a concession was granted to the island for a submarine cable to Scotland, but this project was not carried out until 1906, when a cable service was opened between Seyðisfjörður and the British Islands. In the meantime, a telephone line had been erected between Reykjavík and Hafnarfjörður, and by 1911 there was a line from Reykjavík through Akureyri to Seyðisfjörður, and a few years later to Vestmannaeyjar. It was not until 1929 that the southern link from Reykjavík to Seyðisfjörður via Vík was completed. A year later carrier equipment and a teleprinter service were introduced.

Although at present most of the long-distance routes are poled, the future policy seems to be to establish underground routes, especially on the more exposed sections of the system. This is proving to be a slow and expensive task owing to the geological formation of the country. Open wire cannot satisfactorily stand up to the gales and the inevitable load of snow and ice.

In 1918 a coast radio station was established at Reykjavík, and eight years later a 5 kW. broadcasting station was opened. In 1935 short-wave radio-telephony was established with Europe. Communication with the United States, at first via Great Britain, was made direct in 1938. In the same year telephone subscribers were able to communicate with ships at sea; the broadcasting station was enlarged and the power increased to 100 kW., and a relay station of 1 kW. was erected at Eiðar on the east coast.

* These notes take no account of alterations made since the beginning of the present war.

In Reykjavík there is a large modern automatic exchange of the Ericsson type, and there is also a small exchange of similar make at Hafnarfjörður. The automatic telephone service only caters for the Reykjavík and Hafnarfjörður areas, but there are provincial switching centres at Reykjavík, Borðeyri, Akureyri, Ísafjörður, Seyðisfjörður, Stykkishólmur, Siglufjörður, Egilstaðir and Selfoss. There is a Wheatstone telegraph circuit from Reykjavík to the cable head at Seyðisfjörður, and almost every village of any size has a telegraph office.

The bulk of the system in Reykjavík now consists of underground routes. Apart from short junction circuits between Reykjavík, Mosfell and Hafnarfjörður, there is no long-distance underground network in Iceland. All long-distance circuits are carried on overhead open-wire routes which usually follow the general line of the roads. For reasons of economy, and because of the small volume of traffic, in the outlying districts farms and houses are usually on a 'party line'; several scattered subscribers are connected to the same line, using a system of rings for individual subscribers.

Submarine Cables

The submarine telegraph cable from Seyðisfjörður, which provides an outlet to the world network via Scotland, runs through the Faroe and Shetland Islands to Wick in Caithness, and is a single core line 987 km. long. The Great Northern Telegraph Company laid the cable with grants from the Icelandic and Danish governments, and secured the sole right of operating it for twenty years. This privilege expired in 1926, but was then renewed. Connexion with Reykjavík is made by means of the open-wire routes along the north and south coasts. Messages are normally received and transmitted from Reykjavík telegraph office, but when this is closed Reykjavík radio station is used. There are also submarine telephone cables from the mainland to Vestmannaeyjar and Hrísey (both double-core type).

Radio Telephone Links

A radio-telephone link between Reykjavík and Copenhagen and London was in operation until the arrival of the British troops in 1940. At Reykjavík there is also a 0·5 kW. transmitting set which can be connected with the public system. This provides communication with fishing vessels and passenger ships. In 1918 only one Icelandic

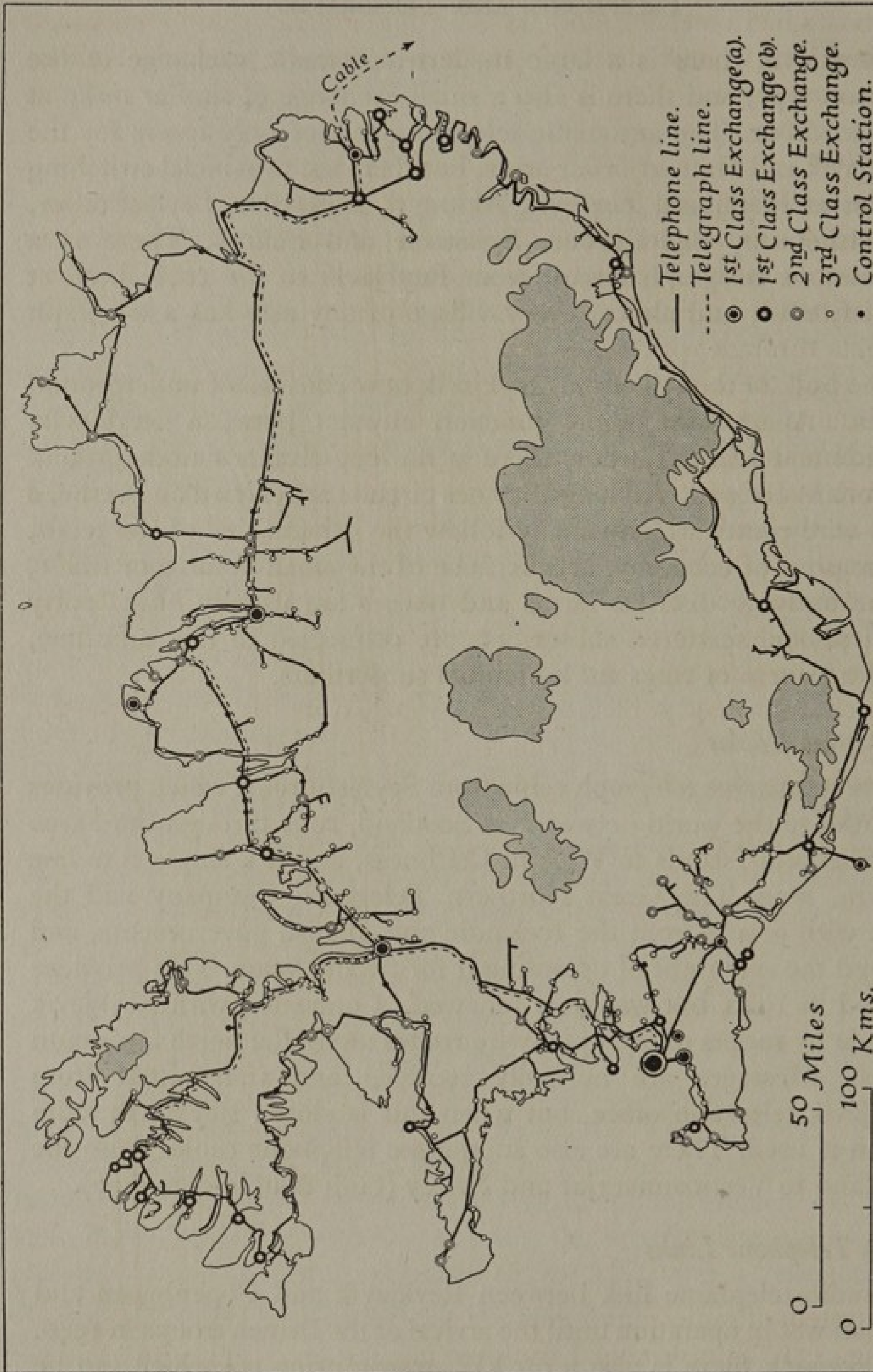


Fig. 130. Telephone and telegraph lines. For explanation of symbols see p. 401.
Source: *Símakort Íslands* (Copenhagen, 1932).

ship had a wireless receiving set, but by 1938 more than 280 ships and boats had receiving and transmitting apparatus and could send telegrams to or talk directly with any station or private telephone in the country.

Operation

The telegraph and telephone service is operated by the state. The Director-General and Chief Engineer of Posts and Telegraphs are responsible to the Minister of Communications. All trunk lines are constructed by the state, the local lines partly at the expense of the districts through which they run.

In 1935 there were 6,414 telephones, or one for every eighteen inhabitants. At that time the corresponding figures for the United Kingdom and U.S.A. were one telephone for every sixteen and seven inhabitants respectively. The length of the telephone and telegraph lines at the end of 1939 was just over 15,600 km. There were 504 telegraph and telephone offices. The number of dispatches sent in 1939 was 201,000, of which 152,000 were international. The number of telephone conversations was 25,279,000.

The main telephone and telegraph lines are shown in Fig. 130. This is based on a map published in Copenhagen in 1932; no important long-distance lines have been constructed since that date. The symbols for the exchanges indicate the periods of operation, as follows:*

1st class exchange:	(*a*)	Open	0800–2100	Weekdays
		,,	1000–2000	Sundays
	(*b*)	,,	0830–1400	Weekdays
		,,	1530–2000	
		,,	1000–1100	Sundays
		,,	1600–1900	
2nd class exchange:		,,	0900–1200	Weekdays
		,,	1600–1900	
		,,	1000–1100	Sundays
		,,	1600–1800	
3rd class exchange:		,,	0900–1000	Weekdays
		,,	1600–1700	
		,,	1000–1100	Sundays
		,,	1600–1800	

Radio

The system of radio communication as it existed in 1939 is illustrated in Fig. 131. The principal transmitting station working to Europe

* There is a temporary 24 hr. service at exchanges where British troops are stationed.

and the U.S.A., and for use when the cable to Scotland fails, is situated at Vatnsendi, 8 km. south-east of Reykjavík. This consists of a 12 kW. high-frequency transmitter for telegraphy and radio-telephony. The associated receiving station is at Gufunes, 5 km. east of Reykjavík.

There are five other coastal transmitting stations—under the control of Administration General Telegraph—which are open to public correspondence:

Reykjavík (TFA). In peace time three sets were used at this station, which is situated on the outskirts of the town: (1) a 1 kW. set used for two-way radio-telephony work through the telephone exchange to trawlers fishing in territorial waters, (2) a 0·6 kW. set used as the link station for Seyðisfjörður, Ísafjörður, and Siglufjörður, and (3) a 0·5 kW. set used for shipping control. Reykjavík Radio normally transmits regular meteorological bulletins.

Seyðisfjörður (TFY) has a 0·5 kW. set equipped with automatic Wheatstone equipment for directly retransmitting cable traffic from Scotland should the inland lines be out of order.

Siglufjörður (TFX) and Ísafjörður (TFZ) are equipped with 0·06 kW. sets. These are held in reserve in case the inland line communications fail, but they are also used for communication with various small islands and the fishing fleet.

Vestmannaeyjar (TFV) has a 0·1 kW. set.

There are 0·004 kW. fixed radio-telephone stations at Djúpivogur, Flatey (in Breiðifjörður), Flatey (in Skjálfandi), Grímsey, Húsavík, Stykkishólmur and Hornafjörður. These are used for communicating with radio-telephone posts on islands and isolated farms. Eleven isolated farms are at present equipped in this way (see Fig. 131).

Radio-beacon and fog-signal stations have been established at Dýrhólaey, Reykjanes and Vestmannaeyjar. These have been of great assistance to fishing boats off the south coast.

A modern long- and short-wave broadcasting station is situated at Vatnsendi. This was originally designed in 1930 as a 20 kW. station, but was later increased to 100 kW. The long-wave transmitter (TFU) works on a wave-length of 1,442 metres at 100 kW. and the short-wave transmitter (TFJ) on a wave-length of 24·52 m. at 7 kW. At Eiðar there is a medium-wave 1 kW. transmitter (TFE) which relays the Reykjavík programme for the east coast. The broadcasting

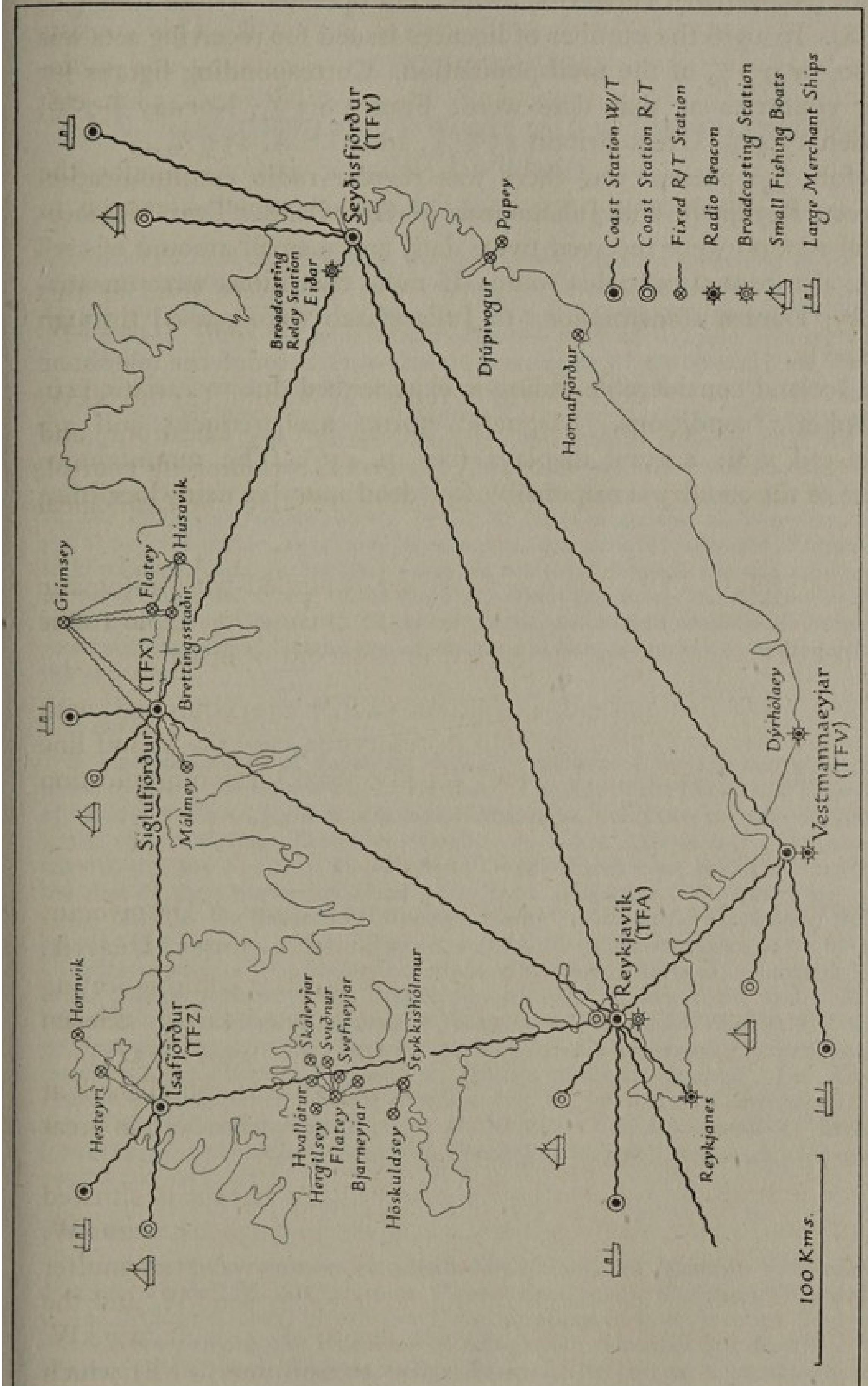


Fig. 131. Radio communications, 1939. Wavy lines indicate normal connections. Sources: (1) *Nomenclature des Stations Fixes* (Berne, 1938). (2) War Office.

service (*Ríkisútvarp Íslands*) is owned and operated by the state (see p. 148). In 1936 the number of licences issued for receiving sets was 12,500, or 9·3 % of the total population. Corresponding figures for other countries at that date were: France 6·3 %, Norway 6·7 %, Sweden 13·4 %, Great Britain 15·8 %, and U.S.A. 17·7 %.

Before the present war there was regular radio communication between Reykjavík and Julianehaab in Greenland. Two Meteorological reports were received twice daily and a small amount of civil traffic also passed over this route. If radio conditions were unsatisfactory, Danish transmissions to Julianehaab were passed through Reykjavík.

In Iceland considerable fading is experienced due to variations in ionospheric conditions. Magnetic storms are frequent and are associated with auroral displays (see p. 436). The mountainous nature of the country is responsible for 'dead spots' in many localities.

BIBLIOGRAPHY

A. Classified List of Works used in Preparation of the Handbook

Chapter I. *Geology and Physical Geography*

The most detailed description of the geology and physical geography of Iceland is by Þ. Thoroddsen ('Island', *Petermanns Mitteilungen*, Ergänzungshefte 152, 153, Gotha, 1905–6). In a posthumous work (*Die Geschichte der Isländischen Vulkane*, Copenhagen, 1925) the same author tells the story of volcanic, hot spring, and earthquake activity in historic times. Summaries of the geology are given by H. Pjeturss ('Island', *Handbuch der Regionalen Geologie*, Bd. IV, Heidelberg, 1910) and G. G. Bárðarson (*Ágrip af Jarðfraeði*, Reykjavík, 1927). The latest general account is by W. Iwan ('Island', *Berliner Geographische Arbeiten*, Heft VII, Stuttgart, 1935, Bibliography, pp. 129–50). There is no comprehensive work in English, but Thoroddsen's summary ('An account of the Physical Geography of Iceland' in *The Botany of Iceland*, edited by L. K. Rosenvinge and E. Warming, Part I, pp. 190–343, London, 1914) may be recommended as an introduction. The advances in knowledge made during later years are scattered through the scientific journals of many countries. Some of the more important papers are cited below under the main headings of Chapter I. These references are cited in some detail because the geological features of Iceland are so unique and because no select bibliography has yet appeared.

The Rocks

Recent discussions of the much debated problem of the age and arrangement of the rocks may be followed in L. Hawkes ('The Age of the Rocks and Topography of Middle Northern Iceland', *Geological Magazine*, Vol. LXXV, pp. 289–96, London, 1938; and 'Icelandic Tectonics—Graben or Horst', *Geological Magazine*, Vol. LXXVIII, pp. 305–8, 1941); H. Pjeturss ('On the Pleistocene Rocks of Iceland and the Age of the Continental Shelf', *Geological Magazine*, Vol. LXXVI, pp. 233–6, 1939); and H. G. Backlund ('Islandprobleme', *Geologische Rundschau*, Bd. XXX, pp. 625–30, Leipzig, 1939). There are accounts of the intrusive rocks by H. K. Cargill and others ('The Major Intrusions of South-east Iceland', *Quarterly Journal of the Geological Society*, Vol. LXXXIV, pp. 505–39, London, 1928), and L. Hawkes ('The Sandfell Laccolith', *Quarterly Journal of the Geological Society*, Vol. LXXXIX, pp. 379–400, 1933); of the Pliocene deposits by G. G. Bárðarson ('A Stratigraphical Survey of the Pliocene Deposits at Tjörnes in North Iceland', *Det Kongelige Danske Videnskabernes Selskabs Skrifter*, Afd. IV, pp. 1–118, Copenhagen, 1925), and of the Palagonite Formation by N. Nielsen ('Om den islandske "Palagonitformation's" Oprindelse', *Geografisk Tidsskrift*, Bd. XXXIX, pp. 1–36, Copenhagen, 1936).

Volcanoes

The forms of the volcanoes are classified by N. Nielsen ('Islandske Vulkanformer', *Naturens Verden*, Bd. XIII, pp. 1–21, Copenhagen, 1929). K. Sapper (*Vulkankunde*, p. 303, Stuttgart, 1927) gives a list of the eruptions of historic times. The phenomena accompanying the eruptions of sub-glacier volcanoes are described by N. Nielsen (*Vatnajökull, Kampen mellem Ild og Is*, pp. 1–124, Copenhagen, 1937); areal eruptions by H. Reck ('Die Masseneruption', *Deutsche Island Forschung*, Bd. II, pp. 24–49, Breslau, 1930); the Reykjanes peninsula by G. G. Bárðarson

('Geologisk Kort over Reykjanes-Halvoen', *Beretning om det 18 Skandinaviske Naturforskermøde*, pp. 182–90, Copenhagen, 1929), and the Mývatn area by A. Rittmann ('Die Vulkane am Mývatn', *Bulletin Volcanologique*, Série II, tome IV, pp. 3–38, Naples, 1938).

Accounts of individual volcanoes are of Askja by N. H. Van Doorninck ('De Askja in Centraal-Ijsland', *Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap*, Deel LI, pp. 218–37, Amsterdam, 1934); of Laki by K. Sapper ('Ueber einige isländische Vulkanspalten und Vulkanreihen', *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie*, Beilage Bd. XXVI, pp. 1–43, Stuttgart, 1908), and of Herðubreið by H. Reck ('Isländische Masseneruptionen', *Geologische und Palaeontologische Abhandlungen*, Neue Folge, Bd. IX, pp. 1–103, Berlin, 1910).

Hot Springs

The chief worker in this field is Th. Thorkelsson ('The Hot Springs of Iceland', *Det Kongelige Danske Videnskabernes Selskabs Skrifter*, Afd. VIII, pp. 179–264, Copenhagen, 1910; and 'On Thermal Activity in Iceland and Geyser Action', *Visindafélag Íslendinga*, Afd. XXV, pp. 1–139, Reykjavík, 1940, Bibliography, pp. 137–9). T. F. W. Barth writes on the distribution of alkaline and acid springs ('Varme kilder og vulkanisme paa Island', *Naturen*, Bd. LXIII, pp. 11–27, Bergen, 1939), and T. F. W. Barth ('Stóri Geysir paa Island vekket til nytt liv', *Naturen*, pp. 1–6, Bergen, 1936) and T. Einarsson ('Über die neuen Eruptionen des Geysir in Haukadalur', *Greinar*, Vol. I, Part 2, pp. 137–50, Reykjavík, 1937) discuss the artificial production of geyser activity. The connexion of hot springs with dykes is pointed out by T. Einarsson ('Über eine Beziehung zwischen heissen Quellen und Gängen in der Isländischen Basaltformation', *Greinar*, Vol. I, Part 2, pp. 135–45, Reykjavík, 1937). J. Humlum ('Hveradalir in Kerlingarfjöll', *Geografisk Tidsskrift*, Bd. XXXIX, pp. 11–34, Copenhagen, 1936) describes the hot springs of the Kerlingarfjöll region. For a recent discussion of geyser theory see E. T. Allen and A. L. Day (*Hot Springs of the Yellowstone National Park*, Washington, 1935). In his latest work, T. Einarsson ('Über das Wesen der Heissen Quellen Islands', *Vísindafélag Íslendinga*, Afd. XXVI, Akureyri, 1942) questions the orthodox view that hot springs are connected with vulcanicity.

Earthquakes

S. Thorarinsson ('Das Dalvík-Beben in Nordisland, 2 Juni 1934', *Geografiska Annaler*, Bd. XIX, pp. 232–77, Stockholm, 1937) has made a detailed study of the Dalvík earthquake, and Th. Thorkelsson ('Frequency distribution of Macroseisms at Reykjavík since 1800', *Greinar*, Vol. I, Part I, pp. 57–9, Reykjavík, 1935) records the seismic activity experienced at Reykjavík. F. Bernauer ('Vulkanische und tektonische Spalten auf Island', *Zeitschrift der Deutschen Geologischen Gesellschaft*, Bd. XCI, pp. 405–29, Berlin, 1939) describes the *gjár*. In another paper ('Island und die Frage der Kontinentalverschiebungen', *Geologische Rundschau*, Bd. XXX, pp. 357–8, Leipzig, 1939) he makes an estimate of the rate at which crustal extension appears to be going on. A brief report of the triangulation survey made with a view to testing the theory of extension is given by O. Niemczyk ('Die Arbeiten der Deutschen Island-Expedition, 1938', *Geologische Rundschau*, Bd. XXX, pp. 312–14, Leipzig, 1939).

The Great Ice Age

Accounts of inter-glacial deposits are given by J. Askelsson ('Um islensk dyr og jurtir fra jökultima', *Natturufræðingurinn*, pp. 1–16, Reykjavík, 1938, and 'Interglaziale Pflanzenablagerungen', *Meddelelser fra Danske Geologisk Forening*, Bd. IX, Heft 3, pp. 300–19, Copenhagen, 1938). J. H. Lindal ('The Interglacial formation in Viðidal, northern Iceland', *Quarterly Journal Geological Society*, Vol. XCV, pp. 261–73, London, 1939) describes the evidence from Viðidal.

Glaciers and Glacial Lakes

A general account has been written by G. G. Bárðarson ('Islands Gletcher', *Visindafélag Íslendinga*, Afd. XVI, pp. 1–60, Reykjavík, 1934). The form, nourishment, movements, and glacial lakes of Vatnajökull are described by H. W. Ahlmann and S. Thorarinsson in a series of papers in English (*Geografiska Annaler*, Stockholm, 1937, 1938, 1939, and 1940). J. Keindl ('Untersuchungen über den Hofs- und Langjökull', *Zeitschrift für Gletscherkunde*, Bd. XX, pp. 1–28, Berlin, 1932) describes the lesser known Hofsjökull and Langjökull, and J. W. Wright ('The Hagavatn Gorge', *Geographical Journal*, Vol. LXXXVI, 1935, pp. 218–34) gives an account of the sudden lowering of the level of Hagavatn in 1929.

Former Shore Levels

Changes in shore level in west Iceland since the time of the last Ice Age are described by G. G. Bárðarson ('Fornar Sjávarminjar við Borgarfjörð og Hvalfjörð', *Visindafélag Íslendinga*, Afd. I, pp. 1–118, Akureyri, 1923, English summary). Changes in north Iceland are discussed by Th. Thorkelsson ('Old Shore-lines in Iceland and Isostacy', *Greinar*, Vol. I, Part I, pp. 71–7, Reykjavík, 1935). Evidence of shore deposits now covered by Vatnajökull is cited by H. Pjeturss ('Reise in Sud-Island im Sommer 1906', *Zeitschrift der Gesellschaft für Erdkunde*, Bd. XLII, pp. 597–621, Berlin, 1907) and N. Nielsen (*Vatnajökull: Kampen Mellem Ild og Is*, p. 73, Copenhagen, 1937). The interpretation of the significance of the submarine topography is discussed by F. Nansen ('The Bathymetrical Features of the North Polar Seas, with a Discussion of the Continental Shelves and Previous Oscillations of the Shore-line', *Scientific Results Norwegian North Polar Expedition*, 1893–96, Vol. IV, pp. 70–86, Christiania, 1904).

The Land Surface

A general summary is given by N. Nielsen ('Contributions to the Physiography of Iceland', *Det Kongelige Danske Videnskabernes Selskabs Skrifter*, pp. 185–287, Copenhagen, 1933). Other papers are S. Emilsson ('Lössbildung auf Island', *Visindafélag Íslendinga*, Afd. XI, Reykjavík, 1931) on the loess; L. Hawkes ('Frost Action in Superficial Deposits, Iceland', *Geological Magazine*, pp. 509–13, London, 1924); H. Reck ('Über vulkanische Horstgebirge', *Zeitschrift für Vulkanologie*, Bd. VI, pp. 156–69, Berlin, 1921–22) on horsts; S. Thorarinsson ('The ice-dammed lakes of Iceland', *Geografiska Annaler*, pp. 216–41, Stockholm, 1939) on the glacial outwash deposits; and B. Sæmundsson ('Thingvallasoen', *Geografisk Tidsskrift*, Bd. XVII, pp. 175–81, Copenhagen, 1904) on Þingvallavatn.

Mineral Deposits

The Mývatn sulphur deposits are described by C. C. Blake (*Sulphur in Iceland*, London, 1873), and the Krísuvík deposits by C. W. Vincent ('On the sulphur deposits of Krísuvík', *Chemical News and Journal of Physical Science*, Vol. XXVII, pp. 111–26, London, 1873). Iceland spar and coal are described by H. H. Eiriksson ('Coal-Mining in Iceland and the Spar Mine at Helgustaðir', *Transactions of the Institution of Mining Engineers*, Vol. LIX, pp. 52–63, London, 1920). G. G. Bárðarson ('Om Goldfund paa Island', *Beretning om det 18 Skandinaviske Naturforskermøde*, pp. 190–2, Copenhagen, 1929) reports analyses of gold-bearing rocks, and M. Gruner ('Die Bodenkultur Islands', *Archiv für Biontologie*, Bd. III, pp. 1–214, Berlin, 1912) of kaolin. Former workings of bog iron ore are described by N. Nielsen ('La Production du Fer en Islande dans les Temps Anciens', *Mémoires Société Royale des Antiquités du Nord*, pp. 149–86, Copenhagen, 1929).

Chapter II. *Coasts*

See sources listed under Chapter XI and Appendix II on Maps.

Chapter III. *Climate*

There is no comprehensive work dealing with the climate of Iceland. The fullest and most recent treatment will be found in:

'The Norwegian and Barents Seas.' *Weather in Home Waters and the North-Eastern Atlantic*, Vol. II, Part 7 (London: Meteorological Office, 1941).

W. IWAN. *Island*, pp. 33–43 (Stuttgart, 1935).

H. H. LAMB. 'A Visit to Iceland.' *Quarterly Journal Royal Meteorological Society*, Vol. LXV, pp. 244–52 (1939).

The following papers deal with special aspects:

H. THOMSEN. 'Hydrography of Icelandic Waters.' *Zoology of Iceland*, Vol. I, Part 4 (Copenhagen and Reykjavík, 1938).

C. RYDER. 'Overfladevandets Maanedlige Middeltemperatur i Atlanterhavet Nord for 50° N.Br.' *Nautisk-Meteorologisk Aarbog* (Copenhagen, 1917).

N. H. JACOBSEN. 'Isotermekort over Island for Januar og Juli.' *Geografisk Tidsskrift*, Bd. XXXV, pp. 54–66 (Copenhagen, 1932).

H. G. CANNEGIETER and W. BLEEKER. 'Mittlere Temperatur und Feuchtigkeitswerte über Holland und Reykjavík.' *Beiträge zur Physik der freien Atmosphäre*, Bd. XXIV, pp. 117–21 (Leipzig, 1937).

H. RENIER. 'Niederschlag und Bewölkung auf Island.' *Annalen der Hydrographie*, Bd. LXI, pp. 252–4 (Berlin, 1933).

Þ. ÞORKELSSON. 'Um úrkoma á Íslandi' (Precipitation in Iceland). *Búnadarrit* (Reykjavík, 38 ár. [1924?]).

In recent years particular attention has been paid to upper air conditions. The following are the most important papers:

K. DE BILT. 'Aerologische Beobachtungen und Terminbeobachtungen in Reykjavík während des internationalen Polarjahres, 1932–3.' *Ergebnisse aerologischer Beobachtungen*, No. 21 A (The Hague, 1933).

W. BLEEKER. 'Die mittlere Windgeschwindigkeit und Luftversetzung in Angmagssalik und Reykjavík während des zweiten internationalen Polarjahres.' *Beiträge zur Physik der freien Atmosphäre*, Bd. XXIII, pp. 39–44 (Leipzig, 1935).

J. GEORGI. 'Meteorologische Beobachtungen auf einer Forschungsreise mit *Meteor* nach Island und Grönland im Sommer 1928.' *Archiv der Deutschen Seewarte*, Bd. XLIX, Nr. 3 (Hamburg, 1930).

J. GEORGI and L. KUHLBRODT-RAEHDER. 'Höhenwindmessungen auf Island, 1909–1928.' *Archiv der Deutschen Seewarte*, Bd. LI, Nr. 5 (Hamburg, 1932).

K. H. SOLTAU. 'Beiträge zur Flugmeteorologie von Island.' *Annalen der Hydrographie*, Bd. LVIII, pp. 73–84 (Berlin, 1930).

E. KANTZENBACH. 'Beiträge zur Flugmeteorologie von Island. Teil II.' *Annalen der Hydrographie*, Bd. LX, pp. 98–106 (Berlin, 1932).

Statistics will be found in *Meteorologisk Aarbog*, 2nd Part (*Bilandene*) (Copenhagen, 1874–1919). The Meteorological Institute in Reykjavík has published a monthly journal, *Veðrattan*, since 1924. Publication of this journal was suspended in September 1939. Weather records between 1920 and 1923 were published in *Íslensk Veðurfarsbók* (Reykjavík, 1921–4). Average figures have been calculated in 'The Norwegian and Barents Seas', mentioned above, and in the two following sources:

Arctic Pilot, Vol. II, fourth edition (London, 1934).

B. J. BIRKELAND and N. J. FÖYN. 'Klima von Nordwesteuropa und den Inseln von Island bis Franz Joseph Land.' *Handbuch der Klimatologie*, Bd. III, Teil L (Berlin, 1932).

Ice conditions round Iceland are summarized in 'Isforholdene i de Arktiske Have' (The State of the Ice in the Arctic Seas). Annual report in *Nautisk-Meteorologisk Aarbog* (Copenhagen, 1898–1939).

Chapter IV. *Vegetation*

There are a large number of small papers on the vegetation of Iceland, but only three comprehensive works:

L. K. ROSENVINGE and E. WARMING (editors). *The Botany of Iceland*, Vols. I, II and III, Part I (Copenhagen, 1912–30).

C. H. OSTENFELD and J. GRÖNTVED. *The Flora of Iceland and the Færoes* (Copenhagen, 1934).
[A small field book intended to enable amateurs to identify the vascular plants. It provides keys and descriptions of the species, statements concerning their habitats and distribution within the area, and notes about the times of flowering.]

S. STEFÁNSSON. *Flora Íslands*, 2nd ed. (Copenhagen, 1924). [In Icelandic.]

Chapter V. *Medical Services and Health Conditions*

The main source for this chapter has been the latest comprehensive report by Vilmundur Jónnson, the Director of Public Health.

Heilbrigðisskýrslur (*Public Health in Iceland, 1938*) [with an English summary]. (Reykjavík, 1940.) Further information has been supplied by the War Office. The insects of Iceland have been described by C. H. Lindroth in *Die Insectenfauna Islands und ihre Probleme* (Uppsala, 1931).

Chapter VI. *The People*

The fullest and most recent treatments in English are:

Þ. ÞORSTEINSSON. *Iceland*, 1936 (Reykjavík, 1936).

HJALMAR LINDROTH. *Iceland: a Land of Contrasts* (New York, 1937).

VILHJALMUR STEFANSSON. *Iceland: the First American Republic* (New York, 1939).

The origin and racial affinities of the people are discussed in several of the works listed under Chapter VIII. The most comprehensive anthropometric study is:

GUÐMUNDUR HANNESSON. 'Körpermasse und Körperproportionen der Isländer: Ein Beitrag zur Anthropologie Islands.' *Árbók Háskóla Íslands*, pp. 1–254 (Reykjavík, 1925).

There are two outstanding books on the folk culture of Iceland; both are very fully illustrated with drawings and photographs:

JÓNAS JÓNASSON. *Íslenzkir Þjóðhættir* (Reykjavík, 1934).

SIGFÚS BLÖNDAL and SIGURÐUR SIGTRYGGSSON. *Myndir úr Menningarsögu Íslands á Liðnum Öldum* (Reykjavík, 1929).

Three books of photographs have been published to illustrate all aspects of Icelandic life and scenery:

WALTER HEERING. *Das unbekannte Island* (Harzburg, 1936).

PÁLMI HANNESSON. 100 *Íslenzkar Myndir*. Published by Ísafoldarprentsmiðja H/F (Reykjavík, no date).

Ísland: Ljósmyndir af Landi og Þjóð (*Iceland: Nature and Nation in Photographs*). Published by Ísafoldarprentsmiðja H/F in co-operation with the Tourist Association of Iceland and the Committee for Iceland in the New York World's Fair, 1939 (Reykjavík, 1939).

Until a few years ago there was no standard dictionary of modern Icelandic, but this gap has been filled by the large work *Íslandsk-dansk Ordbog* (*Íslenzk-dönsk Orðabók*) (Reykjavík, 1920–4), compiled by Sigfus Blöndal. The best dictionaries for English-speaking peoples are the *English-Icelandic Dictionary*, 3rd ed. (Reykjavík, 1932), and the *Icelandic-English Dictionary*, 2nd ed. (Reykjavík, 1922), both by Geir T. Zoëga. The only grammar is *A Primer of Modern Icelandic*, by Snæbjörn Jonsson, 2nd ed. (Oxford, 1940). A key to the exercises in this Primer may be obtained from Messrs W. Heffer and Sons Ltd., Cambridge; Messrs John Grant Ltd., Edinburgh; or from The English Bookshop, Reykjavík.

Chapter VII. *Sagas and other Medieval Literature*

It is only possible to mention a few outstanding works from the very large number available:

HALVDAN KOHT. *The Old Norse Sagas* (London, 1931).
[In this book the late foreign minister of Norway discusses the place of the sagas in European literature and their value as historical evidence. There is a useful bibliography.]

KNUT LIESTÖL. *The Origin of the Icelandic Family Sagas* (Oslo, 1930).
[A brilliant investigation from the point of view of the student of folklore.]

W. A. CRAIGIE. *The Icelandic Sagas* (Cambridge, 1913).
[A short general introduction to the subject, with a list of English translations and other aids.]

BERTHA S. PHILLPOTS. *Edda and Saga* (London, 1931; 'Home University Library').

The following is a list of selected English translations of the Icelandic sagas which are particularly recommended:

W. G. COLLINGWOOD and JÓN STEFÁNSSON. *The Life and Death of Cormac the Skald*, Viking Club Translation Series, No. 1 (Ulverston, 1902).

G. W. DASENT. *The Story of Burnt Njal, or Life in Iceland at the End of the Tenth Century*. 2 vols. (Edinburgh, 1861; reprinted in one volume in 1900, and again in 'Everyman's Library', 1912).

G. W. DASENT. *The Story of Gisli the Outlaw* (Edinburgh, 1866; London, 1909).

W. C. GREEN. *The Saga of Egil Skallagrímsson: being an Icelandic family history of the ninth and tenth centuries* (London, 1893).

EDMUND HEAD. *Viga-Glum's Saga: The Story of Víga-Glúm* (London, 1866).

EIRÍKR MAGNÚSSON and WILLIAM MORRIS. *Grettis Saga: the Story of Grettir the Strong* (London, 1896; reprinted in 1900).

EIRÍKR MAGNÚSSON and WILLIAM MORRIS. *Three Northern Love Stories and other Tales* (London, 1875, reprinted in 1901).
[Gunlaugs saga, Víglundar saga, Frithiof's saga, and others.]

EIRÍKR MAGNÚSSON and WILLIAM MORRIS. *The Story of the Volsungs and Niblungs* (London, 1870; reprinted in the 'Camelot Series', 1888).
[Probably the best of the fictitious sagas.]

WILLIAM MORRIS and EIRÍKR MAGNÚSSON (editors). *The Saga Library*. Vols. I–IV (London, 1891–1905).
[Translations of several sagas, Vols. III–IV comprising the *Heimskringla*, or Chronicles of the Kings of Norway.]

MURIEL A. C. PRESS. *Laxdæla Saga* (London, 1899, 1906, 'Temple Classics').

ROBERT PROCTOR. *The Story of the Laxdalers* (London, 1903).

ARTHUR REEVES. *The Finding of Wineland the Good* (London, 1890).
[Sagas relating to the discovery of Greenland and America by the Icelanders.]

JOHN SEPHTON. *The Saga of King Olaf Tryggwason, who reigned over Norway* A.D. 995 *to* A.D. 1000, Northern Library, Vol. I (London, 1895).

GUÐBRAND VIGFÚSSON. *Sturlunga Saga*, 2 vols. (Oxford, 1878).
[A long introduction contains an excellent general account of Icelandic literature. A map in vol. 2 contains place-names taken exclusively from the sagas, and thus provides a useful rough map of medieval Iceland.]

GUÐBRAND VIGFÚSSON and F. YORK POWELL. *Origines Islandicae*, 2 vols. (Oxford, 1905).
[A collection of Icelandic texts and English translations of the more important sagas relating to the settlement and early history of Iceland.]

Chapter VIII. *Historical Summary*

The following works deal with the history of Iceland from the time of the settlement until the early twentieth century:

KNUT GJERSET. *History of Iceland* (London, 1924).
[References to sources and authorities are given in the footnotes of this comprehensive work.]

JÓN J. AÐILS. *Íslandssaga* ('*The History of Iceland*') (Reykjavík, 1923).

ARNÓR SIGURJÓNSSON. *Íslendingasaga* ('*The History of the Icelandic People*') (Akureyri, 1930).

Reference should also be made to:

P. E. K. KÅLUND. *Bidrag til en historisk-topografisk Beskrivelse af Ísland* (Copenhagen, 1877–82).

JÓN HELGASON. *Íslands Kirke fra dens Grundlæggelse til Reformationen* (Copenhagen, 1925); *Íslands Kirke fra Reformationen til vore Dage* (Copenhagen, 1922).

The general background for the first period of Icelandic history is covered in:

HALVDAN KOHT. 'The Scandinavian Kingdoms until the end of the Thirteenth Century.' *Cambridge Medieval History*, Vol. VI, pp. 362–92 (London, 1929).

T. D. KENDRICK. *A History of the Vikings* (London, 1930).

There has been much specialist controversy on the part played by King Haraldr Hrfagri in the history of the settlement, and on the chronology of his reign. See the papers cited below and the references given in them, and note the general conclusions of Professor Nordal:

SIGURÐUR NORDAL. 'Egils Saga Skalla-Grímssonar.' *Íslenzk Fornrit*, Vol. II, pp. xxxvii–xxxviii, xlviii–xlix (Reykjavík, 1933).

HALVDAN KOHT. 'Når levde Harald Hårfagre og sønene hans?' (*Norsk*) *Historisk Tidsskrift*, Rekke v, Bd. VI, pp. 146–69 (Oslo, 1924); 'Innlegg i Stridsspursmål', (*Norsk*) *Historisk Tidsskrift*, Bd. XXVIII, pp. 425–38 (1929).

J. SCHREINER. 'Harald Hårfagre og hans efterfølgere', (*Norsk*) *Historisk Tidsskrift*, Bd. XXVIII, pp. 161–224 (1928).

The most important original sources dealing with the settlement and early history of Iceland may be consulted in the translations and editions of texts listed below; the only general collection available is contained in the two large volumes of *Origines Islandicae*.

HALLDÓR HERMANNSSON. 'The Book of the Icelanders (Íslendingabók).' *Íslandica*, Vol. XX (Ithaca, New York, 1930).

GUÐBRAND VIGFÚSSON and F. YORK POWELL. *Origines Islandicae*, 2 vols. (Oxford, 1905). For the translation of *Landnámabók* see Vol. I, pp. 13–236.
FINNUR JÓNSSON. *Landnámabók* (Copenhagen, 1900).
FINNUR JÓNSSON. *Heimskringla* (Copenhagen, 1911).
ERLING MONSEN. *Heimskringla, or the Lives of the Norse Kings* (Cambridge, 1932).

For the history and political organization of the Icelandic Republic, see the following general and special studies:

T. D. KENDRICK. *A History of the Vikings* (London, 1930), pp. 336–60.
JAMES BRYCE. *Studies in History and Jurisprudence*, Vol. I, pp. 312–58 (Oxford, 1901).
A. HEUSLER. *Das Strafrecht der Isländersaga* (Leipzig, 1911).
F. PAASCHE. *Snorre Sturlason og Sturlungerne* (Oslo, 1922).
EIRÍKR MAGNÚSSON. 'The Last of the Icelandic Commonwealth.' *Saga-Book of the Viking Club*, Vol. V, pp. 308–40; Vol. VI, pp. 90–122 (London, 1907–10).

For heathen religion and mythology see:

H. SHETELIG and H. FALK. *Scandinavian Archaeology*, pp. 406–435 (Oxford, 1937).
W. A. CRAIGIE. *The Religion of Ancient Scandinavia* (London, 1906).

The historical evidence concerning 'Wineland' is examined, and the most important previous contributions to the subject are discussed in the first work listed below; the second reference is primarily for the translation of the sagas.

HALLDÓR HERMANNSSON. 'The Problem of Wineland.' *Íslandica*, Vol. XXV (Ithaca, New York, 1936).
G. M. GATHORNE-HARDY. *The Norse Discoverers of America* (Oxford, 1921).

The following works are important recent contributions to the commercial history of Iceland. The first two contain accounts of the two periods of special relations with England before the introduction of free trade:

E. M. CARUS WILSON. 'The Iceland Trade', *Studies in English Trade in the Fifteenth Century*, edited by Eileen Power and M. M. Postan (London School of Economics Studies in Economic History, Vol. V), pp. 155–82 (London, 1933).
HALLDÓR HERMANNSSON. 'Sir Joseph Banks and Iceland.' *Íslandica*, Vol. XVIII (Ithaca, New York, 1928).
JÓN J. AÐILS. *Den danske Monopolhandel paa Island* 1602–1787 (Copenhagen, 1926–7).

Chapter IX. *Government, Administration and Law*

Much of the material in this chapter is contained in *The Constitution of the Kingdom of Iceland*, of which an English translation was published in Reykjavík in 1940.

The following works deal with Icelandic legal and administrative matters:

Þ. ÞORSTEINSSON. *Iceland, 1936*.
[General information about administration and legislative power, pp. 21–41.]
AAGE GREGERSEN. *L'Islande: Son Statut à travers les Ages* (Paris, 1937).
[A particularly sound and careful survey.]
RAGNAR LUNDBORG. *Islands völkerrechtliche Stellung* (Berlin-Grunewald: Verlag für Staatswissenschaften und Geschichte, 1934).
[A brief summary of the development of Icelandic public law by a well-known Swedish writer on international law who has made Icelandic international relations his speciality.]

Stjórnartiðindi fyrir Ísland (Reykjavík, annually).

[Contains the texts of all acts of the *Alþingi* and treaties passed during the previous year; also the texts of regulations issued by government departments and financial statements of all public institutions.]

Lagasafn, Gilandi Lög Íslenzk, 1931 (Reykjavík, 1932).

[Collected texts of all laws in force in 1931. A new edition is now in preparation.]

Alþingisokningar, 1937, *Hagskýrslur Íslands*, No. 96 (Reykjavík, 1938).

[This and earlier numbers in the same series give statistics of parliamentary elections.]

Further information has been supplied by the staff of the British Legation at Reykjavík.

Chapter X. *Distribution and Growth of Population*

This chapter is based mainly on statistics in *Manntal á Íslandi 1 Desember* 1910 (Reykjavík, 1913) and the corresponding census returns for 1920 and 1930 which were published in *Hagskýrslur Íslands*, No. 46 and No. 92 (Reykjavík, 1926, 1937). Some preliminary details of the 1940 census are to be found in *Hagtiðindi*, Nr. 3 (Reykjavík, March 1941). In the series *Hagskýrslur Íslands* a report is published every five years entitled 'Mannfjöldaskýrslur'. This gives population statistics for each year. Comparative vital statistics for other countries can be found in *Annuaire Statistique*, 1939–40: *Statistical Year-Book of the League of Nations* (Geneva, 1940).

Apart from these statistics there is very little information available. The most useful papers are:

E. Hanson. 'The Renaissance of Iceland.' *Geog. Review*, Vol. xviii, pp. 41–61 (New York, 1928).

G. Hannesson. 'Körpermasse und Körperproportionen der Isländer.' *Árbók Háskóla Íslands*, pp. 1–254 (Reykjavík, 1925).

Chapter XI. *Ports*

Much of this chapter is based on unpublished Naval reports. In addition to Admiralty Charts, the main printed sources are as follows:

Arctic Pilot, Vol. ii, 4th ed. (London, 1934, and Supplement No. 6, 1942).

Den Islandske Lods (Copenhagen, 1927, and Supplement, 1934).

[Danish Pilot Book.]

Leiðsögubók Fyrir Sjómenn við Ísland (Reykjavík, 1932, and Supplement, 1934).

[Icelandic Pilot Book; largely based on the Danish Pilot, but much has been added or deleted with special reference to the requirements of Icelandic seamen. The line-block illustrations of coastal features are exceptionally good.]

Íslenzkt Sjómanna-Almanak, 1942 (Reykjavík, 1941).

[Published annually by Fiskifélag Íslands. In addition to the usual subjects found in nautical almanacks this work contains complete lists, with details, of Icelandic lighthouses, radio beacons, leading marks, life-boat stations, tide tables, etc. Information is also provided about laws and regulations affecting shipping in Icelandic waters. A list of Icelandic vessels, with port registration numbers, is also included.]

Admiralty List of Lights, Part ii, pp. 615–38 (London, 1938, and Supplement No. 2, 1940).

A brief illustrated account of Reykjavík harbour will be found in the *Dock and Harbour Authority*, Vol. XXI, No. 245, pp. 95–7 (London, March 1941).

It cannot be considered that any of these sources provide information about depths, quays, jetties and other harbour facilities which is sufficiently precise for the compilation of adequate port descriptions.

Chapter XII. *Agriculture*

The fullest and most interesting account of Icelandic agriculture and farm life is now seriously out of date:

Þ. THORODDSEN. *Lýsing Íslands*. Vols. III and IV (Copenhagen, 1917–22).

A recent summary will be found in:

ARNI G. EYLANDS. 'Spredte Oplysninger om det islandske Landbrug.' *Tidsskrift for Landøkonomi*, Nr. 2, pp. 81–138 (Copenhagen, 1938).

More general accounts are available in the following:

VILHJALMUR STEFANSSON. *Iceland: The First American Republic*, pp. 139–65 (New York, 1939).

HJALMAR LINDROTH. *Iceland: a Land of Contrasts*, pp. 38–54 (New York, 1937).

Þ. ÞORSTEINSSON. *Iceland, 1936*, pp. 56–68 (Reykjavík, 1936).

The problems of reafforestation have been discussed by the Director of Icelandic Forestry:

HÁKON BJARNASON. 'Betingelser for traevaekst i Island.' *Dansk Skovforenings Tidsskrift*, 1 Hæfte, pp. 1–8 (Copenhagen, 1940).

In addition to the numerous standard works on the subject, the co-operative movement in Iceland is dealt with in:

RAGNAR OLAFSSON. 'Co-operative Iceland.' *American Scandinavian Review*, Vol. XXVII, No. 1, pp. 23–31 (New York, 1939).

The following are periodical sources of detailed information and statistics:

Búnaðarskýrslur, Statistique de l'Agriculture. Annual publication in the series *Hagskýrslur Íslands* (Hagstofu Íslands, Reykjavík).

Statistical Bulletin. Issued monthly by the National Bank of Iceland and the Statistical Bureau of Iceland, from 1932.
[Useful for provisional statistics.]

Skógræktarfjelag Íslands Árskrit. Annual published in Reykjavík by the Icelandic Forest Protection Society.

Chapter XIII. *Fisheries*

The fullest treatment is found in:

BJARNI SÆMUNDSSON. *Fiskarnir* (*Pisces Islandiæ*) (Reykjavík, 1926).
This work is in Icelandic and contains a general survey of the fishes found within the 400 m. depth contour. In addition to illustrated descriptions, details are given of distribution, food, migrations, spawning, growth, economic value, methods of capture, curing, etc. A good English summary of this book has been provided in:

BJARNI SÆMUNDSSON. 'Synopsis of the Fishes of Iceland', *Vísindafélag Íslendinga*, II (Reykjavík, 1927).
[Bibliography of 138 references on pp. 56–63.]

The best general accounts of the Icelandic fisheries from an economic point of view are:

BJARNI SÆMUNDSSON. 'Die Isländische Seefischerei', *Handbuch der Seefischerei Nordeuropas*, Bd. VII, Heft 4 (Stuttgart, 1930).

J. LE GALL. 'La Pêche en Islande (Rapport de Mission)', *Revue des Travaux de l'Office des Pêches Maritimes*, Tome III, Fasc. 3, pp. 213–382 (Paris, 1930).

ÁRNI FRIÐRIKSSON and PALMI HANNESSON. *Fisk og Fiskeri ved Island*, Dansk-islandsk Samfunds Smaaskrifter, Nr. 14 (Copenhagen, 1925).

The following articles and periodicals contain useful information:

BJARNI SÆMUNDSSON. 'Mammalia', *The Zoology of Iceland*, Vol. IV, Part 76 (Copenhagen and Reykjavík, 1939).

[Details of whaling.]

ÞORSTEINN ÞORSTEINSSON. *Iceland, 1936*. (Reykjavík, 1936.)

[Information about the best rivers for salmon fishing, pp. 198–205.]

BJARNI SÆMUNDSSON. *Fiskirannsóknir*.

[Reports to the Government issued since 1896 and up to date, except 1903; 1896–1908 every year, since 1908 every other year, in the periodical *Andvari* (Reykjavík).]

Ægir.

[A monthly review of fisheries and the fish trade in Iceland, published by Fiskifélag Íslands, Reykjavík.]

Íslenzkt Sjómanna-Almanak (Reykjavík, 1942).

[On pp. 246–7 there is a list of fish of commercial importance found in Icelandic waters giving the corresponding names in Icelandic, Faroese, Norwegian, Danish, German, English, French and Latin.]

Fiskiskýrslur og Hlunninda, Hagskýrslur Íslands (Reykjavík, annually).

Statistiques Annuelles des Pêches Maritimes (Ministre de la Marine Marchande, Paris, 1860–1930).

Bulletin Statistique des Pêches Maritimes des Pays du Nord et de l'Ouest de l'Europe (Conseil Permanent International pour l'exploration de la Mer; Copenhagen, annually).

Further information has been supplied by the Ministry of Agriculture and Fisheries and the Icelandic Legation in London.

Chapter XIV. *Industries and Public Utilities*

Most of this chapter has been prepared from unpublished Admiralty and War Office reports. Details of the power, type of current and voltage of public and private electrical plants may be found in *Rafveitur á Íslandi* (Rafmagnseftirlit Ríkisins, Reykjavík, 1941). Only two published works on hydro-electric power appear to be available:

A. B. BERDAL and JACOB NISSEN. *Report on the Development of Ljósafoss in Sog as Water Power Plant for Reykjavík Electricity Works* (Oslo, 1934).

The Community of Reykjavík and the Sog Power Plans. Compiled by the Burgomaster and Officials of the Municipality of Reykjavík (Reykjavík, 1934).

Chapter XV. *Social Legislation*

The material in this chapter has been obtained mainly from Þ. Þorsteinsson, *Iceland*, 1936, pp. 120–33 (Reykjavík, 1936). A more detailed account of variations in the cost of living has been written by the same author in Part IV of *Sweden, Norway, Denmark and Iceland in the World War* (New Haven, 1930). Information about the attitude of Icelanders towards alcohol is given by H. Lindroth, *Iceland, a Land of Contrasts*, pp. 115–18 (New York, 1937).

Chapters XVI and XVII. *Foreign Trade and Finance*

Foreign Trade. There is no detailed survey of the foreign trade of Iceland. General summaries will be found in the following:

ÞORSTEINN ÞORSTEINSSON. *Iceland, 1936*. A Handbook published on the fiftieth anniversary of Landsbanki Íslands (the National Bank of Iceland). 3rd ed., pp. 87–97 (Reykjavík, 1936).

J. BOWERING. *Report on Economic and Commercial Conditions in Iceland, September 1937*. Department of Overseas Trade (London, 1937).

A good detailed account of the economic position in Iceland during the years following the war of 1914–18 will be found in:

ÞORSTEINN ÞORSTEINSSON. 'Iceland and the War.' Part IV of *Sweden, Norway, Denmark and Iceland in the World War*. Carnegie Endowment for International Peace (New Haven, 1930).

The greater part of this chapter has been compiled from data given in statistics in the following:

Árbók Hagstofu Íslands (Annuaire Statistique de l'Islande). Published by the Bureau of Statistics of Iceland (Reykjavík, 1930).

Verslunarskýrslur (Statistique du commerce). Annual, 1849–1938. From the series *Hagskýrslur Íslands* (Statistique de l'Islande). Published by the Statistical Bureau of Iceland, Reykjavík.
[By far the most useful source for trade statistics.]

Statistical Bulletin. Issued monthly by the National Bank of Iceland and the Statistical Bureau of Iceland, from 1932.
[Useful for provisional up-to-date statistics.]

Statistisk Aarbog. Danmarks Statistisk. Annual, Copenhagen.
[Includes some statistics for Iceland.]

Íslands Adressebog, 1940. Directory of Iceland (Reykjavík, 1939).
[Includes a complete list of commercial establishments.]

Further information has been supplied by the Icelandic Legation in London and by the Ministry of Economic Warfare.

Finance. The information and statistics contained in this chapter have been obtained mainly from the sources listed above. An account of the first ten years' activity of the Farmers' Bank of Iceland will be found in:

Búnaðarbanki Íslands: tíu ára, 1929–1939 (Reykjavík, 1939).

The most recent information and statistics have been supplied by the Icelandic Legation in London.

Chapter XVIII. *Communications and Transport*

Apart from the general works mentioned under Chapter VI, the following sources have been used:

ADAM RUTHERFORD. *Transport in Iceland* (London, 1938; privately printed).

G. H. F. SCHRADER. *Hestar og Reiðmenn á Íslandi* (Akureyri, 1913).
[The most comprehensive work on Icelandic ponies.]

Information about aviation is given in *Iceland: Past and Present* by Björn Thórdarson, pp. 39–42 (London, 1941), and in the *Polar Record* (Cambridge, bi-annually since 1931).

Information about the distribution of petroleum products has been supplied by Messrs Shell-Mex Ltd.

Chapter XIX. *Signal Communications*

The latest official report is *Skýrsla um Storf Landssímans, árin* 1934–35 (Reykjavík, 1938). This contains statistics of telephones and telegraphs for the years 1934 and 1935. Later abbreviated statistics will be found in the *Statesman's Year Book* (London). Useful details are published in the introduction to the telephone directory *Landssími Íslands, Símaskrá*, published annually in Reykjavík. The most recent map of telephone and telegraph lines is *Símakort Íslands*, scale 1 : 830,000 (Geodetic Institute, Copenhagen, 1932).

Information about radio communications will be found in several of the general works mentioned under Chapter V. An incomplete list of stations is published in *Nomenclature des Stations Fixes* (Bureau de l'Union Internationale des Télécommunications, Berne, 1938). Further details have been supplied by the War Office.

Official Publications containing Statistical Data concerning Iceland

Hagskýrslur Íslands (*Statistique de l'Islande*). Published by the Statistical Bureau of Iceland (Hagstofu Íslands), Reykjavík, since 1912.

[The numbering is consecutive, but there are separate annual reports under the following headings: *Verslunarskýrslur* (Commercial statistics), *Búnaðarskýrslur* (Agricultural statistics), *Fiskiskýrslur og Hlunninda* (Fishing, sealing and fowling statistics). In the same series reports are published at longer intervals under the following headings: *Alþingiskosningar* (Elections to the *Alþingi*), *Mannfjöldaskýrslur* (Movements of the population, at 5-year intervals), *Manntal á Íslandi* (Population census, at 10-year intervals).]

Hagtíðindi (*Statistical Journal*). Published by Hagstofu Íslands, Reykjavík, since 1916.

Árbók Hagstofu Íslands (*Annuaire Statistique de l'Islande*). Published by Hagstofu Íslands, Reykjavík, 1930.

[On pp. xiii–xiv there is a list of original Icelandic publications containing the statistics which are here summarized.]

Statistical Bulletin. Issued monthly by Landsbanki Íslands and Hagstofu Íslands, Reykjavík, since 1932.

Bibliographies

G. H. Boehmer. 'Bibliography of the Volcanoes, Earthquakes and Geysers of Iceland', *Annual Report Smithsonian Institution*, pp. 513–41 (Washington, 1886).

Willard Fiske. *Books printed in Iceland*, 1578–1884 [four supplements to the *British Museum Catalogue*, Florence, 1886–90] (Ithaca, New York, 1907).

Halldór Hermannsson. *Catalogue of the Icelandic Collection bequeathed by Willard Fiske* [Cornell University Library] (Ithaca, New York, 1914). *Additions*, 1913–26 (New York, 1927).

[This is by far the most useful and complete bibliography of Iceland].

Olaf Klose. *Islandkatalog der Universitäts-bibliothek Kiel und der Universitäts- und Stadtbibliothek Köln* (Kiel, 1931).

T. W. Lidderdale. *Catalogue of Books printed in Iceland from* 1578–1880 *in the Library of the British Museum* (London, 1885).

Olai Skulerud. *Catalogue of Norse Manuscripts in Edinburgh, Dublin and Manchester* (Kristiania, 1918).

OLAI SKULERUD. *Katalog over De Oldnorsk-Islandske Håndskrifter i det Store Kongelige Bibliotek og i Universitets biblioteket* (Copenhagen, 1900).

B. LIBRARIES IN COUNTRIES OTHER THAN ICELAND CONTAINING SPECIAL ICELANDIC COLLECTIONS

The following list of libraries containing Icelandic works or works in foreign languages dealing with Iceland is intended as a guide to some of the more accessible collections outside Iceland:

**Cornell University Library, Ithaca, New York.* The largest Icelandic collection in America and one of the largest in the world. Bequeathed and endowed in 1905 by Willard Fiske, Professor of North European languages and Librarian of the University from 1863 to 1883, and continually being enlarged and brought up to date. Contains Icelandic books, pamphlets and periodicals, whether printed in Iceland or elsewhere, as well as writings of Icelanders in languages other than their own, and other works in foreign languages dealing with Iceland. The collection is in the charge of Professor Halldór Hermannsson, a world leader in Icelandic scholarship.

Harvard University Library. A collection of medieval literature, about six hundred books of prose and verse by modern authors, and a large collection of modern Icelandic periodicals.

Leeds University, Brotherton Library. The largest collection of Icelandic works in England. The collection of Bogi Thorarensen Melsteð, the distinguished Icelandic historian and author, acquired in 1929. This library is designed to serve practical needs, and is outstanding in its section of modern Icelandic literature and history. Large additions are made each year, and, besides an extensive collection of recent literature, there are sets of the principal newspapers and magazines, transactions of learned societies, and the reports of social, religious and industrial organizations.

**John Rylands Library, Manchester.* A small collection of Icelandic manuscripts.

Bodleian Library, Oxford. A collection of Scandinavian manuscripts, chiefly Icelandic, and known as the 'Boreal Manuscripts', acquired in 1828 from the Icelandic lawyer, Finn Magnússen.

Edinburgh University Library. A collection of about 1000 books, mainly on the literature of Iceland.

Christ Church Library, Oxford. A collection of printed works, mainly on the literature of Iceland. No modern publications.

National Library of Scotland, Edinburgh* (Advocates Library*). A collection of about 100 Icelandic manuscripts.

Cambridge University Library. A considerable collection of printed works, with recent additions.

**British Museum, London.* In addition to recent publications, a special collection of books printed in Iceland from 1578 to 1880. The Department of Printed Books has a good series of maps, charts and plans from 1761 onwards.

University College, London. [A considerable collection, including the library of the Viking Society, was destroyed by enemy action in 1940.]

**Trinity College, Dublin.* A collection of Icelandic manuscripts selected chiefly with reference to the history of the relations between the northern nations and Great Britain.

There are also important Icelandic collections at:

*Royal Library, Stockholm; University Library, Uppsala; *Royal Library, Copenhagen; University Library, Oslo; *University Library, Kiel; *University Library, Cologne.*

* See p. 417 for published catalogues of these libraries.

Appendix I

ICELANDIC PLACE NAMES

Spelling

Ever since the period of Danish rule there has been much confusion about the forms and spellings of Icelandic place names. The Danes generally spelt Icelandic place names as if they were Danish, and they also avoided the peculiar Icelandic letters ð and þ. They used, therefore, to write Seydisfjord, Reikevig and Thorshavn for Seyðisfjörður, Reykjavík and Þórshöfn. English travellers sometimes adopted the Icelandic and sometimes the Danish forms; they also transliterated Icelandic letters in various inconsistent ways. Sometimes they translated half the name into English. Thus Þingvallavatn became Thingvalla Lake and Öræfajökull became Oraefa Glacier. Confusion naturally arose when these forms were mixed. Further complications were introduced by ignorance of the declension of Icelandic place names (see p. 421).

The only work dealing with the origin and forms of Icelandic place names as a whole is P. E. K. Kålund's *Bidrag til en historisk-topografisk Beskrivelse af Island*, 2 vols. (Copenhagen, 1877). In cases of doubt his index may be consulted. It should be noted, however, that Kålund prefers a slightly more old-fashioned spelling than the official Icelandic spelling of to-day. He thus prefers Akreyri to the more modern Akureyri, and Dalr to Dalur. The final *-r*, which was often the ending of the nominative singular in old Icelandic, has become *-ur* in modern Icelandic. Kålund's work is an exceptionally reliable source of information.

It is obvious that these many variant forms have led to considerable confusion. In order to avoid this the Icelandic nominative singular should always be used when speaking or writing English. In the text and maps of this Handbook, Icelandic names are spelt in accordance with the official maps published by the Geodetic Institute at Copenhagen (see pp. 425–9). These maps were prepared in collaboration with the Icelandic government.

The spelling of the majority of Icelandic place names on Admiralty charts does not conform either with those in the *Arctic Pilot*, vol. II, 4th ed., 1934, or with those on the Danish official maps. In general, the *Pilot* follows the authorized Icelandic spelling, but þ is transliterated as *th* and ð as *d*, and many of the Icelandic accents have been omitted. The majority of these names were taken from Danish charts and sailing directions owing to the difficulty of obtaining all the Icelandic forms of the names mentioned in British Admiralty publications. In the present Handbook this difficulty has only arisen in the case of features in the harbour plans, and the names in these have either been obtained from Iceland or are obviously English descriptive terms.

The names on most of the Admiralty charts of Iceland have not been revised for many years. In addition to the purely Danish forms, which are used in the *Pilot*, these charts contain many English translations and transliterations, and also a number of place names which are unknown locally.

Pronunciation

In Icelandic words the stress is always placed on the first syllable.

The Roman alphabet is used, but it has been modified to suit the particular needs of the language. Acute accents, which were originally introduced to mark long vowels, are now used to indicate a difference of quality (i.e. in the position of the tongue). The following list shows the chief peculiarities of Icelandic pronunciation:

Vowels

á as English *ow* in *cow*; *Hvítá*, *Jökulsá*.

a the sound is between that of English *a* in *father* and English *a* in *dare*; *Akureyri*, *Aðalvík*.

é as English *ye* in *yes*, *yet*. *je* is sometimes written instead of *e*; *Pétursey* (also written *Pjetursey*).

í as English *ee* in *seen*; *Vík*, *Reykjavík*.

ó as English *ow* in *glow*; *Ólafsfjörður*, *Blönduós*.

ú as English *oo* in *boot*; *Úlfsey*, *Djúpivogur*.

u rather like French *eux* in *deux*; *Suðurnes*. Before *ng*, *u* is pronounced as Icelandic *ú*; *Tunga*.

ö as German *ö*, or as English *ur* in *turn*; *Ölfusá*, *Önundarfjörður*.

æ as English *i* in *mile*; *Æðey*, *Bægisá*.

au no equivalent in English. The sound is that of Icelandic *ö* followed by a short *i*; *Hraun*, *Laugardalur*.

ei and *ey* both pronounced as English *ay* in *bay*; *Deildartunga*, *Reykjavík*.

Consonants

The consonants ð and þ, which were used in English throughout the Middle Ages, are now peculiar to Icelandic. ð (capital Đ) is pronounced as English *th* in *bathe*; *Seyðisfjörður*, *Reyðarfjörður*. þ (capital Þ) is pronounced as English *th* in *think*; *Þingvellir*, *Þorshöfn*.

f initially as English *f*; *Færeyjar*, *Flatey*. Between two vowels *f* generally resembles English *v*; *Drífandi*. Before *n*, Icelandic *f* resembles English *p*; *Hafnarfjörður*, *Bjarnarhöfn*.

g initially, and in many combinations, as English *g* in *gas*; *Grindavík*, *Gullfoss*. In some positions *g* is practically silent, or combines with the preceding vowel; *Laugardalur*, *Lágafell*.

j as English *y* in *year*; *Jökulsá*, *Bjarnarhöfn*.

l as English *l*, but *ll* as *dl*; *Jökull* (accusative *Jökul*), *Fjall*, *Eyjafjallajökull*.

n as English *n*, but *nn* in many positions as *tn*; *Dvergasteinn*.

rn as *dn*; *Horn*, *Bjarnarhöfn*.

r trilled sharply on the tip of the tongue, as in lowland Scottish; *Ísafjörður*, *Rangá*.

Declension

Icelandic is a highly inflected language. The nouns are declined in four cases, nominative, genitive, dative and accusative. Nouns are divided into three genders, masculine, feminine and neuter. Each gender has several distinct declensions. Place names are declined as nouns. To give a detailed account of the declensions of Icelandic place names would be beyond the scope of the present work, but the declensions of some of the elements most commonly used in Icelandic place names are shown below:

Masculine Names.	Sing.	Nom.	jökull (a glacier)	Pl. jöklar
		Gen.	jökuls	jökla
		Dat.	jökli	jöklum
		Acc.	jökul	jökla

Examples: Eyjafjallajökull, Vatnajökull, Eiríksjökull, etc.

Sing.	Nom.	fjörður (a fjord)	Pl. firðir
	Gen.	fjarðar	fjarða
	Dat.	firði	fjörðum
	Acc.	fjörð	firði

Examples: Seyðisfjörður, Reyðarfjörður, Ísafjarðardjúp, etc.

Sing.	Nom.	flói (a bay)	Pl. flóar
	Gen.	flóa	flóa
	Dat.	flóa	flóm
	Acc.	flóa	flóa

Examples: Húnaflói, Faxaflói, etc.

Feminine Names.	Sing.	Nom.	vík (a creek, inlet)	Pl. víkur
		Gen.	víkur	víka
		Dat.	vík	víkum
		Acc.	vík	víkur

Examples: Reykjavík, Keflavík, Grindavík, Breiðdalsvík, etc.

Sing. Nom.	höfn (a harbour)	Pl. hafnir
Gen.	hafnar	hafna
Dat.	höfn	höfnum
Acc.	höfn	hafnir

Examples: Þorshöfn, Raufarhöfn, Hafnarfjörður, etc.

Sing. Nom.	ey (an island)	Pl. eyjar
Gen.	eyjar	eyja
Dat.	ey	ejum
Acc.	ey	eyjar

Examples: Grímsey, Drangey, Flatey, Eyjafjallajökull, etc.

The plural is also used in collective names for groups of islands. Examples: Vestmannaeyjar, Svefneyjar, Færeyjar, etc.

Sing. Nom.	eyri (a sandbank)	Pl. eyrar
Gen.	eyrar	eyra
Dat.	eyri	eyrum
Acc.	eyri	eyrar

Examples: Stokkseyri, Akureyri, Oddeyri, etc.

Neuter Names.

Sing. Nom.	nes (a cape)	Pl. nes
Gen.	ness	nesja
Dat.	nesi	nesjum
Acc.	nes	nes

Examples: Snæfellsnes, Reykjanes, etc.

Sing. Nom.	fjall (a mountain)	Pl. fjöll
Gen.	fjalls	fjalla
Dat.	fjalli	fjöllum
Acc.	fjall	fjöll

When compounded in place names, the form 'fell' is generally used instead of 'fjall'. It is declined in the same way.

Examples: Ingólfsfell, Lágafell, etc.

Sing. Nom.	land (land, country)	Pl. lönd
Gen.	lands	landa
Dat.	landi	löndum
Acc.	land	lönd

Examples: Ísland, England, etc.

Use of cases. The subject of a sentence is normally placed in the nominative case, and the direct object in the accusative.

The genitive case is used after the preposition *til* ('to'), e.g. til Reykjavíkur, 'to Reykjavík'; til Seyðisfjarðar, 'to Seyðisfjörður'; til Grímseyjar, 'to Grímsey'.

The dative is used after the prepositions á ('at') and í ('in') when they denote place of rest: á Akureyri, 'at Akureyri'; á Vatnajökli, 'on Vatnajökull'; a Reykjanesi, 'on Reykjanes'; í Reykjavík, 'in Reykjavík'; í Faxaflóa, 'in Faxaflói'; í Seyðisfirði, 'in Seyðisfjörður'. The dative is always used after the preposition frá ('from'): frá Ísafirði, 'from Ísafjörður'; frá Eyjafjallajökli, 'from Eyjafjallajökull'; frá Vestmannaeyjum, 'from Vestmannaeyjar'.

The accusative case is used after the prepositions *í* ('into') and á ('onto') when they denote the direction in which one travels: í Seyðisfjörð, 'into Seyðisfjörður'; í Húnaflóa, 'into Húnaflói'; á Vatnajökul, 'onto Vatnajökull'.

Glossary of Icelandic Words which occur in Place Names

Nearly all Icelandic place names are descriptive, and because the language has changed so little since they were given their meanings are still clear. A list of the most common elements is given below. It is interesting to notice that many of these names occur as components of place names which still survive in Britain, especially in those areas which are known to have been affected by Norse invasions. For example, compare Faxa Flói and Scapa Flow, Múli and Mull, Fjörður and Firth, Tjörn and Tarn, etc. It must be borne in mind that place names mean something to an Icelander, and assist him in differentiating features of a landscape. The following list therefore has a practical value.

á =river, stream
afréttur =mountain pasture
alda =wave
áll =narrow deep channel
ás =rocky rise
askja =box
aur =mud, clay
austur =east
bær =farm
bakki =bank of a river
barð =rim, edge
barmur =rim, edge
bjarg =rock, cliff
boði =rock awash
bogi =curve, bow
borg =town, rocky hill, pinnacle
botn =bottom, corrie, head of a valley
breiður =broad, wide
brekka =hillside, slope
brú =bridge
bruni =burning
bú =house
bunga =rounded peak, knoll
dalur =valley
djúp =deep
drag =watercourse
drangur =isolated pillar of rock
dyngja =dome
egg =edge, rise
ey =island
eyri =delta, sandy plain (formed by river), sandpit
eystri =more easterly
fell =mountain, hill
fjall =mountain, hill
fjara =shore
fjörður =fjord, inlet
flaga =bare rock slab
fljót =large river
flói =large bay, marshy country
foss =waterfall
garðurinn =mole
gerði =fenced field
gígur =crater
gil =ravine, gulley, deep gorge
gjá =fissure, rift
gljúfur =gorge
gnípa =peak, pinnacle
grjót =stones
grunn =shoal, shallow
hagi =pasture
háls =isthmus, long hill
hamar =precipice, crag
hangur =mound
haus =head
heiði =heath
heim =home
hilla =shelf
hjalli =terrace
hlein =landing rock
hlið =slope, mountain side
hnappur =knob
hnjúkur =peak
höfði =headland
höfn =harbour
hol =hollow
hóll =rounded hill
hólmi, hólmur =islet
holt =stony hill
hop =land-locked inlet
hraukur =rick
hraun =lava field, desert
hryggur =mountain ridge
hvammur =grassy hollow, dell
hver =hot spring
hverfi =group of farms
hvilft =hollow, corrie
hvítur =white
hvoll =hill
hyrna =mountain peak
innri =inner
jökulsá =glacier river
jökull =glacier
kaldur =cold
kinn =cheek
kirkja =church
klaustur =monastery
kleif =cleft
klettur =rock, cliff
kollur =summit
kot =small farm
kvísl =fork, branch (of a stream)
lækur =brook
laug =clear, hot spring
laut =hollow place

leiga = rent
leir = mud, clay
litli = little
lón = inlet, lagoon
lyng = heather
mel = shingle
múli = headland
mynni = mouth, opening
mýri = swamp
náma = mine, quarry
nef = point
nes = point, headland
norður = north
nupur = peak
nyrðri = more northerly
oddi = tongue of land, point
öræfi = desert
ós = river mouth
öxl = shoulder
pollur = pool
rek = drifting, jetsam
rétt = fold
rif = reef
reykur = smoke
sandur = sand flat
sel = pasture, shieling
siki = ditch
skafl = snowdrift
skál = basin, hollow
skarð = mountain pass
sker = skerry, rock
skogur = wood
skriður = scree
sljetta = plain
staður = place, parsonage
stapi = bluff
steinn = stone
stekkur = lambfold
stiga = step, rise
stór = great
suður = south
sulur = mountain with two peaks
svartur = black, dark
syðri = more southerly
tangi = narrow point (projecting into sea)
teigur = strip of land
tindur = peak, summit
tunga = tongue
tjörn = small lake, tarn
torf = turf
vað = ford
varða = beacon, cairn
vatn = water, lake
vegur = way, road, track
vestur = west
vík = bay, cove, creek
vogur = bay, inlet
völlur = field, plain
vör = landing place
ytri = outer
þúfa = knoll, mound
þver = transverse
þverá = tributary

Appendix II

MAPS OF ICELAND

The history of the mapping of Iceland up to the end of the nineteenth century has been admirably summarised by Halldór Hermannsson in 'The Cartography of Iceland,' *Islandica*, Vol. XXI, (Ithaca, New York, 1931). Hermannsson's work contains reproductions of many of the earlier maps, and is well documented with references to the literature on the subject. The following account is restricted to those modern maps which will be found of most practical value.

Danish Maps

The best maps of Iceland are those published by the Danish Geodetic Institute, Copenhagen. The aim of the Danish survey has been to provide a complete map of the whole island on a scale of 1 : 100,000. The work was begun in 1900, but was interrupted in 1914 by the war. Between 1930 and 1938 the Geodetic Institute sent an expedition every year to Iceland, where the mapping was carried out in co-operation with the Icelandic Government. A new triangulation was made, and this now covers the whole island. The mapping was begun in 1902 by plane-table surveys on a scale of 1 : 50,000, but after the first four years the scale was changed to 1 : 100,000, and the work was continued until 1936, when the whole coastal tract had been mapped on this scale. Since 1930 parts of the desolate and uninhabited regions in the centre of the country have been mapped on a scale of 1 : 200,000.

In 1930 a photogrammetric survey from the ground was carried out in the neighbourhood of Akureyri and Siglufjörður. In the following years the Geodetic Institute made extensive aerial surveys in Greenland. As these proved successful and gave very detailed maps, it was decided to complete the mapping of Iceland on a scale of 1 : 100,000 by means of an aerial survey of all the central and more inaccessible parts of the country. The necessary photographs were taken in 1937 and 1938, a total of 1,884 pictures being obtained from a height of 4,000 m. in 124 flying hours. The area which can be plotted from these air photographs is approximately 32,000 sq. miles. This area is nearly identical with that part of the key map (Fig. 132) which is shown as not yet published, except for the east coast, of which two sheets mapped from the ground have not yet been issued. Maps showing the base-lines, triangulation and astronomical stations, and the locations of the air photographs upon which these maps are based, were published in *Geografisk Tidsskrift*, Bd. XLII, Copenhagen, 1939.

The key map shows the sheets already published.

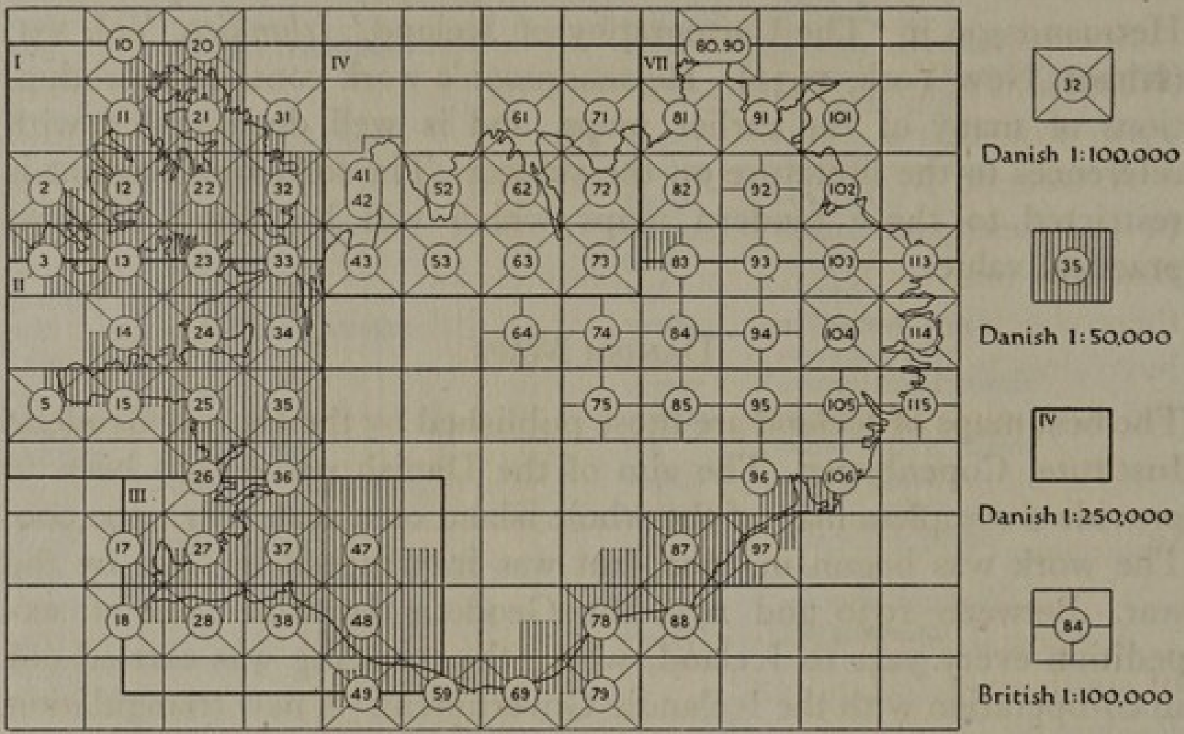


Fig. 132. Key to published maps of Iceland.

The sheets of the Topographical Map (*Atlasblöð*), on a scale of 1 : 100,000 (1·6 miles to the inch), each cover 680 sq. miles, and aim to cover the entire populated area of Iceland. The size of the sheets is 17 × 16 in. Fifty-three sheets have been published on this scale, and thirty-four others are planned, as the work of plotting by stereoplanigraph is accomplished.

Relief by reddish brown contours at 20 m. intervals, each fifth weakened by pecking; cliff drawing in black. Roads, bridle paths, marked and unmarked paths in different black symbols overprinted brown. Water blue. Elaborate surface symbols for cultivated ground, meadow, bog, grass, moraine, lava, sand, glaciers, etc. Longitudes from Greenwich. Explanation in Icelandic, Danish and English.

The 'Quarter-sheets' (*Fjórðungsblöð*), on a scale of 1 : 50,000 (0·79 mile to the inch), each cover 170 sq. miles, so that four 'quarter-sheets' cover the same area as one of the 1 : 100,000 sheets. It is not planned to continue this series beyond the 118 sheets indicated on the key map. The size of the sheets is 17 × 16 in.

Relief by reddish brown contours at 20 m. intervals, changing to blue on the ice-caps and glaciers, with moraines in black. Rocks in black. Streams blue with black margin. Lakes and sea lined blue with solid ribbon margin. Elaborate symbols for vegetation, lava, sand, etc. Key on separate sheet. Longitudes from Copenhagen. Horizontal scale of metres and *alnir* (1,000 *alnir* = 625 m.). The mean error of these 1 : 50,000 maps is reported by the Danish Geodetic Institute to be about 2 m. for heights and 20 m. in the horizontal direction, which corresponds to $\frac{1}{2}$ mm. in the scale of the map. The contours are interpolated between the spot heights indicated. The accuracy is certainly not of such a high degree in some of the more mountainous districts, especially in the north-west peninsula.

Special sheets are published, on a scale of 1 : 50,000, of the Westmann Islands (Vestmannaeyjar) and Mývatn; dimensions about 17 × 16 in.

A General Map of Iceland (*Aðalkort*), on a scale of 1 : 250,000 (3·95 miles to the inch), has also been commenced. It is planned that this map will cover the whole country in nine sheets. Five of these sheets, covering the western and northern parts of the country, have already appeared. The area of each sheet is about 8,160 sq. miles, the size being 28 × 20 in.

Relief by brown contours at 20 m. intervals and black cliffs. Roads brown; meadows green. Elaborate symbols much as in 1 : 100,000 map described above. Water blue.

A Special Sheet (*Sérkort*), on a scale of 1 : 250,000, is available of south-west Iceland and covers the tourist district which includes Reykjavík, Þingvellir, Gullfoss, Hekla and the geysers.

Finally, there is a small-scale map (1 : 1,000,000, or approx. 16 miles to the inch) showing motor roads (*Yfirlitskort með bilvegum*). Revised 1936. This is already seriously out of date.

In 1928 the Topographical Section of the Danish General Staff, Copenhagen, prepared a coloured physical map (*Skólakort*) of Iceland on a scale of 1 : 500,000. The title of this is *Ísland, Landslagsuppdrattur eftir Samuel Eggertsson*, (published by *Samband Íslenskra barnakennara, Reykjavík*). Until the publication of more recent British Maps, mentioned below, this was the best general map of the island. It is still the best as far as place names are concerned.

British Maps

The Geographical Section of the General Staff has published the following maps of Iceland:

G.S.G.S. No.	Scale	
4212	1 : 1,000,000	Single-sheet map of Iceland. Contours and numbered roads in red; water and glaciers in blue (published 1941)

G.S.G.S. No.	Scale	
4140	1 : 600,000	Single-sheet air map of Iceland. Purple layer tints showing relief; roads in brown, glaciers and water in blue. The map is gridded and contains magnetic information. The physical features appear to be more nearly correct than in any other map of the whole island, but the form and spellings of place names are most unsatisfactory (published 1940)
4185	1 : 500,000	Four-sheet map of Iceland. Layer tints showing relief in brown and green; water and glaciers in blue; roads in black and red. This is a very generalized map which has suffered from hurried compilation (published 1941)
4104	1 : 250,000	Gridded maps compiled from sheets 1, 2, 3, 4 and 7 of the Danish series. Coast, rivers, lakes and glaciers blue. Relief by brown contours at 50 m. intervals. Numerous symbols for other special features (2nd ed. 1941). Sheets 5 and 8 ('Mid-Island' and 'Midausturland') (published 1942). It is proposed to publish one further sheet to cover the south-east coast
4137	1 : 100,000	Fifty-three sheets reproduced from the Danish series. The following sheets are available with grids: 11, 13, 14, 15, 20, 21, 22, 23, 25, 26, 32, 33, 34, 35, 36, 43, 47, 48, 52, 53, 59, 61, 62, 63, 69, 71, 72, 73, 79, 80–90, 88, 91, 102, 103, 104, 113 and 114 (published 1940–42). A further set of British maps, prepared by the 19th Field Survey Company, R.E., is being issued for the regions not yet covered by the Danish series. Those which have been published so far are indicated in Fig. 132
4138	1 : 50,000	Twenty gridded maps of the south-west peninsula reproduced from the following Danish sheets: 17, 18, 26, 27, 28, 36, 37 and 38. Black and red, with blue water filling (published 1940–41)
4186	1 : 25,000	Four sheets of the area round Reykjavík: 'Hafnarfjörður-Keflavík Road', 'Reykjavík and Hafnarfjörður', 'Álafoss', 'Sandskeið'. Contours in brown; water in blue; numerous symbols for special features, including classified roads, telephone and power lines. Surveyed by plane table in 1940 (published 1941)
4188	1 : 25,000	Four sheets of the area around Akureyri: 'Horgárdalur and Eyjafjörður'. Enlarged and corrected from the Danish 1 : 100,000 map. Contours in black at 20 m. intervals; water in blue (published 1941)
4189	1 : 25,000	'Búðareyri'. In the same style as 4186. Surveyed by plane table in 1940 (published 1941)
4190	1 : 5,000	'Town Plan of Reykjavík' with index to street names (published 1941)
4191	1 : 5,000	'Town Plan of Hafnarfjörður', showing street names (published 1941)
4192	1 : 5,000	'Town Plan of Akureyri', showing street names (published 1941)

Charts

A key to the charts of Iceland published by the Admiralty will be found at the beginning of the *Arctic Pilot*, vol. II, 4th ed., 1934. It should be noted, however, that a number of new charts have been issued since the date of that publication.

Special Maps

The best geological map of the island was published in 1901 under the title: *Geological map of Iceland by Th. Thoroddsen, surveyed in the years 1881–1898, edited by the Carlsberg Fund.* Scale 1 : 600,000, size 96 × 67 cm., in 2 sheets and in 13 colours. A German edition on a smaller scale appeared in 1906: *Geologische Karte von Island* (Gotha, Justus Perthes). Scale 1 : 750,000, size 75·5 × 50·7 cm., together with an orographical map by Thoroddsen: *Höhenschichten-Karte* (Gotha, Justus Perthes, 1906), on the same scale as the other.

A large number of special maps of particular areas have been published in scientific periodicals. Many of these have formed the basis of the maps included in this Handbook. The sources are indicated under each.

Appendix III

DURATION OF DAYLIGHT

The length of the twilight periods increases with increasing latitude and thus becomes of greater significance in Iceland than in the British Isles. The *Nautical Almanac* defines 'twilight' as the two *periods*, morning and evening, between the *times* (called 'astronomical twilight') when the sun is 18° below the horizon and the *times* when its refracted upper limb is on the horizon at sunset or sunrise. It then divides these periods each into three by defining 'civil twilight' as the *times* when the centre of the sun is 6° below the horizon, and 'nautical twilight' as the *times* when it is 12° below. At sunset as above defined the unrefracted centre of the sun is 50′ below the horizon; 16′ being allowed for the semi-diameter of the sun, and 34′ for refraction.

If the sun is much lower than 6°, ordinary outdoor civil occupations are usually impracticable without artificial light. Civil twilight, or some time near it, indicates the moment when the horizon ceases to be visible in a sextant; the brightest stars are just visible, but terrestrial objects are easily distinguishable. Nautical twilight is supposed to mark the end of the period in which there is just enough light for handling and landing boats. These statements assume a clear sky and the absence of moonlight; they take no account of the light of the night sky from stars or from auroral glow. The shortening of effective twilight caused by cloudy skies may be as much as an hour.

In Figs. 133 and 134 the times of sunrise and sunset, and of the beginning and end of civil twilight, are given for every week of the year for the Reykjavík district (lat. 64° N) and for the Akureyri district (lat. 66° N). Although Akureyri is south of the Arctic Circle, the sun does not set there for about 3 weeks in midsummer, whilst at mid-winter daylight always lasts for more than $2\frac{1}{2}$ hr. The sunrise curve is not quite symmetrical with the sunset curve owing to the equation of time. This adjusts apparent time to mean time which is used in the diagrams. The noon line does not bisect the area of daylight because Icelandic mean time is based on long. 15° W, while Akureyri lies on long. 18° W and Reykjavík on long. 22° W.

Twilight adds nearly 3 hr. of midwinter illumination each day at Reykjavík, and over $3\frac{1}{2}$ hr. at Akureyri. For most of the year this addition is $1\frac{3}{4}$–2 hr., but it increases rapidly towards midsummer and

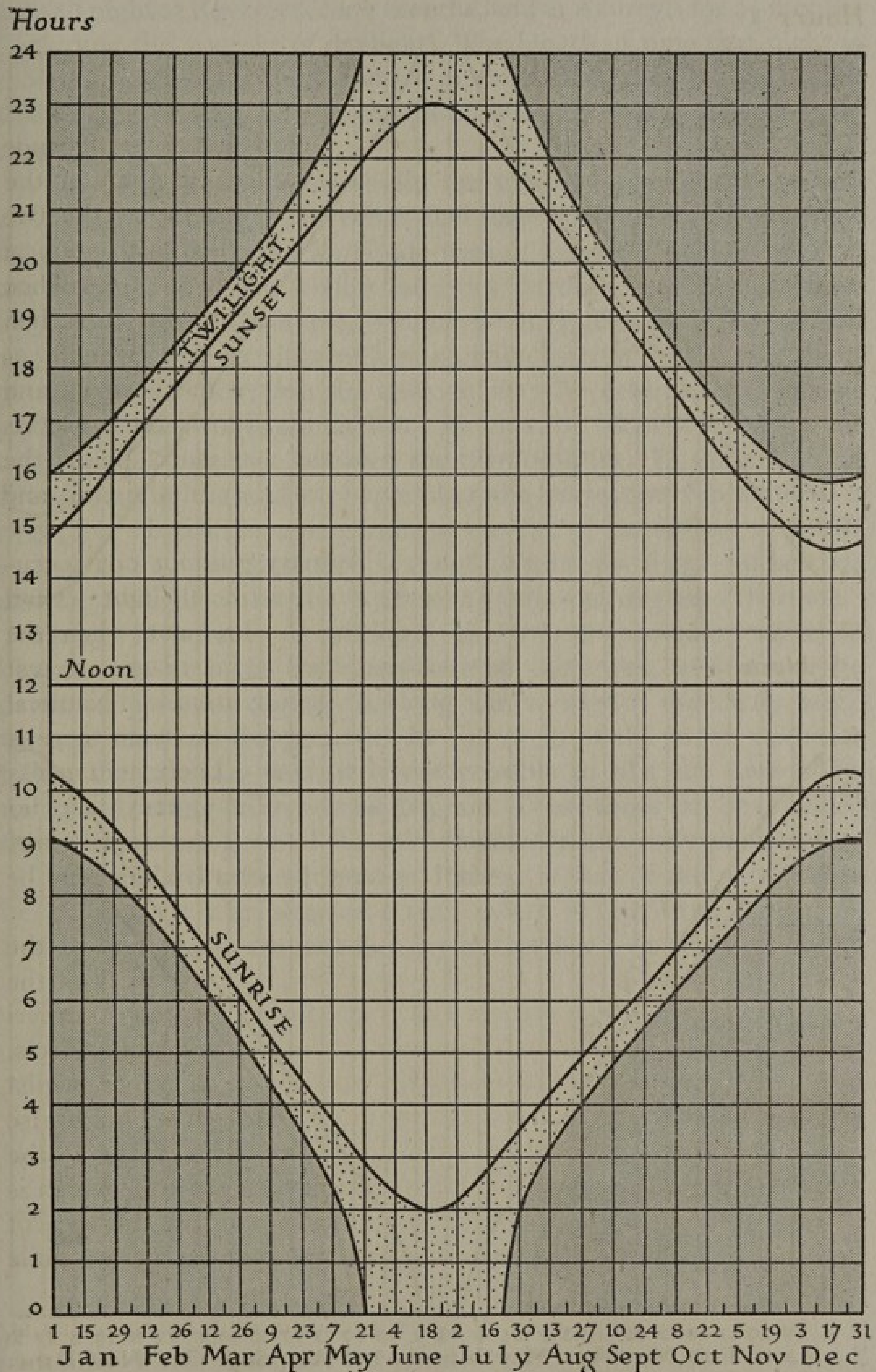


Fig. 133. Twilight, sunrise and sunset. Icelandic Mean Time (G.M.T. + 1 hr.). Reykjavík district; lat. 64° N, long. 22° W. Compiled from figures in *Air Almanac* (London).

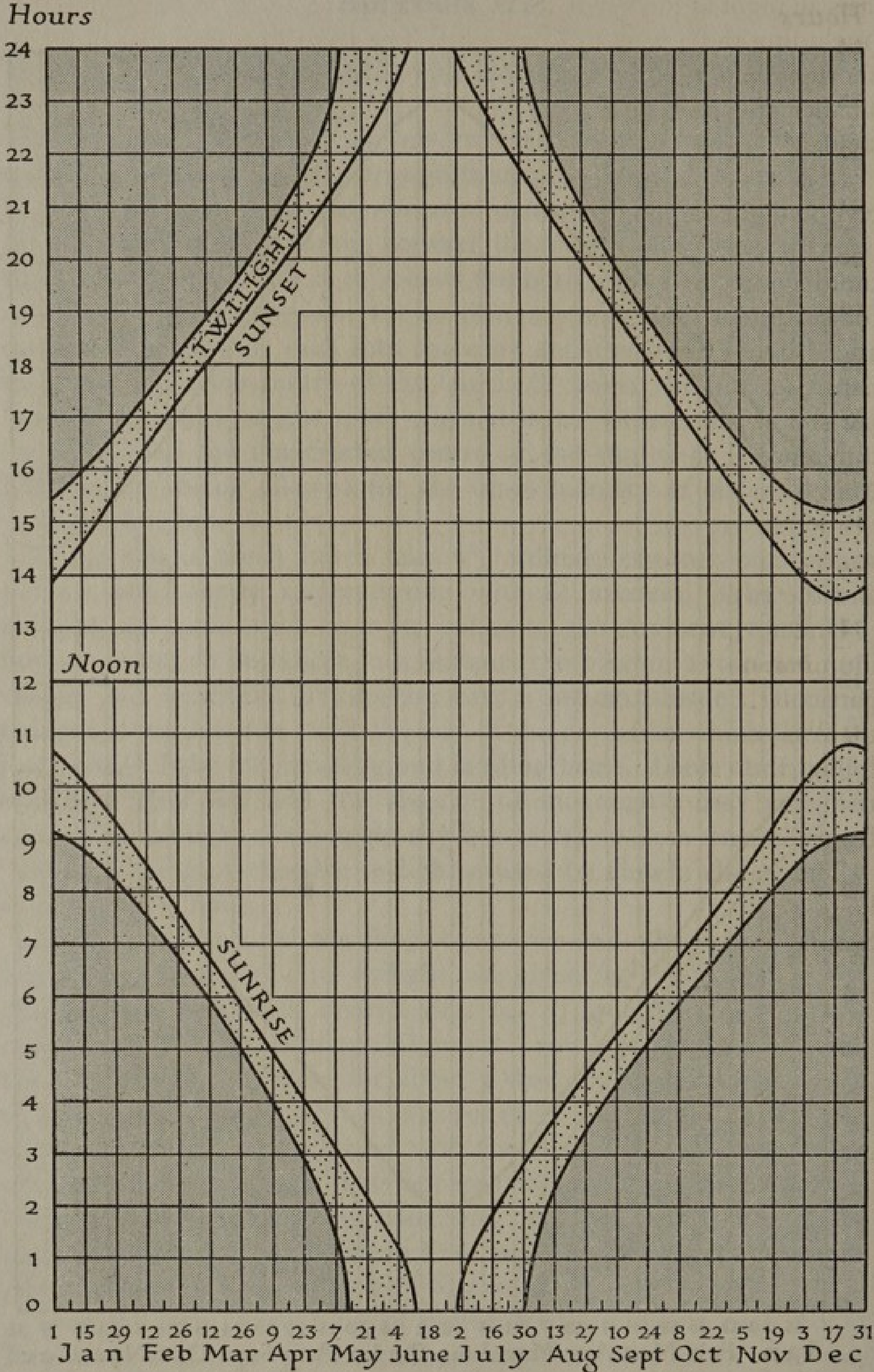


Fig. 134. Twilight, sunrise and sunset. Icelandic Mean Time (G.M.T. + 1 hr.). Akureyri district; lat. 66° N, long. 18° W. Compiled from figures in *Air Almanac* (London).

lasts all night at Reykjavík for 2 months, and at Akureyri for 2½ months (including the 3 weeks of daylight). The length of time that night is shorter than day is well shown in both diagrams by the much smaller area shaded dark as compared with that left white or lightly shaded.

It is a simple matter to obtain the times of sunrise, sunset and civil twilight for longitudes other than those shown. All occur 4 min. later for every degree of longitude west of the standard longitude in the diagram, or 4 min. earlier for every degree east. The correction for latitude is not so simple, because it varies from month to month and also does not vary in simple proportion with latitude. The general nature of this correction for latitude may be determined by comparison of the two diagrams, but care must be taken to allow for the difference in longitude between the two localities. In the middle of March and at the end of September the correction for latitude is negligible. It reaches a maximum at the end of December, when the sunrise and sunset correction is about 10 min. per degree of latitude and the twilight correction is about 25 min. per degree of latitude.

Under favourable conditions, the moon provides sufficient illumination at night for many outdoor activities, and it can be particularly useful during the long winter nights, especially when there is snow on the ground. As the cycle of the moon does not follow the calendar year, it is not possible to plot the time of its rising and setting on an annual diagram. These times can be obtained from the current issue of the *Air Almanac* (a quarterly publication).

The standard time adopted in Iceland is that of the meridian of long. 15° W, or 1 hr. slow on G.M.T. G.M.T. is kept from the second Sunday in April to the first Sunday in October.

Appendix IV

MAGNETIC DISTURBANCES

Normal magnetic variation is shown in Fig. 135.

The rocks of Iceland are markedly magnetic. The compass cannot be used with confidence for accurate direction-finding ashore, and the coasts are notable for magnetic disturbances affecting ships' compasses. The disturbances occur in the fjords as well as far out to sea. It used to be thought that they were due to influences from the land, but it is now known that they come from the rocks of the sea floor. The maximum depth at which disturbances may be observed

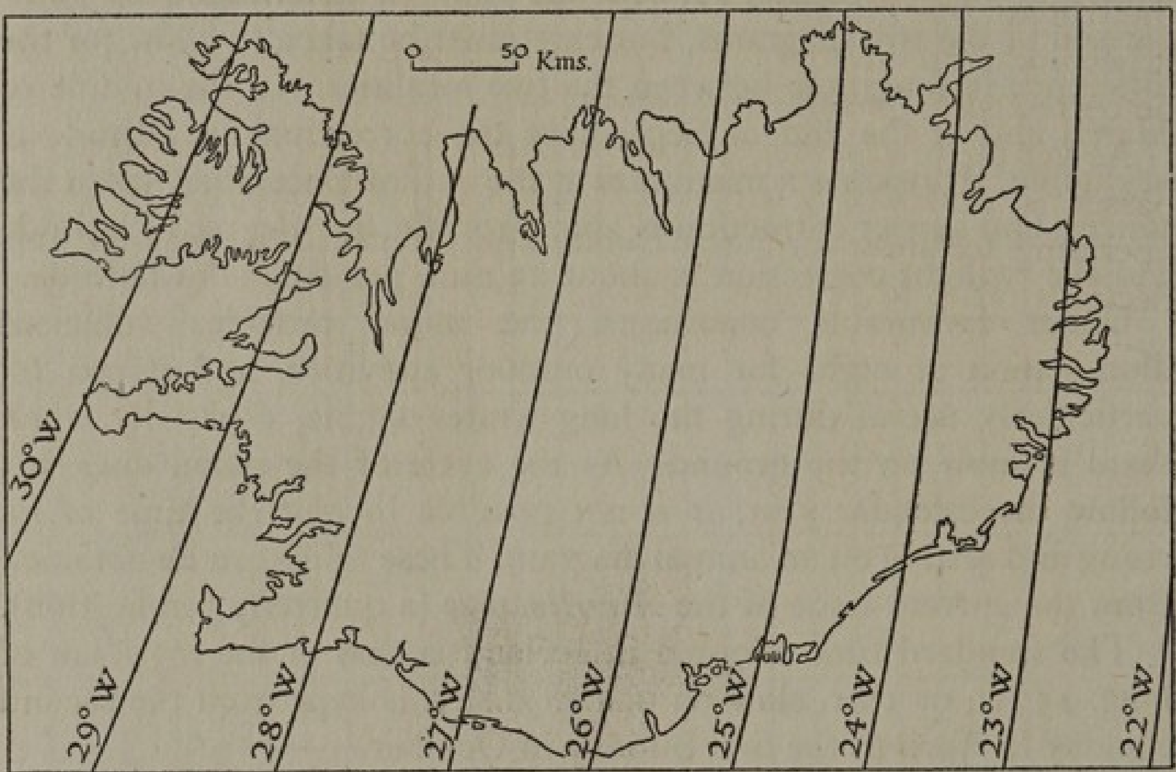


Fig. 135. Magnetic variation, 1940. Decreasing annually by about 13 min., and subject to marked local disturbances. Source: *Iceland, Air Map*, 1 : 600,000 (G.S.G.S., No. 4140).

is not known, but with a depth of 140 m. a disturbance of 12° has been noted. Disturbances of up to 20° have been observed in the waters north of Reykjavík. These disturbances are of varied type. In some places the compass becomes dead; in others there is sudden deviation; in others again the compass is slowly affected so that the deviation does not easily attract attention and is therefore the more dangerous. As a rule large disturbances affect small areas; smaller ones may persist for many miles.

For these reasons, compass users should not rely too much on the magnetic variations shown in Fig. 135. If there is suspicion of disturbance, the readings should be tested by the usual method of comparing the forward (direct) and backward (reverse) bearings between two points. These should differ by 180°.

In parts of Iceland it is sometimes more satisfactory to take approximate bearings from the sun.

True North by Watch and Sun. Lay the watch flat with the hour hand pointing to the sun. The direction of true south (in the northern hemisphere) is then midway between the hour hand and XII. Thus, at 1500 hr., with the watch set as described above, south lies in the direction midway between the figures I and II, and north in the opposite direction. This method is very rough. It is of no use in the tropics, but the farther away from the equator the more accurate it becomes. If summer time is in force (see p. 433) the watch must be corrected before the observation.

As yet no precise information of the behaviour of aircraft compasses is available; accurate navigation is not attempted by those operating Icelandic aircraft. Limited experience indicates that deflections of up to 20° may occur.

Appendix V

THE AURORA

The aurora is a peculiar glow visible in cloud-free night sky. It is most frequently seen in high latitudes, but during very intense displays it may occur even in the tropics. The aurora in the northern hemisphere is called aurora borealis; in the southern aurora australis.

The most common form of aurora is a steady luminous arc with its summit in the direction of the magnetic north and the ends nearing the horizon in the north-west and north-east. The lower edge of the arc is more sharply defined and brighter than the upper. Diverging rays frequently extend upwards from the arc.

Ray forms of aurora are usually very mobile. The rays brighten and darken, advance and recede, or sweep sideways. A spectacular corona effect occurs in northern latitudes when the rays extend in all directions from a central ring of light near the zenith. Less frequently, displays resemble luminous curtains hanging in the sky. Surfaces of pulsating brightness and steady bands of light are occasionally seen.

The auroral colour is not pure like that of the rainbow. It is a mixture of light of different colours, and variations are due to enhancement of certain components of the mixture. Thus a vertical ray may appear reddish at its low end, yellowish green in the middle, and bluish green or violet near the top. Displays of deep red aurora have occasionally been seen.

Observers have sometimes reported hearing faint rushing and crackling sounds which they have associated with the aurora, and it has also been claimed that auroras have been seen near the ground—even in some cases between the observer and distant clouds or mountains. No attention should be paid to reports of this kind because it is definitely known that auroras never descend much below a height of 60 km.

It is generally agreed that the phenomenon is caused by streams of electrified particles, i.e. atoms and electrons, coming into the outer layers of the earth's atmosphere. The glow is in fact very like that of electric discharge through low-pressure gas in a glass bulb such as a neon lamp or a Crooke's tube. The effect of aurora on the reception of long-distance short-wave radio signals, which may be completely cut off, also indicates that strong ionization must be produced by the aurora in the upper atmosphere. As yet, however, no completely satisfactory explanation of the mode of generation of the streams of particles which cause the aurora has been found, though a number of theories have been put forward.

Geographical Distribution

Fig. 136 shows the relative frequency of occurrence of aurora at different places in the northern hemisphere. A similar distribution is found in the Antarctic. The lines of equal frequency are approximately circular and are concentric about a point in north-west Green-

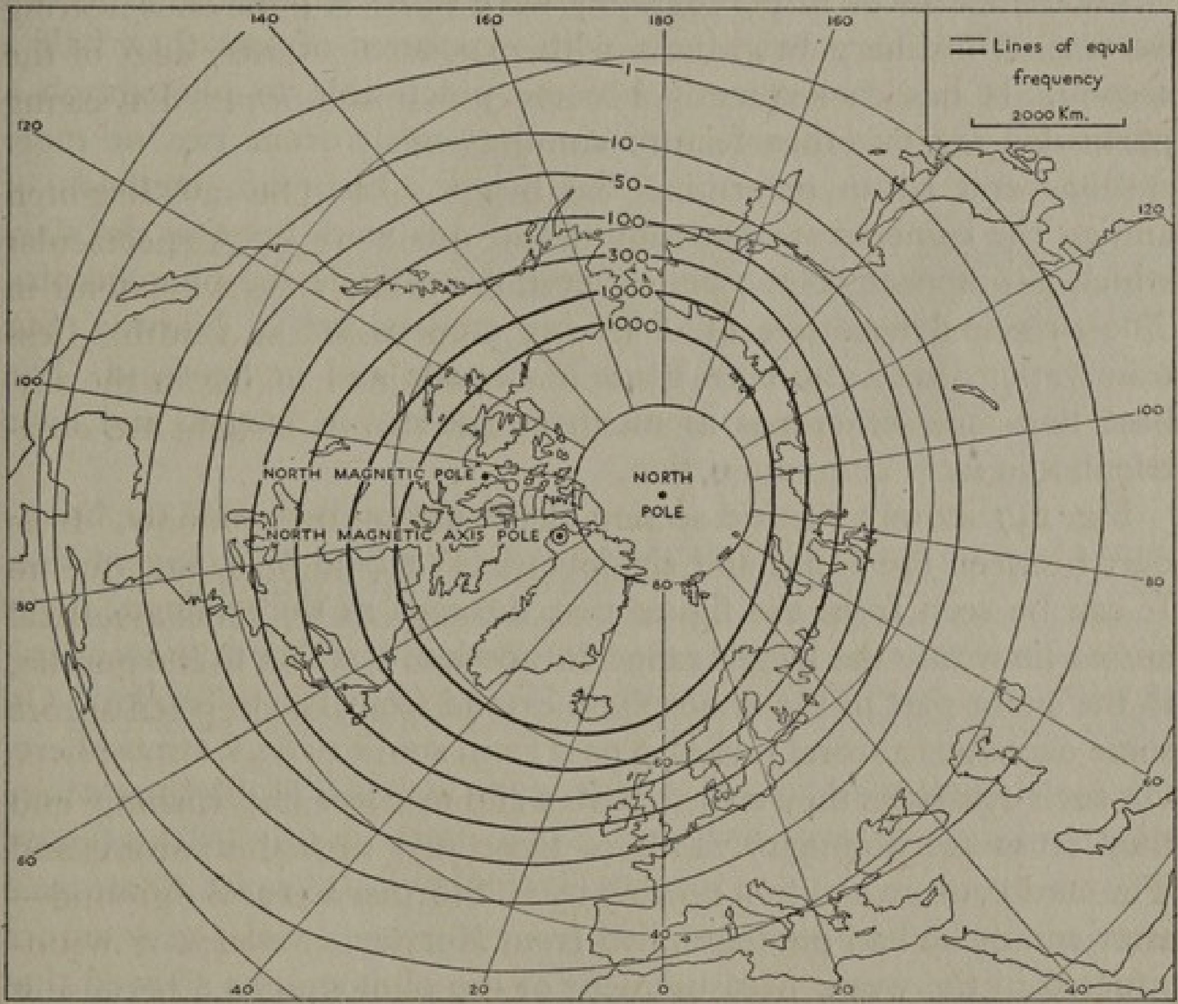


Fig. 136. Geographic distribution of aurora. The numbers on the lines of equal frequency indicate the relative frequencies. Data are lacking for the central part of the map.

land about midway between the North Pole and the North Magnetic Pole. This point is, in fact, the northern end of the magnetic axis of the earth, sometimes called the Geomagnetic Pole, but better described as the Magnetic Axis Pole.* The zone of maximum auroral

* The North Magnetic Pole (*c.* lat. 70° 30′ N, long. 96° W) is the place at which the dip needle sets vertically. The North Magnetic Axis Pole (*c.* lat. 78° 30′ N, long. 69° W) is a point which has been determined by calculation from observations of the magnetic field over the whole surface of the earth; it is the north end of

activity, which circles through northern Canada, the Shetlands and Norway, is centred on the Magnetic Axis Pole and has a radius (angular) of about 23°. In this zone the aurora may be seen nearly every night. It is evident from the manner in which the aurora depends upon magnetic latitude that the streams of particles causing the phenomenon must somehow be strongly influenced by the earth's magnetic field before they reach the outer atmosphere.

Height

Recent advances in photography have made it possible to record auroras of ordinary brightness with exposures of less than half a second. It has consequently become practicable to photograph a particular ray or other feature simultaneously from two or more stations and so to determine the height. Elaborate methods of aiming the cameras are not required in this work because the stars which also appear on the plates serve to orientate the photographs. The principal networks of observing stations are in Norway, but observations have also been made in Canada and in Scotland. The base lines are sometimes as much as 400 km. in length, and have telephonic inter-communication.

Fig. 137 shows a vertical section of the atmosphere with the boundary between the sunlit and shadow parts marked by a tangent line. It can be seen from the figure that the rays of the ordinary night aurora lie within the height range 80–400 km. but that rays occurring in the sunlit part of the atmosphere extend from 160 to 800 km. On some occasions auroral rays also pass from sunlit to dark atmosphere. On such occasions they always have a gap or a less visible part where they cross the boundary. Two of these rays appear in the figure. The sunlit aurora was first noticed by C. Störmer in 1926. Some time after sunset he had photographed from Norway a violet-grey aurora situated in the west. Measurement of the photographs showed that this aurora was over the Shetlands in a fully sunlit part of the atmosphere and that some of the rays reached a height of over 1,000 km.

The streams of particles or electrons producing the aurora and coming to the 80 km. level at night must have sufficient energy to penetrate a thickness of the atmosphere equivalent to 10 cm. of air at atmospheric pressure. In the sunlit atmosphere, for some quite unknown reason, the aurora can penetrate only to the 160 km. level.

the axis of the average magnetic field of the earth. It differs from the North Magnetic Pole because of field distortion produced by variations in the magnetic properties of the earth's crust.

As the pressure of the atmosphere becomes halved for each 8 km. of ascent, it can be calculated that at 160 km. the pressure will be only 0·001 of the pressure at 80 km. and thus the equivalent thickness of air at atmospheric pressure for particles descending to 160 km. is only 0·01 cm. It is possible that the sunlit atmosphere is sufficiently heated, expanded and so raised by the absorption of the sun's rays as to make the aurora higher; or it may be that the sunlight makes the atmosphere somehow more capable of absorbing the auroral discharge.

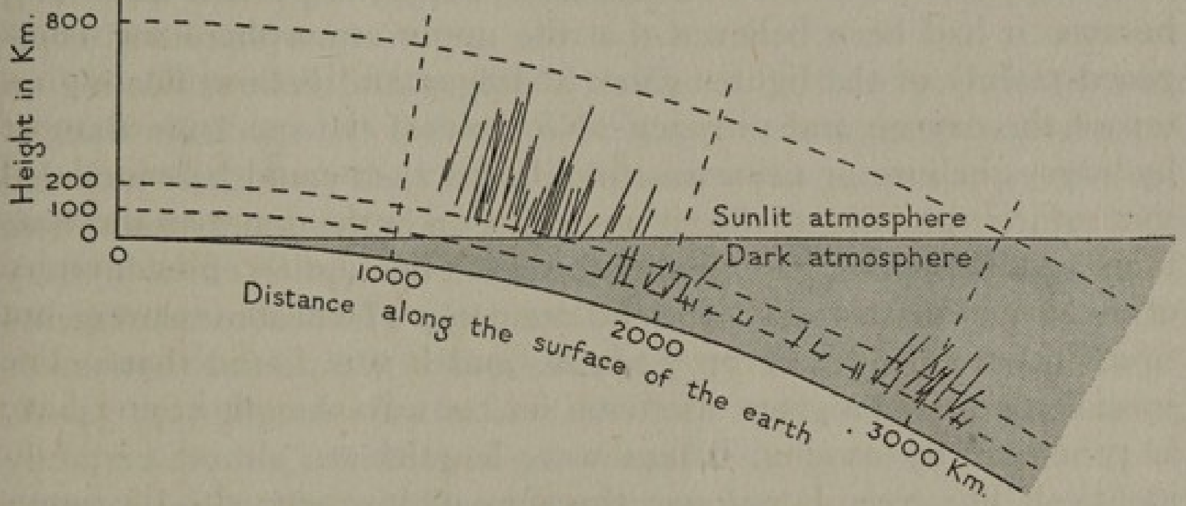


Fig. 137. Position of auroral rays in the atmosphere. The rays have been plotted, not in their actual positions with respect to the observing stations, but at their distances from the tangent point of the sun's rays. By this method, auroral rays lying in the shadow of the earth are separated from those which were wholly or partly in the sunlight atmosphere at the time of observation. Adapted from C. Störmer, *Zeitschrift f. Geophysik*, Bd. v, pp. 177–94 (Braunschweig, 1929).

One important result of these studies is that they provide reliable evidence that the atmosphere of the earth extends in appreciable amount to a height of at least 1,000 km.

Spectrum

Light from the aurora has been successfully analysed by the spectrometer, and the spectrum lines have been photographed and compared with the lines produced by electric discharge through gases in the laboratory. The wave-lengths of the spectrum lines produced by electric discharge in a gas are characteristic of that particular gas. Thus a study of the spectrum of the light from the sun or a star enables the elements producing the light to be identified. In this way the rare gas helium, before it was known to exist on the earth, was discovered by its spectrum in the light from the sun. There was therefore some excitement among physicists when the spectrum of the aurora was found to have, among some known lines, a characteristic green line which could not be reproduced in the laboratory. It was debated whether there was some new unknown substance in the outer atmosphere of the earth. The green line was first seen by A. J. Ångström in 1869, but it was not until 1925 that the mystery of its origin was cleared up. One of the difficulties was to get enough light from the aurora to enable powerful spectrometers to be used. Gradually, as time went on, all the red and violet lines were identified with known nitrogen lines, thus showing the presence of nitrogen in the upper atmosphere. This in itself was an important discovery, because it had been believed that the upper atmosphere was composed mainly of the lighter gases hydrogen and helium floating on top of the oxygen and nitrogen. No trace of the spectrum lines of hydrogen, helium or neon was found, and so it could be concluded that sufficient mixing of the air was going on in the upper atmosphere to prevent the lighter gases separating out. The solution of the mystery of the green line was not in the end dramatic. The best measurements fixed its wave-length at 5577·344 A., and it was found that under special conditions a green spectrum line of wave-length 5577·341 A. is produced by oxygen. These wave-lengths are almost certainly identical. The green line shows, therefore, that oxygen also is present at very great heights in the atmosphere.

Suggested Causes of the Aurora

When a comparison is made between the records of the daily count of the number of sunspots visible on the sun's disk and records of the frequency of occurrence of aurora and of magnetic storms, it is found that times of sunspot activity are very often also times of magnetic storm and intense aurora. There is evidently some connexion between the three phenomena, and it is natural to suppose that streams of electrified corpuscles and bursts of intense ultra-violet light may issue from the sun during the tremendous local convulsions associated with sunspots. One theory of the aurora starts from the assumption that streams of electrified corpuscles come directly from the sun; another assumes that nothing but ultra-violet light comes from the sun, and that the electrified corpuscles originate elsewhere.

The Corpuscular Theory. The first step in the corpuscular theory is the mathematical calculation of the paths or trajectories followed by electrified corpuscles or electrons as they approach the earth through its magnetic field. Computations were first made by

C. Störmer about 1905, and his elaborate calculations since then show how zones of maximum auroral activity can be produced, and also give the correct shape and direction of auroral rays. A difficulty arises, however, because the calculated diameter of the zone of maximum activity is much too small. Also it is contended against the theory that a stream of electrons coming from the sun would be dispersed by its own electrostatic repulsion long before it reached the earth. Partially successful attempts have been made to improve the theory by supposing that the streams from the sun consist of positively and negatively charged corpuscles mixed in approximately equal numbers.

The Ultra-violet Light Theory. The difficulties associated with streams of corpuscles coming directly from the sun can be overcome by supposing that the corpuscles causing the aurora are generated in the upper atmosphere in equatorial latitudes by ultra-violet light from the sun. They are assumed to be shot upwards to heights of 50,000 km. above the equator and from there descend under the influence of the earth's magnetic field to the polar regions. When, under the influence of a sudden and very intense flash of ultra-violet light, a very large current of particles travels upwards, there may be observed also the sudden commencement which is characteristic of many magnetic storms. This theory, however, finds difficulty in explaining just how the corpuscles are shot to this great height. Moreover, the exact 27-day recurrence of magnetic storms, which corresponds with the period of rotation of the sun, would seem to require the sun to send out a narrow searchlight beam of ultra-violet light which rotates with it and sweeps across the earth. We can imagine much more easily the production of a narrow beam of corpuscles by the sun. The ultra-violet light theory, on the other hand, accounts very well for the zones of maximum aurora and, by reason of the time taken by the corpuscles to make the trip from equator to pole, it accounts also for the fact that the onset of an auroral display tends to occur about a day after the commencement of a magnetic storm.

It will be evident from the above that only a beginning has been made towards the construction of a satisfactory theory of the cause of the aurora.

Appendix VI.—CLIMATE TABLES

[In tables 6 to 8 and 10 to 14 maximum figures are printed in black type; minimum figures in italics.]

Table 1. *Average Surface Temperature of the Sea* (° C.), 1924–33

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Range	Yearly mean, 1924–1933	Yearly mean, 1876–1915
Grindavík	4·6	5·0	5·4	6·3	8·2	9·8	11·1	11·1	9·8	7·5	5·9	5·4	6·5	7·5	—
Reykjavík	1·8	2·0	2·6	4·0	6·9	10·1	11·8	11·8	10·0	7·0	4·4	3·2	10·0	5·3	—
Stykkishólmur	1·2	1·2	1·5	3·0	5·8	8·7	10·8	10·9	9·4	6·5	3·8	2·7	9·7	5·5	4·9
Suðureyri	0·8	0·6	0·8	2·1	4·8	7·6	9·6	10·1	8·8	5·9	3·7	2·3	9·5	4·8	—
Grænhóll	1·7	1·5	1·8	2·5	4·0	6·0	8·0	8·6	7·8	6·3	4·5	3·1	7·1	4·6	—
Grímsey	2·5	2·2	2·2	3·0	4·6	6·6	8·3	8·9	7·5	5·9	4·5	3·1	6·7	4·9	3·7
Raufarhöfn	2·0	1·4	1·3	2·0	3·9	6·4	8·8	9·0	7·2	5·2	4·1	3·0	7·7	4·5	—
Berufjörður	1·8	1·5	1·9	3·2	5·3	8·2	10·2	8·8	6·7	5·2	3·4	2·6	8·7	4·9	—
Papey	2·2	1·9	1·8	2·6	4·1	6·1	7·6	8·1	7·4	5·6	4·0	2·8	6·3	4·5	3·2
Vestmannaeyjar	6·0	5·9	6·3	7·0	8·4	9·6	10·9	11·2	10·0	7·8	6·6	6·3	5·3	8·0	7·0

The above figures are calculated from daily observations at coast stations. The temperature curves in Fig. 56 are not directly comparable with the figures in this table, the mean surface temperature of the years 1924–33 being higher than that of 1876–1915. Source: H. Thomsen, 'Hydrography of Icelandic Waters', *Zoology of Iceland*, vol. I, part 4, pp. 10–11 (Copenhagen and Reykjavík, 1938).

Table 2. *Average Atmospheric Pressure* (*mb.*), 1876–1925

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Stykkishólmur	997	999	1,004	1,008	1,012	1,010	1,009	1,008	1,005	1,004	1,002	997	1,005
Raufarhöfn	1,001	1,003	1,007	1,012	1,015	1,013	1,011	1,011	1,007	1,008	1,005	1,002	1,008
Berufjörður*	998	1,000	1,004	1,008	1,012	1,010	1,008	1,007	1,005	1,004	1,002	998	1,005
Vestmannaeyjar	997	999	1,004	1,007	1,012	1,011	1,009	1,008	1,005	1,004	1,002	997	1,005

Figures corrected to M.S.L. and gravity at lat. 45°. Source: B. J. Birkeland and N. J. Föyn, 'Klima von Nordwesteuropa...', *Handbuch der Klimatologie*, Bd. III, Teil L, p. 82 (Berlin, 1932).

* All observations recorded for Berufjörður in these tables were made at Teigarhorn, on the south side of the fjord.

Table 3. *Percentage Frequency of Wind Observations of different Forces*

Beaufort Scale	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Stykkishólmur													
0–1	18	17	23	24	26	37	39	36	29	26	23	20	27
2–3	29	29	34	33	34	33	36	34	33	32	30	34	32
4–5	31	34	24	26	25	23	18	19	23	26	27	26	25
6–7	16	15	14	13	12	6	6	9	13	11	16	15	12
8–12	6	5	5	4	3	1	1	2	2	5	4	5	4
Grímsey													
0	5	7	11	10	12	24	23	13	9	10	5	6	11
1–3	19	23	26	33	29	29	33	31	25	26	23	24	26
4–5	26	20	23	24	30	26	26	25	28	26	23	25	25
6–7	33	33	27	25	22	17	17	26	29	30	34	35	28
8–12	17	17	13	8	7	4	1	5	9	8	15	10	10
Berufjörður													
0	27	25	33	25	25	35	41	36	31	31	28	32	31
1–3	27	28	28	29	39	38	32	34	29	30	31	26	31
4–5	31	33	26	31	27	22	21	24	30	29	29	31	28
6–7	13	11	11	13	7	5	6	6	9	10	11	10	9
8–12	2	3	2	2	2	0	0	0	1	0	1	1	1
Vestmannaeyjar													
0–1	3	3	2	4	4	5	6	4	5	5	3	2	4
2–3	16	16	19	23	27	31	33	33	25	26	16	18	24
4–5	23	18	22	24	27	32	32	29	27	23	21	23	25
6–7	32	36	41	35	30	25	25	23	30	34	40	35	32
8–12	26	27	16	14	12	7	4	11	13	12	20	22	15

Period covered unknown. Source: *Arctic Pilot*, vol. II, p. 393 (London, 1934).

Table 4. *Percentage Frequency of Wind Direction*

	Stykkishólmur (10 years)									Grímsey (9 years)								
	N	NE	E	SE	S	SW	W	NW	Calm	N	NE	E	SE	S	SW	W	NW	Calm
Jan.	12	9	29	13	11	11	8	2	5	5	8	25	16	11	8	14	8	5
Feb.	9	7	27	14	14	14	7	2	6	2	7	27	16	12	9	15	5	7
Mar.	12	9	25	14	16	10	5	1	8	4	10	26	14	10	7	13	5	11
Apr.	20	16	25	10	10	4	5	2	8	7	14	30	15	7	4	6	7	10
May	21	18	24	7	5	4	8	6	7	8	11	31	17	5	3	7	6	12
June	22	8	18	6	10	5	10	7	14	7	6	31	9	1	1	9	12	24
July	18	7	22	6	15	4	9	7	12	7	7	31	13	2	2	6	9	23
Aug.	21	10	22	7	10	3	9	6	12	6	11	40	11	2	1	8	8	13
Sept.	19	9	21	10	13	8	8	3	9	6	11	29	18	8	4	10	5	9
Oct.	19	10	23	13	12	8	5	2	8	6	10	30	14	6	4	13	7	10
Nov.	19	9	23	14	11	11	5	2	6	5	8	25	16	9	10	18	5	4
Dec.	15	9	21	16	13	11	7	2	6	2	6	29	17	12	8	15	4	7
Year	17	10	23	11	12	8	7	3	9	5	10	29	14	7	5	12	7	11

	Berufjörður (9 years)									Vestmannaeyjar (8 years)								
	N	NE	E	SE	S	SW	W	NW	Calm	N	NE	E	SE	S	SW	W	NW	Calm
Jan.	30	11	10	5	9	5	0	3	27	12	3	20	15	15	13	12	9	1
Feb.	22	10	13	5	14	5	0	5	26	10	3	23	20	16	11	9	8	0
Mar.	26	11	7	3	10	6	0	4	33	12	2	20	24	14	12	8	8	0
Apr.	34	9	14	5	9	2	0	2	25	18	2	20	22	10	6	9	12	1
May	26	10	27	2	6	2	0	2	25	11	3	21	21	11	7	12	13	1
June	16	5	27	3	8	3	0	3	35	6	2	13	22	14	11	19	12	1
July	12	3	23	2	8	9	0	2	41	6	2	14	22	17	13	14	11	1
Aug.	18	9	22	2	7	5	0	1	36	8	3	20	25	13	7	12	12	0
Sept.	26	9	14	2	9	6	0	3	31	16	3	13	16	13	14	11	14	0
Oct.	30	13	11	2	6	4	0	3	31	19	5	23	18	9	8	7	10	1
Nov.	28	12	8	4	9	6	0	5	28	19	4	20	11	12	11	13	10	0
Dec.	25	11	11	4	7	6	0	4	32	15	3	18	16	14	13	11	10	0
Year	24	10	16	3	8	5	0	3	31	13	3	19	19	13	10	11	11	1

Table 4 *continued. Percentage Frequency of Wind Direction*

	Reykjavík (20 years)									Akureyri (20 years)								
	N	NE	E	SE	S	SW	W	NW	Calm	N	NE	E	SE	S	SW	W	NW	Calm
Jan.	7	9	26	20	14	13	6	2	3	12	4	2	9	39	3	1	2	28
Feb.	6	7	27	21	15	14	5	2	3	11	2	4	14	34	3	1	3	28
Mar.	6	8	25	23	13	12	5	9	5	15	2	3	12	29	5	1	3	30
Apr.	15	12	20	18	9	8	6	7	5	27	4	5	10	22	1	1	5	25
May	16	13	16	12	6	8	11	14	4	41	5	7	6	17	1	0	4	19
June	17	7	8	10	9	13	14	16	6	50	2	2	3	20	1	1	5	16
July	15	6	7	12	11	13	15	15	6	47	1	1	4	24	0	0	4	19
Aug.	15	8	12	14	9	10	11	14	7	42	2	3	5	15	1	0	5	27
Sept.	14	8	14	18	12	19	7	9	5	29	1	1	9	28	2	1	3	26
Oct.	11	9	24	21	12	10	5	4	4	19	3	3	7	31	2	1	4	30
Nov.	11	7	23	20	14	14	4	4	3	19	5	3	9	37	2	1	3	27
Dec.	8	8	24	21	14	14	5	2	4	14	3	3	10	34	4	1	2	29
Year	12	9	19	17	11	11	8	8	5	27	9	3	9	27	2	1	3	25

Percentage of observations at 0800, 1400 and 2100 hr. ($z+1$). Sources: (1) *Arctic Pilot*, vol. II, pp. 383–6 (London, 1934). (2) Information supplied by the War Office.

Table 5. *Average Number of Days with Gale*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Stykkishólmur	2·7	2·6	2·4	2·0	1·0	0·2	0·2	0·5	1·3	2·4	2·2	2·2	19·8
Suðureyri	5·8	4·8	3·9	1·2	2·8	1·7	0·6	1·5	2·4	4·2	4·7	4·8	39·1
Grænhóll	1·2	1·9	1·0	—	0·4	0·4	—	0·1	0·5	0·4	0·7	1·8	8·7
Grímsey	1·9	1·9	1·4	0·5	0·3	0·2	0·1	0·2	0·9	0·9	1·5	1·5	10·5
Raufarhöfn	1·9	1·3	1·1	0·3	0·5	0·4	0·2	0·4	0·5	0·8	1·2	1·9	10·1
Papey	3·5	3·8	3·9	3·3	2·3	1·3	0·8	1·7	2·3	3·0	3·0	3·4	32·8
Berufjörður	1·1	0·9	0·9	0·7	0·3	0·1	0·2	0·3	0·3	0·6	0·7	0·5	6·6
Vestmannaeyjar	10·1	8·2	4·8	2·9	3·0	1·3	0·3	2·4	3·8	3·7	6·4	8·3	56·1
Eyrarbakki	1·3	1·1	0·6	0·7	0·4	0·2	0·2	0·3	0·5	0·7	1·0	1·0	8·1

Wind of Beaufort Force 9 or more during period of 25 years. Source: War Office.

Table 6. *Average Air Temperature* (° C.), 1873–1920

	Altitude m.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	Annual range	Mean annual extremes Max.	Mean annual extremes Min.
Reykjavík	5	*−1·2*	*−1·2*	−0·5	2·4	6·0	9·2	**10·9**	10·3	7·5	4·0	1·0	−1·1	3·9	12·1	17·6	−15·7
Stykkishólmur	11	−1·9	*−2·4*	−2·0	0·6	4·4	8·2	**10·0**	9·3	7·3	3·8	0·7	−1·4	3·1	12·4	17·7	−16·2
Moðruvellir	?	−3·4	*−3·7*	−3·4	0·1	4·6	9·1	**10·3**	8·9	6·6	2·2	−1·3	−2·9	2·2	14·0	23·7	−20·7
Grímsey	22	−2·0	−2·9	*−3·2*	−1·2	1·8	5·6	**7·2**	6·9	5·6	2·7	0·1	−1·3	1·6	10·4	17·7	−17·3
Grímsstaðir	385	−6·0	*−6·1*	−5·8	−2·0	2·2	7·3	**9·0**	7·0	4·0	0·5	−3·8	−5·5	0·1	15·1	23·6	−23·9
Berufjörður	18	−1·1	−1·1	*−1·2*	1·4	4·2	7·4	**8·9**	8·5	6·8	3·6	0·9	−0·6	3·1	10·1	20·7	−15·9
Vestmannaeyjar	8	1·6	*1·1*	1·6	3·8	6·6	8·8	**10·5**	10·0	8·3	5·5	2·7	*1·1*	5·0	9·4	18·3	−12·7

For Vestmannaeyjar the averages are for the period 1878–1920 and the mean annual extremes for 1878–1932. Sources: (1) B. J. Birkeland and N. J. Föyn, 'Klima von Nordwesteuropa...', *Handbuch der Klimatologie*, Bd. III, Teil L, p. 62 (Berlin, 1932). (2) 'The Norwegian and Barents Seas', *Weather in Home Waters and the North-Eastern Atlantic*, vol. II, part 7, p. 139 (Meteorological Office, London, 1941).

Table 7. *Average Number of Days with Frost*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Stykkishólmur	**27**	26	25	18	9	1	—	—	1	13	20	26	164
Grímsey	25	25	**27**	23	16	6	2	2	5	17	21	24	191
Berufjörður	24	24	24	18	11	2	—	0·5	2	13	18	**25**	160
Vestmannaeyjar	**20**	19	18	9	4	0·3	—	0·1	1	8	14	**20**	112

Period covered unknown. Source: B. J. Birkeland and N. J. Föyn, 'Klima von Nordwesteuropa...', *Handbuch der Klimatologie*, Bd. III, Teil L, p. 99 (Berlin, 1932).

Table 8. *Average Ground Temperature at Reykjavík* (° C.), 1923–8

Depth m.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
0·2	*0*	0·3	1·4	2·9	6·3	8·9	10·5	**11·6**	8·0	4·8	1·2	0·9	4·7
0·5	1·3	*1·1*	1·3	2·6	4·8	7·4	8·8	9·7	8·4	5·9	3·3	2·3	4·7
1·0	2·8	*2·3*	*2·3*	3·0	4·2	6·1	7·4	8·2	8·0	5·6	4·8	3·6	4·9
1·5	4·7	4·2	*3·7*	*3·7*	4·4	5·5	6·8	7·7	8·1	7·2	6·3	5·4	5·6

These figures are the only ones so far recorded and are probably typical of the south-west lowlands. Conditions in the highlands and in the north are more rigorous. Source: B. J. Birkeland and N. J. Föyn, 'Klima von Nordwesteuropa...', *Handbuch der Klimatolgie*, Bd. III, Teil L, p. 102 (Berlin, 1932).

Table 9. *Average Monthly Temperature and Extreme Monthly Range* (° C.) *of Upper Air at Reykjavík*

	Winter			Spring			Summer			Autumn		
	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
4,500 m.:												
Temperature	−25·5	−28·3	−24·4	−25·5	−21·6	−16·6	−13·3	−11·6	−14·4	−18·3	−20·5	−26·1
Range		±7·7			±8·3			±6·7			±8·3	
3,000 m.:												
Temperature	−15·5	−18·8	−16·6	−16·1	−12·7	−8·3	−5	−3·8	−6·1	−10	−12·2	−16·6
Range		±7·7			±8·3			±6·1			±6·1	
1,500 m.:												
Temperature	−6·6	−9·4	−9·4	−7·2	−6·1	−0·5	2·7	3·8	1·6	−2·7	−3·8	−6·6
Range		±5·0			±6·1			±5·0			±5·6	
Surface:												
Temperature	1·6	1·1	−1·6	2·2	3·8	9·4	10·5	12·7	11·6	7·2	3·8	2·2
Range		±5·6			±5·0			±3·9			±5·6	

Averages are based on observations during one year (1932–3). The figures for range represent the greatest range in any one of the three months within the season. Source: H. G. Cannegieter and W. Bleeker, 'Mittlere Temperatur und Feuchtigkeitswerte über Holland und Reykjavík', *Beiträge zur Physik der freien Atmosphäre*, Bd. 24, pp. 117–21 (Leipzig, 1937).

Table 10. *Average Number of Days with Fog*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Stykkishólmur (1896–1930)	0·2	0·5	0·5	0·7	**2**	1	1	1	0·7	0·3	0·3	0·2	8
Grímsey (1896–1930)	0·3	0·3	2	2	5	5	**7**	**7**	3	0·9	0·2	0·4	33
Berufjörður (1905–1922)	0·7	0·8	1	2	6	8	**10**	8	4	3	1	0·9	45
Vestmannaeyjar (1896–1930)	2	2	2	3	5	8	**10**	6	5	4	3	2	52

The definition of 'fog' is not stated. The figures agree fairly closely with recent observations in which 'fog' is defined as 'visibility less than half a mile', but there are considerable variations from the average. Source: 'The Norwegian and Barents Seas', *Weather in Home Waters and the North-Eastern Atlantic*, vol. II, part 7, pp. 137–40 (Meteorological Office, London, 1941).

Table 11. *Average Cloud-Cover* (*Scale* 0–10), 1901–20. *Observations at* 0800 *hr*. ($z+1$)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Stykkishólmur	7·5	**7·7**	6·9	7·1	6·9	7·0	7·0	6·8	7·5	7·4	7·4	7·2	7·2
Grímsey	7·9	8·1	7·8	8·1	7·5	7·0	7·7	7·8	7·6	7·6	8·0	**8·6**	7·8
Berufjörður	6·2	6·4	6·0	6·5	6·8	6·3	**6·9**	6·6	6·5	6·4	6·4	6·7	6·5
Vestmannaeyjar	**6·9**	6·7	6·2	6·5	6·5	6·9	6·8	6·2	6·8	6·7	6·1	6·5	6·6

The amount of cloud at Stykkishólmur shows a gradual decrease during the period from more than nine-tenths in 1901 to less than six-tenths in 1920. Source: 'The Norwegian and Barents Seas', *Weather in Home Waters and the North-Eastern Atlantic*, vol. II, part 7, pp. 137–40 (Meteorological Office, London, 1941).

Table 12. *Average Rainfall (mm.)*, 1876–1925

	Altitude m.	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	Selected annual means (cm.) Max.	Selected annual means (cm.) Min.
Reykjavík	5	1876–1925	**98**	84	69	62	*48*	49	*48*	51	90	87	95	89	870		
Stykkishólmur	11	1876–1925	**76**	70	48	39	*32*	38	35	39	68	75	72	60	650	88 (1896)	38 (1881)
Stykkishólmur	11	1921–1925	107	85	95	54	*15*	50	50	38	80	81	**111**	76	840	103 (1921)	75 (1923)
Moðruvellir	?	c. 1876–1925	33	31	27	26	24	*22*	*22*	25	29	27	30	**38**	336		
Grímsey	22	c. 1876–1925	25	31	27	*17*	21	23	29	31	43	**52**	45	29	374	66 (1874)	17 (1881)
Berufjörður	18	1876–1925	128	108	78	82	72	67	*66*	81	125	125	113	**138**	1180	174 (1884)	57 (1887)
Vestmannaeyjar	8	1878–1925	**155**	122	112	95	81	81	75	*73*	139	142	133	139	1347		

Sources: (1) B. J. Birkeland and N. J. Föyn, 'Klima von Nordwesteuropa...', *Handbuch der Klimatologie*, Bd. III, Teil L, p. 62 (Berlin, 1932). (2) 'The Norwegian and Barents Seas,' *Weather in Home Waters and the North-Eastern Atlantic*, vol. II, part 7, p. 139 (Meteorological Office, London, 1941).

Table 13. *Average Number of Days with* 1 *mm.* (0·04 *in.*) *or more of Rainfall*, 1901–20

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Stykkishólmur	14	12	9	9	10	*8*	*8*	*8*	13	**15**	13	12	131
Grímsey	*4*	*4*	*4*	*4*	*4*	*4*	6	**7**	**7**	**7**	**7**	5	63
Berufjörður	**13**	10	10	9	8	*6*	7	7	11	12	10	12	115
Vestmannaeyjar	**19**	15	14	13	13	12	13	*10*	16	18	16	16	175

Averages of '41 years'. Source: 'The Norwegian and Barents Seas', *Weather in Home Waters and the North-Eastern Atlantic*, vol. II, part 7, pp. 137–40 (Meteorological Office, London, 1941).

Table 14. *Average Duration (in hours) of 'Bright Sunshine'*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Reykjavík	14	54	99	150	211	**216**	180	165	122	88	31	5	1,334
Akureyri	4	38	74	120	**187**	174	143	110	84	44	17	*1*	996

The sunshine recorder at Reykjavík is only in action from 0300 to 2100 hr. For some weeks in early summer, therefore, a few additional hours of early and late sunshine may be experienced. All available records; Reykjavík 15 years and Akureyri 10 years. Source: *Veðrattan* (Reykjavík, 1924–39).

Table 15. *Average Number of Days with Snowfall*, 1927–38

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Reykjavík	**15**	12	8	5	2	—	—	—	0·3	3	8	10	63
Stykkishólmur	**14**	9	9	5	2	0·1	—	—	0·4	3	6	9	58
Þórustaðir	**17**	13	12	9	3	3	1	0·5	3	11	13	13	99
Grímsey	7	**8**	7	6	2	1	—	—	0·5	5	4	5	46
Berufjörður	**9**	7	5	3	1	0·1	—	—	0·1	1	3	5	35
Vestmannaeyjar	**12**	9	6	4	2	—	—	0·1	0·2	2	4	7	46
Grímsstaðir	**13**	9	11	10	2	3	0·3	0·5	3	9	9	10	80

Source: *Veðrattan* (Reykjavík, 1928–39).

Table 16. *Average Number of Days with Snow-Cover*, 1927–38

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Reykjavík:													
All clear*	6	9	18	25	30	—	—	—	30	29	20	16	274
Partly covered	6	5	6	4	0·5	—	—	—	0·1	1	3	4	31
Covered	19	14	7	2	0·3	—	—	—	0	1	7	11	60
Stykkishólmur:													
All clear	5	10	11	21	30	—	—	—	—	27	18	11	255
Partly covered	4	2	7	5	0·4	—	—	—	—	1	5	8	32
Covered	22	16	14	4	0·9	—	—	—	—	3	7	12	78
Þórustaðir:													
All clear	5	3	5	6	27	30	—	—	29	20	9	5	201
Partly covered	2	6	4	13	3	0·1	—	—	0	3	6	5	43
Covered	24	19	22	11	1	0·1	—	—	0·5	8	15	21	121
Grímsey:													
All clear	7	8	9	10	28	30	—	—	—	25	18	15	241
Partly covered	14	14	16	18	3	0·1	—	—	—	5	9	13	92
Covered	10	6	6	3	0	0	—	—	—	1	3	3	32
Berufjörður:													
All clear	7	10	13	21	30	—	—	—	30	30	25	18	275
Partly covered	9	6	10	5	0·3	—	—	—	0	0·3	1	4	37
Covered	15	12	7	4	0·8	—	—	—	0·1	0·6	4	9	53
Vestmannaeyjar:													
All clear	15	16	24	26	30	—	—	—	—	30	26	23	312
Partly covered	7	5	4	2	0·3	—	—	—	—	0·8	2	4	25
Covered	9	7	3	2	0·3	—	—	—	—	0·2	2	4	28
Grímsstaðir:													
All clear	1	4	5	6	25	28	—	31	28	14	6	3	181
Partly covered	4	3	4	7	3	0·3	—	0·1	1	1	6	7	37
Covered	26	21	22	17	3	2	—	0·1	1	16	18	21	147

For definitions of these terms see p. 109. Averages rounded to whole days when more than 24 hr. Source: *Veðrattan* (Reykjavík, 1928–39).

Appendix VII. AGRICULTURAL STATISTICS

Table 1. *Chief improvements in Cultivation*, 1895–1939

Year	Levelling of homefields ha.	New cultivation of homefields* ha.	Gardens ha.	Drainage†		Fencing km.	Barns	
				Covered drains length in m.	Open ditches cu.m. of soil removed		Dry cu.m.	Silo cu.m.
1895–1904	1,588	—	—	—	—	759	—	—
1905–1914	2,735	545	—	—	—	3,747	—	—
1915–1924	1,634	769	123·4	150,932	—	2,213	—	—
1925	182	399	11·1	41,552	41,962	665	55,484	2,038
1926	178	544	13·5	33,974	55,899	673	66,582	3,099
1927	216	703	14·4	41,938	72,694	763	58,055	4,241
1928	368	1,068	20·3	87,179	161,872	1,535	74,651	2,118
1929–30	308	1,660	12·4	54,242	98,894	1,295	86,837	2,719
1931	345	1,466	16·9	79,031	136,091	1,000	59,215	4,707
1932	445	1,329	48·8	105,765	175,330	480	28,784	1,920
1933	316	1,101	62·2	64,092	99,348	325	35,478	1,771
1934	363	1,020	48·6	75,476	117,155	465	75,492	2,967
1935	351	986	60·8	85,076	121,352	506	69,101	10,763
1936	299	757	156·0	76,820	114,760	422	88,464	7,069
1937	254	647	108·8	68,530	94,850	389	112,778	6,541
1938	307	693	143·5	99,200	177,050	483	—	8,072
1939	320	737	203·0	79,680	111,610	431	—	—

* Before 1905 no distinction was made between the levelling of old *tún* and the preparation of new *tún*.

† These figures include only the draining of manured ground. The draining of uncultivated grassland is not included.

Sources: (1) *Búnaðarskýrslur*, 1935, p. 14; 1938, pp. 13–14 (Reykjavík). (2) *Árbók Hagstofu Íslands*, pp. 40–1 (Reykjavík, 1930). (3) A. G. Eylands, *Tidsskrift for Landøkonomi*, p. 117 (Copenhagen, 1938).

Table 2. *Area of Cultivated Land and Yield*, 1900–1939

Year	Cultivated land		Yield of cultivated land			
	Homefields ha.	Market gardens ha.	Hay from homefields 100 kg.	Hay from wild meadows 100 kg.	Potatoes barrels	Turnips barrels
1900	16,843	249	—	—	—	—
1901–1905 (av.)	—	—	524,000	1,002,000	18,820	19,040
1906–1910 (av.)	—	—	536,000	1,059,000	24,060	14,580
1910	18,591	325	—	—	—	—
1911–1915 (av.)	—	—	574,000	1,138,000	24,600	13,800
1916–1920 (av.)	—	—	513,000	1,176,000	28,580	12,440
1920	22,031	453	—	—	—	—
1921–1925 (av.)	—	—	647,000	1,039,000	22,765	9,562
1926–1930 (av.)	—	—	798,000	1,032,000	39,737	14,403
1930	26,184	455	—	—	—	—
1931–1935 (av.)	—	—	1,101,000	1,022,000	42,642	17,000
1935	32,029	544	1,126,000	1,006,000	46,054	15,288
1936	33,398	657	1,149,596	1,138,539	84,873	24,677
1937	34,156	657	1,004,535	1,045,705	63,168	14,821
1938	34,848	737	1,097,561	996,544	64,677	17,636
1939	—	—	1,324,012	1,010,279	119,601	25,715

Sources: (1) A. G. Eylands, *Tidsskrift for Landøkonomi*, p. 113 (Copenhagen, 1938). (2) *Árbók Hagstofu Íslands*, pp. 8–9 (Reykjavík, 1930).

Table 3. *Livestock*, 1703–1939*

Year	Cattle			Sheep			Horses			Other livestock	
		Per 100 persons			Per 100 persons			Per 100 persons			
	Total thousands	Relation to total number of inhabitants	Relation to persons living by agriculture	Total thousands	Relation to total number of inhabitants	Relation to persons living by agriculture	Total thousands	Relation to total number of inhabitants	Relation to persons living by agriculture	Poultry thousands	Furred animals total
1703	35·8	70	—	278·9	550	—	26·9	53	—	—	—
1800	23·3	51	c. 58	304·2	644	c. 760	28·3	60	c. 71	—	—
1849	25·5	43	c. 55	619·1	1,048	c. 1,330	37·6	64	c. 81	—	—
1900	23·6	33	51	469·5	614	1,021	41·7	53	91	—	—
1910	26·4	31	59	578·6	671	1,334	44·8	53	103	—	—
1920	23·5	25	58	578·8	611	1,426	50·6	53	125	15·5	—
1930	30·1	28	77	690·2	642	1,770	48·9	45	125	44·4	—
1935	35·6	31	c. 91	656·1	569	c. 1,682	45·0	39	c. 115	80·9	1,669
1936	37·0	32	c. 95	653·3	561	c. 1,700	46·0	39	c. 120	86·9	1,833
1937	37·6	32	c. 96	655·4	558	c. 1,700	47·2	40	c. 127	84·8	2,650
1938	36·7	31	—	591·9	500	—	49·0	41	—	86·1	5,337
1939	37·4	—	—	593·8	—	—	52·5	44	—	79·4	5,827

* These figures are based on official statistics, but are approximate only. There are reasons for believing that the actual figures were considerably higher.

Sources: (1) A. G. Eylands, *Tidsskrift for Landøkonomi*, pp. 120–2 (Copenhagen, 1938). (2) Þ. Þorsteinsson, *Iceland, 1936*, pp. 60–3 (Reykjavík, 1936). (3) *Búnaðarskýrslur*, p. 7 (Reykjavík, 1938). (4) *Statistical Bulletin* (Reykjavík, 1936–40).

Table 4. *Main Agricultural Produce*, 1901–1937

Year	Population engaged in agriculture		Total production						Production per head of population						
	Number	% of population	Mutton 1000 kg.	Other kinds of meat 1000 kg.	Milk 1000 kg.	Wool 1000 kg.	Potatoes and turnips 1000 kg.	Eggs thousands	Mutton kg.	Other meat kg.	Milk kg.	Wool kg.	Potatoes and turnips kg.	Number of eggs	Value of agricultural produce in Icel. kr.
1901	45,993	58·6	3,255	1,030	38,488	603	2,724	397	71	22	837	13	59	9	7,554,000
1905	44,702	54·6	3,841	1,126	40,890	679	4,123	397	86	25	915	15	92	9	8,364,000
1910	43,411	51·0	4,462	1,084	39,826	723	4,542	544	107	25	917	17	105	13	9,292,000
1915	42,013	46·7	2,370	1,005	40,843	695	4,251	921	128	24	972	17	101	22	16,334,000
1920	40,614	42·0	5,623	994	38,006	723	4,433	1,767	138	24	936	18	109	44	30,875,000
1925	39,809	39·8	5,772	1,115	45,761	707	4,623	2,512	145	28	1,150	18	116	63	30,082,000
1930	39,003	35·8	6,896	1,189	54,794	863	4,868	5,066	177	30	1,405	22	125	130	22,147,000
1934	39,900	34·5	7,418	1,302	59,899	874	6,417	8,442	190	33	1,536	22	165	216	24,307,000
1935	c. 39,000	—	7,094	1,350	61,614	820	6,144	9,229	182	35	1,580	21	158	237	25,355,000
1936	c. 39,000	—	6,964	1,400	65,449	817	10,895	9,791	178	36	1,678	21	279	251	28,459,000
1937	c. 39,000	—	6,882	1,400	66,457	818	7,900	9,677	176	36	1,704	21	203	248	29,257,000

Sources: (1) A. G. Eylands, *Tidsskrift for Landøkonomi*, p. 124 (Copenhagen, 1938). (2) V. Stefansson, *Iceland: the First American Republic*, p. 270 (New York, 1939).

Table 5. *The Eiderdown Industry*

Quantity of down produced and exported, with average value				Quantity of down collected, 1914–38					
Years	Production kg.	Export kg.	Value per kg. Icel. krónur	Year	kg.	Year	kg.	Year	kg.
1897–1900	3,345	3,585	20·94	1914	3,921	1923	3,815	1932	3,536
1901–1905	3,299	3,032	20·98	1915	4,290	1924	3,850	1933	3,282
1906–1910	3,472	3,500	21·38	1916	4,355	1925	3,838	1934	3,161
1911–1915	4,055	3,800	29·89	1917	3,915	1926	3,963	1935	2,786
1916–1920	3,679	1,464	34·56	1918	3,490	1927	4,138	1936	3,011
1921–1925	3,715	3,059	48·41	1919	3,238	1928	4,287	1937	3,084
1926–1930	4,007	2,895	41·49	1920	3,393	1929	4,018	1938	2,852
1931–1935	3,234	1,905	35·40	1921	3,349	1930	3,631		
1936–1938	2,978	2,141	56·86	1922	3,719	1931	3,400		

Source: *Fiskiskýrslur og Hlunninda*, 1938, p. 16; 1922, p. 20 (Reykjavík, 1925 and 1940).

Appendix VIII. FISHERY STATISTICS*

Table 1. *Number and Tonnage (g.r.t.) of Vessels in the Icelandic Fishing Fleet*, 1905–38

	Sailing vessels		Motor vessels (above 12 tons)		Steam trawlers		Other steam vessels		Motor boats (under 12 tons)	Rowing boats
	No.	Tons	No.	Tons	No.	Tons	No.	Tons	No.	No.
1905	—	—	—	—	1	151	3	255	—	—
1910	—	—	—	—	6	1,106	2	199	—	—
1915	95	3,721	40	990	20	5,059	6	1,248	391	1,121
1920	39	1,190	120	3,538	28	8,730	2	223	355	1,002
1925	11	328	201	5,691	47	13,570	27	2,769	394	811
1930	0	—	224	5,506	41	13,888	35	3,865	787	171
1935	0	—	277	6,588	37	12,417	23	2,682	665	117
1936	0	—	286	7,006	38	13,091	30	3,638	620	94
1937	0	—	275	6,899	37	12,771	27	3,136	624	116
1938	0	—	286	7,324	37	12,771	27	3,087	651	112

Sources: *Fiskiskýrslur og Hlunninda, Hagskýrslur Íslands*, 1912, p. 8; 1929, pp. 5–8; 1938, pp. 5–8 (Reykjavík, 1914, 1931, and 1940 respectively). Before 1915 the statistics make no distinction between sailing vessels and motor vessels or small motor boats and rowing boats.

Table 2. *Registered Icelandic Vessels in* 1940

	Steam vessels		Motor vessels		Total	
	No.	Gross tonnage	No.	Gross tonnage	No.	Gross tonnage
Size of vessel (gross reg. tons):						
1000–2000	8	11,185	1	1,347	9	12,532
500–1000	4	3,020	—	—	4	3,020
100– 500	49	13,768	11	2,458	60	16,226
50– 100	17	1,409	33	2,098	50	3,507
30– 50	—	—	62	2,434	62	2,434
12– 30	—	—	241	4,436	241	4,436
Total	78	29,382	348	12,773	426	42,155
Types of vessel:						
Trawlers	35	12,091	—	—	35	12,091
Other fishing vessels	29	3,321	339	9,645	368	12,966
Passenger ships	6	8,121	3	1,697	9	9,818
Freight ships	6	5,512	3	798	9	6,310
Government Inspection Ships	1	226	2	569	3	795
Salvage ship	—	—	1	64	1	64
Tug	1	111	—	—	1	111
Total 1940	78	29,382	348	12,773	426	42,155
1939	77	29,500	343	11,981	420	41,481
1938	79	29,756	316	9,465	395	39,221

Source: *Statistical Bulletin*, vol. x, no. 1 (Reykjavík, 1941).

* All the tables in this Appendix refer to the catch of the Icelandic fishing fleet.

Table 3. *The Catch of Cod and Cod-like Species (in thousands of fish)*, 1897–1937

	Cod	Small cod	Had-dock	Ling	Other species	Total
1897–1900 (av.)	4,639	4,925	4,972	72	289	14,897
1901–1905 (av.)	5,823	6,167	4,223	111	707	17,031
1906–1910 (av.)	7,223	7,182	2,546	217	926	18,094
1911–1915 (av.)	8,735	10,406	2,175	172	1,340	22,828
1916–1920 (av.)	10,566	8,198	3,749	238	1,341	24,092
1921–1925 (av.)	17,933	15,970	3,487	256	2,459	40,105
1926–1930 (av.)	28,505	26,845	3,511	171	3,779	62,811
1931–1935 (av.)	31,511	40,095	2,374	75	1,789	75,844
1936	17,796	9,986	1,469	224	2,366	31,841
1937	18,896	10,572	1,404	108	2,376	33,356

Source: *Fiskiskýrslur og Hlunninda*, 1938; *Hagskýrslur Íslands*, no. 105, p. 10 (Reykjavík, 1940).

Table 4. *Weight of Cod taken (fresh, without head, gutted and split), in thousands of kg.*, 1930–8.

	Trawlers	Other decked vessels	Boats of less than 12 tons	Total
1930	72,610	73,777	48,226	194,613
1931	65,386	54,948	41,933	162,267
1932	50,330	57,139	41,312	148,781
1933	66,683	66,080	39,861	172,624
1934	63,929	64,231	35,239	163,399
1935	53,156	56,589	24,593	134,338
1936	33,396	30,205	17,817	81,418
1937	29,519	34,463	20,564	84,546
1938	36,533	34,666	23,021	94,220

Sources: *Fiskiskýrslur og Hlunninda*, 1934 and 1938; *Hagskýrslur Íslands*, no. 90, p. 11; no. 105, p. 10 (Reykjavík, 1936, 1940).

Table 5. *The Catch of Herring off Iceland*, 1937–40

	1937			1938		
	North coast Barrels	South-west coast Barrels	Total Barrels	North coast Barrels	South-west coast Barrels	Total Barrels
Pickled herrings:						
Common salted	84,220	368	84,588	107,966	—	107,966
Special cure salted				52,920	—	52,920
Matjes	74,194	—	74,194	111,001	—	111,001
Spiced	37,877	—	37,877	47,995	—	47,995
Sweetened	13,723	—	13,723	17,288	—	17,288
Special cure	257	358	615	1,471	9,038	10,509
Total	210,271	726	210,997	338,641	9,038	347,679
Uncured herrings delivered to herring-oil factories (hl.)	2,162,007	10,131	2,172,138	1,520,956	9,460	1,530,416

	1939			1940		
	North coast Barrels	South-west coast Barrels	Total Barrels	North coast Barrels	South-west coast Barrels	Total Barrels
Pickled herrings:						
Common salted	68,484	—	68,484	411	—	411
Special cure salted	78,495	—	78,495	60,955	—	60,955
Matjes	37,649	—	37,649	21,193	—	21,193
Spiced	44,306	—	44,306	1,712	—	1,712
Sweetened	16,096	—	16,096	2,341	—	2,341
Special cure	1,681	13,311	14,992	2,755	600	3,355
Total	246,711	13,311	260,022	89,367	600	89,987
Uncured herrings delivered to herring-oil factories (hl.)	1,152,913	16,321	1,169,234	2,465,331	11,407	2,476,738

Source: *Statistical Bulletin*, vol. VII, no. 12; vol. VIII, no. 12; and vol. X, no. 2 (Reykjavík, 1938, 1939 and 1941). 1 barrel (*síldartunna*) = 1·0821 hl.

Table 6. *The Catch of Herring off Iceland and the Export of Herring Products*, 1921–38

	Catch of fresh herring hl.	Export of salted and cured herring metric tons	Export of herring oil metric tons	Export of herring meal* metric tons
1921	102,482	11,216	300	18
1922	282,709	20,615	1,441	1,265
1923	325,392	21,499	3,081	3,191
1924	236,768	11,741	2,568	379
1925	341,054	20,205	2,701	2,528
1926	208,073	15,204	2,461	2,507
1927	597,347	24,631	6,355	7,137
1928	576,352	18,080	6,151	6,694
1929	566,732	13,873	6,346	7,327
1930	686,801	18,023	5,796	6,373
1931	776,077	16,502	8,361	6,236
1932	710,252	25,273	9,837	7,618
1933	755,244	23,227	9,595	9,991
1934	772,208	20,679	8,526	7,689
1935	679,000	15,008	7,760	5,324
1936	1,312,569	25,654	15,156	12,462
1937	2,188,799	20,456	20,549	25,447
1938	1,731,963	32,867	22,827	17,900

Sources: *Hagskýrslur Íslands, Fiskiskýrslur og Hlunninda* and *Verslunarskýrslur*, 1921–38 (Reykjavík, 1924–40).

* A considerable proportion of the meal is used in Iceland as cattle food.

Appendix IX

TRADE STATISTICS

Table 1. *Value of Icelandic Imports and Exports*, 1896–1940 (*in* 1,000 *Kr.*)

	Imports	Exports	Total imports and exports	Surplus of exports (+) or imports (−)
1896–1900 (av.)	5,966	7,014	12,980	1,048
1901–1905 (av.)	8,497	10,424	18,921	1,927
1906–1910 (av.)	11,531	13,707	25,238	2,176
1911–1915 (av.)	18,112	22,368	40,480	4,256
1916–1920 (av.)	53,709	48,454	102,162	−5,256
1921–1925 (av.)	56,562	64,211	120,774	7,650
1926–1930 (av.)	64,853	66,104	130,957	1,251
1931	48,111	48,009	96,120	−102
1932	37,351	47,785	85,136	10,434
1933	49,373	51,833	101,206	2,460
1934	51,723	47,854	99,577	−3,869
1935	45,470	47,772	93,242	2,302
1936	43,053	49,642	92,695	6,589
1937	53,309	58,988	112,297	5,679
1938	50,479	58,607	109,086	8,128
1939	64,163	70,536	134,699	6,373
*1940	73,955	132,908	206,836	58,953

* Provisional figures. Final figures probably slightly higher.

Sources: (1) *Árbók Hagstofu Íslands* (Reykjavík, 1930). (2) *Verslunarskýrslur* (Reykjavík, 1926–38). (3) *Statistical Bulletin* (Reykjavík, monthly to April 1940). (4) *Íslands Adressebog* (Reykjavík, 1940).

Table 2. *Chief Groups of Icelandic Imports*, 1933–5.

	Total value in 1,000 Kr.			Percentage of total value		
	1933	1934	1935	1933	1934	1935
Foodstuffs	4,187	4,413	4,454	8·5	8·8	9·8
Coffee, sugar, tobacco, etc.	3,474	3,255	3,416	7·0	6·3	7·5
Other consumables	3,431	3,360	2,162	7·0	6·5	4·8
Textiles and clothes	8,352	7,607	5,799	16·9	14·7	12·7
Fuel and lighting materials	5,542	5,649	5,980	11·2	10·9	13·1
Building materials	4,860	5,986	4,530	9·8	11·6	10·0
Materials for the fishing trade	7,813	7,490	6,074	15·8	14·5	13·4
Materials for farming	2,016	2,361	1,851	4·1	4·6	4·1
Various materials for production	9,698	11,602	11,204	19·7	22·4	24·6
Total	49,373	51,723	45,470	100·0	100·0	100·0

Source: Þ. Þorsteinsson, *Iceland, 1936*, p. 94 (Reykjavík, 1936).

Table 3. *Chief Groups of Icelandic Exports*, 1901–38 (*values in* 1,000 *Kr.*)

	Fish and fish products	'Natural' produce*	Products from whaling	Agricultural produce	Other exports	Total
1901–05 (av.)	6,178	149	1,865	2,192	40	10,424
1906–10 (av.)	8,823	152	1,669	2,986	77	13,707
1911–15 (av.)	16,574	192	370	5,091	141	22,368
1916–20 (av.)	36,147	176	—	10,879	1,252	48,454
1921–25 (av.)	54,664	354	—	8,445	748	64,211
1926–30 (av.)	58,072	400	—	7,319	313	66,104
1931–35 (av.)	43,473	183	9	4,634	352	48,651
1934	42,868	177	—	4,516	293	47,854
1935	40,852	302	56	6,354	208	47,772
1936	41,189	375	171	7,689	218	49,642
1937	47,795	369	250	9,837	737	58,988
1938	48,423	335	440	8,764	645	58,607
			Percentage of total value			
1901–05 (av.)	59·3	1·4	17·9	21·0	0·4	100·0
1906–10 (av.)	64·3	1·1	12·2	21·8	0·6	100·0
1911–15 (av.)	74·1	0·9	1·6	22·7	0·7	100·0
1916–20 (av.)	74·6	0·4	—	22·4	2·6	100·0
1921–25 (av.)	85·1	0·6	—	13·1	1·2	100·0
1926–30 (av.)	87·9	0·6	—	11·1	0·4	100·0
1931–35 (av.)	89·4	0·4	0·0	9·5	0·7	100·0
1934	89·6	0·4	—	9·4	0·6	100·0
1935	85·5	0·6	0·1	13·3	0·5	100·0
1936	83·0	0·8	0·3	15·5	0·4	100·0
1937	81·0	0·6	0·4	16·7	1·3	100·0
1938	82·6	0·6	0·8	15·0	1·0	100·0

* i.e. eiderdown, ptarmigan, sealskins and foxskins, etc.
Source: *Verslunarskýrslur*, p. 18 (Reykjavík, 1938).

Table 4. *Details of Imports to Iceland*, 1933–5 (*values in* 1,000 *Kr.*)

	1933	1934	1935
Cereals	3,123	3,308	3,388
Garden produce and fruits	1,396	1,599	1,452
Coffee and coffee substitutes	638	497	542
Sugar	1,190	1,052	1,148
Tobacco and cigars	1,061	1,071	894
Wines and spirits	355	377	648
Yarn, thread, rope, etc.	2,220	2,009	2,276
Dry goods	3,335	3,155	2,458
Clothes	3,159	2,822	1,740
Other textiles	928	996	724
Footwear	1,649	1,581	1,161
Petroleum products	1,382	1,921	1,654
Timber, unwrought	2,224	2,665	2,499
Timber, wrought	1,310	1,121	1,031
Paper and manufactures of paper	1,399	1,515	1,239
Coal	4,156	3,723	4,323
Cement	695	835	693
Salt	2,846	1,793	1,665
Stone-, earthen-, and glassware	922	966	757
Iron and ironmongery	4,183	5,048	3,668
Ships and boats	405	1,666	726
Vehicles and machines	3,870	4,874	4,513
Other goods	6,857	7,129	6,271
Total	49,373	51,723	45,470

Source: Þ. Þorsteinsson, *Iceland, 1936*, p. 94 (Reykjavík, 1936).

Table 5. *Details of Chief Icelandic Exports*, 1933–40* (*values in* 1,000 *Kr.*)

	1933	1934	1935	1936	1937	1938	1939	1940*
Klipfish (cured fish)	26,358	19,747	17,240	11,555	12,339	10,246	10,551	15,161
Saltfish (uncured)	4,324	4,539	3,534	2,888	3,667	6,973	6,546	4,828
Freshfish (on ice and frozen)	3,375	4,859	5,206	4,603	4,795	5,732	8,925	67,741
Herring, cured	4,701	5,338	6,080	6,890	5,833	9,514	11,661	2,759
Fish and herring meal	3,167	2,812	1,883	3,649	6,585	4,722	7,195	9,320
Cod-liver oil	2,663	3,236	3,799	3,590	4,145	4,039	5,729	13,188
Herring oil	1,710	1,344	1,782	5,127	8,678	5,234	6,297	12,653
Mutton, salted	666	706	1,103	747	794	908	1,131	294
Mutton, frozen	794	1,278	1,405	1,838	2,213	2,412	1,863	1,832
Wool	1,759	1,024	1,306	1,878	2,960	1,415	2,096	743
Sheep skins, green salted	941	997	1,536	1,806	2,428	2,622	3,276	1,300
Other products	1,375	1,974	2,898	5,071	4,551	4,790	5,226	3,089
Total	51,833	47,854	47,772	49,642	58,988	58,607	70,536	132,908

* Provisional figures. Final figures probably slightly higher.

Sources: (1) Þ Þorsteinsson, *Iceland, 1936*, p. 95 (Reykjavík, 1936). (2) *Statistical Bulletin* (Reykjavík, 1938–41).

Table 6. *Imports to Iceland from Foreign Countries*, 1934–40

(Values in 1,000 Kr.)

	1934	1935	1936	1937	1938	1939	1940*
Great Britain	15,673	13,352	11,515	15,226	14,152	15,604	32,206
Denmark	12,167	9,563	7,059	7,884	7,528	14,003	3,183
Germany	6,254	6,088	9,444	11,010	11,891	10,413	420
Spain	1,675	2,777	1,753	193	122	510	1,219
Norway	6,150	4,834	2,932	5,107	4,382	5,890	2,512
Sweden	2,715	3,281	4,471	4,968	4,161	4,884	1,169
Portugal	236	164	393	162	318	66	669
Italy	1,212	2,112	2,369	4,366	4,435	5,426	3,504
U.S.A.	1,078	665	510	711	633	2,316	19,535
Other countries	4,563	2,634	2,607	3,682	2,857	5,051	9,538
Total	51,723	45,470	43,053	53,309	50,479	64,163	73,955

Percentage of total value

	1934	1935	1936	1937	1938	1939	1940
Great Britain	30·3	29·4	26·7	28·6	28·0	24·3	43·5
Denmark	23·5	21·0	16·4	14·8	14·9	21·8	4·3
Germany	12·1	13·4	21·9	20·6	23·6	16·2	0·6
Spain	3·2	6·1	4·1	0·4	0·2	0·8	1·7
Norway	11·9	10·6	6·8	9·6	8·7	9·2	3·4
Sweden	5·3	7·2	10·4	9·3	8·2	7·6	1·6
Portugal	0·5	0·4	0·9	0·3	0·6	0·1	0·9
Italy	2·3	4·6	5·5	8·2	8·8	8·5	4·7
U.S.A.	2·1	1·5	1·2	1·3	1·3	3·6	26·4
Other countries	8·8	5·8	6·1	6·9	5·7	7·9	12·9
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0

* Provisional figures. Final figures probably slightly higher.

Sources: (1) Þ. Þorsteinsson, *Iceland, 1936*, pp. 95–96 (Reykjavík, 1936). (2) *Statistical Bulletin* (Reykjavík, monthly to January 1941). (3) *Statesman's Yearbook* (London, 1940 and 1941).

Table 7. *Exports from Iceland to Foreign Countries*, 1934–40

(Values in 1,000 Kr.)

	1934	1935	1936	1937	1938	1939	1940*
Great Britain	6,484	7,276	7,417	10,385	12,008	12,269	91,333
Denmark	3,562	3,941	3,914	5,300	5,747	6,674	3,376
Germany	4,271	5,106	8,160	11,175	9,432	7,608	—
Spain	7,921	6,115	1,360	364	2,918	11	6,011
Norway	4,049	3,745	4,984	7,467	4,990	7,670	1,488
Sweden	2,999	4,460	4,002	4,065	5,662	8,735	989
Portugal	8,305	7,620	6,169	5,411	874	5,358	4,748
Italy	5,568	2,808	2,832	2,691	4,831	4,800	4,549
U.S.A.	2,598	4,220	5,432	4,529	5,320	7,747	18,153
Other countries	2,097	2,481	5,372	7,601	6,825	9,664	2,261
Total	47,854	47,772	49,642	58,988	58,607	70,536	132,908

Percentage of total value

	1934	1935	1936	1937	1938	1939	1940
Great Britain	13·5	15·2	15·0	17·6	20·5	17·4	68·7
Denmark	7·4	8·3	7·9	9·0	9·8	9·5	2·6
Germany	8·9	10·7	16·4	18·9	16·1	10·8	—
Spain	16·6	12·8	2·8	0·6	5·0	0·0	4·5
Norway	8·5	7·8	10·0	12·6	8·5	10·9	1·1
Sweden	6·3	9·3	8·0	6·9	9·6	12·3	0·7
Portugal	17·4	16·0	12·4	9·2	1·5	7·6	3·6
Italy	11·6	5·9	5·7	4·6	8·2	6·8	3·4
U.S.A.	5·4	8·8	11·0	7·7	9·1	11·0	13·7
Other countries	4·4	5·2	10·8	12·9	11·7	13·7	1·7
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0

* Provisional figures. Final figures probably slightly higher.

Sources: (1) Þ. Þorsteinsson, *Iceland, 1936*, pp. 95–96 (Reykjavík, 1936). (2) *Statistical Bulletin* (Reykjavík, monthly to January 1941). (3) *Statesman's Yearbook* (London, 1940 and 1941).

Appendix X

DISTANCES BY ROAD

(1) *From Reykjavík to*

	Km.	Miles
Akranes	112	69·6
Akureyri	439	273·9
Álafoss	17	10·6
Ásbyrgi	595	369·7
Ásólfsstaðir	118	73·3
Bakkasel	389	242·3
Bessastaðir	12	7·5
Blönduós	288	178·9
Bólsstaðarhlíð	317	197·6
Borðeyri	208	129·3
Borgarnes (round Hvalfjörður)	131	81·4
Breiðabólsstaður	298	185·2
Breiðamýri	496	308·2
Brúarland (in Mosfellssveit)	16	9·9
Búðardalur (round Hvalfjörður)	192	119·3
Búðardalur (via Kaldadalur)	225	139·8
Búðir (on Snæfellsnes) (round Hvalfjörður)	235	146·0
Dalsmynni	147	91·3
Dalvík	462	287·1
Dettifoss	624	387·7
Dverghamar	307	191·4
Egilsstaðir á Völlum	786	488·4
Eskifjörður	836	519·5
Eyrarbakki	71	44·1
Ferstikla (round Hvalfjörður)	84	52·2
Fornihvammur (via Kaldadalur)	201	124·7
Fornihvammur (round Hvalfjörður)	168	104·4
Galtalækur	122	75·8
Garður	59	36·7
Gaulverjabær	74	45·9
Geysir	118	73·3
Goðafoss	487	302·6
Grímsstaðir	648	402·7
Grindavík (Járngerðarstaðahverfi)	56	34·8
Grótta	4	2·5
Grýta í Ölfusi	48	29·9
Gufunes	12	7·5
Gullfoss	123	76·4
Hafnarfjörður	10	6·2
Haganesvík	434	269·7
Hlíðarendi	126	78·3
Hofsós	404	251·0
Hólmavík	294	182·7
Húsafell	116	72·1
Húsavík	534	331·8
Hvammstangi	237	147·3

	Km.	Miles
Hveradalur (ski hut)	34	21·1
Hveragerði	46	28·6
Hveravellir	219	136·1
Hvítárbrú (round Hvalfjörður)	116	72·1
Hvítárnes (mountain station)	171	106·3
Hvítárvatn	160	99·4
Keflavík	50	31·0
Kerlingarfjöll (mountain station)	199	123·7
Kirkjubæjarklaustur	294	182·7
Kirkjuvogur (Hafnir)	54	33·6
Kollafjörður	21	13·0
Kolviðarhóll	31	19·3
Kópasker	630	391·5
Króksfjarðarnes	256	159·1
Laugarvatn (via Þingvellir)	72	44·7
Laugarvatn (via Sogsbrú)	95	59·0
Laxá (in Kjós)	48	29·8
Ljósafoss	75	46·6
Lækjarbotnar	17	10·6
Máfahlíð (on Búlandshöfði; round Hvalfjörður)	254	157·8
Markarfljótsbrú	133	82·7
Múli á Landi	112	70·2
Mælifell	350	218·1
Möðrudalur	684	425·0
Ólafsvík (round Hvalfjörður)	252	156·6
Reyðarfjörður	821	510·2
Reykholt	138	85·8
Reykjahlíð (Mývatn)	542	336·8
Reykjanes	69	42·9
Sandgerði	64	39·8
Sauðárkrókur	364	226·8
Selfoss	59	36·7
Seyðisfjörður	803	499·0
Skagaströnd	311	193·9
Skútustaðir	528	328·1
Stokkseyri	73	45·4
Stykkishólmur	227	141·0
Varmahlíð	338	210·0
Vatnsendi	8	5·0
Viðfjörður	859	533·8
Víðimýri	335	208·2
Vífilsstaðir	9	5·6
Vík í Mýrdal	202	125·5
Þingvellir	49	30·4
Þjórsártún	77	47·8
Þykkvibær	112	70·2
Þyrill (Hvalförður)	72	44·7
Ægissíða	95	59·0

(2) *From Borgarnes to*

	Km.	Miles		Km.	Miles
Akranes	71	44·1	Húsavík	425	264·1
Akureyri	330	205·0	Hvammstangi	128	79·5
Blönduós	179	111·2	Hvítárbrú (near Ferjukot)	15	9·3
Borðeyri	99	61·5	Norðtunga	39	24·2
Breiðamýri	387	240·5	Norðurárbrú (Skagafjörður)	267	165·9
Brúarfoss	30	18·6	Ólafsvík	127	78·9
Búðardalur	83	51·6	Reykholt	44	27·3
Búðir (on Snæfellsnes)	104	64·6	Reykjavík (via Kaldadalur)	182	113·1
Dalsmynni (Norðurárdalur)	38	23·6	Reykjavík (round Hvalfjörður)	131	81·4
Fnjóskárbrú	358	222·5	Sauðárkrókur	255	158·5
Fornihvammur	59	36·7	Skútustaðir	419	260·4
Goðafoss	378	234·9	Stykkishólmur	102	63·4
Grund (Skorradalur)	27	16·8	Víðimýri	226	140·4
Gröf (Miklaholtshrepp)	60	37·3			
Hreðavatn	32	19·9			
Húsafell	66	41·0			

(3) *From Akureyri to*

	Km.	Miles		Km.	Miles
Akranes	379	235·5	Hjalteyri	26	16·2
Ásbyrgi	156	96·9	Hofsós	115	71·4
Bakkasel	50	31·1	Húsavík	95	59·0
Blönduós	251	160·0	Laufás	53	33·0
Borgarnes	330	205·0	Munkaþverá	18	11·2
Breiðamýri	57	35·4	Mýri (Bárðardalur)	83	51·6
Dalvík	45	28·0	Möðrudalur	245	152·2
Dettifoss	184	114·3	Möðruvellir	14	8·7
Egilsstaðir	347	215·6	Reyðarfjörður	382	237·4
Eskifjörður	397	246·7	Reykjahlíð	103	63·9
Fnjóskárbrú	28	17·4	Reykjavík	439	273·9
Fornihvammur	271	168·4	Sauðárkrókur	75	46·6
Goðafoss	48	30·0	Seyðisfjörður	364	226·2
Grenivík	60	37·3	Skútustaðir	89	55·3
Grímsstaðir	209	129·9	Svartárkot	94	58·4
Grund	19	11·8	Vermahlið	101	62·7
Haganesvík	115	71·4	Viðfjörður	420	261·0
Hallormsstaður	377	234·3	Urðir (Svarfaðardalur)	61	37·9

(4) *From Ísafjörður to*

	Km.	Miles		Km.	Miles
Dýrafjörður	41	25·5	Hnífsdalur	35	21·7
Flateyri	25	15·5	Núpsskóli	48	29·8

(5) *From Húsavík to the east*

Ásbyrgi	61	37·9	Kópasker	96	59·2
Dettifoss	89	55·3	Leirhöfn	111	69·8
Eskifjörður	302	187·6	Möðrudalur	150	93·2
Egilsstaðir	252	156·6	Reyðarfjörður	287	178·3
Grenjaðarstaður	31	19·3	Seyðisfjörður	280	173·9
Grímsstaðir	114	70·8	Skjöldólfsstaðir	195	121·2
Hallormsstaður	282	175·2			

(6) *From Seyðisfjörður to*

	Km.	Miles		Km.	Miles
Akureyri	364	226·2	Jökulsárbrú	52	32·3
Brekka	57	35·4	Ketilsstaðir	46	28·6
Egilsstaðir	26	16·1	Möðrudalur	155	96·3
Eiðar	35	21·7	Reyðarfjörður	57	35·4
Eskifjörður	72	44·7	Skjöldólfsstaðir	82	50·9
Fossvellir	54	33·6	Valþjófsstaður	69	42·9
Hallormsstaður	65	40·4	Viðfjörður	104	64·6

(7) *From Höfn (Hornafjörður) to*

	Km.	Miles		Km.	Miles
Almannaskarð	12	7·5	Hólar	6	3·7
Hoffell	21	13·0	Jökulsá í Lóni	24	14·9

LIST OF CONVERSION TABLES

METRIC AND BRITISH UNITS[1]

It is customary to think of the 'metre' and the 'yard' as representing unalterable units of length. This is not so. The metre was originally intended to be the 10,000,000th part of the earth's meridional quadrant. But the accurate determination of this length proved to be extremely difficult—partly for technical reasons, and partly because of different conceptions of the 'figure of the earth'. In view of these difficulties it became necessary to define the length of the metre in terms of suitable metal bars measured under specified conditions of temperature, pressure, humidity, etc. Similar standard bars were also used to define the length of other units such as the yard. As all these metallic standards are subject to change, conversion tables differ according to the date of comparison between different bars. The tables that follow are based on the comparison between the yard and the metre made in 1895. This made 1 metre equivalent to 39·370113 inches.

The first five tables provide the ratios between units of the same kind, e.g. length, area, etc. For convenience in printing, negative powers of 10 have been used to indicate very small fractions, instead of the decimal system. Thus the figure 0·00000032 becomes $3{\cdot}2 \times 10^{-7}$; the first significant figure is the *seventh* after the decimal point. Conversely, $7{\cdot}34 \times 10^{-5}$ becomes 0·0000734.

Tables 6–18 give more fully the ratios between metric units and their equivalent British units. Metric digits (*0* to *9*) are printed in italics at the top of each table, reading horizontally from left to right. Metric tens, likewise in italics, read vertically from top to bottom on the left of the table. Thus, in Table 6, to convert *87* centimetres into inches, read *8* down on the left, then move horizontally to the right to the 7 digit column, where the answer 34·252 is read.

Metric System. List of Prefixes

Deca means ten times.	Deci means a tenth part of.
Hecto means a hundred times.	Centi means a hundredth part of.
Kilo means a thousand times.	Milli means a thousandth part of.

In abbreviations the Decametre, etc., is Dm., and the decimetre, etc., dm.

Note on British 'nautical', 'geographical' and 'statute' miles

A 'nautical mile' is the length of the minute of the meridian at the latitude in question and is therefore a variable unit. It is given in feet for Clarke's 1880 spheroid by the formula

$$60771{\cdot}1 - 30{\cdot}7 \cos 2 \text{ Lat.}$$

This is the sea mile of the scale of latitude and distance of the Admiralty Charts. From the above formula it will be found to vary from 6,046·4 ft. at the equator to 6,107·8 ft. at the poles, being 6,077·1 ft. at latitude 45°.

A 'geographical mile' is a fixed unit, being defined by some as the length of a minute of the equator and by others as that of the minute of the meridian at latitude 45°. According to the former definition its value on Clarke's spheroid is 6,087 ft. and according to the latter 6,077 ft. The round figure 6,080 is usually adopted for the purposes of ordinary navigation.

The so-called 'international nautical mile' of 1,852 m. or 6,076 ft. is the length of the minute of the meridian at latitude 45° on the International Spheroid. This corresponds to the 6,077 ft. for Clarke's spheroid.

The British 'statute mile' measures 5,280 ft.

[1] The layout of the tables has been checked by Mr J. E. Sears, C.B.E., M.A., Superintendent of the Metrology Department of the National Physical Laboratory.

Table 1. *Length*

Nautical mile	Statute mile	Kilometre	Metre	Yard	Foot	Inch	Centimetre
1	1·152	1·853	1853	2027	6080*	72,960	185,300
$8{\cdot}684 \times 10^{-1}$	1	1·60934	1609·34	1760	5280	63,360	160,934
$5{\cdot}396 \times 10^{-1}$	$6{\cdot}21372 \times 10^{-1}$	1	1000	1093·61	3280·84	39,370·1	100,000
$5{\cdot}396 \times 10^{-4}$	$6{\cdot}21372 \times 10^{-4}$	$1{\cdot}0 \times 10^{-3}$	1	1·09361	3·28084	39·3701	100
$4{\cdot}934 \times 10^{-4}$	$5{\cdot}68182 \times 10^{-4}$	$9{\cdot}14399 \times 10^{-4}$	$9{\cdot}14399 \times 10^{-1}$	1	3	36	91·4399
$1{\cdot}645 \times 10^{-4}$	$1{\cdot}89394 \times 10^{-4}$	$3{\cdot}048 \times 10^{-4}$	$3{\cdot}048 \times 10^{-1}$	$3{\cdot}33333 \times 10^{-1}$	1	12	30·48
$1{\cdot}371 \times 10^{-5}$	$1{\cdot}57828 \times 10^{-5}$	$2{\cdot}54 \times 10^{-5}$	$2{\cdot}54 \times 10^{-2}$	$2{\cdot}77778 \times 10^{-2}$	$8{\cdot}33333 \times 10^{-2}$	1	2·54
$5{\cdot}390 \times 10^{-6}$	$6{\cdot}21372 \times 10^{-6}$	$1{\cdot}0 \times 10^{-5}$	$1{\cdot}0 \times 10^{-2}$	$1{\cdot}09361 \times 10^{-2}$	$3{\cdot}28084 \times 10^{-2}$	$3{\cdot}93701 \times 10^{-1}$	1

* This is the customary British practice, and not the 'international nautical mile,' which Great Britain has not adopted.

Table 2. *Area*

Square mile	Square kilometre	Hectare	Acre	Square metre	Square yard
1	2·58998	258·998	640	$258{,}998 \times 10$	$30{,}976 \times 10^{2}$
$3{\cdot}86103 \times 10^{-1}$	1	100	247·106	1,000,000	$119{,}599 \times 10$
$3{\cdot}86103 \times 10^{-3}$	$1{\cdot}0 \times 10^{-2}$	1	2·47106	10,000	11,959·9
$1{\cdot}5625 \times 10^{-3}$	$4{\cdot}04685 \times 10^{-3}$	$4{\cdot}04685 \times 10^{-1}$	1	4046·85	4840
$3{\cdot}86103 \times 10^{-7}$	$1{\cdot}0 \times 10^{-6}$	$1{\cdot}0 \times 10^{-4}$	$2{\cdot}47106 \times 10^{-4}$	1	1·19599
$3{\cdot}22831 \times 10^{-7}$	$8{\cdot}36126 \times 10^{-7}$	$8{\cdot}36126 \times 10^{-5}$	$2{\cdot}06612 \times 10^{-4}$	$8{\cdot}36126 \times 10^{-1}$	1

Table 3. *Yield per Area*

Tons per acre	Metric tons per hectare	Quintals per hectare
1	2·51071	25·1071
$3{\cdot}98294 \times 10^{-1}$	1	10
$3{\cdot}98294 \times 10^{-2}$	$1{\cdot}0 \times 10^{-1}$	1

Table 4. *Volume and Cubic*

Kilolitre	Cubic metre	Cubic yard	Bushel	Cubic feet	Imp. gall.	Litre	Pint
1	1·000027	1·30799	27·4969	35·3157	219·976	1000	1759·80
$9{\cdot}99973 \times 10^{-1}$	*1*	1·30795	27·4962	35·3148	219·970	999·973	1759·75
$7{\cdot}64532 \times 10^{-1}$	$7{\cdot}64553 \times 10^{-1}$	*1*	21·0223	27	168·178	764·532	1345·43
$3{\cdot}63677 \times 10^{-2}$	$3{\cdot}63687 \times 10^{-2}$	$4{\cdot}75685 \times 10^{-2}$	*1*	1·28435	8	36·3677	64
$2{\cdot}83160 \times 10^{-2}$	$2{\cdot}83167 \times 10^{-2}$	$3{\cdot}70370 \times 10^{-2}$	$7{\cdot}78602 \times 10^{-1}$	*1*	6·22882	28·3160	49·8306
$4{\cdot}54596 \times 10^{-3}$	$4{\cdot}54608 \times 10^{-3}$	$5{\cdot}94607 \times 10^{-3}$	$1{\cdot}25 \times 10^{-1}$	$1{\cdot}60544 \times 10^{-1}$	*1*	4·54596	8
$1{\cdot}0 \times 10^{-3}$	$1{\cdot}000027 \times 10^{-3}$	$1{\cdot}30799 \times 10^{-3}$	$2{\cdot}74969 \times 10^{-2}$	$3{\cdot}53157 \times 10^{-2}$	$2{\cdot}19976 \times 10^{-1}$	*1*	1·75980
$5{\cdot}68245 \times 10^{-4}$	$5{\cdot}68260 \times 10^{-4}$	$7{\cdot}43258 \times 10^{-4}$	$1{\cdot}5625 \times 10^{-2}$	$2{\cdot}00680 \times 10^{-2}$	$1{\cdot}25 \times 10^{-1}$	$5{\cdot}68245 \times 10^{-1}$	*1*

Table 5. *Weight*

Ton	Metric ton or Millier	Quintal	Kilogram	lb.
1	1·01605	10·1605	1016·05	2240
$9{\cdot}84207 \times 10^{-1}$	*1*	10	1000	2204·62
$9{\cdot}84207 \times 10^{-2}$	$1{\cdot}0 \times 10^{-1}$	*1*	100	220·462
$9{\cdot}84207 \times 10^{-4}$	$1{\cdot}0 \times 10^{-3}$	$1{\cdot}0 \times 10^{-2}$	*1*	2·20462
$4{\cdot}46429 \times 10^{-4}$	$4{\cdot}53592 \times 10^{-4}$	$4{\cdot}53592 \times 10^{-3}$	$4{\cdot}53592 \times 10^{-1}$	*1*

Table 6. *Centimetres to Inches*

1 cm. = 0·393701 in.

	0	1	2	3	4	5	6	7	8	9
—	—	0·394	0·787	1·181	1·575	1·969	2·362	2·756	3·150	3·543
1	3·937	4·331	4·724	5·118	5·512	5·906	6·299	6·693	7·087	7·480
2	7·874	8·268	8·661	9·055	9·449	9·843	10·236	10·630	11·024	11·417
3	11·811	12·205	12·598	12·992	13·386	13·780	14·173	14·567	14·961	15·354
4	15·748	16·142	16·535	16·929	17·323	17·717	18·110	18·504	18·898	19·291
5	19·685	20·079	20·472	20·866	21·260	21·654	22·047	22·441	22·835	23·228
6	23·622	24·016	24·409	24·803	25·197	25·591	25·984	26·378	26·772	27·165
7	27·559	27·953	28·346	28·740	29·134	29·528	29·921	30·315	30·709	31·102
8	31·496	31·890	32·283	32·677	33·071	33·465	33·858	34·252	34·646	35·039
9	35·433	35·827	36·220	36·614	37·008	37·402	37·795	38·189	38·583	38·976
10	39·370									

Table 7. *Metres to Feet*

1 m. = 3·28084 ft.

	0	1	2	3	4	5	6	7	8	9
—	—	3·3	6·6	9·8	13·1	16·4	19·7	23·0	26·3	29·5
1	32·8	36·1	39·4	42·7	45·9	49·2	52·5	55·8	59·1	62·3
2	65·6	68·9	72·2	75·5	78·7	82·0	85·3	88·6	91·9	95·1
3	98·4	101·7	105·0	108·3	111·6	114·8	118·1	121·4	124·7	128·0
4	131·2	134·5	137·8	141·1	144·4	147·6	150·9	154·2	157·5	160·8
5	164·0	167·3	170·6	173·9	177·2	180·5	183·7	187·0	190·3	193·6
6	196·9	200·1	203·4	206·7	210·0	213·3	216·5	219·8	223·1	226·4
7	229·7	232·9	236·2	239·5	242·8	246·1	249·3	252·6	255·9	259·2
8	262·5	265·8	269·0	272·3	275·6	278·9	282·2	285·4	288·7	292·0
9	295·3	298·6	301·8	305·1	308·4	311·7	315·0	318·2	321·5	324·8
10	328·1	331·4	334·6	337·9	341·2	344·5	347·8	351·0	354·3	357·6

Table 7 (*continued*). *Metres to Feet*

	0	1	2	3	4	5	6	7	8	9
11	360·9	364·2	357·5	370·7	374·0	377·3	380·6	383·9	387·1	390·4
12	393·7	397·0	400·3	403·5	406·8	410·1	413·4	416·7	419·9	423·2
13	426·5	429·8	433·1	436·4	439·6	442·9	446·2	449·5	452·8	456·0
14	459·3	462·6	465·9	469·2	472·4	475·7	479·0	482·3	485·6	488·8
15	492·1	495·4	498·7	502·0	505·2	508·5	511·8	515·1	518·4	521·7
16	524·9	528·2	531·5	534·8	538·1	541·3	544·6	547·9	551·2	554·5
17	557·7	561·0	564·3	567·6	570·9	574·1	577·4	580·7	584·0	587·3
18	590·6	593·8	597·1	600·4	603·7	607·0	610·2	613·5	616·8	620·1
19	623·4	626·6	629·9	633·2	636·5	639·8	643·0	646·3	649·6	652·9
20	656·2	659·4	662·7	666·0	669·3	672·6	675·9	679·1	682·4	685·7
21	689·0	692·3	695·5	698·8	702·1	705·4	708·7	711·9	715·2	718·5
22	721·8	725·1	728·3	731·6	734·9	738·2	741·5	744·8	748·0	751·3
23	754·6	757·9	761·2	764·4	767·7	771·0	774·3	777·6	780·8	784·1
24	787·4	790·7	794·0	797·2	800·5	803·8	807·1	810·4	813·7	816·9
25	820·2	823·5	826·8	830·1	833·3	836·6	839·9	843·2	846·5	849·7
26	853·0	856·3	859·6	862·9	866·1	869·4	872·7	876·0	879·3	882·5
27	885·8	889·1	892·4	895·7	899·0	902·2	905·5	908·8	912·1	915·4
28	918·6	921·9	925·2	928·5	931·8	935·0	938·3	941·6	944·9	948·2
29	951·4	954·7	958·0	961·3	964·6	967·8	971·1	974·4	977·7	981·0
30	984·3	987·5	990·8	994·1	997·4	1000·7	1003·9	1007·2	1010·5	1013·8
31	1017·1	1020·3	1023·6	1026·9	1030·2	1033·5	1036·7	1040·0	1043·3	1046·6
32	1049·9	1053·1	1056·4	1059·7	1063·0	1066·3	1069·6	1072·8	1076·1	1079·4
33	1082·7	1086·0	1089·2	1092·5	1095·8	1099·1	1102·4	1105·6	1108·9	1112·2
34	1115·5	1118·8	1122·0	1125·3	1128·6	1131·9	1135·2	1138·5	1141·7	1145·0
35	1148·3	1151·6	1154·9	1158·1	1161·4	1164·7	1168·0	1171·3	1174·5	1177·8
36	1181·1	1184·4	1187·7	1190·9	1194·2	1197·5	1200·8	1204·1	1207·3	1210·6
37	1213·9	1217·2	1220·5	1223·8	1227·0	1230·3	1233·6	1236·9	1240·2	1243·4
38	1246·7	1250·0	1253·3	1256·6	1259·8	1263·1	1266·4	1269·7	1273·0	1276·2
39	1279·5	1282·8	1286·1	1289·4	1292·7	1295·9	1299·2	1302·5	1305·8	1309·1
40	1312·3	1315·6	1318·9	1322·2	1325·5	1328·7	1332·0	1335·3	1338·6	1341·9

Table 7 (*continued*). *Metres to Feet*

	0	1	2	3	4	5	6	7	8	9
41	1345·1	1348·4	1351·7	1355·0	1358·3	1361·5	1364·8	1368·1	1371·4	1374·7
42	1378·0	1381·2	1384·5	1387·8	1391·1	1394·4	1397·6	1400·9	1404·2	1407·5
43	1410·8	1414·0	1417·3	1420·6	1423·9	1427·2	1430·4	1433·7	1437·0	1440·3
44	1443·6	1446·9	1450·1	1453·4	1456·7	1460·0	1463·3	1466·5	1469·8	1473·1
45	1476·4	1479·7	1482·9	1486·2	1489·5	1492·8	1496·1	1499·3	1502·6	1505·9
46	1509·2	1512·5	1515·7	1519·0	1522·3	1525·6	1528·9	1532·2	1535·4	1538·7
47	1542·0	1545·3	1548·6	1551·8	1555·1	1558·4	1561·7	1565·0	1568·2	1571·5
48	1574·8	1578·1	1581·4	1584·6	1587·9	1591·2	1594·5	1597·8	1601·0	1604·3
49	1607·6	1610·9	1614·2	1617·5	1620·7	1624·0	1627·3	1630·6	1633·9	1637·1
50	1640·4	1643·7	1647·0	1650·3	1653·6	1656·8	1660·1	1663·4	1666·7	1669·9
51	1673·2	1676·5	1679·8	1683·1	1686·4	1689·6	1692·9	1696·2	1699·5	1702·8
52	1706·0	1709·3	1712·6	1715·9	1719·2	1722·4	1725·7	1729·0	1732·3	1735·6
53	1738·8	1742·1	1745·4	1748·7	1752·0	1755·2	1758·5	1761·8	1765·1	1768·4
54	1771·7	1774·9	1778·2	1781·5	1784·8	1788·1	1791·3	1794·6	1797·9	1801·2
55	1804·5	1807·8	1811·0	1814·3	1817·6	1820·9	1824·1	1827·4	1830·7	1834·0
56	1837·3	1840·6	1843·8	1847·1	1850·4	1853·7	1857·0	1860·2	1863·5	1866·8
57	1870·1	1873·4	1876·6	1879·9	1883·2	1886·5	1889·8	1893·0	1896·3	1899·6
58	1902·9	1906·2	1909·4	1912·7	1916·0	1919·3	1922·6	1925·9	1929·1	1932·4
59	1935·7	1939·0	1942·3	1945·5	1948·8	1952·1	1955·4	1958·7	1961·9	1965·2
60	1968·5	1971·8	1975·1	1978·3	1981·6	1984·9	1988·2	1991·5	1994·8	1998·0
61	2001·3	2004·6	2007·9	2011·1	2014·4	2017·7	2021·0	2024·3	2027·6	2030·8
62	2034·1	2037·4	2040·7	2044·0	2047·2	2050·5	2053·8	2057·1	2060·4	2063·6
63	2066·9	2070·2	2073·5	2076·8	2080·1	2083·3	2086·6	2089·9	2093·2	2096·5
64	2099·7	2103·0	2106·3	2109·6	2112·9	2116·1	2119·4	2122·7	2126·0	2129·3
65	2132·5	2135·8	2139·1	2142·4	2145·7	2149·0	2152·3	2155·5	2158·8	2162·1
66	2165·4	2168·6	2171·9	2175·2	2178·5	2181·8	2185·1	2188·3	2191·6	2194·9
67	2198·2	2201·5	2204·7	2208·0	2211·3	2214·6	2217·9	2221·1	2224·4	2227·7
68	2231·0	2234·3	2237·5	2240·8	2244·1	2247·4	2250·7	2253·9	2257·2	2260·5
69	2263·8	2267·1	2270·4	2273·6	2276·9	2280·2	2283·5	2286·8	2290·0	2293·3
70	2296·6	2299·9	2303·2	2306·4	2309·7	2313·0	2316·3	2319·6	2322·8	2326·1

Table 7 (*continued*). *Metres to Feet*

	0	1	2	3	4	5	6	7	8	9
71	2329·4	2332·7	2336·0	2339·2	2342·5	2345·8	2349·1	2352·4	2355·6	2358·9
72	2362·2	2365·5	2368·8	2372·0	2375·3	2378·6	2381·9	2385·2	2388·5	2391·7
73	2395·0	2398·3	2401·6	2404·9	2408·1	2411·4	2414·7	2418·0	2421·3	2424·5
74	2427·8	2431·1	2434·4	2437·7	2440·9	2444·2	2447·5	2450·8	2454·1	2457·3
75	2460·6	2463·9	2467·2	2470·5	2473·8	2477·0	2480·3	2483·6	2486·9	2490·2
76	2493·4	2496·7	2500·0	2503·3	2506·6	2509·8	2513·1	2516·4	2519·7	2523·0
77	2526·2	2529·5	2532·8	2536·1	2539·4	2542·7	2545·9	2549·2	2552·5	2555·8
78	2559·1	2562·3	2565·6	2568·9	2572·2	2575·5	2578·7	2582·0	2585·3	2588·6
79	2591·9	2595·1	2598·4	2601·7	2605·0	2608·3	2611·5	2614·8	2618·1	2621·4
80	2624·7	2628·0	2631·2	2634·5	2637·8	2641·1	2644·4	2647·6	2650·9	2654·2
81	2657·5	2660·8	2664·0	2667·3	2670·6	2673·9	2677·2	2680·4	2683·7	2687·0
82	2690·3	2693·6	2696·9	2700·1	2703·4	2706·7	2710·0	2713·3	2716·5	2719·8
83	2723·1	2726·4	2729·7	2732·9	2736·2	2739·5	2742·8	2746·1	2749·3	2752·6
84	2755·9	2759·2	2762·5	2765·7	2769·0	2772·3	2775·6	2778·9	2782·2	2785·4
85	2788·7	2792·0	2795·3	2798·6	2801·8	2805·1	2808·4	2811·7	2815·0	2818·2
86	2821·5	2824·8	2828·1	2831·4	2834·6	2837·9	2841·2	2844·5	2847·8	2851·0
87	2854·3	2857·6	2860·9	2864·2	2867·5	2870·7	2874·0	2877·3	2880·6	2883·9
88	2887·1	2890·4	2893·7	2897·0	2900·3	2903·5	2906·8	2910·1	2913·4	2916·7
89	2919·9	2923·2	2926·5	2929·8	2933·1	2936·4	2939·6	2942·9	2946·2	2949·5
90	2952·8	2956·0	2959·3	2962·6	2965·9	2969·2	2972·4	2975·7	2979·0	2982·3
91	2985·6	2988·8	2992·1	2995·4	2998·7	3002·0	3005·2	3008·5	3011·8	3015·1
92	3018·4	3021·7	3024·9	3028·2	3031·5	3034·8	3038·1	3041·3	3044·6	3047·9
93	3051·2	3054·5	3057·7	3061·0	3064·3	3067·6	3070·9	3074·1	3077·4	3080·7
94	3084·0	3087·3	3090·6	3093·8	3097·1	3100·4	3103·7	3107·0	3110·2	3113·5
95	3116·8	3120·1	3123·4	3126·6	3129·9	3133·2	3136·5	3139·8	3143·0	3146·3
96	3149·6	3152·9	3156·2	3159·4	3162·7	3166·0	3169·3	3172·6	3175·9	3179·1
97	3182·4	3185·7	3189·0	3192·3	3195·5	3198·8	3202·1	3205·4	3208·7	3211·9
98	3215·2	3218·5	3221·8	3225·1	3228·3	3231·6	3234·9	3238·2	3241·5	3244·8
99	3248·0	3251·3	3254·6	3257·9	3261·2	3264·4	3267·7	3271·0	3274·3	3277·6
100	3280·8									

Table 8. *Kilometres to Statute Miles*

1 km. = 0·621372 mile

	0	1	2	3	4	5	6	7	8	9
—	—	0·621	1·243	1·864	2·485	3·107	3·728	4·350	4·971	5·592
1	6·214	6·835	7·456	8·078	8·699	9·321	9·942	10·563	11·185	11·806
2	12·427	13·049	13·670	14·292	14·913	15·534	16·156	16·777	17·398	18·020
3	18·641	19·263	19·884	20·505	21·127	21·748	22·369	22·991	23·612	24·234
4	24·855	25·476	26·098	26·719	27·340	27·962	28·583	29·204	29·826	30·447
5	31·069	31·690	32·311	32·933	33·554	34·175	34·797	35·418	36·040	36·661
6	37·282	37·904	38·525	39·146	39·768	40·389	41·011	41·632	42·253	42·875
7	43·496	44·117	44·739	45·360	45·982	46·603	47·224	47·846	48·467	49·088
8	49·710	50·331	50·952	51·574	52·195	52·817	53·438	54·059	54·681	55·302
9	55·923	56·545	57·166	57·788	58·409	59·030	59·652	60·273	60·894	61·516
10	62·137									

Table 9. *Kilometres to Nautical Miles*

1 km. = 0·5396 nautical mile

	0	1	2	3	4	5	6	7	8	9
—	—	0·54	1·08	1·62	2·16	2·70	3·24	3·78	4·32	4·86
1	5·40	5·94	6·48	7·01	7·55	8·09	8·63	9·17	9·71	10·25
2	10·79	11·33	11·87	12·41	12·95	13·49	14·03	14·57	15·11	15·65
3	16·19	16·73	17·27	17·81	18·35	18·89	19·43	19·97	20·50	21·04
4	21·58	22·12	22·66	23·20	23·74	24·28	24·82	25·36	25·90	26·44
5	26·98	27·52	28·06	28·60	29·14	29·68	30·22	30·76	31·30	31·84
6	32·38	32·92	33·46	33·99	34·53	35·07	35·61	36·15	36·69	37·23
7	37·77	38·31	38·85	39·39	39·93	40·47	41·01	41·55	42·09	42·63
8	43·17	43·71	44·25	44·79	45·33	45·87	46·41	46·95	47·48	48·02
9	48·56	49·10	49·64	50·18	50·72	51·26	51·80	52·34	52·88	53·42
10	53·96									

Table 10. *Square Metres to Square Feet*

1 sq. m. = 10·763911 sq. ft.

	0	1	2	3	4	5	6	7	8	9
—	—	10·764	21·528	32·292	43·056	53·820	64·583	75·347	86·111	96·875
1	107·639	118·403	129·167	139·931	150·695	161·459	172·222	182·986	193·750	204·514
2	215·278	226·042	236·806	247·570	258·334	269·098	279·861	290·625	301·389	312·153
3	322·917	333·681	344·445	355·209	365·973	376·737	387·501	398·265	409·029	419·792
4	430·556	441·320	452·084	462·848	473·612	484·376	495·140	505·904	516·668	527·432
5	538·196	548·959	559·723	570·487	581·251	592·015	602·779	613·543	624·307	635·071
6	645·835	656·599	667·363	678·126	688·890	699·654	710·418	721·182	731·946	742·710
7	753·474	764·238	775·002	785·765	796·529	807·293	818·057	828·821	839·585	850·349
8	861·113	871·877	882·641	893·405	904·169	914·932	925·696	936·460	947·224	957·988
9	968·752	979·516	990·280	1001·044	1011·808	1022·572	1033·335	1044·099	1054·863	1065·627
10	1076·3911									

Table 11. *Hectares to Acres*

1 ha. = 2·47106 acres

	0	1	2	3	4	5	6	7	8	9
—	—	2·47	4·94	7·41	9·88	12·36	14·83	17·30	19·77	22·24
1	24·71	27·18	29·65	32·12	34·59	37·07	39·54	42·01	44·48	46·95
2	49·42	51·89	54·36	56·83	59·31	61·78	64·25	66·72	69·19	71·66
3	74·13	76·60	79·07	81·54	84·02	86·49	88·96	91·43	93·90	96·37
4	98·84	101·31	103·78	106·26	108·73	111·20	113·67	116·14	118·61	121·08
5	123·55	126·02	128·50	130·97	133·44	135·91	138·38	140·85	143·32	145·79
6	148·26	150·73	153·21	155·68	158·15	160·62	163·09	165·56	168·03	170·50
7	172·97	175·45	177·92	180·39	182·86	185·33	187·80	190·27	192·74	195·21
8	197·68	200·16	202·63	205·10	207·57	210·04	212·51	214·98	217·45	219·92
9	222·40	224·87	227·34	229·81	232·28	234·75	237·22	239·69	242·16	244·63
10	247·11									

Table 12. *Square Kilometres to Square Miles*

1 sq. km. = 0·386103 sq. mile

	0	1	2	3	4	5	6	7	8	9
—	—	0·386	0·772	1·158	1·544	1·931	2·317	2·703	3·089	3·475
1	3·861	4·247	4·633	5·019	5·405	5·792	6·178	6·564	6·950	7·336
2	7·722	8·108	8·494	8·880	9·266	9·653	10·039	10·425	10·811	11·197
3	11·583	11·969	12·355	12·741	13·128	13·514	13·900	14·286	14·672	15·058
4	15·444	15·830	16·216	16·602	16·989	17·375	17·761	18·147	18·533	18·919
5	19·305	19·691	20·077	20·463	20·850	21·236	21·622	22·008	22·394	22·780
6	23·166	23·552	23·938	24·324	24·711	25·097	25·483	25·869	26·255	26·641
7	27·027	27·413	27·799	28·186	28·572	28·958	29·344	29·730	30·116	30·502
8	30·888	31·274	31·660	32·047	32·433	32·819	33·205	33·591	33·977	34·363
9	34·749	35·135	35·521	35·908	36·294	36·680	37·066	37·452	37·838	38·224
10	38·610									

Table 13. *Numbers per Square Kilometre to Numbers per Square Mile*

(*or* square miles to square kilometres)

1 sq. mile = 2·58998 sq. km.

	0	1	2	3	4	5	6	7	8	9
—	—	2·59	5·18	7·77	10·36	12·95	15·54	18·13	20·72	23·31
1	25·90	28·49	31·08	33·67	36·26	38·85	41·44	44·03	46·62	49·21
2	51·80	54·39	56·98	59·57	62·16	64·75	67·34	69·93	72·52	75·11
3	77·70	80·29	82·88	85·47	88·06	90·65	93·24	95·83	98·42	101·01
4	103·60	106·19	108·78	111·37	113·96	116·55	119·14	121·73	124·32	126·91
5	129·50	132·09	134·68	137·27	139·86	142·45	145·04	147·63	150·22	152·81
6	155·40	157·99	160·58	163·17	165·76	168·35	170·94	173·53	176·12	178·71
7	181·30	183·89	186·48	189·07	191·66	194·25	196·84	199·43	202·02	204·61
8	207·20	209·79	212·38	214·97	217·56	220·15	222·74	225·33	227·92	230·51
9	233·10	235·69	238·28	240·87	243·46	246·05	248·64	251·23	253·82	256·41
10	259·00									

Table 14. *Cubic Metres to Cubic Feet*

1 cu. m. = 35·3148 cu. ft.

	0	1	2	3	4	5	6	7	8	9
—	—	35·315	70·630	105·944	141·260	176·574	211·889	247·204	282·518	317·833
1	353·148	388·463	423·778	459·092	494·407	529·722	565·037	600·352	635·666	670·981
2	706·296	741·611	776·926	812·240	847·555	882·870	918·185	953·500	988·814	1024·129
3	1059·444	1094·759	1130·074	1165·388	1200·703	1236·018	1271·333	1306·648	1341·962	1377·277
4	1412·592	1447·907	1483·222	1518·536	1553·851	1589·166	1624·481	1659·796	1695·110	1730·425
5	1765·740	1801·055	1836·370	1871·684	1906·999	1942·314	1977·629	2012·944	2048·258	2083·573
6	2118·888	2154·203	2189·518	2224·832	2260·147	2295·462	2330·777	2366·092	2401·406	2436·721
7	2472·036	2507·351	2542·666	2577·980	2613·295	2648·610	2683·925	2719·240	2754·554	2789·869
8	2825·184	2860·499	2895·814	2931·128	2966·443	3001·758	3037·073	3072·388	3107·702	3143·017
9	3178·332	3213·647	3248·962	3284·276	3319·591	3354·906	3390·221	3425·536	3460·850	3496·165
10	3531·480									

Table 15. *Litres to Gallons*

1 l. = 0·219976 gal.

	0	1	2	3	4	5	6	7	8	9
—	—	0·220	0·440	0·660	0·880	1·100	1·320	1·540	1·760	1·980
1	2·200	2·420	2·640	2·860	3·080	3·300	3·520	3·740	3·960	4·180
2	4·400	4·619	4·839	5·059	5·279	5·499	5·719	5·939	6·159	6·379
3	6·599	6·819	7·039	7·259	7·479	7·699	7·919	8·139	8·359	8·579
4	8·799	9·019	9·239	9·459	9·679	9·899	10·119	10·339	10·559	10·779
5	10·999	11·219	11·439	11·659	11·879	12·099	12·319	12·539	12·759	12·979
6	13·199	13·419	13·639	13·858	14·078	14·298	14·518	14·738	14·958	15·178
7	15·398	15·618	15·838	16·058	16·278	16·498	16·718	16·938	17·158	17·378
8	17·598	17·818	18·038	18·258	18·478	18·698	18·918	19·138	19·358	19·578
9	19·798	20·018	20·238	20·458	20·678	20·898	21·118	21·338	21·558	21·778
10	21·998									

Table 16. *Kilogrammes to Pounds*

1 kg. = 2·20462 lb.

	0	1	2	3	4	5	6	7	8	9
—	—	2·205	4·409	6·614	8·818	11·023	13·228	15·432	17·637	19·842
1	22·046	24·251	26·455	28·660	30·865	33·069	35·274	37·478	39·683	41·888
2	44·092	46·297	48·502	50·706	52·911	55·115	57·320	59·525	61·729	63·934
3	66·139	68·343	70·548	72·752	74·957	77·162	79·366	81·571	83·776	85·980
4	88·185	90·389	92·594	94·799	97·003	99·208	101·413	103·617	105·822	108·026
5	110·231	112·436	114·640	116·845	119·049	121·254	123·459	125·663	127·868	130·073
6	132·277	134·482	136·686	138·891	141·096	143·300	145·505	147·710	149·914	152·119
7	154·323	156·528	158·733	160·937	163·142	165·346	167·551	169·756	171·960	174·165
8	176·370	178·574	180·779	182·983	185·188	187·393	189·597	191·802	194·007	196·211
9	198·416	200·620	202·825	205·030	207·234	209·439	211·644	213·848	216·053	218·257
10	220·462									

Table 17. *Temperature: Equivalents of Fahrenheit and Centigrade Scales*

°F.	°C.	°F.	°C.	°F.	°C.	°F.	°C.	°F.	°C.	°F.	°C.
212	100	192	88·8	172·4	78	153	67·2	133·25	56·25	114	45·5
211	99·4	191·75	88·75	172	77·7	152·6	67	133	56·1	113	45
210·2	99	191	88·3	171·5	77·5	152	66·6	132·8	56	112	44·4
210	98·8	190·4	88	171	77·2	151·25	66·25	132	55·5	111·2	44
209·75	98·75	190	87·7	170·6	77	151	66·1	131	55	111	43·8
209	98·3	189·5	87·5	170	76·6	150·8	66	130	54·4	110·75	43·75
208·4	98	189	87·2	169·25	76·25	150	65·5	129·2	54	110	43·3
208	97·7	188·6	87	169	76·1	149	65	129	53·8	109·4	43
207·5	97·5	188	86·6	168·8	76	148	64·4	128·75	53·75	109	42·7
207	97·2	187·25	86·25	168	75·5	147·2	64	128	53·3	108·5	42·5
206·6	97	187	86·1	167	75	147	63·8	127·4	53	108	42·2
206	96·6	186·8	86	166	74·4	146·75	63·75	127	52·7	107·6	42
205·25	96·25	186	85·5	165·2	74	146	63·3	126·5	52·5	107	41·6
205	96·1	185	85	165	73·8	145·4	63	126	52·2	106·25	41·25
204·8	96	184	84·4	164·75	73·75	145	62·7	125·6	52	106	41·1
204	95·5	183·2	84	164	73·3	144·5	62·5	125	51·6	105·8	41
203	95	183	83·8	163·4	73	144	62·2	124·25	51·25	105	40·5
202	94·4	182·75	83·75	163	72·7	143·6	62	124	51·1	104	40
201·2	94	182	83·3	162·5	72·5	143	61·6	123·8	51	103	39·4
201	93·8	181·4	83	162	72·2	142·25	61·25	123	50·5	102·2	39
200·75	93·75	181	82·7	161·6	72	142	61·1	122	50	102	38·8
200	93·3	180·5	82·5	161	71·6	141·8	61	121	49·4	101·75	38·75
199·4	93	180	82·2	160·25	71·25	141	60·5	120·2	49	101	38·3
199	92·7	179·6	82	160	71·1	140	60	120	48·8	100·4	38
198·5	92·5	179	81·6	159·8	71	139	59·4	119·75	48·75	100	37·7
198	92·2	178·25	81·25	159	70·5	138·2	59	119	48·3	99·5	37·5
197·6	92	178	81·1	158	70	138	58·8	118·4	48	99	37·2
197	91·6	177·8	81	157	69·4	137·75	58·75	118	47·7	98·6	37
196·25	91·25	177	80·5	156·2	69	137	58·3	117·5	47·5	98	36·6
196	91·1	176	80	156	68·8	136·4	58	117	47·2	97·25	36·25
195·8	91	175	79·4	155·75	68·75	136	57·7	116·6	47	97	36·1
195	90·5	174·2	79	155	68·3	135·5	57·5	116	46·6	96·8	36
194	90	174	78·8	154·4	68	135	57·2	115·25	46·25	96	35·5
193	89·4	173·75	78·75	154	67·7	134·6	57	115	46·1	95	35
192·2	89	173	78·3	153·5	67·5	134	56·6	114·8	46	94	34·4

Table 17 (*continued*). *Temperature: Equivalents of Fahrenheit and Centigrade Scales*

°F.	°C.	°F.	°C.	°F.	°C.	°F.	°C.	°F.	°C.	°F.	°C.
93·2	34	73	22·7	52·25	11·25	31	− 0·5	10·4	−12	−10	−23·3
93	33·8	72·5	22·5	52	11·1	30·2	− 1	10	−12·2	−10·75	−23·75
92·75	33·75	72	22·2	51·8	11	30	− 1·1	9·5	−12·5	−11	−23·8
92	33·3	71·6	22	51	10·5	29·75	− 1·25	9	−12·7	−11·2	−24
91·4	33	71	21·6	50	10	29	− 1·6	8·6	−13	−12	−24·4
91	32·7	70·25	21·25	49	9·4	28·4	− 2	8	−13·3	−13	−25
90·5	32·5	70	21·1	48·2	9	28	− 2·2	7·25	−13·75	−14	−25·5
90	32·2	69·8	21	48	8·8	27·5	− 2·5	7	−13·8	−14·8	−26
89·6	32	69	20·5	47·75	8·75	27	− 2·7	6·8	−14	−15	−26·1
89	31·6	68	20	47	8·3	26·6	− 3	6	−14·4	−15·25	−26·25
88·25	31·25	67	19·4	46·4	8	26	− 3·3	5	−15	−16	−26·6
88	31·1	66·2	19	46	7·7	25·25	− 3·75	4	−15·5	−16·6	−27
87·8	31	66	18·8	45·5	7·5	25	− 3·8	3·2	−16	−17	−27·2
87	30·5	65·75	18·75	45	7·2	24·8	− 4	3	−16·1	−17·5	−27·5
86	30	65	18·3	44·6	7	24	− 4·4	2·75	−16·25	−18	−27·7
85	29·4	64·4	18	44	6·6	23	− 5	2	−16·6	−18·4	−28
84·2	29	64	17·7	43·25	6·25	22	− 5·5	1·4	−17	−19	−28·3
84	28·8	63·5	17·5	43	6·1	21·2	− 6	1	−17·2	−19·75	−28·75
83·75	28·75	63	17·2	42·8	6	21	− 6·1	0·5	−17·5	−20	−28·8
83	28·3	62·6	17	42	5·5	20·75	− 6·25	0	−17·7	−20·2	−29
82·4	28	62	16·6	41	5	20	− 6·6	− 0·4	−18	−21	−29·4
82	27·7	61·25	16·25	40	4·4	19·4	− 7	− 1	−18·3	−22	−30
81·5	27·5	61	16·1	39·2	4	19	− 7·2	− 1·75	−18·75	−23	−30·5
81	27·2	60·8	16	39	3·8	18·5	− 7·5	− 2	−18·8	−23·8	−31
80·6	27	60	15·5	38·75	3·75	18	− 7·7	− 2·2	−19	−24	−31·1
80	26·6	59	15	38	3·3	17·6	− 8	− 3	−19·4	−24·25	−31·25
79·25	26·25	58	14·4	37·4	3	17	− 8·3	− 4	−20	−25	−31·6
79	26·1	57·2	14	37	2·7	16·25	− 8·75	− 5	−20·5	−25·6	−32
78·8	26	57	13·8	36·5	2·5	16	− 8·8	− 5·8	−21	−26	−32·2
78	25·5	56·75	13·75	36	2·2	15·8	− 9	− 6	−21·1	−26·5	−32·5
77	25	56	13·3	35·6	2	15	− 9·4	− 6·25	−21·25	−27	−32·7
76	24·4	55·4	13	35	1·6	14	−10	− 7	−21·6	−27·4	−33
75·2	24	55	12·7	34·25	1·25	13	−10·5	− 7·6	−22	−28	−33·3
75	23·8	54·5	12·5	34	1·1	12·2	−11	− 8	−22·2	−28·75	−33·75
74·75	23·75	54	12·2	33·8	1	12	−11·1	− 8·5	−22·5	−29	−33·8
74	23·3	53·6	12	33	0·5	11·75	−11·25	− 9	−22·7	−29·2	−34
73·4	23	53	11·6	32	0	11	−11·6	− 9·4	−23	−30	−34·4

Table 18. *Pressure: Equivalents of Millibars, Millimetres of Mercury, and Inches of Mercury at 32° F. in Latitude 45°*

Mercury in.	Milli-bars	Mercury mm.	Mercury in.	Milli-bars	Mercury mm.	Mercury in.	Milli-bars	Mercury mm.	Mercury in.	Milli-bars	Mercury mm.	Mercury in.	Milli-bars	Mercury mm.
27·02	915	686·3	27·82	942	706·6	28·62	969	726·8	29·41	996	747·1	30·21	1,023	767·3
27·05	916	687·1	27·85	943	707·3	28·65	970	727·6	29·44	997	747·8	30·24	1,024	768·1
27·08	917	687·8	27·88	944	708·1	28·67	971	728·3	29·47	998	748·6	30·27	1,025	768·8
27·11	918	688·6	27·91	945	708·8	28·70	972	729·1	29·50	999	749·3	30·30	1,026	769·6
27·14	919	689·3	27·94	946	709·6	28·73	973	729·8	29·53	1,000	750·1	30·33	1,027	770·3
27·17	920	690·1	27·97	947	710·3	28·76	974	730·6	29·56	1,001	750·8	30·36	1,028	771·1
27·20	921	690·8	28·00	948	711·1	28·79	975	731·3	29·59	1,002	751·6	30·39	1,029	771·8
27·23	922	691·6	28·03	949	711·8	28·82	976	732·1	29·62	1,003	752·3	30·42	1,030	772·6
27·26	923	692·3	28·05	950	712·6	28·85	977	732·8	29·65	1,004	753·1	30·45	1,031	773·3
27·29	924	693·1	28·08	951	713·3	28·88	978	733·6	29·68	1,005	753·8	30·48	1,032	774·1
27·32	925	693·8	28·11	952	714·1	28·91	979	734·3	29·71	1,006	754·6	30·51	1,033	774·8
27·35	926	694·6	28·14	953	714·8	28·94	980	735·1	29·74	1,007	755·3	30·53	1,034	775·6
27·38	927	695·3	28·17	954	715·6	28·97	981	735·8	29·77	1,008	756·1	30·56	1,035	776·3
27·41	928	696·1	28·20	955	716·3	29·00	982	736·6	29·80	1,009	756·8	30·59	1,036	777·1
27·44	929	696·8	28·23	956	717·1	29·03	983	737·3	29·83	1,010	757·6	30·62	1,037	777·8
27·46	930	697·6	28·26	957	717·8	29·06	984	738·1	29·86	1,011	758·3	30·65	1,038	778·6
27·49	931	698·3	28·29	958	718·6	29·09	985	738·8	29·89	1,012	759·1	30·68	1,039	779·3
27·52	932	699·1	28·32	959	719·3	29·12	986	739·6	29·92	1,013	759·8	30·71	1,040	780·1
27·55	933	699·8	28·35	960	720·1	29·15	987	740·3	29·94	1,014	760·6	30·74	1,041	780·8
27·58	934	700·6	28·38	961	720·8	29·18	988	741·1	29·97	1,015	761·3	30·77	1,042	781·6
27·61	935	701·3	28·41	962	721·6	29·21	989	741·8	30·00	1,016	762·1	30·80	1,043	782·3
27·64	936	702·1	28·44	963	722·3	29·24	990	742·6	30·03	1,017	762·8	30·83	1,044	783·1
27·67	937	702·8	28·47	964	723·1	29·26	991	743·3	30·06	1,018	763·6	30·86	1,045	783·8
27·70	938	703·6	28·50	965	723·8	29·29	992	744·1	30·09	1,019	764·3	30·89	1,046	784·6
27·73	939	704·3	28·53	966	724·6	29·32	993	744·8	30·12	1,020	765·1	30·92	1,047	785·3
27·76	940	705·1	28·56	967	725·3	29·35	994	745·6	30·15	1,021	765·8	30·95	1,048	786·1
27·79	941	705·8	28·59	968	726·1	29·38	995	746·3	30·18	1,022	766·6	30·98	1,049	786·8

Table 19. *Icelandic Weights and Measures*

The metric system is now obligatory in Iceland, but the following units may be found in old publications and are sometimes still used:

Length.	1 míla = 7·532 km., 1 sjómíla = 1·852 km., 1 vika sjávar = 7·408 km., 1 faðmur = 1·8831 m., 1 alin = 0·6277 m., 1 fet = 0·31385 m., 1 þumlungur = 2·615 cm., 1 lína = 2·18 mm.
Area.	1 fermíla = 56·7383 sq. km., 1 túndagslátta = 0·31914 ha., 1 engjateigur (a day's mowing) = 0·56736 ha., 1 ferfaðmur = 3·546 sq. m., 1 feralin = 0·394 sq. m., 1 ferfet = 0·0985 sq. m., 1 ferþumlungur = 6·84 sq. cm.
Volume.	1 teningsfet = 0·030916 cu.m., 1 teningsalin = 0·2473 cu.m., 1 teningsfaðmur = 6·678 cu.m., 1 brennifaðmur (72 teningsfet) = 2·226 cu.m.
Capacity.	1 pottur (1/32 teningsfet) = 0·9661 l., 1 peli = 2·415 dl., 1 almenn tunna (lýsistunna, 120 pottar) = 1·1593 hl., 1 öltunna (136 pottar) = 1·3139 hl., 1 korntunna (144 pottar) = 1·3912 hl., 1 kornskeppa = 17·39 l., 1 síldartunna (112 pottar) = 1·0821 hl., 1 anker (39 pottar) = 37·68 l.
Weight.	1 skippund = 160 kg., 1 pund = 0·5 kg., 1 kvint = 5 g., 1 kjöttunna (224 pund) = 112 kg.

The following are the Icelandic forms of the metric system, with the abbreviations officially adopted in 1909:

Length.	1 metramíla (mrm.) = 10 kílómetrar (km.), 1 kílómetri (km.) = 1,000 metrar (m.), 1 hektómetri (hm.) = 100 m., 1 dekametri (dam.) = 10 m., 1 metri (m.) = 100 sentímetrar (cm.), 1 desímetri (dm.) = 10 cm., 1 sentímetri (cm.) = 10 millímetrar (mm.).
Area.	1 ferkílómetri (km.^{2}) = 100 hektarar (ha.), 1 hektari (ha.) = 10,000 fermetrar (m.^{2}), 1 ari (a.) = 100 fermetrar (m.^{2}), 1 fermetri (m.^{2}) = 10,000 fersentímetrar (cm.^{2}), 1 fersentímetri (cm.^{2}) = 1000 fermillímetrar (mm.^{2}).
Volume.	1 teningsmetri (m.^{3}) = 1,000,000 fersentímetrar (cm.^{3}), 1 fersentímetri (cm.^{3}) = 1,000 fermillímetrar (mm.^{3}).
Capacity.	1 teningsmetri (m.^{3}) = 1,000 lítrar (l.), 1 hektólítri (hl.) = 100 l., 1 dekalítri (dal.) = 10 l., 1 lítri (l.) = 10 desílítrar (dl.), 1 desílítri (dl.) = 10 sentílítrar (cl.).
Weight.	1 tonn (t.) = 1,000 kílógrömm (kg.), 1 kvintal (q.) = 100 kg., 1 kílógramm (kg.) = 1,000 grömm (g.), 1 hektógramm (hg.) = 100 g., 1 dekagramm (dag.) = 10 g., 1 gramm (g.) = 100 sentígrömm (cg.), 1 desígramm (dg.) = 10 cg., 1 sentígramm (cg.) = 10 millígrömm (mg.).

Source: *Árbók Hagstofu Íslands*, pp. 149–50 (Reykjavík, 1930).

INDEX

PRINTED UNDER THE AUTHORITY OF H.M. STATIONERY OFFICE
AT THE UNIVERSITY PRESS, CAMBRIDGE


EUROPE 1:1,000,000
ICELAND
FIRST EDITION
SPECIAL SHEET
HOFS-
JÖKULL
LANGJÖKULL
VATNAJÖKULL
REYKJAVIK
Reference
Glossary
Scale 1:1,000,000