Preliminary Report on the Vascular Flora of the Lesser Westman Islands

by

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Introduction

The prospect of future colonization of terrestrial plants on the volcanic island Surtsey, is affected by the available source of species on the adjacent land masses as well as means of dispersal and environmental conditions on Surtsey.

As a background for the evolution of colonization of plants on the new island a good knowledge of the flora of these land masses is necessary. In the manual of vascular plants of Iceland, such as Flóra Íslands by Stefán Stefánsson (1924) and Íslenzkar Jurtir by Áskell Löve (1945), records are made of the occurrence of vascular plants in the Westman Islands as well as the various locations on the adjacent mainland. A thorough study of higher plant life on Heimaey, the only inhabited island of the Westman Islands group, was carried out by Baldur Johnsen (1939) who also made some studies on Bjarnarey. A few observations have been made on the vegetation of the lesser islands, although no floral lists were available. It was thus considered of primary value to carry out a thorough investigation of the vegetation of these islands. The work was sponsored by the Surtsey Society with a grant from the United States Atomic Energy Commission.

Some Topographical Features

According to present knowledge, geologists believe the Westman Islands to have been created by volcanic activity towards the end and after the last Glaciation. The formation of Surtsey

has clarified facts concerning the origin of other islands in the group which lie along a NE-SW tectonic fissure, which is a part of the Atlantic ridge. Remnants of volcanic craters are noticable throughout the islands, which are mostly made of palagonite tuff (consolidated volcanic ash) with streaks and veins of intruded basalt. The palagonite tuff accounts for most of the bedrock, but large areas of Heimaey and Surtsey are also covered with lava. These two are the largest islands, and they show greater variation in topography than the smaller members of the group, some of which are mere stacks, 50 m high with a mantle of vegetation on the slanting summit. The soil in the older islands is rather deep, loessy in character, fertile and rich in organic matter due to birds droppings. Sea birds inhabit the islands in great numbers; among these is the puffin (Fratercula arctica) which digs deep nesting holes in the soil on the top of the islands whereas the other bird species inhabit the cliffs.

Climate

No meteorological records have been carried out on Surtsey or the smaller islands. On Heimaey, however, there is a meteorological station with available records from 1872.

The climate is highly oceanic. It is relatively warm and moist in comparison to the average climate on the mainland or, for example, the island of Grímsey. The precipitation is the seventh highest, and the mean temperature the third highest in Iceland. (See Table I).

Excursions

Various excursions were made to the smaller islands from Heimaey, which was used as a base of operation. The study commenced in early July 1965 when the students, Björn Johnsen and Sigurdur Helgason went to the Westman Islands, later to be joined by other

groups of investigators. The last trip was made on Sept. 9th. On all these excursions ecological survey was carried out and herbarium material collected as well as live specimen for laboratory study. Following is brief account of the excursions.

Excursion No. 1. July 9th to Brandur.

The party left Heimaey at midday with the boat t/b Adolf piloted by H. Johnsen.

Brandur island is an old volcano with the crater bowl facing the sea on its southwest side. Landing conditions there proved tolerable compared to other islands yet to be explored. The island is extremely steep and rugged; nevertheless the ecological survey was carried out and plant specimens collected. The party stayed overnight in a small hut and had to leave at noon the following day because of the unexpectedly early arrival of the coastguard vessel, which was to take the expedition to the other islets.

Excursion No. 2. to Geirfuglasker and Thrídrangar.

The coastguard boat Árvakur, on its annual visits to the lighthouses on Geirfuglasker and Thrídrangar, carried the party to the precipitous rocky islet of Geirfuglasker. When arriving, a rubber boat was manned and padded to the rock. The party succeeded in landing there safely in spite of rough sea and climbed about 50 m up the steep cliff to the summit. The climb was facilitated by chains bolted to the cliff which is very rough due to differential erosion. The summit of the rock is almost level and only a few hundred square yards in area. A thick layer of volcanic ash carried from Surtsey had accumulated there and partly killed and buried the extremely sparse vegetation.

The next destination was Thrídrangar (Three Pillars), two hours trip by boat WNW from Geirfuglasker. Conditions there are quite similar to those of Geirfuglasker as regards landing and ascending, but the islet is still smaller in size.

Excursion No. 3. July 13th to Álsey.

The party arrived on Álsey by evening with the boat t/b Soffia piloted by J. Bryngeirsson. Landing conditions there are quite difficult except in calm sea. The expedition was assisted by bird collectors, who were on the island during the bird hunting season. The following day the island was explored and an ecological study performed. Samples of living plants were taken. The party had to leave for Heimaey the same evening although the work was not quite completed.

Excursion No. 4. July 21st to Ellidaey.

The trip was made on the boat t/b Soffia piloted by H. Jonsson. Participants were C.H. Lindroth and H. Anderson, Swedish entomologists, S. Jónsson algologist, and S. Helgason. The landing and ascending conditions were favourable. Later that day strong wind delayed the return of the boat, and the rough sea made the landing extremely difficult but at last the party succeeded in getting on board and returned to Heimaey.

Excursion No. 5. July 23rd to Sudurey.

The party left Heimaey by the boat t/b Soffia piloted by H. Jonsson. Participants were S. Jónsson and B. Johnsen. The first landing was on Brandur island to collect additional samples of living plants for cytological studies. Then the course was taken to Sudurey and a successful landing made although conditions are extremely difficult there compared to other islands. As the party had disembarked and supplies had been unloaded the boat returned to Heimaey. The island is surrounded by precipitous cliffs on three sides. On the fourth side there is a high (160 m) and steep slope which had to be climbed in order to reach the top. The following day the plant life and algae were studied and samples collected. The expedition left the island by nightfall.

Excursion No. 6. July 25th to Ellidaey.

The party left Heimaey at midday with the boat t/b Hlýri piloted by B. Gudmundsson. Participants were S. Jónsson, B. Johnsen and S. Helgason. The course was taken to the shallows east of Heimaey and samples of algae collected by a bottomscraper. Currents were favourable and the results excellent. Samples of algae were also taken from shoals between Ellida-island and Bjarnar-island. A short excursion was made to Ellidaey and samples collected.

Excursion No. 7. August 4th to Hellisey.

The party left for Hellisey on the boat t/b Hlýri piloted by B. Gudmundsson. The island is crescent-shaped and precipitous with the concavity facing the main wind direction, and during winter the surf reaches high. Without the help of a guide, who knew the routes, the steep ascent was made with difficulty. The vegetation is sparse at lower levels but increases gradually until it forms a continuous mantle on the top. The plant-life and algae were studied and samples taken.

Excursion No. 8. August 8th. A second trip to Geirfuglasker.

The party left Heimaey with the boat t/b Adolf piloted by H. Johnsen. Participants S. Jónsson algologist. The main purpose of the trip was to collect algae from Geirfuglasker. The trip was quite successful.

Excursion No. 9.

An excursion to Súlnasker was made on September 10th by a helicopter supplied by the Icelandic Coast Guard, piloted by B. Jónsson. Participants were S. Fridriksson and S. Helgason. The island is 80 m high with vertical cliffs on all sides and quite unaccessable. A study was carried out on the vegetation of the island during a three hours' stay.

Excursion No. 10.

An excursion was made to the south coast of Iceland on August 17th to 25th for a botanical study of the mountain isolates of Pétursey, Hjörleifshöfdi and Hafursey.

Vegetation

The flora of the Westman Islands consists of 150 species of vascular plants according to Johnsen (1939). All the species recorded on the smaller islands are similarily found growing on Heimaey. On these islands the vegetation is prolific but scanty in species, with a total of only 27 species of vascular plants. On Ellidaey, the largest of the smaller islands, the number of species is 22, but on the pinnacles of Geirfuglasker and Thrídrangar the species recorded were four and two respectively.

The species found on each individual island are listed in Table II.

An attempt was made to classify the species of the Westman Islands according to geographical distribution and life forms. The species are compared with those of four other Icelandic isolates. Three of those are tuff mountains isolated by alluvial gravel and sand, and situated on the mainland in the neighbourhood of Mýrdalur: Pétursey was found to have 73 species, Hjörleifshöfdi 75, and Hafursey 89 species. The fouth isolate is the island of Grímsey, situated off the north coast of Iceland with a total of 116 species.

The comparison shows that the number of Arctic species increases with increased latitude, changing from no Arctic element in the flora of Súlnasker and Geirfuglasker to 42% Arctic species in the flora of Grímsey. The majority of the species of the Westman Islands, or 74 to 100%, are of European type, which reflects the thermal condition of these respective locations rather than a difference in floral communities in possible glacial refugia in the northern and southern part of the country. (See Mölholm Hansen, 1930, for classification).

The ratios of various life forms (Raunkier, 1907) on the islets are comparable to that of Heimaey, but the Westman Islands group differs in this respect from the three inland isolates as well as from Grímsey. Chameophytes are more frequent on the

mainland, but the percentage of Annuals is higher on the Westman Islands. The percentages of Geophytes and Hemicryptophytes on the islands are similar to that of the mainland. (Table III).

The vegetation of the smaller islands can be classified into four plant communities: The puffin-colony vegetation, the dry meadow land, the coastal cliff vegetation, and the angelica cluster.

I. The puffin-colony type forms the bulk of the vegetation on the southern islands, and is usually situated on slopes facing the sea where the puffin (Fratercula arctica) nests in deep holes. The nesting holes are rather closely packed, two to three holes per square meter. The three main species of vascular plants growing there are: Festuca rubra, Matricaria maritima and Stellaria media. The Festuca is predominating with the approximate cover of 70%, while Matricaria and Stellaria are the associated species.

The soil is deep and damp with high content of organic matter. The fertility-level of the soil is extremely high as a result of bird droppings. These high fertility conditions are quite selective, presumably favouring the red fescue rather than other grass-species. At this level the fescue remains highly vegetative and has a high leave to culms ratio. The puffin-colony vegetation has intense bluish-green tint, contrasting the bleaker tint of the dry meadow land. This difference becomes more conspicuous towards autumn, as the grass in the dry meadow-land reaches maturity and becomes higher in fiber-content and wilts earlier than in the puffin colony. The soil is broken up by the puffin into small columns with tufts of red fescue covering the network of tunnels and trenches. Thus this honeycomb-structure of soil appears to be a continuous mat of vegetation. However, where there is a break in the fescue cover, the associated species have a chance to establish themselves.

Whenever the breeding grounds of puffin are densely populated the growth of the red fescue is hampered by the excavation of the birds. On these occasions the associated species are favoured, sometimes even allowing the Matricaria to predominate,

but, in rare instances, Cochlearia and Atriplex occupy the space.

Apparently this high fertility level, the special water retention of the turf soil, as well as the intense aeration caused by the digging, play an important role in this selective habitat. The soils differ as to the extent of aeration from other highly fertile soils in Iceland such as those of hayfields in the neighbourhood of stables and farmhouses. In that case Poa annua dominates, but is hardly present in the vegetation of the puffin colony except in one instance, i.e. on the island of Súlnasker, where it was found growing on the edge of a small basin containing rain water.

II. The dry meadow land vegetation has a wide distribution, being the second largest plant association on the southern islands and predominating on the northern islands. It is situated on the level or sloping summits and where the soil is dry and too shallow for the puffin to dig their nesting holes. (The puffin colony association can be regarded as a derivative of the grassfield as the puffin hardly establishes nesting colonies except in grass covered soil. On some of the islands any pure grassfield is hardly to be found as it is occupied and deformed by the presence of the puffin). The soil of the dry meadow land is rich in organic matter due to the high annual productivity of this community and its low decomposition. A layer of turf is thus formed at the top. On the southernmost island this top layer includes some fresh volcanic ash derived from the Surtsey eruption. The thickness of the ash varies in proportion to the distance from its source of origin. On the island Álsey 14 km distant from Surtsey the ash layer was 2-3 cm thick. Below the turf layer the soil is rich in minerals, which derive from the basic tuff below. The grassfield is to some extent fertilized by various seabirds constantly swarming over the islands during the nesting period. This accounts for a rather high fertility level of the soil and vigorous growth. The dry meadow land has a predominance of grasses, with Festuca rubra covering 61% of the total area, Poa pratensis covering 32%, Agrostis tenuis 3%, and the associated species covering the remaining 4% as an average

of measurements from Álsey, Brandur and Sudurey. The associated species are Ranunculus acris, Poa trivialis, Rumex acetosa, Cerastium caespitosum and Taraxacum acromauris. All these species are of common occurrence in cultivated grassfields in Iceland (S. Steindorsson 1964, p. 124).

As a rule the grassfield vegetation resembles some cultivated grasslands as regards to species and growing conditions. The bryophyta are completely absent from this plant community as is the case of well cultivated hayfields.

The growth of the grass species is vigorous. The height of mature culms reaches 20 inches, and the yield is five to six tons of dry hay per hectar (5 - 6000 lbs/acre) judged from samples collected in Sudurey and Álsey. The productivity is thus quite high, almost comparable to that of an average cultivated hayfield in Iceland. When this observation was made no sheep had been grazing on the southern islands since the volcanic activity started in the Surtsey area. A number of sheep had previous to that been grazed on the islands all the year around as far back as records go. The grazing of the sheep may be selective to some extent; in dry season the sheep have a tendency to feed on the more succulent broad leaved herbs as drinking water is limited. It is the farmers' opinion that the vegetation on the islands has been more productive after the volcanic activity commenced and that Matricaria and Ranunculus are now more abundant. The volcanic activity may have affected the growth directly by the fertilizing effect of the ash or indirectly by terminating the grazing of sheep.

III. The coastal cliff vegetation is situated in the splashing zone, forming a fringe around the islands, which is, however, not necessarily continuous. It is the vegetation of the slanting slope but is interrupted wherever the cliffs are too steep to hold this type of vegetation. Its lower margin is at high tidemark and the upper border is contiguous with the puffin colony. This zone varies in width, reaching higher level on the southern side, which is exposed to the Atlantic where the surf is more intense than on

the side facing the mainland. This vegetation does not form a continuous mat. The various plants are only found growing in small patches in depressions and cravasses, where some soil or anchorage is to be found on the otherwise bare rock. Estimated ground-coverage is one to five percent of the total area. The predominating species are Puccinella maritima and Cochlearia officinalis with Armeria vulgaris, Atriplex patula and Plantago maritima as associated species.

IV. The Angelica cluster is situated on slopes or rocky shelves on the northern sides of some of the islands. It is described by Johnsen (1939) but was not investigated by our group.

Concluding remarks.

In general the vegetation on the larger islets is predominated by the grasses, especially Festuca rubra, which seems to be favoured by the environmental conditions present.

The surface of the islands is generally sloping towards the sea, preventing water from accumulating. During periods of drought, which can last for several weeks, the soil may become so dry that only the highly drought resistant species survive.

In addition the fertility level of the soil, the effect of the velocity and frequency of winds, the splashing of sea water, as well as the grazing of sheep, are important environmental factors and presumably account for the fact, that no woody plants grow wild on the islands, with the exception of three woody species found on the lava of Heimaey. The high precipitous cliffs, reaching considerable depths below sea level and thus devoid of gravel beaches, exclude some coastal species and hinder dispersal by sea.

The sizes of the individual islands evidently cause further limitations, as the number of species was found to be roughly proportional to the area of the islands.

It is evident that all these highly special environmental factors cause great limitations as to the number of plant species and their association on the islands.

Although the migration of plants is restricted to some extent by the isolation of the islands, the flora of each individual island has to be regarded as a climax community primarily governed by the present environmental conditions.

BIBLIOGRAPHY

Hansen H., Mölholm 1930: Studies on the vegetation of Iceland. Copenhagen.

Johnsen, Baldur 1939: Observations on the vegetation of the Westman Islands. Societas Scientarum Islandica. Vol. XXII.

Löve, Áskell 1945: Íslenzkar jurtir. Einar Munksgård. Köbenhavn.

Raunkier, C. 1907: Planterigets Lifsformer og deres Betydning for Geografien. Copenhagen.

Stefánsson, Stefán 1924: Flóra Íslands. 2nd edition. Reykjavík.

Steindórsson, Steindór 1964: Gróður á Íslandi. Almenna Bókafélagið. Reykjavík.

Steindórsson, Steindór 1964: Flóra Grímseyjar. Journal of Icelandic Botany, p. 89-94.

Veðráttan 1944 og 1962 (A Meteorological Bulletin). Veðurstofan. Reykjavík.

TABLE I

Mean precipitations and temperatures at Stórhöfdi, Westman Islands, Vík, Mýrdal, and Grímsey, 1901-1930, 1931-1960.

Meteorological stations		Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	The whole year
						Mean Temperatures in °C								
Westman Islands (Stór-höfdi) 1901-1930		1.1	1.3	1.6	3.0	5.7	8.5	10.2	9.6	7.5	4.8	2.4	1.4	4.8
Westman Islands (Stór-höfdi) 1931-1960		1.4	1.6	2.7	3.7	6.2	8.5	10.3	10.2	8.4	5.6	3.8	2.5	5.4
Vík, Mýrdal	1901-1930	0.9	1.2	1.5	3.1	6.2	9.3	11.0	10.5	8.0	4.9	2.3	1.3	5.0
Vík, Mýrdal	1931-1960	1.2	1.2	2.6	3.9	6.9	9.5	11.3	11.0	9.0	5.6	3.7	2.3	5.7
Grímsey	1901-1930	- 1.8	- 1.9	- 2.0	- 0.8	2.2	5.7	7.7	6.8	5.5	2.6	0.2	- 0.9	2.0
Grímsey	1931-1960	- 0.5	- 1.1	- 0.4	0.2	3.4	6.3	8.1	8.3	6.7	3.9	1.9	0.3	3.1
						Precipitation in mm								
Westman Islands (Stór-höfdi) 1921-1930		160	147	197	99	84	72	90	89	125	93	129	160	1373
Westman Islands (Stór-höfdi) 1931-1960		138	104	109	97	81	81	84	108	132	166	141	156	1397
Vík, Mýrdal	1931-1960	182	159	164	171	143	167	169	188	237	238	212	226	2256
Grímsey	1951-1962													662

THE METEOROLOGICAL BULLETIN, Veðráttan, 1944-1962, Reykjavík.

TABLE II

Floral list from ten islets of the Westman Islands group.

Species	Life forms [1]	Ellidaey 0.46 km^2	Bjarnarey 0.32 km^2	Álsey 0.25 km^2	Súdurey 0.20 km^2	Brandur 0.10 km^2	Hellisey 0.13 km^2	Súlnasker 0.04 km^2	Geirfuglasker 0.02 km^2	Thrídrangar 0.01 km^2	Surtsey 2.5 km^2
Agrostis stolonifera	H-E_3				x						
Agrostis tenuis	H-E_3	x	x	x	x						
Archangelica officinalis	H-A_2	x	x	x	x						
Armeria vulgaris	CH-A_3	x	x			x	x				
Atriplex petula	TH-E_2			x	x	x	x	x	x		
Cakile edentula	TH										(x)
Cerastium caespitosum	CH-E_3	x	x	x	x	x					
Cochlearia officinalis	H-E_4	x	x	x	x	x	x	x	x	x	
Euphrasia frigida	TH-A_2	x	x		x						
Festuca rubra	H-E_4	x	x	x	x	x	x	x			
Leodonton autumnalis	H-E_3	x	x	x	x						
Matricaria maritima	H-E_3	x	x	x	x	x	x	x	x		
Montia lamprosperma	TH-E_4		x		x						
Plantago maritima	H-E_4	x	x	x		x	x				
Poa annua	TH-E_3		x	x	x			x			
Poa pratensis	G-E_3	x	x	x	x	x					
Poa trivialis	H-E_2	x	x	x	x						
Puccinella maritima	H-E_3	x	x	x	x	x	x	x	x	x	
Ranunculus acris	H-E_4	x	x	x	x						
Ranunculus repens	H-E_4	x			x						
Rumex acetosa	H-E_3	x	x	x							
Sagina procumbens	CH-E_3	x	x	x	x						
Saxifraga caespitosa	CH-A_3	x	x	x							
Saxifraga rivularis	H-A_3			x							
Sedum roseum	H-A_2	x	x	x							
Silene maritima	CH-A_1	x	x	x	x	x					
Stellaria media	TH-E_4	x	x	x	x	x	x	x			
Taraxacum acromauris	H-E_2	x	x	x	x						

[1] For explanations of terms see Table III and Raunkier, C., 1907.

TABLE III

Life forms and number of species from nine Westman Islands, three inland mountain isolates and Grímsey

Locations	No. sp.	A %	E %	PH %	CH %	H %	G %	TH %	HH %
Grímsey	116	42	58		15.5	61.2	12.0	7.7	5.2
Hafursey	89	39	61	1	26	58.4	6.7	8.0	
Hjörleifshöfdi	75	36	64		26.6	54.6	9.3	9.3	
Pétursey	73	29	71		24.6	60.0	7	8	
Heimaey	150	26	74	0	13.4	61.7	8	13.4	3.4
Ellidaey	22	27	73		18	63.6	9	9	
Bjarnarey	22	18	82		12.5	62.5	8.3	16.6	
Álsey	22	18	82		18	63.6	4.5	13.6	
Sudurey	21	14	86		14.2	57.0	4.7	24.0	
Brandur	11	18	82		27	45.4	10	18	
Hellisey	8	12	88		12.5	62.5	0	25	
Súlnasker	7	0	100			71		28	
Geirfuglasker	4	0	100			75		25	
Thrídrangar	2	0	100			100.0			
The smaller islands, total	30	23.3	76.7		16.7	60.0	6.7	16.7	0

A Arctic species
E European species
PH Pheophytes
CH Chamaephytes
H Hemikryptophytes
G Geophytes
TH Therophytes
HH Hydrophytes, Helophytes

ICELAND.

100 km.

1. WESTMAN ISLANDS,

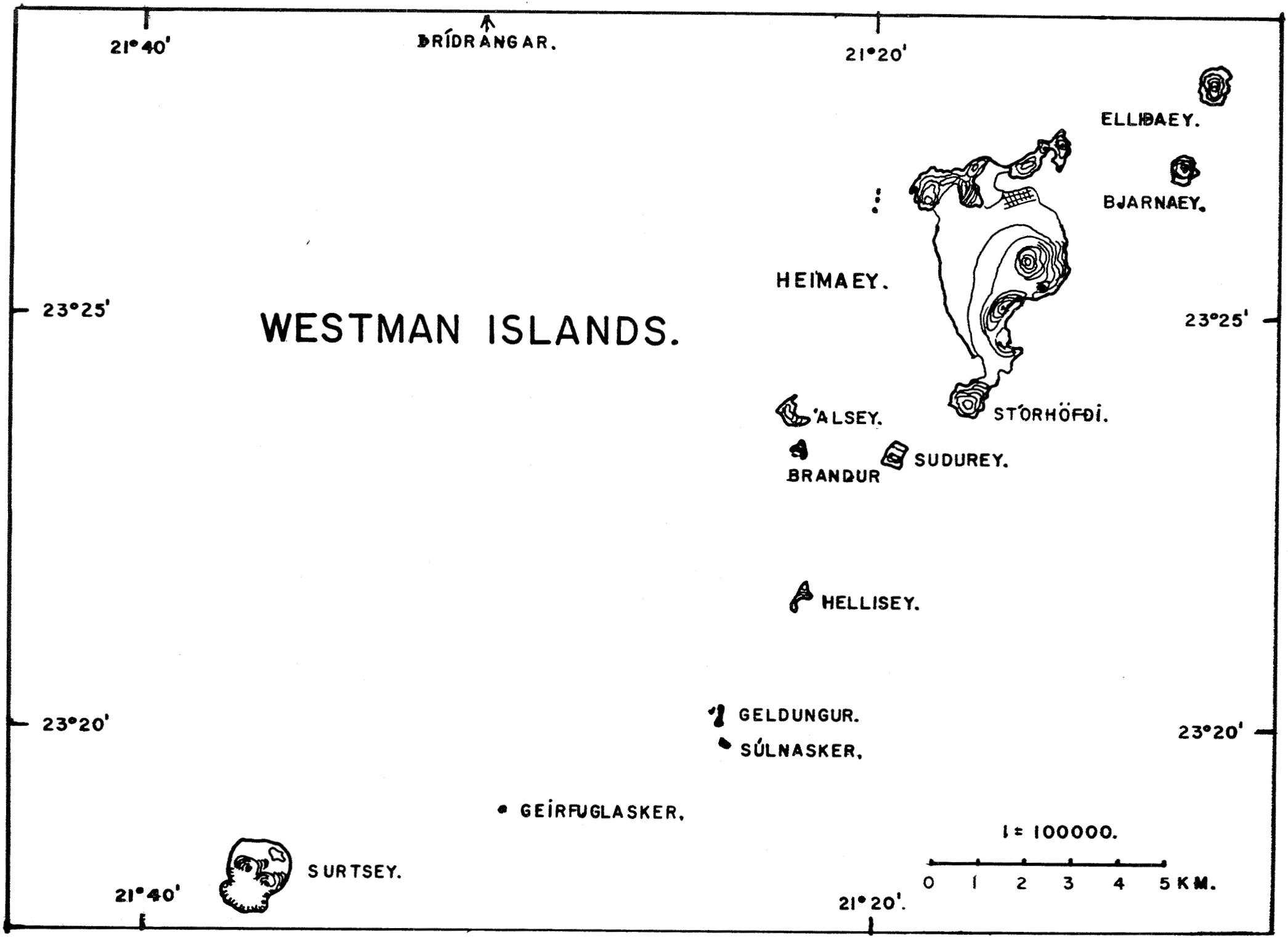
2. PÉTURSEY.

3. VÍK,

4. HJÖRLEIFSHÖFÐI

5. HAFURSEY.

6. GRÍMSEY.


21°40'
ÞRÍDRANGAR.
21°20'
ELLIÐAEY.
BJARNAEY.
HEIMAEY.
23°25'
WESTMAN ISLANDS.
23°25'
'ALSEY.
STÓRHÖFÐI.
BRANDUR
SUÐUREY.
HELLISEY.
23°20'
GELDUNGUR.
SÚLNASKER.
23°20'
GEIRFUGLASKER.
1 = 100000.
0 1 2 3 4 5 KM.
SURTSEY.
21°40'
21°20'.