The Colonization of Vascular Plants on Surtsey in 1967

by

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This report describes the records made on the colonization of vascular plants on Surtsey during the summer of 1967, as well as the planning of fixed quadrates on the four major substrates of the island. The study was financed by the U.S. Atomic Energy Commission under grant No. AT(30-1)3549.

Method of investigation

During the summer the investigation on the island was almost continuous from 31st March to 24th September. The island was visited occasionally during the winter months. Throughout this period the development of vegetation on Surtsey was observed regularly. For this purpose, among other things, the student Sigurdur Richter was stationed on the island. The authors made shorter visits. Daily tours of inspection were made, and the northern part of the island examined with special care. The location and stage of growth of new individual plants were recorded as they were found, and their progress followed during the summer. Every plant was marked with a stake bearing its number, and the position of all plants plotted on an air-photograph. Photographs were taken of the plants for record purposes. About the middle of July the island was visited by a team of surveyors who proceeded to map a grid over the island and select quadrates representing four typical substrates. For this purpose, fixed points were measured throughout the island. These were later marked by conspicuous marks(sandbags) for aerial photography. The island was photographed from the air on 18th July during excellent weather conditions, calm weather and sunshine. From coordinates 05 and 42 in the national grid system a grid was laid over the island. The squares are each one hectare in area and identified by a letter and number, e.g. A 1, B 2, etc. The north shore was closely surveyed according to this system and the corners of the squares marked with iron pipes. After this, the location of the plants within the squares

was determined and plotted on the aerial photograph, from which the accompanying map is drawn. Four fixed quadrates were chosen and specially marked for future more detailed examination. Two were in the northern part of the island, D 11 and F 15, while two were on the lava in the south, K 18 and J 3.

Substrates

One of the vital conditions for the effective colonization of plants is the existence of a favourable soil in which plants can take root and grow.

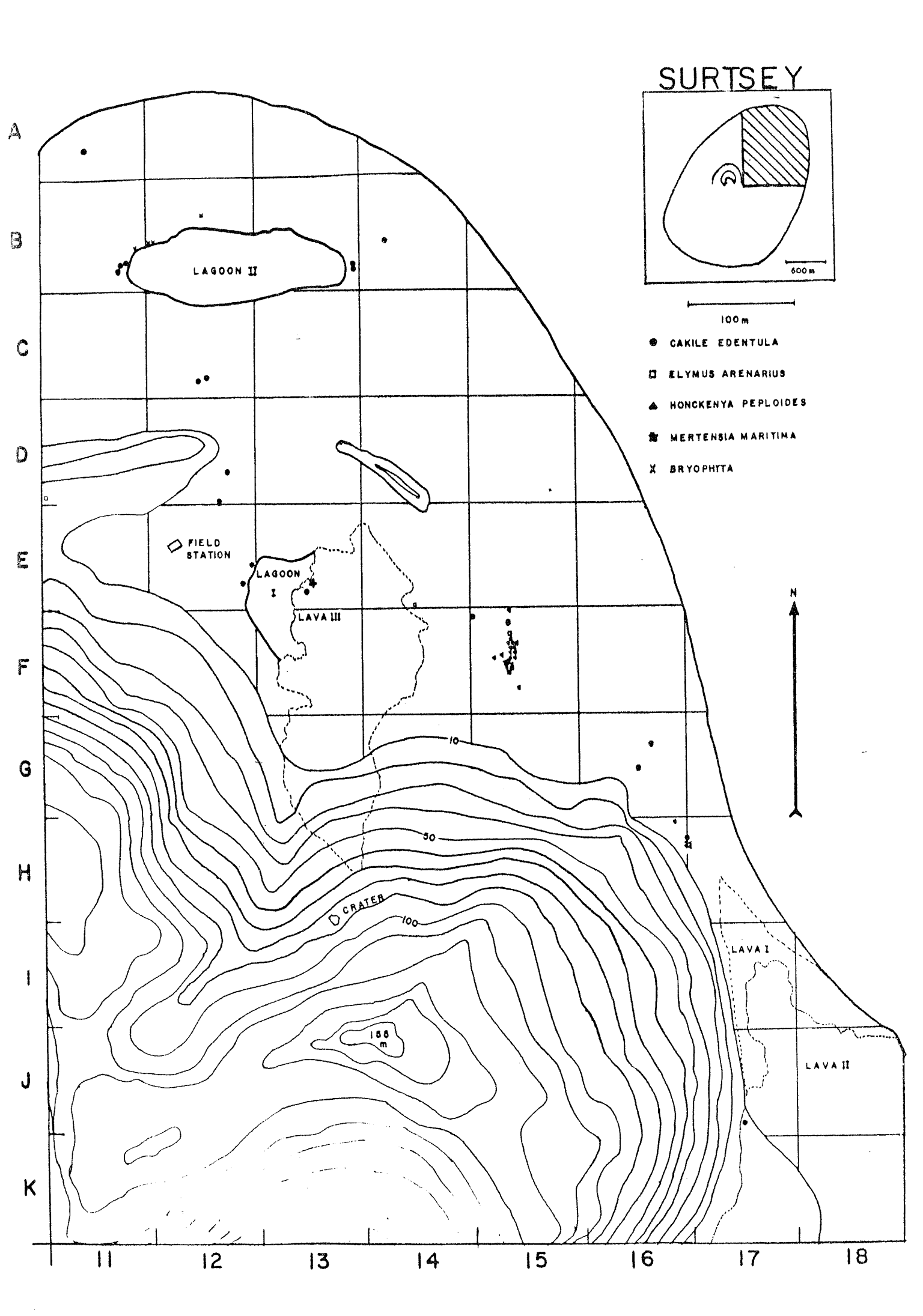
Since Surtsey first emerged from the sea, many changes have taken place from year to year, with an alternation between building up and breaking down, all of which have gone to form the landscape and topography of the island. At present there have been formed four major types of substrates on Surtsey: tuff, old lava, new lava and beach sand.

a) A great deal of the central part of the island was formed during the first phase of the eruption providing a tuff substrate, which is gradually hardening. It was continuously mixed with ocean water and has still a high salt content.

b) Lava from the first outbrake, mostly overlaid with cinder from the eruption of the small islands. Covers a great deal of the southern part of Surtsey.

c) New bare lava was formed after a certain pause in the volcanic activity on the island, starting on 19th August 1966 and continuing without a break for nearly 9½ months, coming to an end on 4th June 1967. During this period the island grew a certain amount towards the south-east owing to this new lava flow; an increase roughly estimated at 0.6 sq.km.

d) The beach at the beginning of the eruption, beaches of cinder, pumice and loose lava fragments started to form at the northern side of the island. During the winter 1966-67 this process continued and a considerable quantity


SURTSEY
600 m
100 m
CAKILE EDENTULA
ELYMUS ARENARIUS
HONCKENYA PEPLOIDES
MERTENSIA MARITIMA
BRYOPHYTA
LAGOON II
FIELD STATION
LAGOON
LAVA III
LAVA I
LAVA II
CRATER
10
50
100
155 m
N
A
B
C
D
E
F
G
H
I
J
K
11
12
13
14
15
16
17
18

of loose tephra from the south of the island was heaped up on the northern side. In this way about 0.13 - 0.15 sq.km. were added to the north beach. This increase of beach area on the north side created conditions much more favourable to plant colonization in the following summer than had existed in the previous one. Under normal circumstances the formation of soil on Icelandic lava is a relatively slow process. On the shore, however, conditions favourable to plant growth can develop rapidly. On Surtsey various forms of organic material are washed ashore, e.g. a considerable amount of seaweed and driftwood, as well as the remains of various marine organisms, such as fish and plankton. This organic matter mixes with the sand, which is washed out volcanic cinders, and as soon as the air temperature rises, begins to disintegrate. Large numbers of seabirds (various species of gull) frequent the shore, supplementing the organic content of the sand with their excreta. This initial step in formation of soil on the beach, however, is not stable. The heavy seas of the winter cause considerable disturbance of the order in which the material may be deposited churning up whatever arrangement there might have been. The most soluble nutrients are washed away, while other organic matter is buried by the sand and shingle. However, though a great deal of organic matter is thus lost, the sea compensates with a fresh supply of drift material. This cycle is repeated annually, so there is no question of a really stable formation of soil on the shore. However, some organic matter may be carried up the beach beyond the highest tide mark, and thus supply the basis for a more consistent soil formation, and such conditions now exist on the northern shore of Surtsey.

Description of fixed quadrates

Following the surveying of the island, four quadrates were selected for a more detailed study. These are according to the map identified by letters and figures as D 11, F 15, K 18 and J 3.

D 11 lies to the north-west of the hut and extends over a low ridge, Bólfell, ca. 10-20 m above sealevel, where meteorological instruments have been installed. The substratum is cinders, similar to that found in the neighbouring hills and formed in the earliest phase of the eruption.

F 15 is east of the southern lagoon. Within the quadrate is an area once covered by the older lagoon, though the greater part of this has since been filled up by sand and lava. The quadrate is on a level platform of sand about 6 m above sealevel. The substratum is washed out beach sand mixed with various kinds of drift material. Almost half the number of plants recorded during the period of investigation, i.e. 24 individuals, which all are coastal species, were found in this area.

K 18 lies on the eastern margins of the new lava, which is bare and has not been overlaid with cinder. This may be regarded as a likely area for the colonization of the first lower plant life, such as mosses and lichens, thus preparing the way for higher species.

J 3 is in the northwestern area of the older lava, about 150 m from the sea and 16 m above sealevel. An automatic meteorological station has been installed here. The quadrate is level for the most part, though with a slight slope towards the west. The basis is ropey-type lava with a 10-15 cm overlay of ash. The ash, deriving from the eruption of the smaller islands Syrtlingur and Jólnir, fills all hollows and crevices in the lava and may therefore accelerate the formation of soil.

These quadrates were selected to provide as wide a variety of growth conditions as possible on the four types of substratum, i.e. washed out beach sand; loose tephra and ash, which hardens to tuff; bare, recent lava; and older lava with a surface-layer of ash. It will be interesting to trace the changes in the substrata which will be a necessary prelude to any plant colonization there.

Description of vegetation

In Surtsey Reports II and III an account was given of the

colonization of plants on Surtsey 1965-66. In the first year about 30 plants of the species Cakile edentula were found in E 14. In the second year 4 seedlings of Elymus arenarius and one plant of Cakile edentula were found in C 11. These plants lasted only a very short time in both years, and they were not to develop beyond the seedling stage. However, the summer of 1967 has been more favourable on Surtsey, and 52 individuals of 4 species of vascular plants have been recorded, beside two species of Bryophyta. One of these mosses was in a small patch on the northern shore of the lagoon, and the other just by the old crater (see Bergthor Jóhannsson's and Eythor Einarsson's reports). In the early summer 15 individuals of Cakile edentula had been observed, the first plant being discovered on 18th May. Most of these were defeated later by unfavourable conditions, especially wind erosion. Later during the summer altogether 21 individuals were recorded of which 15 flowered and 6 bore matured pods. The species is annual. Of Honckenya peploides 26 individuals were recorded, a number of which produced considerable vegetating growth, though none flowered during the summer. This species is perennial. The third species was Elymus arenarius, which is a perennial grass species and of which 4 individuals were found. These only set a few leaves and did not flower. The most developed individual of these was 41 cm in height. The fourth species was Mertensia maritima, a perennial of which only one specimen was found on the "New Year" lava by the lagoon, in E 13. It was trodden on and only one leaf remained when last examined. See Table 1 and accompanying map.

Almost half the recorded specimens were on a single strip of drift-layer in F 15, about 150 m from the shore. It may be assumed that this layer was formed by an exceptionally high tide, reaching a point to which the sea has not yet since attained, and for this reason the seed carried up with the drift was able to germinate undisturbed. It is conceivable that some of the perennials which were there may manage to survive the winter, provided that the quadrate F 15 is not disturbed unduly by the sea. As may be seen from Table 1, the various specimens of Cakile edentula began to germinate at different times and grew under varying conditions. Some

plants barely got beyond the seedling stage, while others achieved normal growth and bore flowers and mature pods.

The first plant to flower on Surtsey was Cakile edentula no. 3 in F 15. We observed it in flowers during an expedition on 26th June. It later set mature pods. Since then 15 individuals of this species flowered and 6 produced matured pods. The total number of pods formed were approximately 300 with almost twice as many seeds.

It is noteworthy that individual plants have succeeded in multiplying in their new habitat, and thus laid the foundation of a new generation.

Acknowledgements

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List of plants found on Surtsey 1967

No.	Species	Location	Date of discovery	Maximum stage of growth	Flowering time	No. of pods developed
1.	Honckenya peploides	F 15	24/6	8 leaves on a branch		
2.	Honckenya peploides	F 15	24/6	10 leaves on a branch		
3.	Cakile edentula	F 15	2/6	10 branches with leaves, flowers and pods	26/6	more than 50 pods
4.	Wilted grass seedling					
5.	Honckenya peploides	G 16	24/6	one stalk and 6 leaves		
6.	Cakile edentula	G 16	2/6	15 branches with leaves flowers and mature pods	6/7	40 pods
7.	Cakile edentula	C 12	2/6	cotyledonous		
8.	Cakile edentula	C 12	2/6	cotyledonous		
9.	Cakile edentula	D 12	2/6	6 leaves and flowerbuds		
10.	Honckenya peploides	F 15	24/6	2 branches with 12 leaves		
11.	Honckenya peploides	F 15	25/6	3 branches with 24 leaves		
12.	Honckenya peploides	F 15	25/6	1 branch with 6 leaves		
13.	Honckenya peploides	F 15	25/6	1 branch with 10 leaves		
14.	Honckenya peploides	F 15	25/6	1 branch with 14 leaves		
15.	Honckenya peploides	F 15	25/6	2 branches with 19 leaves		
16.	Honckenya peploides	F 15	25/6	5 branches with 50 leaves		
17.	Honckenya peploides	F 15	25/6	1 branch with 14 leaves		
18.	Cakile edentula	C 12	27/6	1 branch with flowers	3/8	
19.	Cakile edentula	F 15	29/6	1 branch with 3 leaves 8 flower stalks	3/8	
20.	Cakile edentula	D 12	30/6	1 branch with 6 leaves and 12 flower stalks	14/7	
21.	Honckenya peploides	F 15	6/7	1 branch with 11 leaves		
22.	Honckenya peploides	F 15	6/7	2 branches with 14 leaves		
23.	Elymus arenarius	F 15	12/7	2 leaves 12 cm		
24.	Elymus arenarius	F 15	12/7	3 stolons 25 cm, 20 cm, 40 cm		
25.	Honckenya peploides	F 15	12/7	1 stem with 8 leaves		
26.	Honckenya peploides	F 15	12/7	1 stem with 7 leaves		
27.	Cakile edentula	F 15	12/7	6 branches with leaves and flowers		30 mature pods
28.	Cakile edentula	B 13	13/7	1 stem with 4 leaves		

No.	Species	Location	Date of discovery	Maximum stage of growth	Flowering time	No. of pods developed
29.	Cakile edentula	B 13	13/7	1 stem with 4 leaves		
30.	Honckenya peploides	H 16	14/7	4 leaves		
31.	Cakile edentula	B 14	14/7	stem and leaves, flowers	3/8	
32.	Cakile edentula	B 11	14/7	2 branches with 9 leaves 2 stands of flowers	3/8	
33.	Cakile edentula	B 11	14/7	stem with 8 leaves and flowers	3/8	
34.	Cakile edentula	B 11	14/7	4 branches with 16 leaves, flowers	3/8	
35.	Cakile edentula	E 12	15/7	6 branches with 8 flower stalks	3/8	more than 50 pods
36.	Cakile edentula	E 12	15/7	big plant with number of branches and flower stalks	5/7	more than 50 pods
37.	Elymus arenarius	E 14	18/7	3 leaves, 15 cm		
38.	Cakile edentula	J 17	17/7	dwarf plant, 1 stem with 2 leaves and flower buds		
39.	Honckenya peploides	F 15	18/7	stem with 12 leaves		
40.	Elymus arenarius	F 15	19/7	2 leaves		
41.	Cakile edentula	F 15	18/7	1 stem 4 leaves 1/2 cm		
42.	Honckenya peploides	F 15	20/7	stem with 4 leaves		
43.	Honckenya peploides	F 15	20/7	1 stem with 14 leaves		
44.	Honckenya peploides	H 17	28/7	seedling		
45.	Honckenya peploides	H 17	28/7	1 stem with 7 leaves		
46.	Honckenya peploides	H 17	28/7	1 stem with 6 leaves		
47.	Cakile edentula	H 17	28/7	1 stem with 4 leaves and flowers	3/8	
48.	Cakile edentula	A 1	3/8	1 stem with 7 leaves and 2 flower stalks	3/8	
49.	Honckenya peploides	H 17	3/8	1 stem with 4 leaves		
50.	Honckenya peploides	F 15	3/8	1 stem with 7 leaves		
51.	Mertensia maritima	E 13	11/8	1 cotyledon and 2 leaves		
52.	Cakile edentula	E 13	11/8	5 branches with flowers and pods	11/8	more than 50 pods
53.	Funaria hygrometrica	B 12	11/8			
54.	Funaria hygrometrica	K 10	9/9			
55.	Bryum argenteum	K 10	9/9			