

Preliminary Studies of the Vegetation of the Southern Coast of Iceland

By

S. FRIDRIKSSON, S. H. RICHTER and A. H. BJARNASON

The Agricultural Research Institute, Reykjavik

INTRODUCTION

Ecological studies were undertaken during the summer months of July and August, 1968, with the purpose of doing a provisional survey of vegetation on the south coast of Iceland, with regard to dispersal of plants and plant colonization on the island of Surtsey. Similar investigations had previously been carried out in the Westman Islands (Fridriksson and Johnsen, 1967).

METHOD OF RESEARCH

Observations were made at 34 places along the south coast, from Thorlákshöfn in the west and as far east as Vík, Mýrdal. Efforts were made to select the observation points at fairly regular intervals, although account had to be taken of where access to the coast was convenient.

The method of research was such, that the topography and the substrate of the coast was primarily investigated and described. Further study depended on the type of coast. Where mountains or cliffs descended straight into the sea, it was considered sufficient to list the species growing nearest to the sea. Where there was a sandy beach or low lava protruding into the sea, observations commenced nearest the sea and then proceeded inland. Species were enumerated on a transect diagonally from the shore, and attempts were made, where possible, to obtain a survey of zonation of the vegetation. The transects varied in length, depending on the width of the coastal region. Studies were confined to the coastal area, which was often bordered by grass or moorland vegetation.

The method used in measuring vegetation cover was such that the cover within a quadrat of 1 m² was estimated. Five such adjacent quadrats were investigated at each observation site, and an average found for these five quadrats of each site. The vegetation cover was estimated in units not smaller than 5%.

Unless the contrary is stated, the species are arranged in alphabetical order.

The terminology used for the various species is based on *Förteckning över Nordens växter*, by Nils Hylander, published in 1955.

DESCRIPTION OF THE COAST AND VEGETATION AT THE VARIOUS OBSERVATION SITES

1. WEST OF THORLÁKSHÖFN

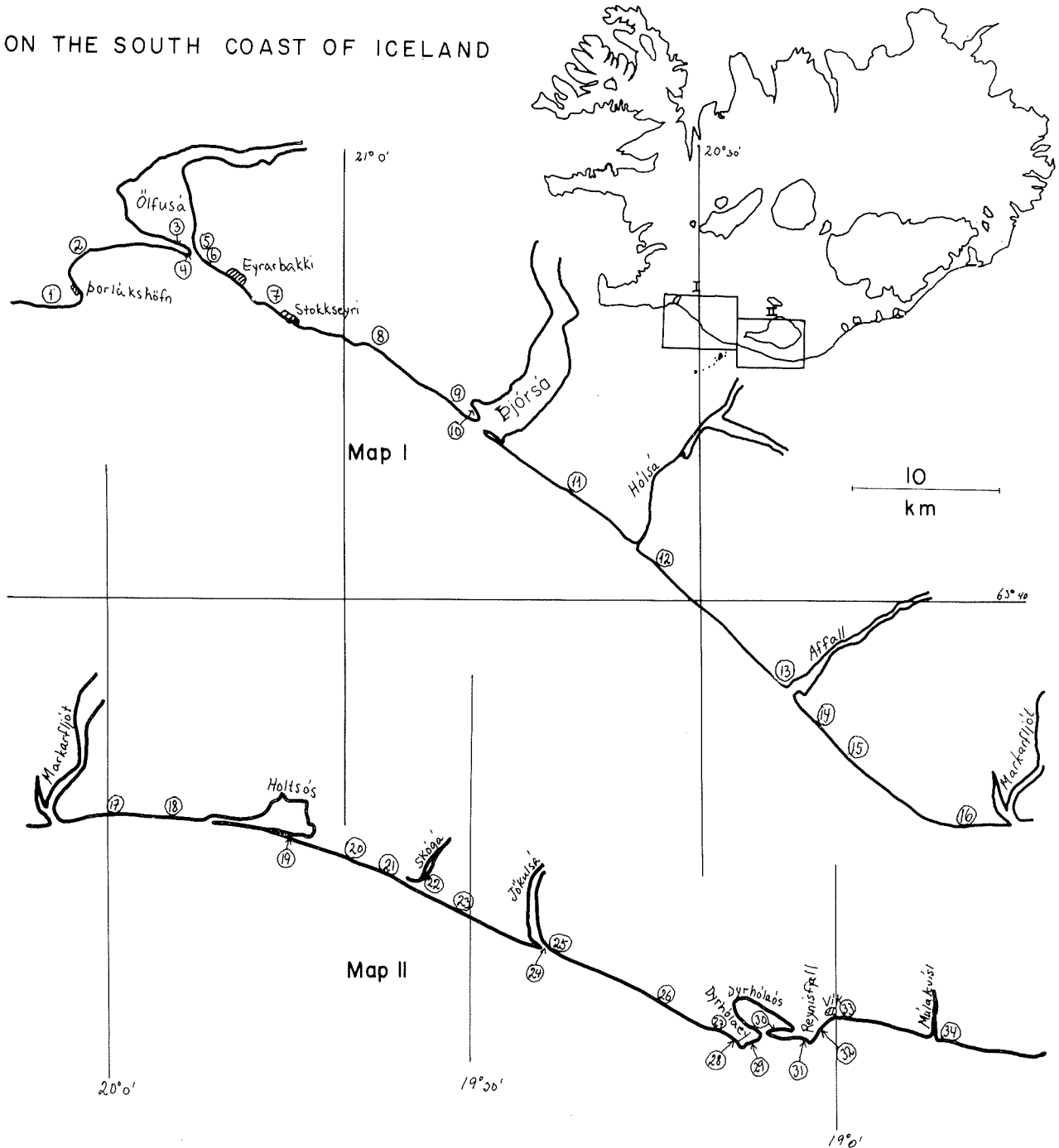
The coast is about 1.5 km west of the lighthouse at Hafnarnes. At this site rocky lava protrudes into the sea, forming 5—10 m high cliffs. Skerries and underwater reefs are offshore. In stormy weather the sea breaks over the cliffs and has formed a ridge of big, stony boulders within 10—50 m of the cliff-edge. The coastline appears similar to this for at least several kilometres to the west and as far as Thorlákshöfn to the east.

The sea-cliffs are completely devoid of vegetation, and the area of boulders is also largely bare. Nevertheless, the following species were encountered there: *Agrostis stolonifera*, *Agrostis tenuis*, *Festuca rubra*, *Mertensia maritima*, *Minuartia peploides*, *Puccinella retroflexa* and *Silene maritima*. This vegetation grows in the cracks between the rocks.

The ridge of boulders is 10—15 m wide, and on its landward side *Elymus arenarius* grows in some places.

The rocky lava behind the ridge of boulders is smooth and very sandy. Although there is some vegetation in the sand, there are bare lumps of lava in between. The total cover of vegetation in this area is about 40%. Results of measurements of vegetation cover performed 50 m above the ridge of bould-

MAP OF VEGETATION OBSERVATION SITES
ON THE SOUTH COAST OF ICELAND



ers show: *Agrostis stolonifera* 5%, *Agrostis tenuis* 5%, *Festuca rubra* 5%, *Silene acaulis* 5% and *Thymus drucei* 5%. In addition there were found within the measuring quadrates, arranged in order of frequency: *Plantago maritima*, *Silene maritima*, *Armeria maritima*, *Cardaminopsis petraea*, *Rumex acetosella*, *Luzula spicata* and *Arenaria norvegica*. Outside the measurement area the following species were discovered: *Cerastium fontanum*, *Elymus arenarius*, *Galium verum* and *Poa glauca*. This belt of vegetation reaches at least 2 km inland.

2. EAST OF THORLÁKSHÖFN

This coast is located 2 km NNE of Thorlákshöfn, with a sandy shore, black sand, but mixed with shellsand nearest to the sea.

The first plants are of the foreshore vegetation visible about 40 m from high-water mark, viz: *Cakile maritima* and *Elymus arenarius*. The next 5 m have thicker vegetation, and then comes a belt about 10 m broad, with a measured cover of about 40% *Cakile maritima*, 5% *Elymus arenarius* and some *Minuartia peploides*.

After that the vegetation thins out suddenly, and the next 5 m have very little vegetation.

Then follows a 3–4 m high sandy ridge, a barrier dune, completely covered with *Elymus arenarius*. This dune is approximately 30 m broad, and behind it the land descends again. Here *Elymus arenarius* grows on small dunes, thickly nearest the edge, but the dunes become less frequent about 4 km inland, where this zone of vegetation ends. Between the sand-dunes, nearest the ridge, the following species grow:

Armeria maritima, *Atriplex patula*, *Cardaminopsis petraea*, *Festuca rubra*, *Minuartia peploides*, *Potentilla anserina*, *Rumex acetosella* and *Silene maritima*.

The distinct zonation stretches from Thorlákshöfn in the west most of the way to the Ölfusárós estuary in the east.

3. WEST OF THE ÖLFUSÁ RIVER

This location is on Óseyrartangi, 1 km west of the mouth of Ölfusá. At this place Óseyrartangi isthmus is about 400 m broad between the sea and the Ölfusárlón lagoon.

The conditions are in many respects similar to those at the preceding observation site (No. 2). The shore is sandy, with the same barrier dune above the shore. However, there is no foreshore vegetation zone on the sea side of the barrier dune. The sea approaches much closer and has begun to break it down, in some places having broken through into the lower land behind.

From high-water mark up to the barrier dune it is about 15 m. The ridge is completely covered with *Elymus arenarius*.

On the lower land behind the barrier dune the vegetation area appears to be very uniform. Results of measurements of vegetation cover performed about 200 m from the sea show: *Festuca rubra* 25%, *Elymus arenarius* 10%, *Minuartia peploides* 5%. In addition there were found, within the measuring quadrates, arranged according to frequency: *Potentilla anserina* and *Mertensia maritima*, and outside the measurement area: *Angelica archangelica*, *Armeria maritima*, *Cardaminopsis petraea*, *Galium verum*, *Hieracium species*, *Lathyrus maritimus*, *Leontodon autumnalis*, *Polygonum aviculare*, *Rumex acetosella*, *Rumex longifolius*, *Silene maritima*, *Taraxacum species* and *Tripleurospermum maritimum*.

In one or two places on the isthmus, *Lathyrus maritimus* grows in large patches and is absolutely predominant there. One of such patches was close to the observation site, having an area of ca. 200 m².

The Ölfusá river is constantly encroaching on Óseyrartangi isthmus from the north.

4. MOUTH OF ÖLFUSÁ RIVER, TO THE WEST

This location is on the extreme east of Óseyrartangi isthmus.

The isthmus extends into sandspit, which is at its outer extremity devoid of vegetation. Farther west *Elymus arenarius* is most conspicuous, but *Cakile maritima*, *Mertensia maritima* and *Minuartia peploides* are also found. One specimen of the plant, *Polygonum aviculare*, was discovered.

The vegetation becomes denser with increasing distance westwards on the isthmus, and gradually merges into the area of vegetation described above (No. 3).

5. MOUTH OF ÖLFUSÁ RIVER, TO THE EAST

This site is on a level with Óseyrartangi isthmus.

The shore is sandy, with dark sand, which seems to be composed of usual black sand and light to light-brown pumice.

Vegetation commences about 30 m from high-water mark and does not appear to have any distinct zonation. Nearest the sea *Elymus arenarius*, *Mertensia maritima* and *Minuartia peploides* are most conspicuous, but also to be found there are *Cakile maritima*, *Festuca rubra*, *Plantago maritima*, *Poa annua*, *Silene maritima* and *Tripleurospermum maritimum*.

6. WEST OF EYRARBAKKI

This location is about 500 m west of the breakwater and about 2 km west of the church at Eyrarbakki.

The shore is sandy with similar sand to that described in the immediately preceding section (No. 5).

Vegetation commences about 20 m from high-water mark, with *Cakile maritima* and *Minuartia peploides*. The vegetation becomes thicker over the next 5 m, after which it is replaced by an approximately 10 m broad zone in which were measured *Minuartia peploides* (45% cover) and *Elymus arenarius* (5% cover), while inside the measuring quadrates were also to be found *Mertensia maritima* and *Cakile maritima*.

Then there is a 100–200 m zone of *Elymus arenarius* dunes. Results of measurements taken about 50 m from seashore: *Elymus arenarius* 25%, *Minuartia peploides* 15%, and in addition, within the measuring quadrate, *Cakile maritima*. Outside the quadrate were *Festuca rubra*, *Galium verum*, *Lathyrus maritimus*, *Leontodon autumnalis*, *Potentilla anserina*, *Rumex acetosella* and *Silene maritima*.

Above the *Elymus arenarius* zone the dunes become less frequent, and the area between them is covered with various psammophilic plants, of which *Rumex acetosella* is most conspicuous.

A little farther east there is a 20 m broad belt of *Elytrigia repens* between the *Elymus arenarius* dunes and the *Minuartia peploides* zone. *Cakile maritima* is also found there in large areas of the shore.

Near Eyrarbakki the influence of the village becomes more dominant, and all the vegetation zones become more irregular.

7. BETWEEN EYRARBAKKI AND STOKKSEYRI

This site is about 1.5 km west of the Stokkseyri church.

Lava protrudes as far as 1 km into the sea, forming many skerries without vegetation. For the last 50 m upto the coast the skerries are completely covered with profuse growth of *Puccinellia maritima*, but also isolated plants of *Polygonum aviculare* and *Plantago maritima*. The skerries are very low, apparently nowhere more than 1 m high, measured at high water. It is obvious that the sea often breaks over them.

Immediately inside the skerries, and adjacent to the innermost ones, there is a ca. 20 m broad sandy shore with dark-brown sand and fine gravel.

There is much decaying seaweed in this area. In these 20 m the shore rises by 3 m. The following species grow there without any distinct zonation: *Achillea millefolium*, *Agrostis tenuis*, *Alopecurus geniculatus*, *Atriplex patula*, *Cakile maritima*, *Capsella bursa-pastoris*, *Cerastium fontanum*, *Elymus arenarius*, *Elytrigia repens*, *Festuca rubra*, *Leontodon autumnalis*, *Mertensia maritima*, *Minuartia peploides*, *Poa pratensis*, *Polygonum aviculare*, *Potentilla anserina*, *Puccinellia maritima*, *Ranunculus acer*, *Silene maritima*, *Stellaria media*, *Tripleurospermum maritimum* and *Urtica wens.*

Then there is a ca. 10 m broad flat zone up to the strongly constructed breakwater, which extends along the coast for a long way. Behind the breakwater the land descends again and becomes grassy.

The coastline is rather irregular, although it appears to be similar for a long way to Eyrarbakki in the west and to Knarrarós in the east. However, the breakwater does not extend more than 1 km east of Stokkseyri.

8. BAUGSSTADIR

This site is located about 200 m west of Baugsstadir.

Lava protrudes into the sea. It is everywhere low and smooth; nowhere higher than 1–2 m at high water.

At the outermost extremity there is a 100 m broad, continuous line of skerries, largeley devoid of vegetation.

Inside this is a ca. 100 m broad channel.

Then one finds a ca. 200 m broad belt of lava inland. Down by the channel are hummocks and, in some places, dense vegetation of *Puccinellia maritima*, but farther up, the lava

has little vegetation, or only a 1% cover in that area. Most conspicuous is *Armeria maritima*, but the following species grow also: *Agrostis stolonifera*, *Agrostis tenuis*, *Cakile maritima*, *Capsella bursa-pastoris*, *Cochlearia officinalis*, *Elymus arenarius*, *Festuca rubra*, *Mertensia maritima*, *Plantago maritima*, *Potentilla anserina*, *Puccinellia maritima*, *Puccinellia retroflexa* and *Stellaria media*.

Above the lava there is flat grassland.

At Baugsstaðir the lava ends towards the east, and is replaced by a sandy shore.

9. WEST OF THE THJÓRSÁ RIVER

This site is located about 2 km west of the Thjórsá estuary.

The shore is sandy, with black sand. For the first 40 m from high-water mark the shore rises into a coastal ridge ca. 10 m high. Then there is a downward slope inland for about 1 km.

About 50 m from the sea the first plants appear. These are *Mertensia maritima* and *Minuartia peploides*. *Mertensia maritima* is predominant, though it nowhere attains a cover of 1%.

About 150 m from the sea the first *Elymus arenarius* dunes appear, and at the 200 m boundary they have become fairly dense. Between them *Mertensia maritima* and *Minuartia peploides* grow in the sand.

At the 500 m boundary no other species had been found than these three, and a vegetation area similar to this seems to extend about 1 km inland, then being replaced by grass.

The vegetation appears to be similar to this all the way west as far as Baugsstaðir and east as far as the Thjórsá estuary.

10. THJÓRSÁ ESTUARY, TO THE WEST

The sandspit between the Thjórsá lagoon and the sea is without vegetation, but to the west of the lagoon the following species grow scattered and without any distinct zonation: *Agrostis stolonifera*, *Agrostis tenuis*, *Armeria maritima*, *Elymus arenarius*, *Mertensia maritima*, *Minuartia peploides*, *Potentilla anserina* and *Silene maritima*. Higher up *Festuca rubra* and *Juncus arcticus* are found growing.

11. WEST OF THE HÓLSÁ RIVER

The coast is 6 km NW of the Hólsá estuary; with a sandy shore, black sand, coarse at the surface. In the first 30 m from high-water mark the shore rises by about 5 m. Then the shore descends inland.

About 100 m from high-water mark the first plants appear, being *Minuartia peploides*. In this area commences a 300 m broad zone of *Minuartia peploides*, with scattered *Elymus arenarius*. The zone thickens for the first 50 m, then again thins out for the last 50 metres. According to measurements of the vegetation cover made 300 m from the sea, *Minuartia peploides* covers about 5%. (This vegetation zone is very reminiscent of the Reynisfjara shore — No. 30.)

Next there is a 50 m broad zone with little vegetation.

There follows a 30 m broad irregular belt of *Elymus arenarius* dunes, with *Minuartia peploides* between the dunes.

Then one finds a 800 m broad zone without vegetation, which is probably an old mud-flat.

Above that *Elymus arenarius* re-appears in dunes. This vegetation area is rather irregular and is about 1 km broad. *Agrostis tenuis*, *Galium verum* and *Minuartia peploides* are also to be found there.

Above this last belt grass and cultivated fields are found.

The shore between the Thjórsá and Hólsá rivers seems to be similar to this, although it is not certain that the zonation is exactly the same.

12. EAST OF THE HÓLSÁ RIVER

The coast is about 2 km SE of the Hólsá estuary.

The shore is sandy, with black sand, rising 2—3 m close to the sea, and is then flat.

The zonation on this shore is not as clear and regular as in many other places.

From high-water mark up to the first vegetation is a distance of about 100 m, and the species found there are *Elymus arenarius* and *Minuartia peploides*.

This is the start of a ca. 100 m broad belt, where *Minuartia peploides* predominates over *Elymus arenarius*. The cover is very irregular, but the total cover is about 1—5%.

Then comes a 100 m zone, where the vegetation is still less.

After that comes a 1.5 km broad zone of *Elymus arenarius* dunes. This area of vegetation is extremely irregular, with large intermediate patches devoid of vegetation. The total cover of *Elymus arenarius* is about 5%. Between the dunes *Minuartia peploides* grows in isolated places.

Above this zone comes a ca. 500 m broad, bare mud-flat and above that marshy ground.

Where the *Elymus arenarius* mounds and the mud-flat converge, the sand is rather moist, and the following species grow: *Agrostis stolonifera*, *Agrostis tenuis*, *Calamagrostis neglecta*, *Carex lyngbyei*, *Carex nigra*, *Elocharis uniglumis*, *Equisetum arvense*, *Equisetum palustre*, *Festuca rubra*, *Galium boreale*, *Galium verum*, *Juncus arcticus*, *Minuartia peploides*, *Parnassia palustris*, *Potentilla anserina*, *Ranunculus acris*, *Rumex acetosella*, *Silene maritima* and *Taraxacum species*.

13. WEST OF THE AFFALL RIVER

This site is located about 200 m west of the mouth of the Affall river.

The shore is sandy, with black sand. The shore rises about 2—3 m near the sea, then becomes flat.

The first plants are found about 200 m from high-water mark. They are *Elymus arenarius* and *Minuartia peploides*, but nowhere do they attain a cover of 1%.

Approximately 300 m from the sea there are a few isolated mounds of gravel.

Behind the gravel mounds is a ca. 150 m zone of little vegetation, which is probably an old mud-flat.

Then one finds *Minuartia peploides* again, among which there are in several places small tufts of *Elymus arenarius*.

About 650 m from the sea, the vegetation has become thick enough to cover about 1%. It is joined by *Cakile edentula* (one specimen), *Carex maritima*, *Plantago maritima* and *Silene maritima*, although *Minuartia peploides* is still the dominant species.

About 800 m from the sea one also finds *Agrostis tenuis*, *Armeria maritima*, *Cardaminopsis petraea*, *Festuca rubra* and *Rumex acetosella*. The cover is 1—5%.

About 850 m from the sea there are three strips where *Elymus arenarius* has been sown parallel to the shore. The strips are each about 2 m broad, with a space between them of about 10 m. Above these zones are small gravel mounds in one or two places.

According to measurements of the vegetation cover made about 1100 m from the sea, no species of plant covered on the average 5% or more, but within the measuring quadrates the following species, arranged in order of frequency, were found: *Silene maritima*, *Rumex acetosella*, *Cardaminopsis petraea*, *Carex maritima*, *Equisetum arvense*, *Plantago maritima*, *Festuca rubra* and *Armeria maritima*, and outside the measurement area: *Agrostis stolonifera*, *Agrostis tenuis*, *Calamagrostis neglecta*, *Elymus arenarius* and *Minuartia peploides*. This

area of vegetation continues almost unchanged for about another kilometre, until the grassy area is reached.

14. EAST OF THE AFFALL RIVER

This site is located about 2.5 km SE of the mouth of the Affall river.

The shore is sandy, with black sand, rising by 2–3 m near the sea, then becomes flat.

The overall picture of the shore is one of sand without vegetation, but in isolated places there are low *Elymus arenarius* dunes. The dune observed nearest the sea was about 250 m from high-water mark. One *Minuartia peploides* was also found there.

Otherwise, no plants were found until a distance of about 700 m from the sea had been reached. There *Elymus arenarius* has been sown in ca. 2 m broad strips at intervals of ca. 50 m. These strips, which are diagonal to the direction of the coastline, are about 350 m long and extend into the grassland. Between the strips there is hardly any vegetation, though a few cotyledons of *Elymus arenarius* were observed.

15. KROSSSANDUR

The coast is about 6 km SE of the mouth of the Affall river.

It is a sandy shore, with black sand, rising 2–3 m near the sea, then becomes flat.

The overall picture of the shore is one of sand without vegetation, but in isolated places there are single *Elymus arenarius* dunes.

In many places on the sand there are visible signs that attempts have been made by various methods to introduce vegetation. In some places there are protection screens against sand-dirfting, or open boxes in which *Elymus arenarius* has been sown. These attempts appear, however, to have met with little success.

About 1.5 km from the sea is a 100 m broad, irregular zone of *Elymus arenarius* dunes, with large open spaces in between.

Above this zone marshy vegetation in moist sand is found, followed by cultivated land.

16. WEST OF THE MARKARFLJÓT RIVER

The coast is about 3 km west of the mouth of the Markarfljót river.

It is a sandy shore, with black sand, rising by 2–3 m close to the sea, and then becoming flat.

The first 250 m from high-water mark are without vegetation, after which comes a 50 m broad zone, where protective screens have been erected and *Elymus arenarius* sown. There is however little sign of growth.

Then comes a 2.3 km broad zone, where the overall picture is one of sand devoid of vegetation, although in one or two places there are hummocks of *Elymus arenarius*, together with a single hummock of *Minuartia peploides*. As at the preceding site (No. 15), attempts have been made to introduce vegetation on the sand, but these seem to have had only limited success.

Above the sand there is a 10 m broad zone of *Elymus arenarius* hummocks.

Immediately above the hummocks marshy vegetation in moist sand is found and 5 m above that cultivated land.

17. EAST OF MARKARFLJÓT RIVER

This site is located about 4 km east of the mouth of the Markarfljót river.

The shore is sandy, with black sand, rising by 2–3 m close to the sea, and then becoming flat. A large part of the sand consists of a mud-flat with rivulets, which on this occasion contained shallow water.

In this area there is a distance of about 3 km until continuous vegetation is reached, and the overall picture is one of sand devoid of vegetation. In one or two places, however, there is *Elymus arenarius* in small or large dunes, and *Minuartia peploides* was also found.

18. VESTURHOLT

The coast is south of Vesturholt, about 8 km east from the mouth of the Markarfljót river.

The shore is sandy, with black sand, rising 2–3 m close to the sea, and then becoming flat.

From the high-water mark up to the first plants is a distance of about 60 m. *Minuartia peploides* appears there in small tufts, but nowhere does it attain a cover of 1%. In one or two places there is *Elymus arenarius*, but nowhere in the dunes.

About 1 km from the sea there is a 1 km broad mud-flat, containing shallow water. In isolated places in the mud-flat there are large *Elymus arenarius* mounds.

Above the mud-flat marshy vegetation in moist sand is found.

19. EYJAFJALLASANDUR

This place is located between the Holtsós estuary and the sea, about 6 km east of the mouth of Holtsós.

It is a sandspit about 400 m broad, with black sand and fine gravel on the surface. For the first 50 m the shore rises to a height of ca. 5 m, then slopes in towards the lagoon.

The overall picture of the spit is sand without vegetation, but the following species are found scattered about the sand, without however attaining anywhere anything near a cover of 1%: *Agrostis stolonifera*, *Agrostis tenuis*, *Cakile maritima* (one plant), *Elymus arenarius* (nowhere forming mounds), *Mertensia maritima* (one plant), *Minuartia peploides*, *Poa annua*, *Puccinellia retroflexa* and *Rumex acetosella*.

20. YZTABAEI

This is a coast located south of the farm Yztabaeli, about 10 km east of the mouth of the Holtsós estuary.

The shore is sandy, with black sand and fine gravel on the surface. For the first 50 m from the sea, the shore rises to a height of about 5 m (with respect to high-water mark), then slopes inwards for the next 300 m.

The shore is about 400 m broad, and its overall picture is one of sand without vegetation. In one or two places there the following species are found without anywhere attaining anything near a cover of 1%: *Agrostis stolonifera*, *Agrostis tenuis*, *Elymus arenarius* (not in dunes), *Mertensia maritima* (one plant) and *Minuartia peploides*.

Above the sandy shore is flat land and cultivated grass. For the last 50 m before the boundary is reached the following additional species appear on the sand: *Alopecurus geniculatus*, *Carex maritima*, *Equisetum arvense*, *Festuca rubra*, *Juncus alpinus*, *Juncus ranarius*, *Poa annua*, *Potentilla anserina*, *Puccinellia retroflexa*, *Rumex acetosella* and *Sagina procumbens*.

21. EYVINDARHÓLAR

This coast is located south of the farm Eyvindarhólar.

The shore is sandy, with black sand. It rises for the first 100 m to a height of about 5 m, then descends inwards.

The first 200 m from the sea are without vegetation, but then there are two 5 m broad sowing zones of *Elymus arenarius*. The zones lie parallel to the shore at intervals of 10 m.

Then one finds a 100 m zone, in which the following species grow without any distinct zonation and with a cover

of less than 1%: *Achillea millefolium*, *Agrostis stolonifera*, *Cardaminopsis petraea*, *Elymus arenarius*, *Equisetum arvense*, *Festuca rubra*, *Minuartia peploides*, *Plantago maritima*, *Poa annua*, *Rumex acetosella* and *Silene maritima*.

Above that there is flat land and cultivated grass. The boundary is abrupt, but irregular.

22. SKÓGASANDUR, WESTERN EXTREMITY

These are sands, about 500 m east of the Skógá river, before the latter turns westwards.

The first 300 m from high-water mark consist of black sand. Then the shore rises by 2—3 m, and the terrain becomes black sand with gravel on the surface.

About 300 m from the sea appear the first plants, and about 400 m from the sea the following species were found scattered about the sand, nowhere attaining a cover of 1%: *Agrostis stolonifera*, *Cardaminopsis petraea*, *Carex maritima*, *Elymus arenarius*, *Festuca rubra*, *Plantago maritima*, *Ranunculus acris*, *Rumex acetosa*, *Rumex acetosella* and *Silene maritima*.

About 500 m above sea level appears the southern edge of the land reclamation fence, which encloses a reclamation area of 7—8 km². This area reaches almost up to the national highway, which is about 4 km from the shore. Inside the fence the thickness of the vegetation is somewhat greater, but it nowhere attains a cover of 1%. The species appear to be the same.

Inside the land reclamation fence, about 2.5 km from the shore, appear extensive sowing areas, reaching nearly as far as the national highway.

23. SKÓGASANDUR, CENTRAL PART

These sands are about 3 km east of the Skógá river, before it turns westwards, about 500 m east of the eastern edge of the land reclamation fence.

The first 80 m from high-water mark consist of black sand without vegetation. Then comes a 2—3 m high ridge, followed by sand stretching far inland. Large boulders are to be found here and there on the sands.

About 90 m from the sea appear the first plants. These are *Cardaminopsis petraea*, *Elymus arenarius*, *Minuartia peploides*, *Plantago maritima*, *Potentilla anserina*, *Rumex acetosella* and *Silene maritima*. This vegetation reaches nowhere anything near a cover of 1%, but the *Elymus arenarius* in one or two places forms isolated mounds.

About 180 m from the sea is a fairly clearly defined patch in the sand, about 1 ha in area, with *Rumex acetosella* as the characteristic species. Measurements of the vegetation cover were taken where the vegetation was thickest, and they showed the following result: *Rumex acetosella* 40%, *Silene maritima* 5%. In addition there were found inside the measuring quadrat: *Cardaminopsis petraea*, *Elymus arenarius* and *Rumex acetosa*.

About 500 m from the sea the vegetation is very sparse and nowhere attains a cover of 1%. The following species were found: *Agrostis stolonifera*, *Armeria maritima*, *Cardaminopsis petraea*, *Elymus arenarius*, *Festuca rubra*, *Plantago maritima*, *Ranunculus acris*, *Rumex acetosa*, *Rumex acetosella* and *Silene maritima*.

About 1 km from the sea *Galium verum* also appears, and in that area *Plantago maritima* is dominant in many places. However, nowhere does the vegetation attain a cover of 1%.

Up by the national highway, about 4 km from the sea, the vegetation is similar to that at the 500 m boundary. However, there is an addition in the form of, for example, *Thymus*

drucei, which is in many places dominant. Vegetation nowhere attains a cover of 1%.

24. MOUTH OF THE JÖKULSÁ RIVER ON SÓLHEIMASANDUR SANDS

This is the eastern side of the mouth.

The sandbanks in the river are formed of black sand and of irregular gravel.

In some places the sandbanks have vegetation, especially on the west side of the river. *Elymus arenarius* in sand-dunes is very noticeable.

The following species grew on the sandbanks on the eastern side, but except in small patches, nowhere attained a cover of 1%: *Agrostis stolonifera*, *Agrostis tenuis*, *Angelica archangelica*, *Arabis alpina*, *Arenaria norvegica*, *Armeria maritima*, *Cardaminopsis petraea*, *Carex maritima*, *Cerastium fontanum*, *Elymus arenarius*, *Festuca vivipara*, *Festuca rubra*, *Minuartia peploides*, *Plantago maritima*, *Poa glauca*, *Rumex acetosella*, *Sedum acre*, *Silene maritima* and *Thymus drucei*.

25. SÓLHEIMAFJARA

This coast is located about 1 km east of the mouth of the Jökulsá river.

Nearest to the sea is a 150 m broad beach of black sand, without vegetation.

Next there is a very steep ridge, about 10 m high, followed by sands with fine gravel on the surface. This penetrates far inland. At first glance the sands appear to be without vegetation, but in one or two places a few plants can be seen, which nowhere form continuous vegetation or attain a cover of 1%.

Nearest to the ridge the following species were found: *Agrostis stolonifera*, *Armeria maritima*, *Cardaminopsis petraea*, *Elymus arenarius* and *Silene maritima*.

About 450 m from the sea the following species appeared in addition: *Festuca rubra*, *Plantago maritima*, *Rumex acetosa* and *Rumex acetosella*.

About 1 km from the sea *Ranunculus acris* was observed.

About 1.5 km from the sea *Thymus drucei* was also found.

Up by the national highway, about 5 km from the coast, no new species were observed, and nowhere did vegetation attain a cover of 1%.

A few hundred metres farther west along the highway, are extensive seeded fields inside the land reclamation fence.

26. HVOLL

This coast is located south of the farm Hvoll.

The first 80 m from high-water mark consist of black sand without vegetation.

Then there is sand with fine gravel on the surface. The first plants also appear there, being *Minuartia peploides*. According to measurements of the vegetation cover made at the 130 m boundary, *Minuartia peploides* covered 15% and *Elymus arenarius* 5%. No other species were found.

At the 200 m boundary there appears *Elymus arenarius* on sand-dunes, interspersed with other species. According to measurements made at the 240 m boundary, *Elymus arenarius* covered 25% and *Minuartia peploides* 5%. In addition, within the measuring quadrat *Equisetum arvense* was found. According to measurements made at the 280 m boundary, *Elymus arenarius* covered 35% and *Equisetum arvense* 5%. Also there were observed outside the measuring quadrat: *Armeria maritima*, *Cardaminopsis petraea*, *Galium verum*, *Minuartia peploides*, *Plantago maritima*, *Potentilla anserina*, *Rumex acetosella*, *Silene maritima*, *Taraxacum species* and *Thymus drucei*.

About 300 m from the sea the sand becomes damper, the dunes disappear and species more associated with marshland make their appearance.

About 450 m from the sea, cultivated grass is found.

The vegetation zones in this area are somewhat irregular, but vegetation seems to be rather similar to this over a long stretch of the coast.

27. THE SAND WEST OF DYRHÓLAEY

This site is located about 1 km west of Dyrhólaey.

The sand is black, with coarse shingle nearest the sea.

From the sea and as far as the farm Dyrhólar, is a 1.2 km broad stretch of sand without vegetation.

The sand narrows to the west, but is as broad and just as devoid of vegetation eastwards to Dyrhólaey.

28. DYRHÓLAEY, TO THE WEST

The coast consists of sheer tuff cliffs right down into the sea, though in some places with piles of coarse shingle at their foot. It is obvious that in stormy weather the sea breaks high up the cliffs.

The shingle is without vegetation, but up in the cliffs the following species were found: *Agrostis stolonifera*, *Angelica archangelica*, *Cakile maritima*, *Deschampsia caespitosa*, *Festuca rubra*, *Minuartia peploides*, *Poa pratensis*, *Potentilla anserina*, *Puccinellia retroflexa*, *Ranunculus acris*, *Rumex acetosa*, *Rumex longifolius*, *Sagina procumbens*, *Sedum rosea*, *Senecio vulgaris*, *Silene maritima*, *Stellaria media*, *Taraxacum species* and *Tripleurospermum maritimum*.

About 100 m east of Dyrhólaey, and about 70 m from the sea, the following species grow in the sand in an area of several square metres: *Cakile maritima*, *Mertensia maritima*, *Minuartia peploides* and *Festuca rubra*.

29. DYRHÓLAEY, TO THE EAST

This is the coast from the easternmost part of Dyrhólaey and west as far as Dyrhólágat.

It consists of sheer tuff cliffs right down into the sea, but in some places with a narrow stretch of sandy beach at their foot.

The shore is without vegetation, and the cliffs have very little. It was impossible to reach this vegetation for observation purposes.

30. REYNISFJARA

This coast is located between Reynisfjall and Dyrhólaey.

It is about 400 m broad sandy beach, bounded on the upper side by the Dyrhólaós estuary. The sand is black, with pebbles on the surface.

With the exception of one small plant of *Elymus arenarius*, only one species, *Minuartia peploides*, grew on the shore. It grew in small tufts, the biggest about one foot in diameter.

Vegetation starts ca. 90 m above high-water mark, and at that point the beach also begins to descend inwards to Dyrhólaós.

At the 100 m boundary the cover was 1%.

At the 200 m boundary the cover was 1–5%.

At the 300 m boundary measurements were made of the vegetation cover, which proved to be 15%.

After the 300 m boundary vegetation again begins to thin out, and it terminates at the 360 m boundary.

The last 40 m to Dyrhólaós are without vegetation.

Down by the farm Garður in Reynishverfi district *Elymus arenarius* grows on the sand in an area of about one hectare.

In the extreme west of Reynisfjara one *Elymus arenarius* hummock was also seen.

31. REYNISFJALL, TO THE WEST

This is a steep, and in some places, sheer tuff mountain. At the western extremity there is appr. 50 m broad sandy beach at its foot. The sea advances right up to the cliffs in stormy weather. Towards the top of the mountain there is a nesting ground of a puffin colony.

The sand beach is without vegetation, but the following species were found on the slopes and among the rocks: *Agrostis stolonifera*, *Angelica archangelica*, *Anthoxanthum odoratum*, *Armeria maritima*, *Botrychium lunaria*, *Cerastium fontanum*, *Cystopteris fragile*, *Deschampsia caespitosa*, *Draba incana*, *Eufrasia frigida*, *Festuca rubra*, *Galium verum*, *Hieracium species*, *Leontodon autumnalis*, *Ligusticum scoticum*, *Luzula multiflora*, *Luzula spicata*, *Myostis arvensis*, *Plantago lanceolata*, *Plantago major*, *Plantago maritima*, *Poa pratensis*, *Potentilla anserina*, *Puccinellia retroflexa*, *Ranunculus acris*, *Rumex acetosa*, *Rumex longifolia*, *Sagina procumbens*, *Sedum acre*, *Sedum rosea*, *Silene maritima*, *Stellaria media*, *Taraxacum species*, *Thymus drucei* and *Tripleurospermum maritimum*.

32. REYNISFJALL, TO THE EAST

This is a steep, scree-covered tuff mountain descending right into the sea. Big puffin colony is found on the slopes.

The following species were observed on the slopes: *Agrostis stolonifera*, *Agrostis tenuis*, *Angelica archangelica*, *Armeria maritima*, *Cardaminopsis petraea*, *Cerastium fontanum*, *Deschampsia caespitosa*, *Draba incana*, *Epilobium collinum*, *Eufrasia frigida*, *Festuca rubra*, *Hieracium species*, *Leontodon autumnalis*, *Myosotis arvensis*, *Oxyria digyna*, *Plantago lanceolata*, *Plantago maritima*, *Poa glauca*, *Poa pratensis*, *Potentilla anserina*, *Puccinellia maritima*, *Ranunculus acris*, *Rumex acetosa*, *Sagina procumbens*, *Saxifraga nivalis*, *Sedum rosea*, *Senecio vulgaris*, *Silene maritima*, *Stellaria media*, *Taraxacum species* and *Tripleurospermum maritimum*.

33. VÍK, MÝRDAL

This coast is located east of the Víkurá river, and due south of the church.

It is a sandy shore, with black sand and fine gravel on the surface.

Vegetation commences about 90 m above high-water mark, with the species *Minuartia peploides*.

About 100 m from the sea the vegetation cover was measured, and this showed that *Minuartia peploides* covered about 5%. Also found but not measured were: *Elymus arenarius* and *Mertensia maritima*.

About 200 m from the sea another measurement was taken, according to which *Rumex acetosella* covered 10%, *Elymus arenarius* 5% and *Silene maritima* 5%. In addition there were found within the measuring square and arranged in order of frequency: *Minuartia peploides*, *Agrostis tenuis* and *Mertensia maritima*, and without measurement: *Cardaminopsis petraea* and *Carex maritima*.

About 260 m from the sea sowing squares commence, reaching up close to Víkurhamrar about 500 m from the sea. According to measurements made about 300 m from the sea, *Elymus arenarius* covered 40% and *Rumex acetosella* 30%. In addition, within the measuring square there were found: *Cardaminopsis petraea*, *Minuartia peploides* and *Silene maritima*, and without measurement: *Agrostis tenuis*, *Hieracium species*, *Matricaria matricaroides*, *Mertensia maritima*, *Plantago maritima* and *Potentilla anserina*.

34. EAST OF MÚLAKVÍSL

This coast is located about 500 m east of Múlakvísl. The sand is black, mixed with gravel.

Overall picture of this area is one of sands without vegetation, extending far inland.

The first plants were found about 150 m above high-water mark. These were *Minuartia peploides* and *Silene maritima*.

About 300 m from the sea the following species were found, without anywhere attaining anything near a cover of 1%: *Agrostis stolonifera*, *Agrostis tenuis*, *Cardaminopsis petraea*, *Carex maritima*, *Cerastium fontanum*, *Poa glauca*, *Poligonum viviparum*, *Rumex acetosella* and *Silene maritima*.

According to measurements made about 500 m from the sea, no plant attained a cover of 5%, but the following plants were found within the measuring quadrat, arranged in order of frequency: *Silene maritima*, *Cardaminopsis petraea*, *Sagina procumbens*, *Cerastium fontanum* and *Agrostis stolonifera*, and in addition, without measurement: *Deschampsia caespitosa*, *Epilobium species*, *Equisetum arvense*, *Festuca rubra*, *Oxyria digyna*, *Plantago maritima*, *Poa alpina*, *Poa glauca*, *Rumex acetosella*, *Saxifraga rivularis*, *Sedum acre* and *Sedum villosum*.

After that the vegetation shows little alteration, and when the national highway has been reached, about 5 km from the coast, the vegetation cover appears similar and most of the species identical.

Some species that appear in the foregoing list of plants according to the nomenclature in Förteckning över Nordens växter and their synonym from Flora Íslands:

Förteckning över Nordens växter:	Flóra Íslands:
<i>Angelica archangelica</i>	<i>Archangelica officinalis</i>
<i>Armeria maritima</i>	<i>Armeria vulgaris</i>
<i>Cakile maritima</i> ssp. <i>islandica</i>	<i>Cakile edentula</i>
<i>Carex nigra</i>	<i>Carex goodenoughii</i>
<i>Cerastium fontanum</i> ssp. <i>scandicum</i>	<i>Cerastium caespitosum</i>
<i>Eleocharis uniglumis</i>	<i>Scirpus uniglumis</i>
<i>Elytrigia repens</i>	<i>Agropyron repens</i>
<i>Festuca rubra</i> v. <i>mutica</i>	<i>Festuca rubra</i>
<i>Galium verum</i> ssp. <i>euverum</i>	<i>Galium verum</i>
<i>Juncus alpinus</i> ssp. <i>nodulosus</i>	<i>Juncus alpinus</i>
<i>Juncus arcticus</i> ssp. <i>intermedius</i>	<i>Juncus arcticus</i>
<i>Juncus ranarius</i>	<i>Juncus bufonius</i>
<i>Lathyrus maritimus</i> v. <i>glaber</i>	<i>Lathyrus maritimus</i>
<i>Plantago maor</i> ssp. <i>eumajor</i>	<i>Plantago major</i>
<i>Poa pratensis</i> ssp. <i>irrigata</i>	<i>Poa pratensis</i>
<i>Poa pratensis</i> ssp. <i>eupratensis</i>	<i>Poa pratensis</i>
<i>Ranunculus acris</i> ssp. <i>boreanus</i>	<i>Ranunculus acris</i>
<i>Ranunculus acris</i> v. <i>pumillus</i>	<i>Ranunculus islandicus</i>
<i>Rumex longifolius</i>	<i>Rumex domesticus</i>
<i>Sedum rosea</i>	<i>Sedum roseum</i>
<i>Thymus drucei</i>	<i>Thymus arcticus</i>
<i>Tripleurospermum maritimum</i>	<i>Matricaria maritima</i> v. ; <i>aeocephala</i>

DISCUSSION

The types of coast at the 34 observation sites may be divided into four main categories:

- I. Sandy shores: This type was recorded at the following observation sites: No: 2, 3, (4), (5), 6, (7), 9, (10), 11, 12, 13, 14, 15, 16, 17,

18, 19, 20, 21, 22, 23, 25, 26, 27, 30, 33, and 34. It is most characteristic for the south shore of Iceland. These shores are often such that *Cakile maritima*, *Mertensia* and *Minuartia peploides* — either one, two or all three of these species — are found in a zone nearest the sea. The next zone inland is then usually dominated by *Elymus arenarius*, frequently mixed with the above-mentioned three species and perhaps other species as distance from the sea increases.

- II. River mouths were studied at sites (4), (5), (10), and 24. All the estuaries studied are bordered with sandbanks sometimes with irregular gravel. The vegetation is extremely scanty on the sandspits as well as on the riverbanks and a zonation is often obscure, where *Elymus arenarius* is commonly mixed with *Mertensia* and *Minuartia*, *Cakile* and the grasses.

- III. Lava protruding into the sea is found at sites (7) and 8, where it forms numerous skerries. The innermost skerries are often rich in vegetation. The dominant species is *Puccinellia maritima* often associated with *Polygonum aviculare* and *Plantago maritima*. Inside the skerries is a sandy shore scattered with seaweed and with a dense vegetation of various coastal species mixed with various others.

- IV. Mountains or sheer cliffs descending right down into the sea were observed at sites 28, 29, 31, and 32. The mountains which are of tuff are sheer or scree-covered, mostly without vegetation in the splashing zone. Above this zone there are various grass species found growing, associated with such species as *Angelica archangelica* and *Sedum rosea*.

Finally, there is an intermediary stage between III and IV at site 1, where there are sand dunes on a lava base which forms cliffs at the seashore or is broken up into boulders. These are devoid of vegetation, but further inland various coastal species are growing in mixed communities.

DISTRIBUTION OF THE SPECIES IN THE OBSERVATION AREA ON THE SOUTH COAST OF ICELAND THAT HAVE BEEN FOUND ON SURTSEY:

On Surtsey island four species have now been clearly identified: *Cakile maritima*, *Elymus arenarius*, *Mertensia maritima*, and *Minuartia peploides*. In addition, *Atriplex patula* has also been recorded in 1968. This identification is, however, somewhat doubtful. These plants are all found

in the area studied on the south coast of Iceland: *Cakile maritima*: This species was found in the observation area, in some places with a large number of individual plants, between Thorlákshöfn in the west (site No. 2) and Baugstadir in the east (No. 8). East of there it was not found, apart from one specimen at No. 13, one at No. 19, and a few plants in a limited area at No. 28.

Elymus arenarius: This species was found in the observation area at nearly all observation sites, usually with a large number of individual plants.

Mertensia maritima: This species was found in the observation area, in some places with a large number of individual plants, between Thorlákshöfn in the west (site No. 1) and as far as the Thjórsá river in the east (No. 10) — though it does not appear at No. 2 (see later). East of the Thjórsá it was not seen except at Nos. 19, 20, 28, and 33, and then only in very small numbers.

Minuartia peploides: This species was found in the observation area at nearly all sites, usually with a large number of individual plants.

All the above four species grow also in the Westman Islands, and there only at the two places where there is a sand-shore: Klaufin and Eiðið on the island of Heimaey.

Atriplex patula: This species was found in the observation area only at two sites, Nos. 2 and 7, and at both sites only in very small numbers. In the Westman Islands it may grow together with the other four at Klaufin and Eiðið, but it is also found in several of the outlying isles of the archipelago, where it grows on rocks and on the nesting grounds of the puffin. (Sturla Fridriksson and Björn Johnsen, 1967.)

The species *Elymus arenarius* and *Minuartia peploides* are fairly evenly distributed over the whole observation area, but the distribution of

Cakile maritima and *Mertensia maritima* is more limited.

The distribution of the two latter plants is very similar: they grow almost exclusively in the westernmost part of the observation area. In most places they grow together, with *Minuartia peploides*, but it is interesting to note that, where *Cakile maritima* is most abundant (site No. 2), *Mertensia maritima* is not found at all.

It is difficult to explain why these two species are hardly encountered in the central and eastern parts of the observation area. Yet the sand-shores there seem to be just the type where one would expect the species to grow profusely. The reason for this is not quite clear, though it should be mentioned that at least *Cakile maritima* is nitrophile and seems to depend on the presence of decaying seaweed in the sand in which it grows. There is a lot of seaweed on the coast in the westernmost part of the observation area, as seaweed grows profusely off the coast. On the other hand, there is hardly any decaying seaweed on the coast in the central and southern parts of the observation area, as growth of seaweed in that section is much less, except in limited areas near Dyrhólaey and Reynisfjall

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