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OF
BIOLOGICAL RESEARCH ON
THE VOLCANIC ISLAND SURTSEY AND ENVIRONMENT
FOR THE YEAR 1976

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The study involves the terrestrial biological research on the volcanic island, Surtsey off the coast of Iceland and the neighbouring islands and environs of the Westman Islands, which are situated on the Mid-Atlantic Ridge.

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MASTER

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In 1976 research work was carried out on the islands of Surtsey and Heimaey during the summer months June through August. Two students, Jón, Gudmundsson and Valgeir Bjarnason stayed on the islands and several scientific excursions were taken.

TOPOGRAPHY

The topographical changes on Surtsey were studied by John O. Norrman, who visited the island in early August 1976. It is evident that the southwestern side is constantly being eroded and that the island decreases in area of some 75 hectares per year.

MICROBIOLOGY

A Swedish group of scientists led by Högni Böldvarsson conducted biological research on the island in the first week of August 1976. They studied among other things the micro flora and fauna, and the possible nitrogen fixation by blue-green algae. (Appendix I.)

Lichen were studied by Hordur Kristinsson, Akureyri, Iceland. The lichens are now found growing on the lava especially around the craters, on the higher levels of the rocks.

MOSS

The moss flora was investigated by the two students, who examined distribution and cover of the various species, and collected samples for biomass measurements. (Appendix II).

VASCULAR PLANTS

The number of higher plants found on Surtsey in 1976 is shown in the accompanying table. Their location was mapped according to the same methods used in earlier years (Appendix III). The dispersal of plants to Surtsey has been observed (Appendix IV) and records made of the drift in 1975 (Appendix V) and in 1976 (Appendix VI).

An investigation of the vascular flora on Heimaey continued in order to observe the colonization of plants on the lava and ash from the eruption that took place on the island in 1973. Some bare spots destroyed by ash cover were mapped and an investigation performed on the gradual come-back of plants into the area (Appendix VII).

ENTOMOLOGY

Recording of insects was continued by Erling Olafsson of the Natural Museum of Iceland and Dr. Högni Bodvarsson of Stockholm University, who visited the island (Appendix VIII).

VERTEBRATES

The ornithological studies were carried out by the two students. Of major interest in 1976 was the addition of the arctic tern to the breeding birds on Surtsey, although there were no young reared (Appendix IX). The nest of the great black-backed gull was sampled for organic matter after the birds had abandoned it. As there might be nitrogen available for other organisms (Appendix X).

SOIL

Investigation of further changes in the substrate were continued by Sveinn Jakobsson, who has studied palagonization of the tephra.

OTHER ACTIVITIES

Additional critics of the book "Surtsey" by the principal investigator, Dr. Sturla Fridriksson, published in 1975 by Butterworths, England, have appeared in various journals, and some of these are included (Appendix XI).

A paper was given on the Surtsey Research by Dr. Sturla Fridriksson for a group of W.W.F. members on an excursion to the Galapagos Islands.

On the following page is an aerial photograph of Surtsey taken in summer of 1976.

Figure 1

The morphological variability of a Synechococcus clone from postvolcanic substrate on the island of Surtsey (Iceland)

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Morphological variation can be studied only with a clone to assure genetically homogeneous material. Such studies are particularly difficult with Cyanophyceae because of their small size and the poor morphological differentiation of their cells. The genera Synechococcus and Synechocystis were until now considered to show little morphological variability in contrast to e.g. some Stigonemataceae and Rivulariaceae. This was tested with material from the new volcanic island of Surtsey (SCHWABE 1972 a,b, 1973, SCHWABE & BEHRE 1971).

A large-celled Synechococcus species which can be attributed to S. aeruginosus Näg. was found in one locality on Surtsey in the course of intensive investigations in respect to Cyanophyceae by the first author. The study of cell variability and growth characteristics of this species seemed rewarding because of its relatively large cells as well as of the rare occasion of earliest stages of ecogenesis found on that island. In such biotopes other species tend to thrive than in older biotopes.

The localities south of Lysihöll, the most recent lava bed of the big crater Surtur I, where Synechococcus was sampled is a favourite resting site for birds. Thus it can be assumed that Synechococcus was brought to the island by birds, a similar case might be with the accompanying species Oscillatoria fracta and Cochlearia groenlandica L. ssp. islandica (Paped.) Löve. Since the first

sampling date of Synechococcus in summer 1972 the species has spread considerably in the vicinity during the following two years.

From a sample of wind-swept tephra (sampling date: 31 July 1974, start of culture: 27 August 1974) the Synechococcus clone was isolated in an nitrogen-poor modification of Zehnder medium. Contrary to other Synechococcus species (Syn. 1. Anacystis) this clone could not be cultivated on agar. During the first weeks Synechococcus sp. showed a relatively uniform and typical morphological appearance (Figure 1) with a cell size of 5.5-7.5 x 11-24 μm . Only few larger cells (7-8 x 20-45 μm) were found. From 24 October 1974 the clone remained in the same medium until 24 August 1975. After 60 days the clone stopped growing, then covering only ca. 25% of the bottom of the culturing flask, where it mostly formed a single cell layer. The colour changed from bright blue-green in the beginning to dirty green towards the end of the growing period, which ceased long before nutrient depletion. Thus a resting phase, typical for many Cyanophyceae, was reached, conserving viability while resting almost at zero growth rate (SCHWABE, 1966).

270 days after the start of the culturing experiment a surprising variety of cell forms was found (Figure 2). Cells were mostly longer than wide (diameter 4.5 - 17 μm), rarely spherical, never shorter, which means that they divided rectangularly to their long axis. Long cells were thinner (4.5 - 15 μm) than short ones (15-17 μm). Cell lengths varied between 10 and 90 μm , with exception 170 μm . The longest cells after 90 days measured 45 μm after 130 days 95 μm and 270 days 170 μm . Morphological variability was lower in the center of the colony than at the edges with fewer cells. Typical cell forms were relatively sparse in

the senescent culture. Increasing cell length and disturbance of cell division were most frequently recorded. Plasma structure and cell colour indicated that the morphologically abnormal cells were possibly of reduced viability, yet no distinct limit between normal cells and cells with teratism could be found. Cell walls proved to be exceptionally thick; cell wall thickness might serve as a taxonomical criterion in Synechococcus.

It is essential to realize that the morphological variability of Synechococcus as demonstrated ~~in the literature~~ included the known "typical" morphological variety of several species of the genera Synechococcus and Synechocystis. Taxonomical differentiation of Synechocystis from Synechococcus by cell morphology thus seems doubtful. However, morphological variability in a natural biotope under favourable growth condition as well as in the beginning in cultures is much less pronounced (~~in the literature~~). No oblique dividing cell walls and inflated cells are then found except in extreme biotopes like thermal waters (EMOTO & HIROSE 1940 a,b).

Pure Synechococcus populations are rare under natural conditions, being rather found in small colonies in between other algae. Only in biotopes with running water (humid or coarse-grained soils, sprinkling water) they can be more abundant. This lack of larger populations of Synechococcus might be explained by the fact of an early growth stop before nutrient exhaustion (which is observed also in cultures of Oscillatoria fracta). It is obvious that the Synechococcus under discussion could tolerate the extreme physicochemical environmental conditions of Surtsey lava fields. On the other hand, it proves sensitive to competition with other algae.

Both Synechococcus sp. and Oscillatoria fracta can be considered as "fugitive species" (HUTCHINSON, 1951), which grow mainly on sites without competitors, typical for Surtsey at that early stage of ecogenesis. These pioneer species will disappear in the course of further succession, or become rare as on the mainland of Iceland (where Oscillatoria fracta does not occur at all).

The genus Synechococcus Næg. has been found on Iceland several times (PETERSEN, 1928, SCHWABE, unpublished data). S. aeruginosus has been cultivated from a soil sample of Iceland by Møholm-Hansen (PETERSEN, 1928). The same species was found by SCHWABE on crude soil of Iceland in the southern part of Hallormstadir forest (cell size $5.3 - 7 \times 9.5 - 12.5 \mu\text{m}$) in between Plectonema as well as on weathered lava between Rejkjahlid and Grimstadir/Mjvatn (cell size $6.8 - 9 \times 13 - 20 \mu\text{m}$) together with many other algae. Synechococcus found in Laugarvatnsheidi can be attributed to S. major Schroeter (cell size $6.5 - 23 \times 12.5 - 47 \mu\text{m}$) according to the taxonomy of GRITLER (1952). Synechococcus species of small cell size ($6.5 \times 12.5 \mu\text{m}$) were rarely found in between S. major stands together with Tolypothrix and some colonies of Pleurocapsa minor Hansg. However, such frequent Synechococcus populations as described from Surtsey have not been detected on Iceland. The rare occurrence of Synechococcus in apparently favourable biotope on Iceland is in contrast to the abundant occurrence in other thermal biotopes (CASTENHOLZ, 1969). The same is the case with the thermal alga Cyanidium caldarium.

In culture experiments FRINGSHEIM (1968) and KOMAREK (1970) showed that a similar variability in morphological characteristic

could be induced by different factors such as temperature ($>20^{\circ}\text{C}$), medium nutrient content and length of cultivation period. This seems to be the case only with certain genera or clones.

In our experiment the small morphological variability ended towards the end of the growing phase. The maximal variability was observed at the bottom of the culturing 100 ml-flask under uniform environmental conditions for all cells. Yet a non-uniform variation in cell forms was observed, the greater variation being at the edges of the colony. Thus it is obvious that some sort of biotic factor may influence the morphological variability of Synechococcus.

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APPENDIX I

Fig. 1: Raw culture of Synechococcus with Oscillatoria
fracta and Schizothrix lardacea.

Fig. 2: Clonal culture of Synechococcus partly showing
elongated cells.

Fig. 3: Same culture as in figure 2 showing more pronounced
'involutionary forms.'

Fig. 4: Typical aggregation of Synechococcus in clonal
culture.

THE MOSS PRODUCTIVITY ON SURTSEY
IN THE YEARS 1971 - 1976

The biomass of mosses on Surtsey has grown from year to year. Measurements commenced in 1971. Between 1971 and 1974 estimates were made at the start of measurements as to which had the greatest moss cover, and samples were taken from these. In 1975 it was decided to take in future samples from quadrats J-8, K-18 and M-11, samples having frequently been taken from them except in 1972 and 1973, when they were taken from L-18 instead of from K-18. Thus, no attempt is made any longer to take measurements in those quadrats where the moss cover is greatest. Nevertheless, it is clear that by far the greatest moss cover is up in Stóri-Gígur, part of which is contained in quadrat J-8.

Measuring Method.

Three 625 cm^2 (25x25 cm) areas are selected in the quadrat that is to be measured. It is not yet possible to localize the measuring areas at random because of the sparsity of the moss. Attempts are made to choose areas where there is most moss. All the moss in such an area is removed, cleaned, dried and weighed. The results are given in dry-weight grams, m^{-2} , and shown on illustration (1), where the y-axis is logarithmic.

Note 1. Each individual sample does not show the annual production, but rather the production of several recent years, as the moss does not wilt during winter, and when samples are taken, attempts are made to obtain all the organic material produced in several years.

Note 2. Observations do not show the average production of organic material on the island, but some proportion of moss increase in specific areas of the island.

Note 3. The measurements are very variable, as there are only three samples from each quadrat. Thus, the measurement in 1975 from K-18 seems to show too high a value, compared to the following year but the low measurement value in 1976 is probably due to a great increase of sand in the quadrat since 1975 and the consequent asphyxiation of much of the moss.

VASCULAR PLANTS IN SURTSEY IN 1976

Of 15 species of vascular plants that grew in Surtsey in the summer of 1975, only 10 species were found in the summer of 1976. One additional species was found, but it has not yet been identified. Thus, altogether 11 species of vascular plants grew in Surtsey in 1976.

Species not found in 1976, but grew there the previous year, were: Cakile edentula (Bigel) Hook, Equisetum arvense L., Juncus sp., Sagina sp., and Silene vulgaris (Moench) Garcke.

Of 1447 individual plants growing on Surtsey in 1975, 502 were found in the spring of 1976. The new additions numbered 630 plants. The total number of plants found in 1976 was thus 1132 individuals, which is 315 individual plants fewer than in 1975. The main reason for the decrease is the smaller number of scurvy-grass seedlings compared with the previous year. Apart from seedlings of scurvy-grass and Cerastium caespitosum, the number of plants was 680, and the mature plants have therefore increased by 175. (Table 1). The total number of vascular plants discovered in Surtsey in 1976 is listed in Table II, and their distribution is given on the map in fig. 2. The high mortality of plants is due to a severe winter but other casualties also took place. A pair of great black-backed gulls that nested in quadrat N-10 used, for instance, Festuca rubra 73-370, Carex maritima 70-72, and 20 sea-sandwort plants for their nest. The birds were particularly fond of the Festuca rubra and the Carex maritima. (See map. figure 3). For overwintering of plants see fig. 4.

3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

- Z CAREX MARITIMA
- V CERASTIUM FONTANUM
- X COCHLEARIA OFFICINALIS
- S CYSTOPTERIS FRAGILIS
- D ELYMUS ARENARIUS
- F FESTUCA RUBRA
- A HONCKENYA PELOIDES
- M MERTENSIA MARITIMA
- P PUCCINELLIA RETROFLEXA
- H TRIPLEUROSPERMUM MARITIMUM
- U UNIDENTIFIED SP
- BRYOPHYTA

A
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SURTSEY

1976

Figure 2

3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

C NESTS OF LARUS MARINUS
O SUCCESSFUL NESTINGS

PLANTS USED FOR NESTBUILDING:

Z CAREX MARITIMA
F FESTUCA RUBRA
A HONCKENYA PELOIDES

PICKING AREA
HONCKENYA PELOIDES UNTOUCHED

A
B
C
D
E
F
G
H
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J
K
L
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N
O
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SURTSEY
PLANTS USED IN NESTBUILDING
1976

Figure 3

NO. OF PLANTS

Figure 4

HONCKENYA PEPLOIDES (L) Ehrh.

There was some increase of sea-sandwort during the year, or from 428 to 500. Of these 428 found in 1975, 337 survived the winter, and there were altogether 163 new plants. There has thus been comparatively little loss, most having been in quadrat B-12, C-12, and G-14, over which the sea flows in winter. A similar number was found now to that of the previous year, which is much smaller than that found in 1973 and 1974. Most of the sea-sandworts are about 50-100 cm² (5-10 culms in size). Some of the largest are no. 70-39 (90x90 cm) in quadrat 6-13, no. 68-83 (100x80 cm) in K-17, and no. 69-62 (100x80 cm) in F-13.

Sea-sandwort no. 68-56 in K-18 produced the greatest number of pods, or about 1000, and a total of 73 sea-sandwort plants flowered during the year.

Sea-sandwort was this time found in 50 quadrats so that the species had spread to four new quadrats, where it had not been found growing previously. Changes have also occurred in the propagation of single plants. The pair of great black-backed gulls that nested in quadrat N-10 disturbed 20 sea-sandwort plants when building their nest, but these partly recovered during the summer. The sea-sandwort is the most conspicuous plant on Surtsey. It increases steadily, as may be seen on the graph, and surprisingly evenly, when it is realized that the plants have to over-winter.

By far the most losses are in the first year, often being due to drifting sand. If the plant is not submerged during the first winter, it will most likely continue to survive, if it is in a fairly

favourable habitat, or not in the drifting sand where it may be submerged. In its second year, the plant already attains a considerable size, and may cover an area of about 30-50 cm². The largest sea-sandwort plants from 1968 and 1969 now cover an area of 5-6000 cm², and are therefore the most conspicuous plants on the island. However, up to now, the sea-sandwort cover on Surtsey is insignificant as vegetation in the vast open fields of lava and sand, but other plants have even less cover.

In 1974, the marking of each new individual sea-sandwort seedling by number was stopped, while a peg of split driftwood was placed beside the plants but without a number. The method adopted as such is that all sea-sandwort plants that attain an age of two years (i.e., survive one winter) are marked with a numbered peg. This means that the plants are one year older than indicated by the number. Sea-sandworts marked last summer are, however, from 1974 and 1975, since by far the biggest losses occur in the first year, this represents a considerable saving of labour. (Fig.5)

COCHLEARIA OFFICINALIS L.

The number of scurvy-grass plants decreased somewhat compared with the previous year, or from 863 down to 501. This decrease is mainly due to the decrease in seedlings. Larger plants increased from 20 to 110, but it is more appropriate to concentrate on these figures rather than on the total number, because the majority of the seedlings die. Most of the seedlings were found at No. 75-1 and in quadrat S-14, or about 130.

Figure 5

Most of the scurvy-grass plants are rather low-growing, and only three of them produced seed during that year. Scurvy-grass vanished from three quadrats during the year, from J-18, P-10 and R-10, but a new plant was discovered in quadrat H-9. Scurvy-grass thus exists in altogether 7 quadrats and usually forms a colony of 10-20 plants, if seedlings are not included. Each colony of plants is marked in such a way that many plants can have the same number, but the plants are often so close together, that it is very difficult to give each individual plant a number.

CAREX MARITIMA GUNN.

One Carex maritima has grown on the island since 1970. It is no. 70-72 and is in quadrat M-11. This plant thrived until 1975, when it had 86 culms and 8 panicles, but in 1976 it was badly damaged, because the pair of great black-backed gulls, that were nesting in quadrat N-10, tore at it and used it for building material in their nest. It was nearly annihilated, but in August it was showing some recovery and had formed two culms and 8 leaves.

Two additional Carex maritima were found last year. One did not survive the winter, but the other, No. 75-10 in quadrat M-9, produced one leaf in June, though by August it had disappeared. No new plant was found last summer. Carex maritima thus suffered much loss during the year.

TRIPLEUROSPERMUM MARITIMUM (L) Koth.

One daisy has grown in quadrat S-14 since 1972. It is No. 72-40. This plant is very small. It had only 2 leaves in 1976, each of which was about 1 cm in length.

Last summer, another daisy was found in the lower part of Stóri-Gígur, or in quadrat I-8. It was given the number 76-171. This plant is much smaller than the old one. It produced 20 leaves, had a diameter of 7 cm, but did not flower. It is almost certain that its seeds were carried by a bird, for they are too heavy to be carried by the wind, and the plant is too far from the sea to have been brought that way. The future of the plant would seem to be fairly secure.

PUCCINELLIA RETROFLEXA (Curt.) Holmb. Borealis
Holmberg.

Eight Puccinellia retroflexa plants grew in quadrat R-14 during the summer, and they are probably all derived from one and the same plant. Two of them grow in a fissure, the others up on the lava table. The plants growing in the fissure are considerably larger than those on the lava. One of those growing in the fissure, No. 74-89, produced three panicles, and this was the only Puccinellia retroflexa to flower that year. Two of the panicles that emerged in August produced mature seed and one emerged at the end of the season but did not develop further. This species of Puccinellia was finally identified last summer as Puccinellia retroflexa after it had flowered, but it had previously been considered to be P. maritima (Huds. Parl.).

CYSTOPTERIS FRAGILIS (L) Bernh.

Two Cystopteris fragilis plants were found during the summer. No. 72-113, in a hollow up in Stóri-Gígur, quadrat I-8, where it was growing among moss had 3 blades, each 5-7 cm in length. When the Cystopteris fragilis No. 73-599 was inspected in

August, 3 blades were found, each being 1-2 cm in length. This *Cystopteris fragilis* grows in a rather dark hollow with a good deal of moss in quadrat 0-13. Neither of the two ferns produced any spores during the year.

ELYMUS ARENARIUS L.

Nine lyme-grass plants survived the winter, and 12 plants grew on the island during the last year. One additional new plant was found: No. 76-100 in quadrat E-13, so that the total number is 10. Most of the plants are small, and none is flowering. The biggest, No. 74-51 in K-18, has 6 culms and 28 leaves, covers an area of 12 x 3 cm, and is about 45 cm in height. Other lyme-grass plants are smaller, most having 1-2 culms and 3-8 leaves.

MERTENSIA MARITIMA (L) S.F. Gray.

Of 11 *Mertensia maritima* plants growing on the island in 1975, 6 were found alive in 1976. No new specimen was discovered. All these plants are small, with 5-7 leaves, and they have not yet flowered. The poor development of these plants is probably due to the low nitrogen of the soil. One *Mertensia maritima*, No. 75-6 in M-15, had been injured when it was inspected in August, probably cut up by a raven. Two of the *Mertensia maritima* are from 1974 and two from 1975.

FESTUCA RUBRA L.

There were two specimens of *Festuca rubra* on the island in 1975. One was a new colonizer from that year, and was found growing in a hollow, together with scurvy-grass, in quadrat J-18. When inspected in June, 1976, the hollow had filled with sand and

the plant had therefore been covered up.

The other Festuca rubra has grown on the island since 1973. It is No. 73-370 in quadrat L-12. It gradually increased in size until 1975, when it had 90 culms. Last spring, the pair of great black-backed gulls that nested in quadrat N-10 used it for material in nest building. All the surface part of the plant had been thus removed. In August this red festuca plant had formed one culm with three leaves. There is thus great uncertainty now about the future of this plant.

CERASTIUM FONTANUM Baumg.

Ninety nine Cerastium fontanum were registered on the island last summer, of which 61 were seedlings. Cerastium fontanum grows in a very small area, a plot of about 10 m² in quadrat M-15. Of 38 plants, 16 were flowering and had about 250 seeds together with about 250 flowers, when the plant was inspected on August 12th.

The future of this species would seem to be fairly secure on the island, and its propagation area is likely to increase in the next few years.

A plant, which has not yet been completely identified, was found in quadrat K-8, and given the number 76-180. This is a new species on the island.

TABLE I.

PLANTS IN SURTSEY IN 1976

Year of Marking:	68	69	70	71	72	73	74	75	76	Total	
Honckenia peploides, marked	9	1	9	6	5	51	22	64	170	337	500
" " unmarked									163	163	
Cochlearia officinalis			16	33	29	5		23	4	110	
Old											501
Seedlings			40	143	70	7		130	1	391	
Carex maritima			1					1			2
Tripleurospermum maritimum				1				1			2
Puccinellia retroflexa					5		1		2		8
Cystopteris fragilis					1	1					2
Elymus arenarius						4	5		1		10
Mertensia maritima							4	2			6
Festuca rubra						1					1
Cerastium fontanum								32	6	38	99
Old											
Seedlings									61	61	
Unidentified Species										1	1

Plants overwintering 502
 New plants in 1976 630-
 TOTAL 1132

- Seedlings of scurvy-
 grass and Cerastium
 caespitosum 452
 Large plants 680

TOTAL 1132

TABLE II

LIST OF VASCULAR PLANTS DISCOVERED IN SURTSEY IN 1976.

<u>NO.</u>	<u>Quadrat</u>	<u>Species</u>	<u>NO.</u>	<u>Quadrat</u>	<u>Species</u>
222	I-17	Honckenya peploides	73-48	I-17	Honckenya peploides
68-8	J-18	" "	73-51	I-18	" "
68-21	J-18	" "	73-65	I-17	" "
68-22	J-17	" "	73-108	I-17	Elymus arenarius
68-24	J-17	" "	73-165	G-13	Honckenya peploides
68-56	K-18	" "	73-170	F-14	" "
68-64	J-18	" "	73-265	K-17	" "
68-70	J-18	" "	73-272	K-17	" "
68-83	K-17	" "	73-275	K-17	" "
68-87	J-18	" "	73-276	K-17	" "
			73-278	L-17	" "
69-62	F-13	" "	73-282	L-17	" "
			73-285	L-17	" "
70-4	J-18	" "	73-287	K-17	" "
70-20	J-18	" "	73-305	J-17	" "
70-25	J-17	" "	73-317	J-17	" "
70-31	J-18	" "	73-318	J-17	" "
70-37	E-12	" "	73-320	J-17	" "
70-39	G-13	" "	73-321	J-17	" "
70-42	F-13	" "	73-322	J-17	" "
70-60	F-13	" "	73-324	J-17	" "
70-64	I-17	" "	73-344	K-17	" "
70-72	M-11	Carex maritima	73-347	K-17	" "
70-74	S-14	Cochlearia officinalis	73-349	K-17	" "
			73-351	K-17	" "
71-35	J-4	Honckenya peploides	73-352	K-17	" "
71-43	F-13	" "	73-353	K-17	" "
71-47	F-13	" "	73-354	K-17	" "
71-54	S-14	Cochlearia officinalis	73-355	K-17	" "
71-57	P-17	" "	73-356	K-17	" "
71-63	J-13	Honckenya peploides	73-357	K-17	" "
71-68	J-5	" "	73-361	K-17	" "
71-69	N-10	" "	73-363	K-17	" "
71-75	R-11	Cochlearia officinalis	73-364	K-17	" "
			73-365	K-17	" "
72-30	J-4	Honckenya peploides	73-370	L-12	Festuca rubra
72-34	S-14	Cochlearia officinalis	73-372	L-11	Honckenya peploides
72-37	S-14	" "	73-385	K-17	" "
72-40	S-14	Tripleurospermum marit.	73-388	L-17	" "
72-41	S-14	Cochlearia officinalis	73-390	K-17	" "
72-42	S-14	" "	73-395	L-17	" "
72-44	S-14	" "	73-409	L-16	" "
72-53	S-14	" "	73-423	L-16	" "
72-56	K-5	Honckenya peploides	73-437	L-17	" "
72-83	F-14	" "	73-440	K-17	" "
72-90	R-14	Puccinellia retroflexa	73-441	K-17	Elymus arenarius
72-108	N-10	Honckenya peploides	73-444	K-18	Honckenya peploides
72-113	I-8	Cystopteris fragilis	73-448	J-18	" "
72-114	K-5	Honckenya peploides	73-449	J-18	" "
			73-509	J-18	" "
			73-538	K-18	" "
			73-545	K-17	" "

TABLE II

No.	Quadrat	Species	No.	Quadrat	Species
73-567	K-17	Elymus arenarius	75-1	S-14	Cochlearia officinalis
73-580	L-16	Honckenya peploides	75-6	M-15	Mertensia maritima
73-587	K-17	"	75-8	M-15	Honckenya peploides
73-594	L-16	Elymus arenarius	75-9	M-16	Cerastium fontanum
73-596	R-11	Cochlearia officinalis	75-10	M-9	Carex maritima
73-599	Q-13	Cystopteris fragilis	75-14	M-12	Honckenya peploides
73-600	M-18	Cochlearia officinalis	75-19	M-9	"
74-2	M-10	Honckenya peploides	75-21	M-11	"
74-4	M-9	"	75-22	M-9	"
74-5	M-9	"	75-23	M-12	"
74-6	M-9	"	75-24	M-9	"
74-7	M-10	"	75-25	M-9	"
74-9	K-10	"	75-26	M-9	"
74-11	I-10	"	75-27	N-9	"
74-13	J-10	"	75-28	M-9	"
74-15	J-10	"	75-33	M-8	"
74-18	J-10	"	75-34	M-9	"
74-19	J-10	"	75-35	M-8	"
74-21	J-10	"	75-36	M-8	"
74-22	K-10	"	75-37	M-8	"
74-23	K-10	"	75-38	N-9	"
74-24	K-10	"	75-40	H-9	"
74-27	I-10	"	75-42	M-9	"
74-29	M-8	"	75-49	N-9	"
74-30	M-9	"	75-44	M-8	"
74-31	M-7	"	75-45	M-8	"
74-32	M-8	"	75-46	O-9	"
74-51	K-18	Elymus arenarius	75-50	O-9	"
74-52	K-17	Honckenya peploides	75-52	L-17	"
74-53	K-18	Mertensia maritima	75-55	M-15	"
74-55	K-17	Elymus arenarius	75-56	N-9	"
74-56	J-17	Honckenya peploides	75-57	N-9	"
74-62	L-17	Mertensia maritima	75-58	N-12	"
74-68	L-17	"	75-59	L-17	"
74-73	K-17	"	75-60	D-12	"
74-78	L-16	Elymus arenarius	75-61	G-13	"
74-79	L-16	"	75-63	J-18	"
74-80	R-14	Puccinellia retroflexa	75-65	L-16	"
74-90	I-12	Elymus arenarius	75-66	J-8	Cochlearia officinalis
75-12	N-12	Honckenya peploides	75-67	K-10	Honckenya peploides
75-13	M-11	"	75-69	K-8	"
75-15	M-12	"	75-71	K-8	Cochlearia officinalis
75-16	L-11	"	75-72	K-8	Honckenya peploides
75-17	L-11	"	75-76	K-8	Cochlearia officinalis
75-18	N-11	"	75-78	O-11	Honckenya peploides
75-20	L-11	"	75-105	D-9	"
75-31	M-9	"	75-106	N-11	"
75-32	M-9	"	75-107	N-11	"
75-39	M-8	"	75-108	K-18	"
75-41	M-8	"	75-109	K-18	"
75-47	M-7	"	75-111	D-14	"
75-48	N-9	"	75-112	D-12	"
75-53	M-15	"	75-114	D-12	"
			75-115	D-14	"
			75-116	D-14	"
			75-118	D-14	"
			75-119	I-12	"

TABLE II

No.	Quadrat	Species	No.	Quadrat	Species
76-1	L-10	Honckenia peploides	76-56	L-17	Honckenia peploides
76-2	K-10	"	76-57	L-17	"
76-3	M-9	"	76-58	L-17	"
76-4	L-10	"	76-59	L-17	"
76-5		"	76-60	K-18	"
76-6	L-14	"	76-61	K-17	"
76-7	L-10	"	76-62	K-17	"
76-8	M-10	"	76-63	K-17	"
76-9	M-14	Cerastium fontanum	76-64	K-17	"
76-10	L-14	Honckenia peploides	76-65	L-17	"
76-11	M-9	"	76-66	K-17	"
76-12	L-10	"	76-67	L-17	"
76-13	L-11	"	76-68	L-17	"
76-14	M-10	"	76-69	K-18	"
76-15	M-10	"	76-70	K-17	"
76-16	L-14	"	76-71	L-17	"
76-17	M-16	"	76-72	K-18	"
76-18	M-16	"	76-73	K-17	"
76-19	M-16	"	76-74	K-18	"
76-20	M-16	"	76-75	K-17	"
76-21	L-16	"	76-76	K-18	"
76-22	L-16	"	76-77	K-17	"
76-23	L-16	"	76-78	K-17	"
76-24	L-16	"	76-79	K-17	"
76-25	L-16	"	76-80	F-14	"
76-26	L-16	"	76-81	J-17	"
76-27	L-16	"	76-82	F-13	"
76-28	L-16	"	76-83	G-13	"
76-29	L-16	"	76-84	F-13	"
76-30	K-17	"	76-85	I-17	"
76-31	L-16	"	76-86	G-13	"
76-32	L-16	"	76-87	I-17	"
76-33	L-16	"	76-88	I-17	"
76-34	L-16	"	76-89	G-13	"
76-35	L-16	"	76-90	J-18	"
76-36	L-16	"	76-91	F-13	"
76-37	K-17	"	76-92	I-18	"
76-38	L-16	"	76-93	G-13	"
76-39	L-16	"	76-94	I-17	"
76-40	L-16	"	76-95	I-17	"
76-41	L-17	"	76-96	I-17	"
76-42	L-17	"	76-97	F-13	"
76-43	K-17	"	76-98	I-17	"
76-44		"	76-99	I-17	"
76-45	L-17	"	76-100	E-13	Elymus arenarius
76-46	L-17	"	76-101	J-18	Honckenia peploides
76-47	L-17	"	76-102	J-18	"
76-48	L-17	"	76-103	J-18	"
76-49	L-17	"	76-104	J-18	"
76-50	L-17	"	76-105	J-18	"
76-51	L-17	"	76-106	J-18	"
76-52	L-17	"	76-107	J-18	"
76-53	L-17	"	76-108	J-18	"
76-54	L-17	"	76-109	K-17	"
76-55	L-17	"	76-110	J-18	"

TABLE II

No.	Quadrat	Species	No.	Quadrat	Species
76-111	J-18	Honckenia peploides	76-166	K-18	Honckenia peploides
76-112	J-18	"	76-167	K-18	"
76-113	K-17	"	76-168	K-18	"
76-114	J-18	"	76-169	K-18	"
76-115	J-18	"	76-170	K-18	"
76-117	J-18	"	76-171	I-8	Tripleurospermum marit.
76-118	J-18	"	76-172	H-9	Cochlearia officinalis
76-119	J-18	"	76-173	D-12	Honckenia peploides
76-120	J-17	"	76-174	D-12	"
76-121	K-17	"	76-175	D-12	"
76-122	K-17	"	76-176	E-12	"
76-123	K-17	"	76-177	E-12	"
76-124	K-17	"	76-178	E-12	"
76-125	K-17	"	76-179	E-12	"
76-126	K-17	"	76-180	K-8	Unidentified sp.
76-127	K-17	"	76-181	D-12	Honckenia peploides
76-128	K-17	"			
76-129	K-17	"			
76-130	K-17	"			
76-131	K-17	"			
76-132	K-17	"			
76-133	K-17	"			
76-134	K-17	"			
76-135	L-11	"			
76-136	K-17	"			
76-137	K-17	"			
76-138	K-17	"			
76-139	K-17	"			
76-140	K-17	"			
76-141	K-18	"			
76-142	R-14	Puccinellia retroflexa			
76-143	L-17	Honckenia peploides			
76-144	K-18	"			
76-145	R-14	Puccinellia retroflexa			
76-146	R-11	Cochlearia officinalis			
76-147	M-14	Cerastium fontanum			
76-148	K-18	Honckenia peploides			
76-149	S-14	Cochlearia officinalis			
76-150	L-11	Honckenia peploides			
76-151	K-18	"			
76-152	S-14	Cochlearia officinalis			
76-153		Honckenia peploides			
76-154	K-18	"			
76-155	K-18	"			
76-156	K-18	"			
76-157	K-18	"			
76-158		"			
76-159	K-18	"			
76-160		"			
76-161	K-18	"			
76-162	K-18	"			
76-163	K-18	"			
76-164	K-18	"			
76-165	K-18	"			

DISPERSAL OF PLANTS TO SURTSEY
1975 - 1976

Example of Dispersal by Birds.

In the summer of 1975 scurvy-grass 74-79 and Festuca rubra 75-5 grew together at an isolated spot in quadrat J-8. The scurvy-grass was found in the summer of 1975, and the Festuca rubra was noticed a year later. It is almost certain that seeds from these plants were borne by birds and were in the vomit or the excrement. The scurvy-grass germinated immediately, the Festuca rubra at the end of the winter.

This is far from being the first example of dispersal of scurvy-grass by birds to Surtsey. Most scurvy-grass plants grow in high places, where birds alight, and it has been proved that birds carry the seeds. Scurvy-grass grew alongside water-tubs that were placed on the island in order to attract birds. On the other hand, this seems to be the first almost indubitable example of a bird that carried Festuca rubra seed. One Festuca rubra has grown on the island for four summers: no.75-370 in quadrat L-12. This plant is high up on the rim of the crater, so it is very likley that a bird carried the seed there.

Example of Marine Dispersal.

The limit of the high tide debris following the winter 1975-76 was at a lower level than in the previous year. It is characterized by big logs and small pieces of wood. This limit is very probably in places where the surf goes highest in winter.

On the other hand, the sea flows much farther inland along the promontory during high storms, for the latter is flat and has a depression just north of the hill where there was previously a lake: Dropi, but this tide is not strong enough to carry logs or large debris so far inland, nevertheless, it drowns nearly all plants on the promontory during winters. Some plants have always been found in the aforesaid high tide line on the peninsula. This line has thus usually appeared as a permanent place of growth on maps. In the summer of 1976, there were 9 sea-sandworts in the high tide limit, and they appear on the plant-map as an almost straight line. Eight sea-sandworts were outside but close to the limit. (See also maps from 1965, 1966 and 1973). The location makes it almost certain that the seeds arrived by sea. It is possible that the seeds are washed ashore in autumn, and they are carried higher up on the island in the winter surf; most would drift together on the high tide limit, but some would be washed at high tide into the old lake bottom. The wind blows some of the seed to the east of the cinder cone, or Bunki; into the gully Svarta-Gil or west to the cinder cone of Bolfell.

Plants carried by ocean ought to appear mostly in the debris near the high tide line. And "shore-plants" are in fact mostly found there. They are the species: lyme-grass, Cakile edentula, sea-sandwort, Mertensia maritima, angelica and thrift grass.

Example of Dispersal by Air.

It has been difficult to find reliable examples of dispersal by air. Spores and light seeds that may

be carried long distances by air are so small that their dispersal is mostly not noticeable by the human eye.

From the two years in question, there is only one reliable example of dispersal by air. On 20th-21st August, 1975, large amounts of cotton-grass seed were blown over the island by the north wind. But conditions favourable for colonization of this species do not so far seem to exist there, as cotton-grass has not yet been found on the island. The question must arise as to whether seed from various other species is not dispersed although it does not survive on Surtsey due to the harsh conditions on the island.

A study of plants in the new lava on Heimaey island revealed that many of the species were the same as on Surtsey. (See article: "Search for Plants in the New Lava on Heimaey in 1975"). On Heimaey there are about 120 species of vascular plants. Of these 17 species have now already been found to occupy the new lava from the 1973 eruption on that island. Ten of these are also found on Surtsey. The greater number of species on the young Heimaey lava compared with that of Surtsey is due to the proximity of a rich vegetation to the former lava and indicates to what extent the distance to Surtsey and the ocean act as selective barriers for dispersal.

A list of organic matter found in the debris on the shores of Surtsey gives some indications to the magnitude and variety of diaspores that have dispersed to the island by ocean.

Some of the plant material such as seed and viable stolons may develop and become colonizers. Other organic matter may decay and become a source of nitrogen in the young, developing soil of the coast of Surtsey.

DRIFT REGISTER 1975 - SURTSEY

A drift check was made on the shore on each day that observers were on the island. Only that part of the shore where there was sand was inspected. This was mostly a section approximately 100 m long on both sides at the end of the promontory (quadrat A-B 18-19). A drawback was that the sand-shore was frequently in the lee of the prevailing wind direction, at which times nothing drifted ashore.

All drift of land origin was recorded, together with the most important material of marine origin. Algae and Calanus finmarchicus, much of which drifted ashore, were not recorded.

Date:	Type of Jetsam:
19.6	Sea sandwort and scurvy-grass leaves drifted onto sand-shore. A carcass of a swan was found in D-13.
20.6	Common seal drifted ashore in G-16 Probably dead for 5 days.
21.6	Scurvy-grass leaves on sand shore.
22.6	Nil.
23.6	Dead daisy just south of <u>Fjallið eina</u> (D-14), probably drifted ashore.
24.6	A <u>Festuca rubra</u> plant, and a good deal of dead lyme-grass stems on sand-shore.
25.6	Nil (wind southeast, strong).
26.6	"
5.7	"
6.7	"
7.7	" (wind southwest).
8.7	" " "
9.7	" " "
10.7	" " "

11.7	Nil
12.7	"
13.8	"
14.8	"
15.8	"
16.8	"
17.8	Dead <u>Festuca rubra</u> , drifted ashore
18.8	Nil
19.8	" (wind north)
20.8	Cotton-grass seed blown about the island.
21.8	Large amounts of cotton-grass seed blown about the island. Among the jetsam are quite a lot of grass-stalks and lyme-grass stalks, together with one scurvy-grass leaf.

DRIFT REGISTER 1976 - SURTSEY

A drift check was made on each day that observers were on the island. All drift of land origin and the most important material of marine origin was recorded. Only that part of the shore where there was sand was inspected. This was mostly on a 200-300 m section at the end of the promontory, but seldom on both sides of the latter. The sand-shore was usually in the lee of the prevailing wind direction, so that there was generally little or no drift.

<u>Date:</u>	<u>Type of Debris, Shore Location and Wind Directions.</u>
19.6	Sand on a section of approx. 100 m. at the eastern part of the promontory, and approx. 70 m. at the western part. There were also large amounts of dead Cypraceae stalks.
20.6	Many <u>Festuca rubra</u> leaves + 3 panicles of <u>Festuca rubra</u> + 3 heads of <u>Tripleurospermum maritimum</u> + part of leaf of <u>Tripl. maritimum</u> + many leaves and flowers of <u>Cochlearia officinalis</u> + one ear of <u>Poa annua</u> . All jetsam at the western part of the promontory. 13 seals lay on the sand at the end of the promontory.
21.6	Stalk with 2 leaves + dead straw of <u>Festuca rubra</u> . Part of leaf of <u>Tripl. maritimum</u> . One young fish. 13 seals lay on the sand.
22.6	Sand-shore largely disappeared on the eastern side of the promontory, but still about 70 m. long. There was quite a lot of debris there, the wind blowing strongly from the east. Much <u>Calanus finmarchicus</u> + <u>Festuca rubra</u> plants and leaves + <u>Cochl. officinalis</u> leaves and <u>Puccinellia maritima</u> whole plants + <u>Poa annua</u> + part of

- Tripl. maritimum and parts of Honckenia peploides.
At the western part of the promontory is a sand-shore of about 100 m. There was more debris there, it being in the lee.
Honckenia peploides parts + Festuca rubra plants + Poa pratensis part + Cochlearia officinalis part + flower-buds of Armeria maritima + part of a plant difficult to identify, probably of Sedum roseum.
- 23.6 Sand-shore exclusively at the western part of the promontory. Part of Honckenia peploides.
10 seals lay on the sand.
(southeast, force 4).
- 24.6 Festuca rubra, 3 leaves. (southeast, force 6-7).
- 25.6 Nil (southwest, force 6).
- 26.6 1 leaf of Festuca rubra (east, force 3)
- 27.6 2 leaves of Tripl. maritimum + 6 leaves of Festuca rubra + 1 ear of Festuca rubra (Calm.)
- 8.8 Sand-shore exclusively at the eastern part of the promontory, a section of about 200-300 m.
Many algae, brown, red and green, also many kinds of marine animals, e.g. small fish and crustacea.
Nil (southwest, force 4).
- 9.8 Nil (south, force 6).
- 10.8 "
- 11.8 "
- 12.8 Part of Poa pratense. Quite a lot of algae.
(south, force 3-4).
- 13.8 Nil
- 14.8 "
- 15.8 "
- 16.8 "
- 17.8 Much Calanus finmarchicus, no higher plants
- 18.8 " " " " " "
- 19.8 " " " " " "
- 20.8 " " " " " "

SEARCH FOR PLANTS IN THE NEW
LAVA ON HEIMAËY IN 1975 AND 1976

A search for plants was made in the new lava on Heimaey island. This was a rough, and by no means thorough, search, and the results may be regarded as a casual cross-section of the vegetation of the lava. The search extended to about one-third of the lava area. Only those plants that were more than 50 m from the western edge of the lava were recorded. Altogether 17 species of vascular plants were discovered. These are given in the following list (Table I and II). Two additional species may possibly be added to this list but were vaguely identified as Cerastium sp./fontana and Sagina sp./saginoides? It is interesting to note that of the total of 17 species 10 have also been found on Surtsey.

TABLE I.

Vascular plants in the New Lava of Helmaey in 1975

	Number of Plants:					
	On the northern side of the crater -in the middle of the lava	In pumice up from the northern coast	In an inlet on the shore of the northern coast	In lava southeast of Eldfell (Fire-Mountain)	In a thermal fissure in the middle of the lava	In pumice up from the eastern coast
* Have grown on Surtsey						
• Perhaps on Surtsey						
<i>Agrostis Stolonifera</i>		1				
* <i>Angelica Archangelica</i>		5				
* <i>Cakile Edentula</i>		1				
<i>Capsella Bursa-Pastoris</i>	1					
<i>Cardaminopsis Petraea</i>		1				
• <i>Cerastium Sp.</i>	1	1				
* <i>Cochlearia Officinalis</i>	2	2				
* <i>Elymus Arenarius</i>		1	10	5		1
* <i>Restuca Rubra</i>	(?) 4	3	12	5		6
* <i>Honckenya Peploides</i>		7	37	3		10
* <i>Mertensia Maritima</i>		2	6			
<i>Poa Sp.</i>		1		1		
• <i>Sagina Saginoides</i>	1					
<i>Senecio Vulgaris</i>	1					
* <i>Silene Vulgaris</i>	1			1		7-500
* <i>Stellaria Media</i>	2			1		
* <i>Tripleurospermum maritimum</i>	2					2-200

TABLE IIVascular Plants in the New Lava of Heimaey 1976(i) In the channel alongside the mountain (August:

Number of Plants

<i>Honckenya poploides</i>	1
<i>Tripleurospermum maritimum</i>	1
<i>Festuca rubra</i>	20
<i>Poa</i> sp.	1
<i>Puccinellia</i> sp	5

(ii) In the pumice to the north of the channel:

<i>Capsella bursa pastoris</i>	4
<i>Elymus arenarius</i>	1
<i>Sagina proculbens</i>	1
<i>Senecio vulgaris</i>	1
<i>Plantago maritima</i>	1

The Development of the Land-arthropod Fauna on Surtsey, Iceland, during 1971-1976
with Notes on Terrestrial Oligochaeta.

Introduction

In 1973 Lindroth et al. published the results of their terrestrial invertebrate survey on Surtsey and in its adjacent areas. In the publication the Surtsey collections from 1964-1970, which consist of 5742 specimens, ^{are} ~~is~~ treated. Only a few species from 1971 and 1972 were included in the discussions.

The field-work 1971-1976

Collecting of terrestrial invertebrates on Surtsey continued the following years. In 1971 the author stayed on the island from June 12 to August 24, and Mr. Hálfðán Björnsson ^{was there} ~~from~~ from October 10-28. Mr. Jón Eldon stayed there from June 6 to August 23, 1972, and from June 24 to August 21, 1973. However only seven collecting days have been noted in 1973. In 1972 (July 4-8) the island was also visited by Dr. C. H. Lindroth, Dr. H. Bodvarsson, Mr. S. H. Richter and Dr. P. Douwes. In 1974-1976 no regular collecting took place on Surtsey. In 1974 and 1976 the island was visited by Dr. Högni Bodvarsson and the author, July 30 to August 3 and August 7-12 respectively. No collecting took place in 1975, and because of unfavourable weather during the visit in 1976 the capture was very poor that year, especially when regarding the flying insects.

In 1971 no traps were in use as all of the available traps had been damaged the previous summer. In 1972 two new screen-traps were set up in the N part of the island and kept running from June 8 to August 15. However collecting by traps was not continuous, often disturbed by unfavourable weather and other events. On August 20, 1973, insects were unusually common around the house. Then 409 flies were caught in a water-filled bowl outside the house.

The new material, 1971-1976.

In this paper unpublished data collected by ^{Dr.} Hogni Bodvarsson is not included, so all numbers given are data from ^{other} collectors.

The new material consists of ⁴⁰⁶⁴~~4064~~ specimens. Most of the groups have been identified to species. The important group Acari (918 specimens) has only partly been treated by a specialist, but the author has not yet received the results. Most of the Hymenoptera (9 specimens) are still in the hands of a specialist. Diptera Sciaridae and some of the Chir^oomidae have not been identified.

Dr. Å. Holm, Uppsala, has been very helpful and has identified the Araneae (10 ex.), Dr. S. L. Tuxen, Copenhagen, identified the single Protura found on the island and Mr. K. J. Hedqvist, Stockholm, the single Chalcid^{-oides}~~idae~~ (Hymenoptera). ^{Dr.} H. Bodvarsson identified the Collembola, and the author is responsible for the identification of the remaining groups.

The new material consists of at least 122 species, 3²/₄ of them new to Surtsey and one new to the Icelandic fauna.

Additions to the Surtsey list of terrestrial arthropods.

DIPTERA

Fam. Bibionidae

Biblio nigriventris Hal. ^{17.} ~~2-9.~~ VI.72, 1 ex. (J.E.).

Fam. Chironomidae

Cricotopus ? sylvestris Fabr. 3.-5. VII.72, 6 ex. ~~(J.E.)~~; 1. VII.73, 1 ex. (J.E.).

Diamesa aberrata Lundb. 11. VI.72, 1 ex. ~~(J.E.)~~; 15. VIII.72, 1 ex. (J.E.).

Fam. Ceratopogonidae

Gen. sp. 3. VIII.74, 1 ex. (E.O.).

Fam. Simuliidae

Eusimulium latizonum Rub. 31. VII.74, 1 ex. (E.O.).

Fam. Tipulidae

Tipula rufina Meig. 4. VII.72, 1 ex. (J.E.).

Fam. Dolichopodidae

Hydrophorus viridis Meig. 23. X.71, 1 ex. (H.B.).

Fam. Syrphidae

Platycheirus manicatus Meig. 1. VII.72, 1 ex. (J.E.).

P. peltatus Meig. 30. VII.72, one dead ex. in drift on the shore; 4. VII.72, 1 ex.; 5. VII.72, 1 ex. (J.E.).

Syrphus torvus O.-Sack. 19. VI.72, 1 ex. (J.E.).

Fam. Muscidae

Spilogona baltica Ringd. (see Lindroth et al., 1973, p. 51, Spilogona sp. A and sp. B) 16. VI.71, 1 ex. (E.O.); 27. VI.72, 1 ex. (J.E.).

HYMENOPTERA

Chalcidoidea

Eupteromalus fuscicola Walk. 21. VII.71, 1 ♀ hatched from a pupa of Coelopa frigida F. collected in drift on the N shore (E.O.).

COLEOPTERA

Fam. Carabidae

Nebria gyllenhali Schnh. 26.VI.72, 1 ex. dead and badly damaged in drift on the N shore.

LEPIDOPTERA

Fam. Tortricidae

Eana osseana Scop. 30.VII.74, 33 ex. dead in drift on the N shore; 2.VIII.74, 4 ex.; 3.VIII.74, 1 ex. (E.O.).

Fam. Nymphalidae

Vanessa atalanta L. 26.X.71, 1 ex. (H.B.).

Fam. Geometridae

Cidaria (Xanthorhoe) designata Hufn. 23.VI.71, 2 ex. (E.O.).

C. (Epirhoe) alternata Müll. 16.VI.71, 1 ex. (E.O.).

Fam. Noctuidae

Euxoa islandica Staud. 10.VIII.72, 1 ex. (J.E.).

Noctua pronuba L. 27.VII.72, 1 ex.; 25.VI.73, 1 ex. (J.E.).

Peridroma saucia Hüb. 16.VII.71, 1 ex. (E.O.).

Diarsia mendica Fabr. 3.VII.72, 1 ex. (J.E.).

Cerapteryx graminis L. 30.VII.74, 9 live and 3 dead ex. in drift on the N shore; 1.VIII.74, 1 ex. newly dead in the lava-slope of Surtur II (E.O.).

Phlogophora meticulosa L. 27.X.71, 1 ex. (H.B.).

TRICHOPTERA

Fam. Limnephilidae

Limnephilus elegans Curt. 1971, 1 ex. ~~(E.O.)~~ dead on the NE shore (E.O.)

L. griseus L. 5.VII.72, 1 ex. (J.E.).

HEMIPTERA

Coccinea

Asterothezia cataphracta Olafs. 1.VIII.74, 9 live and 10 dead ex. in a tuft of grass that washed ashore (E.O.).

PROTURA

Protentomon thienemanni Strenzke 1.VIII.74, one live ex. in a tuft of grass that was washed ashore (E.O.). New to Iceland.

COLLEMBOLA

Three new species (Friesia mirabilis Tullb., Onychiurus armatus Tullb. and Folsomia quadrioculata Tullb.) will be treated by H. Bóðvarsson in a later publication.

ARANEAE

Fam. Linyphidae

Erigone atra Bl. 18.X.71, 1 ♀ (H.B.).

Erigone arctica maritima Kulc. (previously recorded with doubt) 9.VIII.76, 1 ♂ 1 ♀ (E.O.)

E. tirolensis L. 12.VIII.72, 1 ♂ (J.E.).

Islandiana princeps Braend. 29.VII.71, 1 ♀ with an egg cocoon (E.O.).

Of these 33 new species only four can possibly be regarded as permanent settlers on the island, i.e. the spiders and ^{perhaps} the collembole Onychiurus armatus. The ten new Diptera, ten Lepidoptera and the two Trichoptera are all casual visitors, and the remaining species were carried to the island in a tuft of grass, that was washed ashore.

Examples of hydrochorous transport of land-invertebrates ^{to} Surtsey

It was pointed out by Lindroth et al. (1973), that hydrochorous dispersal of land-invertebrates to Surtsey is of great importance. Animals have been carried to the island both by floating objects and simply by floating on the surface of the sea.

Puparia of three species of seashore flies (Coelopa frigida Fabr., Thoracochaeta zosteræ Hal. and Fucellia fucorum Fall.) have been found washed ashore and ^{at least} the two latter species have hatched afterwards.

On July 21, 1971, six puparia belonging to the above mentioned Diptera species (three, two and one specimens respectively) were collected in drift on the N beach. One of the C. frigida puparia hatched a few days later producing the parasitic wasp Eupteromalus fucicola Walk. (Chalcidoidea), which in Iceland is only known from the Westman Islands (Lindroth et al., 1973). The host was unknown. Most likely the pupa became infected outside Surtsey, and the inhabiting wasp managed to survive during the hydrochorous transport.

Apparently floating "tussocks" are going to be of great importance for the establishment of soil fauna on Surtsey. On July 8, 1972, a small tuft of grass (dry weight 52 g) was found washed ashore ~~in the NE part of the~~ on the NE beach. It contained two live specimens of Collembola and ca. 30 specimens of Acari. The origin of the tuft could not be stated (Lindroth et al., 1973, p. 255).

In 1974, August 1, a new floating tussock was washed ashore, this time a large one. It was cylindrical, 90 cm long and 10-20 cm wide. About one half of it (dry weight 884 g) ^{plastic} was sampled and isolated in plastic bags. The other half was left on the beach. A few days later the sample was treated in Berlese funnels. Altogether 65

terrestrial invertebrates were extracted through the funnels. Afterwards the ~~an~~ dry sample was thoroughly looked through, and the search for dead animals resulted in 10 specimens of Arctothezia cataphracta. The invertebrates found in the tussock are listed in table 1.

Various skilled botanists have studied the plant remains in the tussock, but they have not been able to give a definite identification. The tussock could possibly consist of the remains of Poa sp.

To trace the origin of the tussock both pollen analysis and geological studies were performed. The pollen analysis, performed by Margrét Hallsdóttir, Dept. of Quaternary Geology in Lund, showed a marked predominance of grasses (Graminae). The results are given in table 2. ^{These} The results ~~(of the pollen analysis)~~ do not give any proof on the origin of the tussock, but undeniably ^{it} ~~(the tussock)~~ has got the character of the bird cliffs or the puffin grounds of the Westman Islands, which are often characterized by grasses, Festuca rubra and Poa pratensis, the composit Tripleurospermum maritimum and cary^ophyllaceous plants like Stellaria media (Fridriksson et al., 1972).

Sveinn Jakobsson at the Natural History Museum in Reykjavik kindly studied grit sampled from the tussock. The grit proved to be quite palagonitized tuff. Phenocrysts of plagioclase and olivine were common, and zeolites were quite common in holes. This type of tuff resembles that of the Westman Islands, especially in the northernmost part of Heimaey (the Heimaklettur area), where the palagonitization of the old tuff is advanced (Jakobsson, 1968). Thus the tussock could originate from that area, but no proof has been obtained.

Further notes on the land-invertebrate groups found on Surtsey

Diptera.

At least 114 species of Diptera have been caught on Surtsey, but the actual number exceeds 120, as the identity of some species is still uncertain, especially within the families Chironomidae and Sciaridae.

As could be expected the different species have been collected on Surtsey in varying quantities. In figure 1 the 114 species of Diptera are divided into ten groups to illustrate this further. In table 3 the nine most common species are listed.

These nine species make $\frac{80.6}{81.2}$ % of the total Diptera capture, so the remaining 105 species (plus some unidentified species) make only $\frac{19.4}{18.8}$ %. During the period 1964-1970 these same species make 83.8 % and during 1971-1976 they make $\frac{76.5}{77.2}$ %.

Even though these numbers are fairly like, some changes in the abundance of the individual species are noted. Most ~~marked~~^{notable} is the decreasing number of Heleomyza borealis and H. serrata as well. During the first years the conditions were ideal for saprophagous insects like the Heleomyza species, as carcasses, that were washed ashore, could lie there for a long time. Later, 1970 onwards, the beach became a very popular resting place for immature gulls, so all carcasses were quickly devoured. This has no doubt greatly affected the species H. borealis, which was previously known to reproduce on the island.

The increase of Scatophaga stercoraria is due to the great capture on August 20, 1973, when 381 specimens were caught in a water-filled bowl outside the house. In 1973 443 Diptera were caught, so S. stercoraria makes 86 % of that years capture.

Another biotope, that previously favoured at least two species, i.e. Chironomus lugubris Zett. and Scatella tenuicosta Coll., has also disappeared. These two species had reproduced in the artificial freshwater "pools" erected by Dr. Maguire in 1967. In 1971 his plastic tubs were removed, so no freshwater resources ~~are~~^{were} available on the

after that island, except for condensing vapour around the fumaroles. In such places, where algal vegetation is usually luxuriant, the Scatella species can easily reproduce, but they have been observed in great numbers in identical places in the new lava on Heimaey. ^{However} ~~still~~ no Scatella flies have been caught on Surtsey after 1970.

No new species of Diptera have proved to have settled permanently on Surtsey after 1970. Cricotopus variabilis (Chironomidae) no doubt reproduces regularly in the salt water rock-pools, 21 larvae ^{were} collected in 1972. In 1974 many Calliphoridae larvae were observed in a dead kittiwake in the lava slope of Surtur II. ^{However} ~~Through~~ Cricotopus variabilis is the only Diptera species suspected to have a permanent population on the island.

Hymenoptera

During 1964-1970 21 specimens of Hymenoptera were collected. They belong to eight species. Ten specimens were collected 1971-1976. One of them has been identified, i. e. Eupteromalus fucicola Walk. (Chalcidoidea), that hatched from a pupa of the seashore fly Coelopa frigida Fabr., found in drift on the N shore (21. VII. 71). The other specimens are ~~now~~ at present being treated by a specialist.

Coleoptera

Only four species of Coleoptera have been found live on Surtsey, altogether 108 specimens. Additional six species have been found dead in drift on the shore, in some cases only parts of the body. (10 ex.).

The capture of 66 specimens during 1971-1976 gave no new species, except for the drifted and badly damaged Nebria gyllenhali Schnh. Three of the old species were rediscovered. Entomus minutus L. is still regularly met with inside the house. Seven

new specimens of Atheta atramentaria Gyll. have been collected, all caught flying on ~~per~~ sunny days. Then Amara quenseli Schm. was rediscovered, a single beetle was found running on the ground in ~~the~~ crater Surtur I on August 15, 1972 (leg. J.E.). The specimen was macropterous like the ^{one} previously captured. Otiorrhynchus arcticus O. Fabr. has not been found after 1969.

Lepidoptera

Altogether 19 species (124 ex.) of Lepidoptera have been found on Surtsey. Nine species (31 ex.) were captured 1964-1970. During 1971-1976 ten new species were captured and ~~three~~ ^{four} of the old species were rediscovered, i.e. Plutella maculipennis Curt. (5 ex. in 1972), P. senilella Zett. (4 ex. in 1972 and 1 ex. in 1974), ~~and~~ Agrotis ipsilon Hufn. (1 ex. 25.IX.76) ^{leg. Sveinn Jakobsson} and Autographa gamma L. (22 ex. in 1971). The last mentioned species invaded the island on October 19-27, 1971. That event is discussed by Lindroth et al., 1973 (pp. 216-219).

In 1974, July 30, 11 specimens of Cerapteryx graminis L. were found in drift on the N shore. Nine of them were alive but wet and unable to fly. At the same time 33 specimens of Eana osseana Scop. were collected in the drift, but all of them were dead. On August 1 still one specimen of C. graminis was found newly dead (soft and undamaged) in the lavaslope of Surtur II. ^{Then} ~~And~~ on August 2-3 five specimens of E. osseana were found alive. These first days of August, 1974, the island was invaded by a variety of flying insects. ~~(All the other new species were found in)~~ Only one or two specimens were found of the other new species.

Neuroptera

The single Icelandic species, Borionymia nervosa Fabr., was first collected on Surtsey in 1966 (1 ex.). A second specimen was captured on June 14, 1971.

Trichoptera

The first Trichoptera were found on Surtsey in 1970, when three specimens of Limnephilus fenestratus Zett. were captured. The same year a single L. affinis Curt. was found dead in drift on the shore (Lindroth et al., 1973).

In 1971 a single specimen of L. elegans Curt. was found dead on the NE shore. The specimen was in a good condition. (Unfortunately) the datum of this finding is not within reach, when this is written. A new species, L. griseus L., was caught flying on July 5, 1972.

Hemiptera

Two aphid species had previously been found on Surtsey. Now the coccid species Arctothezia cataphracta Olafs. has reach the island, transported by a floating tussock (see above). The species is very common all over Iceland.

Three dead specimens of Arctocoris carinata C. R. Sahlb. were found in drift on the shore in 1969. Still one specimen was found drifted ashore on July 30, 1974.

Protura

Only two species of this order had been found in Iceland, both of them extremely rare. It was therefore surprising when the third species appeared in the tussock, that ^{was} washed ashore on Surtsey in 1974 (see above). This species, Protentomon thienemanni Strenzke, was previously known from West-Germany (Tuxen, 1964)

Collembola

In ~~Saxen~~ Lindroth et al., 1973, the material from 1972 is partly included, i. e. material collected by ^{Dr.} H. Bodvarsson. Eight species were recorded from Surtsey.

The material collected by other collectors 1971-1976 consists of 69 ¹/₂ specimens, that belong to 10-11 species. Three of them had not been recorded, i. e. Friesea mirabilis Tullb., Folsomia quadrioculata Tullb. and Onychiurus armatus Tullb.

~~All~~ These species were collected from the floating tussock found in 1974. The last species has also been found on the island on other occasions, under ~~the~~ pieces of driftwood. Altogether 24 ³/₄ collembolae were extracted from the mentioned tussock. A list of 243 identified specimens consists of five species (table 1).

This group of insects will be treated more thoroughly by ^{Dr.} H. Bodvarsson in a later publication.

Araneae

In 1964-1970 11 spiders belonging to five species were found on Surtsey. In 1971-1976 ten specimens were found, giving three new species to the Surtsey list. One species, Erigone arctica maritima Kulcz., previously identified with doubt, was rediscovered.

The first spiders were found on Surtsey in 1967, i.e. Lepthyphantes mengei Kulcz. (2 ex.) and Meioneta nigripes Sim. (2 ex.) (Lindroth et al., 1973). In 1968 and 1969 no spiders were found, but from 1970 onwards spiders have been found every year. In 1976 silky threads produced by spiders were observed all over the lava-fields, especially in sheltered and damp holes and caves; ^{so} ~~so~~ obviously spiders are becoming quite common. Three specimens were found that year, Erigone arctica maritima, 1 ♂ and 1 ♀ in a cave on the E part of the island, and Meioneta nigripes, 1 ♀ on a big trunk of wood on the boulder beach on the SE part of the island (leg. S. Nilsson). The latter has become the most frequent species on Surtsey, collected in 1967, 1970, 1971, 1973, 1974 and 1976.

One species has been found with eggs, i.e. Islandiana princeps Braend., collected on July 29, 1971, under a ~~pcu~~ piece of driftwood near the airstrip on the northern ness. The egg cocoon was attached to the underside of the wood and was guarded by the mother.

Acari

Acari have been collected in great numbers on Surtsey. The collecting 1964-1970 gave 1894 specimens and 17 species. In 1971-1976 altogether 918 specimens were collected (the collections of ^{Dr} H. Bodvarsson are not included). Unfortunately the material is ^{However} still mostly unidentified because of the lack of specialists. ~~Though~~ the 398 specimens extracted from the floating tussock have been studied by a specialist, but the results are not yet accessible.

Oligochaeta

In 1972 the first representatives of this group of invertebrates were discovered on Surtsey. On July 7 and 9 respectively two and nine specimens of Enchytraeidae were found under driftwood on the northern ness. One specimen of the same group was extracted from the floating tussock in 1974, and one was found under driftwood outside the house on August 10, 1976. No further attempts to identify the species have been made.

The future plans

~~mag~~
~~can~~ It ~~can~~ be assumed, that good information has been achieved on transport of insects to Surtsey and what species are regularly carried out there and thus are most likely to inhabit the island in the future. As the vegetation on the island is now rapidly progressing an increase in permanently settled land-invertebrates should be expected in near future. Thus the most important task for the future is to follow the development of the biotopes ~~(existing)~~ ^{the island} on Surtsey and see how they will be invaded by animals. Active collecting of flying insects will be of minor importance. The island should be visited every second year.

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Table 1. Terrestrial invertebrates found in a tussock, that was washed ashore on Surtsey, 1. VIII.1974.

	No. of specimens
Acari	398
Collembola	
<u>Onychiurus armatus</u> Tullb.	214
<u>Archisotoma besselsi</u> Pack.	18
<u>Friesea mirabilis</u> Tullb.	7
<u>Hypogastrura</u> sp.	3
<u>Folsomia quadrioculata</u> Tullb.	1
Hemiptera	
<u>Arctorthezia cataphracta</u> Olafs.	9 (+ 10 dead)
Protura	
<u>Protentomon thienemanni</u> Str.	1
Diptera	
Chironomidae larva	1
Oligochaeta	
Enchytraeidae	1
	653 (+ 10)

Table 2. Results of pollen analysis performed on the tussock mentioned in table 1.

	No. of pollen	%
Gramineae	776	92.60
Compositae		
Tubuliflorae	31	3.70
Caryophyllaceae	28	3.34
Chenopodiaceae	1	0.12
<u>Rumex acetosa</u> type	1	0.12
<u>Alnus</u>	1	0.12
	838	100.00

Table 3. The most frequent Diptera species on Surtsey	1964-1970		1971-1976		1964-1976	
	No. of specimens	% of Diptera	No. of specimens	% of Diptera	No. of specimens	% of Diptera
<u>Cricotopus variabilis</u> Staeg.	756	24.2	693	30.8	1449	26.9
<u>Heleomyza borealis</u> Boh.	659	21.1	163	7.3	822	15.3
<u>Scatophaga stercoraria</u> L.	317	10.1	430	19.1	747	13.9
<u>Coelopa frigida</u> F.	425	13.6	176	7.8	601	11.2
<u>Diamesa zernyi</u> Edw. / <u>bohemani</u> Goet.	93	3.0	143	6.4	236	4.4
<u>Heleomyza serrata</u> L.	173	5.5	12	0.5	185	3.4
<u>Copromyza similis</u> Coll.	43	1.4	65	2.9	108	2.0
<u>Scatophaga furcata</u> Say	83	2.7	14	0.6	97	1.8
<u>Fucellia fucorum</u> Fall.	70	2.2	24	1.1	94	1.7
	2619	83.8	1720	76.5	4339	80.6

Figure 1. Relation between no. of species and no. of specimens of 114 species of Diptera caught on Surtsey 1964-1976.

BIRD-WATCHING ON THE ISLAND OF
SURTSEY SUMMER 1976

In the summer of 1976 four species of birds nested in Surtsey. These were: black guillemot (Ceppus grylle) and fulmar (Fulmarus glacialis), which have been regular breeders each year since 1970; great black-backed gull (Larus marinus), which laid eggs for the first time in the summer of 1974, and Arctic tern (Sterna paradisaea), whose eggs were found for the first time in the summer of 1975. The first three-mentioned species had some young. Last year the kittiwake also laid eggs in the island, but there were no signs of its breeding this summer. For distribution of nests see fig.6.

Erling Ólafsson localized the black guillemot nests, but all other observations were made by the biologists, Jon Gudmundsson and Valgeir Bjarnason.

Black Guillemot (Ceppus grylle):

The breeding site of the black guillemot was watched during just over one week in August. The nests were localized by observing the birds as they fed their young. In this way 4 black guillemot nests were found in quadrats K-4, O-5, and S-10 (see chart). By this study of the black guillemot breedings it was not possible to count the number of fledglings, or those nests that may have failed.

It was also suspected that there was a black guillemot nest in quadrat K-9, but this could not be confirmed. It is possible that the young from that nest had already gone to sea when the other nests were located.

Figure 6

In August considerable numbers of black quillemots (frequently 10-15) from nearby islands began to be seen on Surtsey. The birds were both adult and young.

Fulmar (*Fulmarus glacialis*):

A search for fulmar nests was made on 20th and 24th June. These totalled 13 nests, whereas in the summer of 1975 a total of 17 fulmar nests was found on the island. Two were in the south, and three in the east (see map of fig. 3).

These nests were inspected on August 15th, when a young bird was found in only four of them. All these successful nests were in the western part of the island: two in quadrat I-4, one in K-4 and one in M-4. This result is similar to that for the year 1975, when four young were also raised from nests in the western part of the island. These casualties may perhaps be ascribed to the unfavourable weather, both these summers having been very wet. Other factors may be involved, e.g. robbery by the great black-backed gull - which is now increasing its breeding in the island.

Great black backed gull (*Larus marinus*):

There were three nests of the great black-backed gull this summer. The pair that nested in 1975 and then hatched one fledgling probably nested again in 1976, as one nest this summer was in a very similar place to that of the previous year, or at the same distance from the edge of the cliff (in R-8 in 1975 and Q-8 in 1976).

The construction of the nest was also similar. It was built mainly of sand, and in it were only

feathers and fish-bones. When the nest was visited on June 20th, three young birds about one week old were found near it. Nearby were also fish-bones, cod intestines, fish-roes, and crab-claws. At the time 23 great black-backed gulls hovered over the observers. All the young grew up and were able to fly at the beginning of August.

Another nest of the great black-backed gull was in quadrat N-10. The nest was on top of a small lava-ridge, built mostly of plants that the birds had collected from an area of about 14 ha. (see map fig. 3). They had particularly attacked the Festuca rubra 73-370, the Carex maritima 70-72, the Honckenya peploides 71-63 and 71-69. Altogether, the birds took 20 Honckenya peploides plants, as well as the Festuca rubra and the Carex maritima. In addition to the plants, the following materials were used for nest-building: sand, fish-bones, parts of planks, birds' thigh-bones and feathers.

When the nest was visited on June 20th, the gull was sitting on one dead young bird, aged about 20-30 hours. The gull threatened the observers while they were at the nest. On the following day, the young bird had disappeared from the nest, and no adult bird was to be seen in the area. It may therefore be safely asserted that no young bird was reared by the pair of great black-backed gulls concerned.

The third nest of a great black-backed gull was in the west of the island in quadrat K-5. The birds had used Honckenya peploides No. 72-114 for

one side of the nest, and the plant-peg for the other. The Honckenya peploides had hardly been pecked, and the nest was in fact largely made of sand. Two of the same species of plants in the vicinity had been slightly pecked. The nest was found on June 23rd, when it contained two young birds and one egg. There was already a hole in the egg and the young bird could be heard cheeping inside it. When the nest was visited four days later, one young bird was in it, and two bigger ones had gone quite a long way from it. Two of the young grew up, and it is not improbable that the little one had been neglected by the parents, because there was a considerable difference in size.

Thus, in 1976 altogether five young great black-backed gulls were raised from three breeding attempts.

In June, there were about 30 adult great black-backed gulls all the time on the island, while in August there were 10-15, of which 5 were young birds.

The gulls were frequently to be seen on the shore of the promontory, where they collected everything that was edible.

Arctic tern (*Sterna paradisaea*):

between 20th and 24th June, practically no Arctic terns were seen, but on 24th June 17 were seen on the promontory. By 26th June, they numbered 50, of which 24 had not reached maturity. On the same day a tern's egg was found in quadrat B-13. It was on the level sand, and no hollow had been dug for the nest.

On 27th June, three more tern's eggs were found (see map). At the southernmost location in A-15 and in B-14 there were eggs in regular nesting hollows, but the fourth one, on the beach in the northern part of the promontory, was - like the first one - on flat sand. It is not known whether the tern lay on these eggs, or whether they were hatched out, as there were no observers on the island from June 28th until August 6th, but it is known that none of the young birds grew up. There were quite a lot of Arctic terns on the island at the beginning of August. On August 11th 300 terns were counted on the promontory, where they were all together. Later, their numbers decreased, and on August 15th there were 100. On August 17th there were 10 terns on the promontory, while on August 19th they were four. Quite frequently a considerable number of the birds were immature, often half of them, and in August it was quite common to see an adult tern with one or two fledglings. These birds were undoubtedly on their way south.

Other Birds:

Kittiwake (*Rissa tridactyla*):

In 1975 the kittiwake nested in quadrat N-5, but in 1976 no nest was to be found. There had been big changes in the area where it nested the previous year, the edge of the cliff having receded by 5-10 meters. It is possible that these changes were partly responsible for the cessation of breeding there. In the second half of June there were all the time about 600-800 kittiwakes on the island, but in August there were rather more, quite a number of young birds having arrived during that month.

On August 18th, there were, for instance, 26 young kittiwakes feeding on Calanus finmarchicus on the shore in the east of the promontory. Most kittiwakes were counted on August 11th, when about 1000 of them were sitting on the cinder cone Eystri-Bunki, as well as about 200 on the promontory itself. The birds obtained their food both from jetsam and from the sea around the island.

On June 20th one glaucous gull (Larus hyperboreus) was seen, together with 7 black-backed gulls, feeding on the shore. On June 21st-27th, a herring gull (Larus argentatus) was seen on the promontory. It would seem that he had marked out a nesting-spot, as he was making warning noises over the observers, when they approached a certain area.

Two ravens (Corvus corax) and two great skuas (Catharacta skua) were observed on almost every day: the skuas were usually towards the end of the promontory and the ravens higher up on the island - often in the vicinity of Svarta-Gil.

One red-breasted sandpiper (Calidris Canutus) was seen on June 25th, and two on August 12th.

During August, a few additional bird species were observed. On August 13th, three turnstones (Arenaria interpres) were observed on the shore. On the 15th, they were 15, and between 16th and 20th August only one was seen each day.

Three Iceland gulls (Croecthia alba) were observed on the beach on August 15th-20th.

On August 17th, one wheatear (Oenanthe oenanthe) was seen.

Between August 10th and 20th, white wagtails (Motacilla alba) were frequently seen on the island. The largest number 7 birds were seen together on August 17th.

During the whole of August, a large group of red-necked phalaropes (Phalaropus lobatus) was observed on the sea near the promontory. They numbered about 2000-2500.

All the above-mentioned birds mainly collected Calanus finmarchicus from the shore, as well as other food that had been washed up. For instance, a turnstone was observed feeding on a kittiwake carcass. Red-necked phalaropes fed mostly in the sea. White wagtails also fed on Calanus finmarchicus.

On August 19th two Arctic skuas (Stercorarius parasiticus) arrived in the island, molesting in particular the kittiwakes. Once in August the ringed plover (Charadrius hiaticula) was heard.

THE BLACK-BACKED SEAGULL'S NEST
ON SURTSEY.

The nest of the black-backed gull may become a centre of colonization for various plants and lower animals. Therefore it was considered of interest to study the organic matter which had accumulated in the nest during the summer. The birds had collected fish and other marine organisms to feed their young. Fish bones, eggshells and feathers were thus deposited in the sand after the birds abandoned the nest. In the centre of the nest these organic remains, larger than 2 mm, amounted to 5.6% of the weight of the uppermost 5 cm layer. And, when the sieved sand was analysed it contained 0.079% N/DM, but farther away from the centre at a distance of 50 cm and 100 cm the content was 0.028% N/DM in both cases.

TABLE 1.

Organic matter in the black-backed gull nest

Location:	% N/DM:	Organic matter % by weight:
Centre of nest	0.079	5.6
50 cm from centre	0.028	0
100 " " "	0.028	0

The samples were sieved through a 2 mm mesh. Two grams of the sieved material was weighed into a Kjeldahl tube and digested with 15 mls of concentrated sulphuric acid (using copper & selenium catalysts). The digest and washings were made up to 50 mls with deionised water and the ammonia concentration determined by steam distillation into boric acid. The ammonia was then titrated with hydrochloric acid (this is the standard Kjeldahl procedure). Dry matter was determined on a separate sub-sample.

* This organic matter becomes available for other organisms and the site could serve as a favourable habitat for various colonists such as; bacteria, molds, mosses, and even higher plants as well as lower animals.

From: The Quarterly Review of Biology. Sept. 1976. 1
By Sturla Fridriksson, Halsted Press (a division of
John Wiley & Sons), New York and Toronto. \$ 14.95 x +
198 p. + 8 pl.: ill.: index 1975.

The "boiling sea" and odors of sulfur off the south coast of Iceland in November 1963 were familiar phenomena to the inhabitants of that segment of the great mid-Atlantic ridge along which the interior of the earth emerges from time to time as volcanic ash and lava. On the mainland, such events have occurred on the average every five years in historical time: among the Westman Islands, the 1963 eruption was followed by another in 1973.

The 1963 event gave birth to a new island built on the ocean floor 120 m deep and piled up 172 m above sea level. It was quickly named Surtsey for the black God of fire (Surtur).

The early Norsemen believed that volcanic processes generated new life: "In the North was a region of snow and ice, and in the South there was heat and fire. And in the yawning gap between these regions life arose" (p.1). In 1963, a group of modern Icelandic scientists set out to achieve a more factual description of the products of vulcanism by detailed study of this new island. These men organized the Surtsey Research Society to promote and co-ordinate scientific research in biology and geology. Systems of travel via air and water, employing the Westman Islands, were developed. A small cabin for living and laboratory activities was built on Surtsey, and each of the scientists made regular trips to collect data during the 12 years since then. Both mature and young researchers operated instruments and carried out observation programs. A careful plan of research was developed in 1964 and conservation practices to reduce human impact on the island were put into operation.

Both terrestrial and marine research have been nurtured, including measurements of soil and atmospheric environmental factors as well as geological and biological features. In 1965 a meeting of 38 scientist, (22 Icelanders) was held to explore desirable research directions.

Funds and scientists from other countries joined the research effort but it has been primarily Icelandic scientists and funds from the United States Atomic Energy Commission which have carried the programs. A high tribute to a small population. The researchers have published many journal articles and the Surtsey Society has published research results in its annual reports.

Sturla Fridriksson, an eminent Icelandic botanist-ecologist, has synthesized the accumulated body of information into the single volume entitled Surtsey published in 1975 by John Wiley & Sons. No better author could have been found, for Fridriksson watched over the development of this island in detail, beginning within hours of the appearance of the first signs that it was on its way.

The author states. "It is a unique event to witness the labour of Mother Earth and watch Nature as midwife dress the newborn with the germents and ornaments of Flora and Fauna." Such colorful language and the inclusion of paragraphs from mythology are inevitable consequences of the efforts of human intellects and language to record and describe fantastic phenomena beyond the limits of the usual scientific endeavors.

This book is not a conventional scientific volume. The author has taken a truly ecological approach to organization and content. With such in perspective and it is a commendable one. Fridriksson has named the island as an ecosystem and therefore has included information on a wide range of features including extracts from Icelandic mythology which illustrate the early Norsemen's interpretation of volcanic events.

The following list of some topics dealt with illustrate the range of information included in this remarkable book. Is it possible that new life has been repeatedly formed in sea-water that has been super-boiled in volcanic eruptions? Do volcanoes sterilize the sea

water around them? What organisms pioneer the invasion of life on island volcanos? How far can plant disseminules move in ocean currents before they lose viability? Does Surtsey resemble a landscape produced by atomic warfare? Can people modify the route of volcanic lava flowing into a human settlement?

It is apparent then that the subtitle which appears on the dust cover of the book "Evolution of Life on a Volcanic Island" could be misunderstood. The subject treated is the "succession" of materials, organisms processes and events, both geological and biological.

The eruption began on 11 November 1963. The explosive ejection of ashes and bombs built an island which at its maximum size was 172 m high and covered 2.5 sq km. Lava flowed out over half of the island and inhibited oceanic erosion of the remainder of the island composed of ashes, sand and gravel. Geologists began watching the eruption from aircraft within hours of the first reports: biological observations were initiated six months after the eruption began and detailed studies have been carried on ever since that time.

The book treats the following subjects in sequence: some basic processes of vulcanism and the relation of the Iceland area to the mid-Atlantic ridge of plate-tectonic processes the history of eruptions the genesis of the current landscape from climate (data from 1872 to present available from nearby island), the appearance of life ecology of Iceland and other islands as sources of organism disseminules mechanisms of dispersal colonization (genesis of biotic communities) studies of marine life terrestrial life (all groups represented from microscopic to vascular plants and birds) the ecology of adjacent islands and the 1973 eruption on Heimaey and at the end "some conclusions and speculations".

Among the facts gleaned from the great mass of data now accumulated are the following: There are no mosquitoes in Iceland! The succession of plants on beaches begins with bacteria and molds on organic debris

washed up by ocean currents or dropped by birds, and skips the usual moss and lichen stages on the way to vascular plants. On lava, mosses appear after three years, lichens after eight years. Mosses have expanded rapidly and now form most extensive cover. Animal populations of birds, insects and invertebrates have developed most rapidly on beaches. Deficiency of water in certain seasons inhibits succession. The current flora includes 11 lichen, 69 moss, 1 fern, 12 vascular plant, 158 insect and 4 arachnoid species: 230 bird species have been observed on the island but many have been mere transients.

The first viable seeds of vascular plants were collected less than a year after the island appeared. Seedlings of the sea rocket (Cakile edentula) were growing in deaving seaweeds on the beach the second growing season (they were subsequently destroyed by a shower of ash). A reinvasion by the sea rocket and Elymus arenarius was washed away. Honchenya peploides arrived in four years and Mertensia maritima was next. Sea rocket was first to reproduce. Cystopteris fragilis was the first fern. Fridriksson states that "of the vast number of species arriving on Surtsey only a very few have been able to establish themselves. Many spores and seeds have germinated without further success of growth and consumers have found a negligible amount of food sources on the island to survive on" (p. 176). Periodic drought is mostly responsible for the slow establishment of life on the island although the climate is cool, windy and rainy.

Moss (especially Racomitrium lanuginosum) development on lava has been spectacular: from 1967 to 1971 the number of sample quadrats covered by moss increased from 3 to 120. Succession on the high areas of the island will probably proceed from lichen through moss to sedges, then heaths and willows. It is unlikely that birch can tolerate the salt spray.

Terrestrial research on adjacent islands identified four stable ecosystems: dry meadowland, puffingground

(modified meadowland), coastal cliffs (within the "splash" zone). *Angelica* clusters herb slope and heath. Grasses (*Festuca rubra*, *Agrostis tenuis* and *Poa pratensis*) are dominants of the plant cover. Over 70 per cent of plant species are European related, the remainder have Arctic affinities.

Marine studies revealed that ashes eliminated all benthic animals as far out as 1 nautical mile, but the phytoplankton, and fish were little affected: changes in water temperature were slight. Zonation of marine organisms was reestablished in three years.

There are few endemics on the Iceland islands because they were denuded in glacial times. Surtsey's biota thus far has probably been derived from adjacent islands and the Iceland mainland. Erosion of cliffs and invasion by new species destroy previous occupants and set back the development of biological cover to the island.

Most biologists think immediately of Krakatoa when the subject of invasion of new island surfaces comes up for discussion. Events following the eruption of that tropical island were described by biologists but dispersal and colonization were so rapid that detailed studies were impossible after 3 years and a complete cover developed in 25 years. These processes are infinitely slower on Surtsey.

Fridriksson sums up the human reaction to this volcanic event in the last sentence of the book (p.190).

The displays of these natural phenomena were so magnificent the powers of the elements both in constructing and demolishing land so apparent and the continuous struggle for the existence of life so fundamental that they are bound to direct one's thoughts towards the creative forces of the universe and to the origin and destiny of life.

This is an attractive volume. The abundance of color photographs convey details which would otherwise be lost. For the little color there is in a volcanic landscape is important.

John W. Marr. Environmental
Population & Organismic Biology.
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Surtsey. Evolution of Life on a Volcanic Island. By Sturla Fridriksson, 198 pages. Illustrated with black-and-white and color photographs. Charts and tables. Preface and index. Harsted Press, N.Y. \$14.95.

Those who are intrigued by nature's awesome power during volcanic upheavals of Krakatoa, Mauna Loa, Parícutin, and our own quasi-dormant peaks of the Cascades, will certainly be fascinated by the spectacular rise from the ocean of Surtsey in 1963, the island of the mythical fire giant 'Surtur'.

The book combines qualities of a text, research papers, and descriptive reports, sufficient to stimulate anyone interested in phenomena of earth and life sciences. Its eighteen chapters trace the source of volcanism relative to marine and continental plate tectonics, particularly concentrating on the Icelandic islands astride the Mid-Atlantic Ridge. Most importantly, the book deals with newly created Surtsey's colonization by a pioneer flora and fauna.

This new island offered a splendid observation post for successive invasion by air and sea of organisms adapted to this mode of dispersal. Surtsey and Heimaey volcanic islands, as part of the Westernman Islands group, received most, if not all of their pioneer flora from nearby Iceland. Plant communities from other, older islands of the archipelago are discussed and their species lists compared with that of the twelve-year-old island of Surtsey.

The book offers an intriguing microcosm for the local origin of life, its climatic-ecologic-ecological adaptations, its subsequent evolution during past years and future decades. Within our lifetime we will observe a subtly adjusting biota to a more or less stable, if fragile, environmental climax. Darwin pondered these questions on visiting the Galapagos Islands, leading to answers which decidedly influenced his philosophy of evolution as documented in his 'Origin of Species.'

Surtsey is truly a living scientific laboratory to enrich our knowledge of this restless planet.

—Herman F. Becker

Jordan Journal
December, 1976

Plane

①

12/16

Harvard Press has issued a handsome book, *Spratley: Evolution of life on a Volcanic Island* by Siurla Erickson, which would be most useful for those interested in the diffusion of plants and animals. Although the birth of the island itself is of great geological interest, since it only began to emerge from the sea on November 14, 1963, of at least equal fascination is the manner in which plants and animals were introduced to the island. The book is beautifully illustrated, at least a third of the photographs being in color. Available from John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10016.

Professional Geographer 11/19/76

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© Surtsey. Evolution of life on a volcanic island (Surtsey — Entwicklung des Lebens auf einer vulkanischen Insel); Surtla Fridriksson, London: Butterworth & Co. 1975. 198 S. mit Abb., Tab. u. Taf. geb. £ 5.30

Der Autor, der zu dem kleinen Kreis der Biologen gehört, die die Insel seit einem Jahrzehnt aufgrund zahlreicher Besuche und eingehender eigener Untersuchungen genauer kennen, bietet aufgrund seiner Erfahrungen und aus seiner Sicht eine umfassende Darstellung der Ökogenese bis 1973. Dabei werden vom ersten Ausbruch im November 1963 an sowohl die vulkanologischen Voraussetzungen und geophysikalischen Bedingungen wie auch die eigentlich ökogenetischen Erscheinungen im marinen Litoral und vor allem im terrestrischen Bereich behandelt und anschließend durch vergleichende Befunde auf benachbarten Inseln und von Island selbst wirkungsvoll ergänzt. Auch der jüngste Ausbruch auf Heimaey (1973) ist noch einbezogen. Besonders eingehend werden die bisherigen Ergebnisse jener Untersuchungen dargestellt, die Verf. mit seinen Mitarbeitern im Verlauf der ökogenetischen Frühphase erzielt hat. Sie beziehen sich vor allem auf die Einwanderung von Phanerogamen und die Ansiedlung der Moose. Artenlisten und Verbreitungskarten für die Frühphase bis 1973 vermitteln ein recht genaues Bild von der terrestrischen Entfaltung des Lebens. — Der Bericht über alle anderen Pioniergegruppen ist durch zugehörige Literaturlisten belegt. Das hervorragend ausgestattete Buch ist die bisher am weitesten umfassende Darstellung des Gesamtthemas und schon deshalb für jeden an ihm Interessierten von hohem Wert, auch wenn er manchen hypothetischen Erwägungen des Autors nicht folgen mag. (Wer sich immer mit der Insel beschäftigt, sollte beachten, daß die farbphotographische Luftaufnahme vor dem Titelblatt leider seitenverkehrt gedruckt ist). Schwabe.

Besprechungs-Belege '76

SURTSEY: EVOLUTION OF LIFE ON A VOLCANIC ISLAND

SURTSEY. EVOLUTION OF LIFE ON A VOLCANIC ISLAND. by Sturla Fridrikson. 1975. John Wiley & Sons (605 Third Ave., New York 10016). 198 p. \$14.95 hardback.

This is a first-hand account of the formation of an island in the mid-1960s through volcanic action in the Atlantic Ridge. The island, located off the coast of Iceland, is called Surtsey. The biologist author, who resides in Iceland, was a founding member of the Surtsey Research Society which is directing observations on natural colonization of Surtsey by plants and animals. The book describes the evolution of Surtsey's abiotic environment for the first fifty pages. The bulk of the book deals with the dispersal mechanisms and colonization patterns for organisms from all five kingdoms. Most especially, the vascular plants are treated. These events are described in a detailed, interesting manner. The author did much of this research himself.

The last section of the book deals with the vegetation of nearby areas including the island of Heimaey which underwent a massive volcanic eruption in 1973. Chapter 18 is an inadequate attempt to put Surtsey into perspective with what is known generally about island colonization.

This book is interesting and informative for mature general audiences. Most of the literature cited is unavailable except in larger university libraries. This collection of fascinating information furnishes much needed data for the plethora of speculations about insular biotas which are currently fashionable in ecology.

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SURTSEY

75L/2727 Surtsey. S. FRIDRIKSSON, (Butterworth), 1974, 300 pp, figs, photos, refs, price £5.30, ISBN 0 408 76701 3.

The book summarizes the first ten years of research on the attempts of living organisms to establish themselves on the island which first erupted in 1963. The main contents are: geological notes on the mid-Atlantic ridge, the eruption; the formation and disappearance of islets; the landscape; climate; the origin of life; ecological aspects; ways of dispersal; the substrate; the colonization; the marine research; the terrestrial research; the outer Westman islands; the vegetation of Heimaey; the southern coast of Iceland.

- from Publisher

SURTSEY

Frédriksson, Sturla: Surtsey.

Evolution of Life on a Volcanic Island. Butterworths. London 1975. 19X25 cm. 198 s. £ 5.30.

Den 14. november 1963 begyndte en ny periode af vulkansk virksomhed i det lavvandede havområde ved Vestmannaøerne, og den første afdeling af denne var med visse afbrydelser effektiv indtil 5. juni 1967. Det mest iøjensfaldende resultat er dannelsen af den nye ø Surtsey, som antages at være sket om natten mellem 13. og 14. november. Den 16. november var det højeste punkt ca. 40 m o.h., den 20. november ca. 70 m o.h., og i februar 1964 var den højeste top ca. 174 m o.h. I marts 1964 var højden 169 m, og den nye ø's areal var da ca. 1 km². Den 4. april 1964 blev kraterzonen lukket mod havet, og man fik påny stærke eksplosioner og lavaafrebrud. Den 5. juni 1967 fik man de sidste lavaafrebrud. På havbunden 600 m øst for Surtsey var der nogen vulkansk virksomhed i tiden december 1963 til januar 1964, og i maj-oktober 1965 dannedes her en ny ø, Sýrdlingur, ca. 70 m høj, som senere blev nedbrudt af havet. I julen 1965 kom et nyt felt i virksomhed ca. 900 m sydvest for Surtsey, hvor man fik en ny ø, ca. 70 m høj. Den fik navnet Jólnir, men også denne ø blev nedbrudt af havet, og disse to mindre vulkaner danner nu to undermåske forhøjninger med toppen liggende i ca. 50 m dybde.

Det næste store vulkanudbrud indtraf allerede den 23. januar 1973, nemlig på Vestmannaøerne, hvor Heimaey blev hårdt ramt. Byen med ca. 5000 indb. måtte forlades, og der skete meget alvorlige skader, store dele af byen blev øde-

lagt, fiskerihavnen blev hårdt ramt, og fiskeriet gik i stå; bygninger og de industrielle anlæg led store tab.

Overigten over de vulkanske processers forløb er ret kortfattet, idet vægten i dette arbejde ligger i behandlingen af de biologiske aspekter. De vulkanske produkter er antagelig helt sterile ved deres udgang af spalter og rørformede kraterer, og spørgsmålet bliver da, på hvilken måde de levende væsener tager den nye jord i besiddelse. På dette punkt er Surtsey et vigtigt område, fordi det i visse henseender er isoleret. Afstanden til Heimaey er ca. 80 km og til de nærmeste ubefolkede – men livbærende øer er kun nogle få km. Havvandet er rigt på levende planter og dyr, men også den atmosfæriske luft bærer levende væsener med sig. Kun få mennesker vil lande på Surtsey, og man kan formentlig forhindre dem i at medføre væsentlige tilskud af nye levende væsener.

Den første karplante synes at være *Cakile maritima*, som blomstrede og satte frugt i 1965. *Elymus* ankom i 1968. Første rugning af *Fulmarus glacialis* skete i 1970 og i 1972 var der 12 reder. Insekterne ankom tidligt, og der er påvist i alt 158 arter. Der kan næppe være tvivl om, at Surtsey som biologisk koloniseringsfelt vil få stor og ret central interesse.

Niels Nielsen

"SURTSEY: EVOLUTION OF LIFE ON
A VOLCANIC ISLAND".

The birth of the island of Surtsey on 14th November 1963, after a submarine volcanic eruption, was not just an interesting geological phenomenon, but a marvellous opportunity to set up a biological laboratory where scientists could observe how living organisms disperse themselves across oceans and manage to colonise completely barren areas. In *Surtsey*, subtitled *Evolution of Life on a Volcanic Island*, by Sturla Friðriksson (Butterworth; £5.30), the author describes the progress of this colonisation. He shows how a vast number of organisms managed to reach the island, although only a proportion of them managed to establish themselves within ten years. These include many mosses, twenty or so vascular plants, 158 terrestrial arthropods, and two nesting birds.

Wildlife
The International Wildlife Magazine
September 1976

76/7-0449

Surtsey.

Sturla Fridriksson John Wiley & Sons, New York, 1975, 198 pages, \$14.95.

Biology Digest, 1976

On the morning of November 14, 1963, a cloud of black smoke rising from the surface of the sea southwest of Geirfuglasker off the southern coast of Iceland signaled the eruption of a submarine volcano that would eventually give birth to an island later named Surtsey (from the mythical fire-giant Surtur, the Black). Sturla Fridriksson describes this fascinating geological phenomenon that demonstrates the volcanic activity of the mid-Atlantic Ridge which extends from the Arctic across Iceland and through the Atlantic to the Antarctic. He also presents a biological study to describe the formation of primitive societies and simple ecosystems. The beautifully illustrated book presents the unique geological and biological events with numerous graphs, charts, and illustrations.

The Surtsey Research Society was established shortly after the island was formed. The island became a laboratory where scientists could study the formation of a volcanic island which attained a height of 172 meters and an area of 2.5 square kilometers. Biologists could determine how life can disperse and develop on barren and dry lava and beside the boiling vapors of fissures and vents in the surface of Surtsey.

During some phases of the volcanic eruption, the ocean was in contact with the magma, producing a vapor cloud column reaching high into the air while falling ash created a black curtain. Because the surrounding clouds were positively charged, the ejecta from the eruption was highly electrified. The potential gradient formed was most intense near the crater. After a black jet had been thrust up, a lightning flash frequently followed (10-50 sec. later), neutralizing or lowering the positive charge towards the earth. Two active craters developed during the course of the eruption. By May 7, 1965, the permanence of Surtsey was assured and a solid lava surface of 1.5 sq. kilometer had been formed on the southern side of the island.

When the author made his first visit to the island six months after the volcano began, strains of bacteria and molds were collected, one fly was seen, and a few birds and plant parts were found. Red-hot magma was still glowing in the crevices and bluish vapor arose above the crater from the magma mass. Biological and ecological investigations were carried out by individual scientists and national and international scientific organizations. The new born island of Surtsey was compared with larger ones, and the primitive societies and simple ecosystems were compared with the complex and more advanced. To understand the comparisons, general biological and ecological aspects of Iceland are presented.

Slower and less spectacular than the formation of the island was the evolution of life on the island. Plant dispersal by air or ocean currents, drifting objects, birds, and man is discussed, and a comparison of the flora of Surtsey with other islands is given. Because the creation of a volcanic island is a unique event, the story of its evolution and colonization is a unique and interesting reading experience. The book is complete with an index and useful convenient bibliography located at the end of each chapter division.