

Benthic Amphipoda and Isopoda (Crustacea) from the sublittoral zone off Surtsey and Heimaey south of Iceland

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ABSTRACT

The volcanic island Surtsey, in the Vestmannaeyjar archipelago, was formed in a series of submarine eruptions, during the years 1963 to 1967. When the rocky shores began to build up, research of the marine colonization started. The most common crustacean groups in the epifaunal assemblage of subtidal hard bottoms are Amphipoda and Isopoda. This paper deals with studies on these groups in the nineties. Species abundance, faunistic changes and differences in distribution pattern of 30 species of peracaridans are discussed. The group of peracaridan crustaceans was found to have a diversity index of 2.3 on a transect at the east coast of Surtsey, both in 1992 and in 1997. The same value was found on a comparative transect surveyed in 1996 at the old lava grounds west of Heimaey, the main island of the Vestmannaeyjar archipelago. Therefore it is concluded that during the 25 years since the formation of the island, the colonization of crustaceans in the subtidal marine communities east of Surtsey has reached the same successional level as the older islands. The more eroded south and west coasts of Surtsey have not yet reached the same successional level due to the instability of the hard bottom.

Four species of amphipods are recorded herein new for the Icelandic fauna: *Gammarellus angulosus*, *Metopa borealis* and *M. solsbergi* from off Surtsey and *Jassa pusilla* from off Heimaey.

INTRODUCTION

The colonization of marine organisms of the new lava grounds formed during the Surtsey eruption, started in the year 1963 and has been studied periodically ever since (Sigurdsson 1999). The author has taken part in the collection of samples from Surtsey during the summer expeditions of 1987, 1992 and 1997, noticing differences and similarities with nearby islands. Lack of information about peracaridan crustaceans (Hauksson 1992) initiated studies on these abundant groups: amphipods and isopods. For comparative studies, similar samples were collected in the summer 1996, off two nearby islands in the Vestmannaeyjar archipelago.

Amphipods and isopods are mainly sedentary-epibenthic crustaceans with eggs-carrying brood-

pouch (not planktonic larval stages) and are very conspicuous and numerous on hard bottom substrates. They are important secondary producers, ranging in size from about 2 to 20 mm, and are an important component of the macrofaunal benthic-communities. In the present paper, a diversity index is used to compare the number of amphipod and isopod species and their relative abundance in samples of the hard bottom communities, between new and old lava grounds in the sublittoral zone off Surtsey and Heimaey.

STUDY AREA, MATERIAL AND METHODS

Surtsey (63° 18'N, 20° 36'W) lies about 30 km southwest off the Icelandic mainland in the Vestmannaeyjar archipelago. It was formed in a

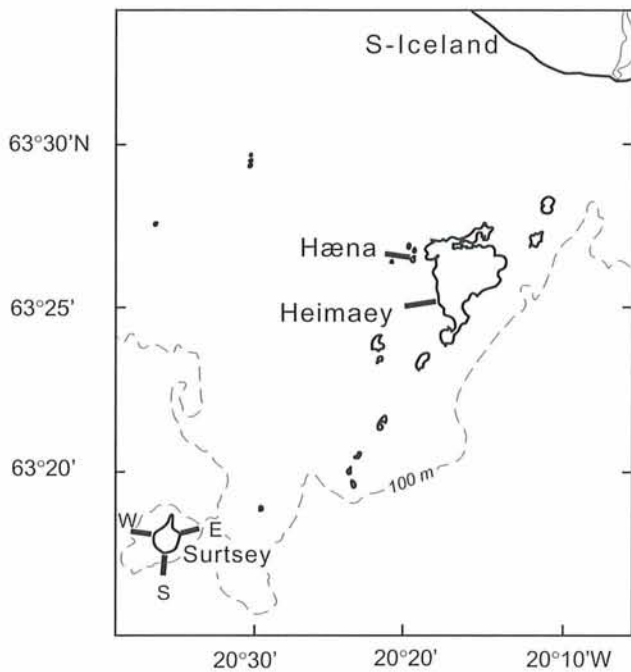


Figure 1. The Vestmannaeyjar archipelago. The study transects are shown with thick lines.

series of submarine eruptions, during the years 1963 to 1967. The biggest island of the archipelago is Heimaey and close to it, to the west is a small island, Hæna (Fig. 1). The waters around the Vestmannaeyjar archipelago are very productive and diving-visibility is frequently less than 5 meters during summer. The waters around Surtsey originate from the North Atlantic current with temperatures about 10 to 11°C during summer and 5 to 6 °C during winter and salinity of 35.2 (Stefánsson 1969). The prevailing southwesterly winds and surf activity constantly erode the exposed southwestern part of Surtsey, shaping the island severely since its formation.

The rocky bottom around Surtsey and Heimaey, generally extends to a water depth of about 30 meters, which marked the lower depth limit of the sampling. The tides are semidiurnal with amplitude of about 2.5 meters at spring tide in the area of study. In Surtsey sampling and photography of the subtidal area were carried out by scuba-diving along three different transects, east, south and west of the island (Fig. 1). The slope of the bottom along the transects is about 30°. Six sampling stations were at each transect, at five meters depth intervals, from 5 to 30 meters depth. The collections were made on one dive at each station. Three divers worked at each station: one collecting algae, one animals and one taking photographs. The

main emphasis of the diving work was a biological surveying, therefore the collections were qualitative. However, the same stations were resampled in each of the years: 1987, 1992 and 1997, by the same diving team. Therefore, the samples offer some semi-quantitative information, as well as data for studying the distributional pattern of organisms.

During the period from the June 20 to June 26, 1992 the east transect off Surtsey was sampled at six different depths 5, 10, 15, 20, 25 and 30 meters. On the south transect it was impossible to dive at the 5 m station due to heavy surf, and the 20 m station had to be left out due to strong wind. At the 30 m station on the west transect no hard substrate was found, only sandy bottom, and hence no collection of hard substrate organisms was possible. During the period from the 4th to the 10th of July in 1997 the same thing happened, with the further limitation that the weather did not allow diving at the 25 m station on the south transect.

The collection of animals in the last three Surtsey expeditions, as well as the collection at the island of Heimaey and the adjacent Hæna island (Fig. 1), were mainly done by the same diver. From the 11th to the 22nd of August in 1996, two transects, one almost horizontal west of Heimaey and the other near vertical at Hæna, were sampled with 5 meter depth intervals, in a similar way as in the Surtsey survey. Two or three dives were conducted at each station. The emphasis was on the collection of all organisms, in a quarter of square meter, randomly selected by throwing a frame some meters above the bottom, at every sampling depth of each transect. All organisms were collected in 0.5 mm mesh plankton nets, until the diver had scraped the hard bottom bare.

In the Surtsey expeditions the material was sorted on board a research vessel under a dissecting microscope and transferred to 70 % isopropanol with seawater. The Hæna and Heimaey samples were fixed in 5% filtered seawater formalin on board and later sorted under a dissecting microscope in the laboratory and then transferred to alcohol for preservation. The crustaceans were sorted and identified to species. The individuals of each species were counted. The proportion of males, females, gravid females and juveniles were also evaluated, when appropriate for assessment of the species life cycle. The diversity index (Margalef 1974) is defined as the total number of species (S) minus one divided with the natural logarithm of the total number (N) of individuals $((S-1)/\ln N)$.

Table 1. Species and number of individuals collected in Surtsey in 1992.

Surtsey 1992	East transect							South transect					West transect						
Depth meters:	5	10	15	20	25	30	A*	10	15	25	30	A*	5	10	15	20	25	A*	B°
<i>Idotea granulosa</i>	9																		
<i>Janira maculosa</i>		2	1					1		2								1	
<i>Janiropsis breviremis</i>																		1	
<i>Muna kroyeri</i>	1																		
<i>Hyperia galba</i>	1																		
<i>Gammarellus angulosus</i>		1						58	22	1			3		3	1			
<i>Parapleustes bicuspidis</i>				1															
<i>Pleusymtes glaber</i>		1	2							4	1					2	1		
<i>Stenothoe monoculoïdes</i>		5	6							7	5					15	10		
<i>Metopa solbergi</i>							3												
<i>Gammaropsis nitida</i>							17												
<i>Ischyrocercus anguipes</i>	36	47	65	7	1			5	8	51	45		6	3	70	26	1		
<i>Jassa falcata</i>	2		7							2						29			
<i>Caprella linearis</i>		1		2						1									
<i>Caprella septentrionalis</i>		3	21	13						40	24					22	20		
N	49	60	103	22	1	20	255	64	30	108	74	276	9	3	141	60	1	214	746
S	5	7	7	3	1	2	14	3	2	8	4	8	2	1	6	7	1	8	15
(S-1)/ln N							2.3					1.2						1.3	2.1

* For total transect °For total survey

The diversity index was calculated for each of the transects and for each year.

RESULTS

Faunal composition and distribution

A total of 6,164 peracaridan animals were counted and identified to 30 species: 22 species of Amphipoda and 8 species of Isopoda (Tables 1, 2 and 3).

The number of animals found in Surtsey indi-

cates how common the species are. Below is a list of species arranged in phylogenetic order, with general comments on their distribution and biology. New records for the Icelandic fauna are marked with an asterisk.

Order Isopoda

Family Idoteidae

Idotea granulosa Rathke, is a common species resident between tidemarks and below. It has predominantly been found in our study at 10

Table 2. Species and numbers of individuals collected in Surtsey in 1997.

Surtsey 1997	East transect							South transect				West transect						
Depth meters:	5	10	15	20	25	30	A*	10	15	30	A*	5	10	15	20	25	A*	B°
<i>Idotea granulosa</i>		1	1	1				1					1	1		1		
<i>Idotea pelagica</i>	1							2					4					
<i>Idotea neglecta</i>		1	1					1	1			1	1					
<i>Janira maculosa</i>		1	1					1	1			1	2	1		1		
<i>Janiropsis breviremis</i>									1									
<i>Muna kroyeri</i>		1																
<i>Hyperoche medusarum</i>	1																	
<i>Gammarellus angulosus</i>		1		1				38	30	1		30	24	1	2	2		
<i>Apherusa jurinei</i>									4									
<i>Stenothoe monoculoïdes</i>				1						1					1			
<i>Metopa borealis</i>					2		2				1							
<i>Pleusymtes glaber</i>					1		1				1				1			
<i>Ischyrocercus anguipes</i>	47	17	38	10				14	18	1		3	20	18	12	11		
<i>Jassa falcata</i>	4	12	37	12					2			1	1	2				
<i>Caprella linearis</i>			1	7				3	5	5		2			8			
<i>Caprella septentrionalis</i>	1	3	21	38	2	1											2	
N	54	37	101	72	2	4	270	60	63	9	132	38	54	24	23	17	156	558
S	5	8	8	8	1	3	14	7	9	5	13	6	8	6	4	5	11	16
(S-1)/ln N							2.3				2.4						1.9	2.3

* For total transect °For total survey

Table 3. Species and number of individuals collected at the Hæna and Heimaey transects in 1996

1996	Hæna transect							Heimaey transect						
	5	10	15	20	25	30	A*	5	10	15	20	25	30	A*
Depth meters:														
<i>Idotea granulosa</i>	1			1				83		2				
<i>Idotea pelagica</i>	4	81				1		8	3			2		
<i>Idotea neglecta</i>	1							6						
<i>Idotea baltica</i>														
<i>Jaera albifrons</i>	1													
<i>Janira maculosa</i>	10	18	1		3			2	4			2		
<i>Janiropsis breviremis</i>	15	83	1	2				34						
<i>Muna kroyeri</i>	18	105	15	17	11	6		14	22	44	21			
<i>Gammarellus homari</i>			2											
<i>Gammarellus angulosus</i>	1	2		3	2	6								
<i>Apherusa jurinei</i>		53						404	69	5				
<i>Pleusymtes glaber</i>	27	155	37	81	33	22			2		20	4		
<i>Parapleustes bicuspidis</i>		26	35								8	4		
<i>Stenothoe monoculoides</i>	12	110	18	11	26			62	16		32			
<i>Metopa borealis</i>		2	12	3	15						2			
<i>Metopa alderi</i>						3								
<i>Acanthonotozoma serratum</i>														1
<i>Dexamine thea</i>			2						5	57	11	2		
<i>Ampithoe rubricata</i>			2					263	5		2			
<i>Ischyrocerus anguipes</i>		130	1		15	26					54			
<i>Jassa falcata</i>	45	159	23	115	17	1		855	278	195	130	14		
<i>Jassa pusilla</i>											2			7
<i>Parajassa pelagica</i>	31	77						40						
<i>Corophium bonelli</i>											1			
<i>Caprella linearis</i>		53		43	12									
<i>Caprella septentrionalis</i>	38		7	10	7	55			30	58	12	2		
N	204	1054	156	286	141	120	1961	1771	434	361	295	31	7	2899
S	13	14	13	10	10	8	22	11	10	6	12	8	1	20
(S-1)/ln N							2.7							2.3

* For total transect

meters depth. Some females had brood pouch with eggs, and juveniles were observed, suggesting at least a two year life span.

Idotea pelagica Leach, was the next common species in our study that was predominantly found at a depth of 10 meters, replacing the preceding species on the more exposed transects. Off Surtsey it first appeared in the samples in 1997.

Idotea neglecta Sars, is a sublittoral species found in small numbers, along all transects off Surtsey.

Idotea baltica (Pallas), has only been found occasionally in our study off Heimaey, but not off Surtsey.

Family Janiridae

Jaera albifrons Leach, is mainly a littoral species found only off the island of Hæna at a 5 meter depth.

Janira maculosa Leach, is a sublittoral species found only in small numbers in the samples off Heimaey and Hæna in 1996 and off Surtsey in 1992 and 1997.

Janiropsis breviremis Sars, is another common sublittoral species found in moderate numbers.

Family Munnidae

Muna krøyeri Goodsir, is a sublittoral species. It is often overlooked because it is very small although it is very numerous, and is found along the east transect off Surtsey, Heimaey and Hæna.

Order Amphipoda

Family Hyperiididae

Hyperia galba (Montagu), is a pelagic species, normally associated with jellyfish. Its appearance in benthic samples was considered accidental. One individual was found off Surtsey in 1992.

Hyperoche medusarum (Muller), is also a pelagic species probably accidentally occurring in benthos samples. Only one animal was found off Surtsey in 1997.

Family Calliopidae

Gammarellus angulosus (Rathke)*, is a shallow sublittoral species common and locally abundant in southwestern Icelandic waters. It appeared in samples off Surtsey in 1992 and 1997, well represented by males, females, some with eggs and juveniles of different size. The same applied to the island of

Hæna. This suggests that *G. angulosus* produces successive broods in a one year life cycle. It was found clinging to algae and other growths in highly exposed areas. The author has observed it preying upon newly dead seabirds (Alcidae) in large quantities.

G. angulosus is recognized herein as a different species from *G. homari*, therefore it is a new record for the fauna of Iceland. Previously, *G. homari* has been reported for Iceland by Stephensen (1940) who wrote: "*G. homari* and *G. angulosus* are no doubt synonymous; most of the Icelandic specimens are big and belong to the form *G. homari*." This synonymy has been maintained in the literature (Enckell 1980). Steele (1972) has however shown them to be separate species as is also considered in the present paper.

Gammarellus homari (Fabricius), is a large sublittoral species for an amphipod, solitary but widespread around Iceland. It is up to 40 mm in length, double that of *G. angulosus*, with which it has often been confused. *G. homari* occurred only in the sample from 15 meters depth at Hæna.

Apherusa jurinei (Milne-Edwards), is a shallow sublittoral species that was locally common amongst algae off the islands Heimaey and Hæna. It was also found at 15 meters depth off Surtsey in 1997.

Family Pleustidae

Parapleustes bicuspis (Kroyer), is a sublittoral species found in moderate numbers in the Heimaey and Hæna samples. It appeared on the east transect of Surtsey in 1992 but it was not found there in 1997.

Pleusymtes glaber (Boeck), is a moderately common species on rocky subtidal areas. It was collected along all transects, with some females carrying eggs.

Family Stenothoidae

Stenothoe monoculoides (Montagu), is a sublittoral species common amongst algae and hydroids, it was found along all transects with the females frequently carrying eggs.

Metopa alderi (Bate), is a rocky sublittoral species, that was only found at 30 meters depth off Hæna.

Metopa borealis Sars*, is a rocky sublittoral species found off Hæna and Heimaey in 1996 and Surtsey in 1997. It is a Northeast-Atlantic species distributed from Norway to the English Channel, but it is not widely recorded and it is reported herein for the first time in Iceland.

Metopa solsbergi Schneider*, is a sublittoral species rarely recorded from Greenland and Norway. It was found for the first time in Iceland

off Surtsey in 1992 at a depth of 30 meters at the east transect.

Family Acanthonotozomatidae

Acanthonotozoma serratum (Fabricius), is a sublittoral species found on just one occasion off Heimaey.

Family Dexaminidae

Dexamine thea Boeck, is a shallow sublittoral species, which appeared locally abundant off the islands of Hæna and Heimaey.

Family Amphithoidae

Amphithoe rubricata (Montagu), is a sublittoral species which lives in tubes attached to hard substratum. It was found locally abundant at the islands Hæna and Heimaey. It was not collected at Surtsey in 1992 and 1997 but it appeared in some samples from 1987.

Family Isaeidae

Gamaropsis nitida (Stimpson), is a sublittoral species that was found only at a depth of 30 meters, east off Surtsey in 1992. Of the animals 50% were females and one half of them carried eggs.

Family Ischyroceridae

Ischyrocerus anguipes Kroyer, is a sublittoral species locally very common all around Iceland. It was the most abundant species off Surtsey in 1992 and 1997. It was also common off the islands Hæna and Heimaey, most abundant between 10 and 20 meters depth, usually in the company of *Jassa falcata*. It is a filter feeder, which constructs tubes amongst algae or hydroids. The proportions of animals found in summer were about 30% males, 30% females with brood pouch, 20% females without brood pouch, and 20% juveniles of different sizes, suggesting successive broods in a one year life cycle.

Jassa falcata (Montagu), is a sublittoral species, very abundant locally. It was found to be the most abundant species off the islands Hæna and Heimaey and was also quite common off Surtsey, along with *Ischyrocerus anguipes*. It is also a filter feeder constructing tubes on solid surfaces and the sex and age proportions of animals are similar to those of *I. anguipes*.

Jassa pusilla (Sars)*, is a sublittoral species recorded in Icelandic waters for the first time, off Heimaey in 1996, at 20 and 30 meters depth, associated with sponges, hydroids, and carapace of spider crabs. This is a species not widely recorded, distributed from northern Norway to the Bay of Biscay.

Parajassa pelagica (Leach), is a shallow sublittoral species locally common at 5 and 10 meters depth off the islands Hæna and Heimaey. This is a filter feeding amphipod, which builds nests amongst algae, hydroids, and bryozoans.

Family Corophiidae

Corophium bonelli (Milne-Edwards), is a shallow sublittoral tube-building amphipod that was only present in one sample off Heimaey.

Family Caprellidae

Caprella linearis Kroyer, is a benthic species found in moderate numbers off Surtsey in 1992 and 1997, as well as off Hæna in 1996.

Caprella septentrionalis (Linnaeus), is a benthic species extremely common, found in almost all the samples off Surtsey, Hæna, and Heimaey. The proportions of males, females, ovigerous females and juveniles were about 25 % each.

Faunal differences in space and time

There is a difference in the species composition and numbers of individuals of the peracaridan crustaceans, between the Vestmannaeyjar islands, as well as within Surtsey in the years 1992 and 1997. A list of the 30 species found during the surveys with their relative abundance is shown in the table 4.

A total of 21 species were collected off Surtsey, 15 species were collected on the transects of Surtsey in 1992 and 16 at Surtsey in 1997. There were 22 species collected at Hæna and 20 at Heimaey. The species lists of the different surveys at Surtsey were similar, even though 4 species collected at Surtsey in 1992 were lacking in 1997, and 5 species found in 1997 were missing in 1992. Likewise, 4 species collected along the Heimaey transect did not appear in the Hæna samples which contained 5 species not found at Heimaey. Further comparisons revealed that 4 species collected on the Surtsey transects were not found in the samples from Hæna and Heimaey in which 9 species were lacking from the Surtsey samples.

Considering the vertical distribution of species and the number of individuals sampled, the stations at 15 meters depth off Surtsey, particularly on the east transect, both in 1992 and 1997, yielded the highest number of species and animals. However, off the Hæna island the maximum number of species and animals was found at 10 meters depth. Off Heimaey island the highest number of species and animals was found at 5 meters depth.

Finally, from a total of 30 species, 17 were

Table 4. List of species and relative abundance (x= 1-10 animals; xx= 10-100 animals; xxx> 100 animals).

Transects:	Surtsey 1992	Surtsey 1997	Hæna	Heimaey
<i>Idotea granulosa</i>	x	x	x	xx
<i>Idotea pelagica</i>		x	xx	xx
<i>Idotea neglecta</i>		x	x	
<i>Idotea baltica</i>				xx
<i>Jaera albifrons</i>			x	
<i>Janira maculosa</i>	x	x	xx	x
<i>Janiropsis brevivemis</i>	x	x	xxx	xx
<i>Muna kroyeri</i>	x	x	xxx	xxx
<i>Hyperia galba</i>	x			
<i>Huperoche medusarum</i>		x		
<i>Gammarellus homari</i>			x	
<i>Gammarellus angulosus</i>	xx	xxx	xx	
<i>Apherusa jurinei</i>		x	xx	xxx
<i>Parapleustes bicuspis</i>	x		xx	xx
<i>Pleusymtes glaber</i>	xx	x	xxx	xx
<i>Stenothoe monoculoides</i>	xx	x	xxx	xxx
<i>Metopa alderi</i>			x	
<i>Metopa borealis</i>		x	xx	x
<i>Metopa solsbergi</i>	x			
<i>Acanthonotozoma serratum</i>				x
<i>Dexamine thea</i>			x	xx
<i>Ampithoe rubricata</i>			x	xxx
<i>Gammaropsis nitida</i>	x			
<i>Ischyrocerus anguipes</i>	xxx	xxx	xxx	xx
<i>Jassa falcata</i>	xx	xx	xxx	xxx
<i>Jassa pusilla</i>				x
<i>Parajassa pelagica</i>			xxx	xx
<i>Corophium bonelli</i>				x
<i>Caprella linearis</i>	x	xx	xxx	
<i>Caprella septentrionalis</i>	xxx	xx	xxx	xxx

common to Surtsey, Hæna, and Heimaey. These species are very typical of hard bottom benthos all around Iceland.

Species diversity

The diversity indices (Tables 1-3) of the transects off Surtsey in 1992 show the highest value of 2.3, for the east transect. The number of animals was very similar for each transect but the number of species was different, 14 on the east transect and 8 on the south and west transects. Combining the three Surtsey transects gives an index value of 2.1, with a total of 15 species. The survey off Surtsey in 1997 gives similar results, the east transect had a diversity index of 2.3 and 14 species and the combined index for the survey was 2.3, with a total of 16 species.

On the almost vertical slope transect off Hæna the diversity index reached the highest value, 2.7, with 22 species. On the near horizontal slope transect off Heimaey the index was 2.3, with 20 species.

The diversity index shows this natural variability from one transect to another and at dif-

ferent times of collection; but the index from the east transect of Surtsey both in 1992 and 1997 was 2.3, the same as for Heimaey in 1996. In addition the total number of species found on the east transects of Surtsey in both year surveys together was 19, very similar to the 20 species found in the survey at the island Heimaey.

DISCUSSION AND CONCLUSION

The new lava grounds at Surtsey have a steep slope and large parts of the shoreline of the island was eroded away by the action of the sea. The rocky shore in the southwestern area has been most severely affected and several hundred meters of seashore have been washed away. The east area is the most stable and there the community at the upper 5 and 10 meters depth, comprises seaweeds as the most conspicuous organisms, mainly: *Alaria esculenta*, which is replaced by *Laminaria hyperborea* at 15 meters depth (Jónsson *et al.* 1987). A deep water community situated between 20 and 30 meters depth is dominated by a faunal assemblage of filter feeders, where the soft coral *Alcyonium digitatum* and hydroids are dominant (Fig. 2).

On the old gently sloping lava grounds off Heimaey the kelp forest of *L. hyperborea* is dominating at 5 m water depth. At the nearby vertical transect off Hæna, *A. esculenta* is the most prominent species at 5 m water depth and *L. hyperborea* at 10 m. On both transects the deep water communities are dominated by the faunal assemblage of *A. digitatum* and hydroids (Galan 2000).

Amongst the crustaceans 4 species of Cirripedia and 6 of Decapoda are known off Surtsey (Hauks-son 1992), which were also found at Hæna and Heimaey in 1996. Cirripeds with pelagic larval stages are early invaders on hard substrates. Decapods have a pelagic larval stage, are relatively large and are very mobile. In contrast amphipods and isopods are mostly sedentary, developing young from eggs carried in a brood-pouch or marsupium, therefore with limited dispersal capabilities. In spite of their small size, they are important secondary producers because of their abundance in the benthos (Calman 1911). Therefore, the 30 species of amphipods and isopods dealt with here are an important component of the benthos off Surtsey and Heimaey.

In general, the highest value of the diversity index for the peracaridan crustaceans and the highest number of species and animals, in the present study were at the sampling sites where the kelp forest of *L. hyperborea* was dominant. This was at 15 m water depth off Surtsey in 1992 and 1997, 10 m

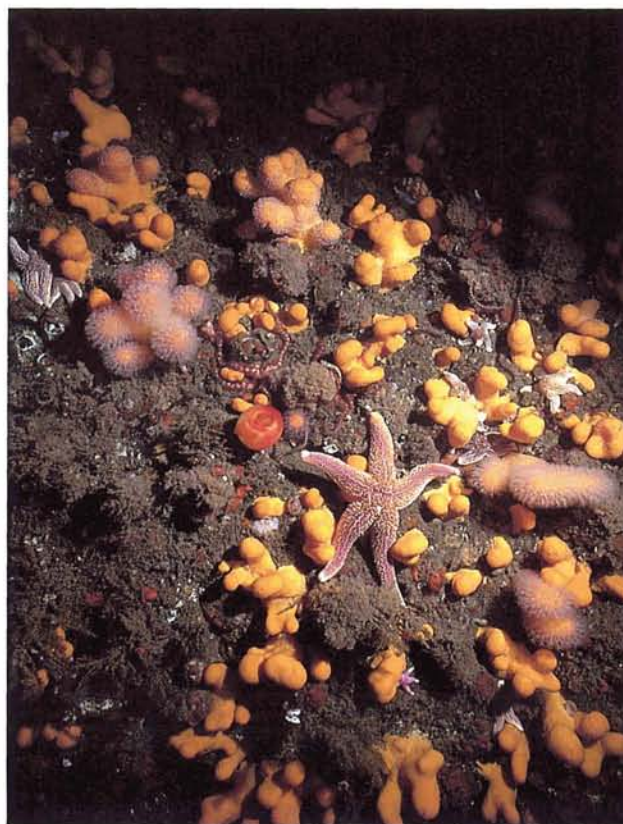


Figure 2. The faunal assemblage of *Alcyonium digitatum* at a depth of 30 meters off the island Hæna.

off Hæna and 5 m off Heimaey in 1996. *Ischyrocerus anguipes*, *Jassa falcata*, *Caprella septentrionalis* and few other species are most numerous in the kelp forest of *Laminaria hyperborea*. The reason for their abundance is most likely the extensive space, which the holdfast of this kelp species provides. The first two species mentioned are actually tube builders and the caprellids hang amongst hydroids and other sessile organisms. The difference in biomass and depth distribution of *L. hyperborea* at different transects are mainly the combined outcome of physical and biological factors (Galan 2000).

The new record of *Gammarellus angulosus* was found in the exposed southwestern transects off Surtsey and vertical one off Hæna. It was however absent from the horizontal transect off Heimaey and it was rare in the more stable one of east Surtsey. This is likely an opportunistic species because it has a short life cycle, numerous broods, it is resistant to exposure and it has diverse feeding habits. *Metopa borealis*, *M. solsbergi* and *Jassa pusilla* are new records for the Icelandic fauna, being rarely recorded in the Northeast Atlantic. At least 23 species of the genus *Metopa* are reported from the area, all small species and thus easily overlooked. *Jassa pusilla* is very difficult to distinguish from *J. falcata* and *Ischyrocerus anguipes*. The females

and young males of these three species are apparently identical and sometimes present in large quantities in one sample. These facts may explain their recent discovery.

The new records for the Icelandic fauna are not only from Surtsey but also from Heimaey, which probably is the result of a lack of studies on hard substrates. Faunal studies of hard bottom subtidal fauna around Iceland is needed.

There are fewer species present off Surtsey than off the nearby islands (Table 4) and there are also fewer animals collected off Surtsey than off the nearby islands (Tables 1-3). This can partly be explained by the difference in working methods between the two areas. The sampling methods were relatively qualitative at Surtsey and quantitative at the nearby islands. Although, taking into account that we are dealing with motile animals in different space and time, the differences in the total number of species and animals collected in the surveys can also be explained by natural variability. If we assume that the relative abundance of each species is reflected in the number of individuals of the species in the sample. Thus the differences in numbers of species and individuals between transects, can be considered reasonably comparable. In the present paper the natural logarithm of the total number of animals related to the number of crustacean species in the benthos is used as diversity index (Margalef 1974) in order to evaluate the colonization off Surtsey with reference to nearby islands with caution and some reserve.

The diversity indices of the south and west transects of Surtsey are very variable and lower than indices of the east transect in Surtsey and those of the nearby islands. This may be explained by the fact that the southwestern area of Surtsey is in constant renovation because of the retreat of the shoreline and sometimes the addition of huge rocks from above, due to the erosive forces of weather and sea. Therefore, the number of species is lower off the south and west transects. In addition high numbers of the opportunistic species *Gammarellus angulosus* further reduces the index. The almost vertical transect off Hæna presents a different picture. Algal cover is less and sessile macrofauna is more abundant in the shallow water depths. Overhanging cliffs adjacent to the transect reduces daylight reaching the sublittoral zone. The number of species and the diversity index was highest off Hæna. However, the highest number of animals, was in the kelp forest off Heimaey. The number of species and the indices are very sim-

ilar in the east transect of Surtsey in 1992 and 1997, and off Heimaey in 1996.

For comparison the new lava grounds, formed off Jan Mayen in 1970, had established shallow water subtidal communities, which had after 10 years reached a successional stage similar to that of the old grounds; because the severe physical conditions, like sea-ice, limited the complexity of the community, resulting in a low faunal diversity on both grounds (Gulliksen *et al.* 1980). Biogeographical reasons like latitude and the lack of kelp forest in Jan Mayen, might help to explain longer time of colonization compared with Surtsey.

By comparing the diversity indices for amphipods and isopods it can be stated that colonization and successional evolution of the east subtidal area of Surtsey has reached a similar level of maturity to that of the old lava grounds at Heimaey, after 25 years. How long it will take the subtidal biocenosis of the south and west coast of Surtsey to reach the same successional stage is a question, that can probably be answered by future studies.

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