Studies of the Subtidal Fauna of Surtsey in 1980 to 1987 and Changes in Subtidal Fauna from 1964 to 1987

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ABSTRACT

This paper deals with results of faunistic investigations of the subtidal around Surtsey, Vestmannaeyjar, South-Iceland, in 1980 to 1987. Results of species occurrences and faunistic changes are discussed from the time of formation of the island to the present (1987).

INTRODUCTION

After the formation of the new volcanic island, which was given the name Surtsey, in 1963, a unique opportunity was presented for investigating the settlement and succession of the fauna and flora assemblages on this new "land". Such opportunities are rather rare in nature.

The formation of the island makes it possible to study the colonization of algae and animals of the bare rock and formation of subtidal algal forests, which are very common around Iceland dominating the hard substrate of Iceland's sublittoral, which provide shelter and feeding-grounds for the young fish of some of the most important commercial species.

Since the formation of this new underwater "land" marine biologists have been following its colonization by marine flora and fauna. This paper deals with results of faunistic surveys carried out by divers in 1980, 1983, 1984 and 1987. Results of these are discussed in comparison with earlier surveys, to get an idea of how colonization of benthic species has propagated, and how the fauna has evolved with time.

MATERIAL AND METHODS

Sampling

Sampling of subtidal animals was commenced shortly after the eruption and formation of the island in 1963, and has continued to the present (1987). Methods of sampling underwater are described in earlier papers of Sigurdsson (1965, 1968, 1970, 1972, 1974a and 1982) and Hauksson (1982). Underwater sampling in the years 1980, 1983, 1984 and 1987, was performed in a similar manner as earlier, and on the main transects and depths, as far as permitted by limited research-vessel time and bad weather conditions for diving. Results of the surveys in 1980, 1983, 1984 and 1987 are presented in Tables 1 to 4.

Analysis of data

As the main emphasis of the diving work is a faunistic survey only qualitative data is collected. However the same depths and to some degree the same transects are revisited every collecting year, so some information about the distribution of species in respect to depths and subtidal areas of Surtsey is obtained.

Not all animal groups are included in this paper, because they are not yet totally assessed, and are the responsibility of other marine scientists participating in the Surtsey project. Those groups omitted are Amphipoda, Polychaeta, Hydrozoa and Bryozoa and will be treated later.

TABLE 1

Occurrences of species of marine benthic animals on the coast of Surtsey in 1980, in relation to transects and depth

Transects	West coast							East coast					South coast			Southwest coast		
Depth (m)	5	10	15	20	25	30	40	5	10	15	20	30	15	20	30	10	15	25
COELENTERATA:																		
Alcyonium digitatum L.	..	..	x	..	..	x	..	..	..	x	..	x	..	x	x	..	..	..
PROSOBRANCHIA:																		
Margarites groenlandicus (Chemn.)	..	..	..	x	..	x	x	..	..	x	..	..	..	..	..	..	..	x
Nassa incrassata (Ström.)	..	..	..	..	..	x	x	..	..	x	x	x	..	..	x	..	..	..
Onoba striata (Mont.)	..	..	..	x	..	x	..	..	..	..	..	..	..	..	..	..	..	..
Velutina velutina (Möller)	..	..	..	x*	..	x	..	..	..	..	..	..	..	..	..	..	..	..
Gibbula tumida (Mont.)	..	..	..	..	..	x	x	..	..	..	..	..	..	..	x	..	..	..
Skeneopsis planorbis (Fabr.)	..	..	..	x	..	..	x	..	..	..	..	..	..	..	..	..	..	..
Odostomia unidentata (Mont.)	..	..	..	..	..	..	x	..	..	..	..	..	..	..	..	..	..	..
Lacuna divaricata (Fabr.)	x	x	x	x	..	..	..	..	x	..	..	..	x	..	..	..	..	..
NUDIBRANCHIATA:																		
Adlaria proxima (Adler&Hancock)	..	..	..	..	..	..	..	..	x	..	..	..	..	x	..	x	..	..
Doto coronata (Gmelin)	..	..	..	..	..	..	..	..	..	x	..	x+	..	..	..	x	..	..
Dendronotus frondosus (Ascanius)	..	..	..	..	..	..	..	x	..	..	..	..	..	..	..	..	..	x
LAMELLIBRANCHIATA:																		
Heteranomia squamula (L.)	..	..	..	x	..	x	..	..	..	x	..	x	..	..	x	..	..	x
Hiatella arctica (L.)	x	x	x	x	x	x	x	x	x	x	..	x	x	x	x	x	x	x
Chlamys pusio (L.)	..	..	..	..	..	x	..	..	..	..	..	x	x	..	..	..	..	x
Modiola phaseolina (Phil.)	..	..	..	x	x	x	x	..	..	..	..	..	..	..	..	..	..	..
Mytilus edulis (L.)	x	x	x	x	x	x	x	x	x	x	..	x	x	x	x	x	x	x
CIRRIPEDIA:																		
Balanus balanus (L.)	x	..	x	x	..	x	x	x	x	x	..	x	..	x	x	..	..	x
Balanus hammeri (L.)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	..	..
Verruca stroemia (O.Fr. Müller)	..	..	x	x	x	x	..	..	..	x	..	x	..	..	..	..	..	x
ISOPODA:																		
Munna kröyeri Goodsir	..	..	..	x	..	x	..	..	..	x	..	x	..	..	..	..	..	..
Janiropsis breviremis Sars	..	..	..	..	..	..	..	x	..	..	..	..	x	x	..	..	..	..
DECAPODA:																		
Galathea nexa Embleton	..	..	..	x	x	x	x	..	..	..	..	..	..	..	x	..	..	x
Hyas coarctatus Leach	..	x	x	x	..	x	x	..	..	x	..	x	..	..	x	..	x	..
Eualus pusiola (Kröyer)	..	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Eupagurus bernhardus L.	..	..	..	..	..	x	..	x	..	x	..	..	..	..	..	..	..	..
PYCNOGONIDA:																		
Chaetonymphon hirtum (Kröyer)	..	..	..	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..
ASTERIOIDEA:																		
Asterias rubens L.	..	x	x	x	..	x	x	x	x	x	..	x	..	x	x	x	x	x
OPHIUROIDEA:																		
Ophiopholis acuelata (O. Fr. Müller)	..	..	x	..	..	..	x	..	x	x	..	x	..	..	..	..	..	..
ECHINOIDEA:																		
Echinus esculentus L.	..	..	x	x	x	..	x	..	..	..	..	..	..	..	..	..	..	..
Strongylocentrotus droebachiensis (O.Fr. Müller)	..	..	..	..	..	..	..	..	..	..	..	x	..	x	..	..	..	..
ASCIDIACEA:																		
Styela rustica L.	..	..	x	..	..	..	..	x	..	..	..	..	..	..	x	..	..	..
Halocynthia pyriformis (Rathke)	..	..	..	..	x	..	..	..	..	..	..	..	x	..	x	..	..	..
PISCES:																		
Cyclopterus lumpus L.	..	..	x	..	..	..	..	..	..	..	..	x	..	..	..	..	..	..

* eggcapsule
\+ juvenile

RESULTS

Occurrences of benthic species

Coelenterata

The dahlia anemone, *Tealia felina* L., was found for the first time in 1987, on the east, south and west coast at 20 to 30 meters. It has however most probably colonised earlier than that, but without being noticed.

The Stauromedusae *Haliclystus octoradiatus* (Rathke), was found for the first time in 1983,

TABLE 2
Occurrences of species of marine benthic animals on the coast of Surtsey in 1983, in relation to transects and depth

Transects	East coast					West coast
Depth (m)	5	10	15	20	30	30
COELENTERATA:						
Haliclystus octoradiatus (Rathke)	..	x	..	..	..	..
Alcyonium digitatum L.	..	..	x	x	..	..
PROSOBRANCHIA:						
Margarites groenlandicus (Chemn.)	x	..	x	..	..	..
Nassa incrassata (Ström.)	x	..	x	x	..	..
Lacuna divaricata (Fabr.)	x	x	x	x	..	..
NUDIBRANCHIATA:						
Adlaria proxima (Alder & Hancock)	..	x	..	..	..	..
Doto coronata (Gmelin)	..	..	x	..	..	x
Dendronotus frondosus (Ascanius)	..	x	..	..	..	..
Aeolidia papilosa (L.)	x	..	..	..	..	..
LAMELLIBRANCHIATA:						
Heteranomia squamula (L.)	..	..	..	x	..	..
Hiatella arctica (L.)	x	x	x	x	..	x
Chlamys pusio (da Costa)	..	..	..	x	..	..
Mytilus edulis (L.)	x	x	x	x	..	..
CIRRIPEDIA:						
Balanus Balanus (L.)	..	x	x	x	..	x
Verruca stroemia (O.Fr. Müller)	..	..	x	x	..	..
ISOPODA:						
Munna kröyeri Goodsir	..	..	..	x	..	..
DECAPODA:						
Hyas coarctatus Leach	..	x	x	x	..	..
ASTERIOIDEA:						
Asterias rubens L.	..	x	x	x	..	..
OPHIUROIDEA:						
Ophiopholis acuelata (O.Fr. Müller)	x	..	x	x	..	..
ASCIDIACEA:						
Styela rustica L.	..	..	x	x	..	..
Halocynthia pyriformis (Rathke)	..	..	x	x	..	..

at 10 meters depth on the east coast. It was found on algae.

Alcyonium digitatum L., is the only octocoral occurring at Surtsey. It was found first in the year 1969, four years after the formation of the island and has been found on every sampling occasion since then. *A. digitatum* is now widely distributed around the island, except on the south coast. It is very dominant at depths of more than 20 meters, but may also occur in water as shallow as 15 meters. Its most likely path of dispersal to the shallow grounds around Surtsey, is from below, from the original surrounding bottom, which the eruption did not disturb.

Prosobranchia

Buccinum undatum L., was first found in 1974 and also in 1977, but has not been found later than that. It occurred at one station on the west coast at 10–18 meters depth. It must therefore be rather rare on Surtsey. Its dispersal to the island is probably hindered by its method of propagating which is by laying egg-capsules, but not having pelagic larvae. *B. undatum* seems much less common on Surtsey, than on the southwest coast of Iceland, where it is a very common and conspicuous conch in the lower littoral and sublittoral zone.

Margarites groenlandicus (Chemn.), was first found in 1977, and has been appearing in the samples since then. It is mainly found at depths of 15 to 30 meters and does not inhabit the most shallow water. It is very common in the littoral and upper sublittoral zone on the southwest coast of Iceland. The late arrival of *M. groenlandicus* to Surtsey may due to it not having pelagic larve.

Margarites olivaceus (Brown), was first found in 1984 and then again in 1987, on the east, west and southeast coast, at depths of from 10 to 30 meters. It seems therefore to be a recent inhabitant on the coast of the island.

Margarites helicinus (Fabr.), was first found in 1987, at the east, south and west coast and seems to be a new inhabitant of Surtsey. As *M. olivaceus* it is quite common on the coast of Iceland so it does not come as a surprise that it has colonised the sublittoral hard rock of the Surtsey.

Nassa incrassata (Ström.), occurred first in the samples taken by divers in 1977 and has appeared in samples since then. It has been found at 30–40 meters depth on the west and east coast, but not at the south coast. In Iceland this whelk only occurs on the southern shores and in shallow waters.

Onoba striata (Mont.), is a small and inconspicuous gastropod occurring at a few depths on the west coast in 1980. Its small size may explain its rarity on Surtsey. It is easily overlooked by divers collecting samples and is most often brought to the surface with other animals or algae by chance.

Velutina velutina (Möller), was found the first time in 1974 and constantly since then. It is found in the lower region of the sampling area at 25 to 30 meters depth and only on the east and west coast. It is rather uncommon at Surtsey.

TABLE 3
Occurrences of species of marine benthic animals on the coast of Surtsey in 1984, in relation to transects and depth

Transects	South east coast					West coast			North east coast				South coast		
Depth (m)	5	10	15	20	30	10	15	20	5	10	15	30	10	15	20
COELENTERATA:															
Haliclystus octoradiatus (Rathke)	..	..	..	..	..	..	..	..	x	..	..	..	..	..	..
Alcyonium digitatum L.	..	..	x	x	x	..	..	..	..	x	..	..	..	..	x
PROSOBRANCHIA:															
Margarites groenlandicus (Chemn.)	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..
Margarites olivaceus (Brown)	..	..	..	x	x	..	..	..	..	..	..	..	..	..	..
Lacuna divaricata (Fabr.)	..	..	x	..	..	..	..	..	..	x	..	..	x	x	..
Acmaea testudinalis (Müller)	..	..	x	..	..	..	..	..	..	x	..	..	..	..	..
NUDIBRANCHIATA:															
Adlaria proxima (Alder & Hancock)	..	..	..	x	x	..	..	..	..	x	x	..	x	x	x
Doto coronata (Gmelin)	..	..	x	x	..	..	..	..	..	..	..	..	..	..	..
Dendronotus frondosus (Ascanius)	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..
Aeolidia papilosa (L.)	..	..	..	x	x	..	..	..	..	..	..	..	..	..	..
LAMELLIBRANCHIATA:															
Heteranomia squamula (L.)	..	..	x	..	x	..	..	..	..	x	..	..	..	..	..
Hiatella arctica (L.)	x	x	x	x	x	..	x	x	..	x	..	..	..	x	x
Mytilus edulis (L.)	x	x	x	x	x	..	..	x	..	x	..	..	..	x	..
CIRRIPEDIA:															
Balanus balanus (L.)	..	x	x	x	..	..	..	..	x	x	..	..	..	x	..
ISOPODA:															
Janiropsis breviremis Sars	..	..	x	x	..	..	..	..	..	..	..	..	..	x	..
DECAPODA:															
Galathea nexa Embleton	..	..	..	..	x	..	..	..	..	..	..	..	..	..	..
Hyas coarctatus Leach	..	..	..	x	x	..	..	..	..	x	..	..	..	..	..
Eupagurus bernhardus L.	..	..	..	..	..	..	..	..	..	..	x	..	..	..	..
ASTERIODIDEA:															
Asterias rubens L.	..	x	x	x	x	..	..	..	..	x	..	x	..	..	..
OPHIUROIDEA:															
Ophiopholis acuelata (O.Fr. Müller)	..	..	..	..	x	..	..	..	..	x	..	..	..	..	x
ASCIDIACEA:															
Halocynthia pyriformis (Rathke)	..	..	..	..	x	..	..	..	..	..	..	..	..	..	..
PISCES:															
Liparis montagui (Donovan)	..	..	..	..	x	..	..	..	..	..	x	..	..	..	..

Gibbula tumida (Mont.), was first found in 1977. It is only found on the west coast at 30 to 40 meters depth.

Skeneopsis planorbis (Fabr.), was found in 1980 at the west coast, at 20 and 40 meters, but not since then, a fact surely explained by its small size since it gets easily overlooked by the collectors. This is however a very common gastropod in the littoral and sublittoral zone of Iceland and it is probably still rare on Surtsey.

Odostomia unidentata (Mont.), was found in the years 1969 to 1980 on the west coast, but not since then, which is hard to explain. This is however a rather small gastropod and could be overlooked. It was only found in deeper water (40 m) on the west coast, and this part of the island, as well as the deeper diving depths, has not been as well sampled in later years.

Lacuna divaricata (Fabr.), was found as early as 1968 and has appeared since then. This is a very common gastropod in the more shallow waters, found frequently on algae and stones. Its egg-capsules are also very conspicuous on the *Laminaria* fronds. It is widely distributed on Surtsey, and is to be found on hard surfaces more or less all around the island.

Lacuna pallidula (Say), occurred first in 1987. It is only found on the west coast, at 10–20 meters depth. It is probably a new inhabitant of the fauna and limited to the west coast, and is still rather rare.

Aporrhais pes-pelicani (L.). One juvenile was found in 1968 at 15 meters depth on the northern shores (Sigurdsson 1970), but has not been found again since then.

Acmaea testudinalis (Müller), was first found at Surtsey in 1984, at 15 meters depth on the southeast coast and 10 meters on the northeast. It was not found however in 1987, so it is probably rare on the island, because it is rath-

TABLE 4

Occurrences of species of marine benthic animals on the coast of Surtsey in 1987, in relation to transects and depth

Transects	East coast						South coast						West coast				
Depth (m)	5	10	15	20	25	30	5	10	15	20	25	30	5	10	15	20	30
COELENTERATA:																	
Tealia felina L.	..	..	..	..	..	x	..	..	..	..	..	x	..	..	..	x	x
Alcyonium digitatum L.	..	..	x	x	x	..	..	..	..	x	x	x	..	..	x	x	x
PROSOBRANCHIA:																	
Margarites groenlandicus (Chemn.)	..	..	x	x	x	x	..	..	..	x	x	..	..	..	..	x	..
Margarites olivaceus (Brown)	..	..	..	..	x	..	..	..	..	..	..	..	..	x	x	x	..
Margarites helicinus (Fabr.)	..	..	..	..	x	..	..	..	..	x	..	..	..	x	..	..	..
Nassa incrassata (Ström.)	..	..	x	x	..	x	..	..	..	..	..	..	..	..	..	..	..
Omalogyra atomeus (Phil.)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..
Lacuna pallidula (Da Costa)	..	..	..	..	..	..	..	..	..	..	..	..	..	x	x	x	..
Lacuna divaricata (Fabr.)	x	..	x	x	x	..	..	..	..	x	x	..	..	x	x	x	..
NUDIBRANCHIATA:																	
Adlaria proxima (Alder & Hancock)	..	..	..	x	..	x	..	..	..	..	x	..	..	..	x	..	..
Doto coronata (Gmelin)	x	..	x	x	..	..	..	..	..	x	x	..	..	..	..	..	..
Dendronotus frondosus (Ascanius)	..	..	..	..	..	..	..	..	..	x	..	..	..	..	..	..	..
Aeolidia papilosa (L.)	..	..	..	..	..	..	..	..	..	x	..	..	..	..	x	..	..
Eubranchus sp.	..	..	..	..	..	..	..	..	..	x	..	..	..	..	..	..	..
Catriona aurantia (Alder & Hancock)	..	..	..	..	..	x	..	..	..	..	..	..	..	..	..	..	..
LAMELLIBRANCHIATA:																	
Heteranomia squamula (L.)	..	..	x	x	x	..	..	..	x	x	x	..	..	..	..	..	..
Hiatella arctica (L.)	x	..	..	x	x	x	..	x	..	x	x	x	x	x	x	..	x
Cardium fasciatum (Mont.)	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Modiola phaseolina (Phil.)	..	..	..	x	..	..	..	..	..	x	..	..	..	..	..	..	..
Mytilus edulis (L.)	x	..	..	x	x	x	x	x	..	x	x	x	x	x	x	x	x
Modiolaria discors (L.)	..	..	..	..	x	x	..	..	..	..	..	..	..	..	..	..	..
Chlamys islandicus (Müller)	..	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..
CIRRIPEDIA:																	
Balanus balanus (L.)	x	..	x	x	x	x	..	..	..	x	x	x	..	..	x	x	x
Balanus balanoides (L.)	..	..	..	..	..	..	..	..	..	..	..	..	x	..	x	..	..
Verruca stroemia (O.Fr. Müller)	x	..	x	x	..	..	..	..	..	..	..	x	..	..	x	..	..
ISOPODA:																	
Janiropsis breviremis Sars	x	..	x	x	..	..	..	x	..	x	..	x	..	x	..	..	x
Idotea granulosa Rathke	..	..	..	..	..	..	..	..	..	x	..	..	..	..	..	..	..
DECAPODA:																	
Galathea nexa Embleton	..	..	..	x	..	..	..	..	..	..	..	..	..	..	..	..	..
Hyas coarctatus Leach	..	..	x	x	x	..	..	..	..	x	x	x	..	..	..	x	x
ASTERIOIDEA:																	
Asterias rubens L.	x	..	x	x	x	..	..	..	..	x	x	x	..	..	x	x	x
OPHIUROIDEA:																	
Ophiopholis acuelata (O. Fr. Müller)	..	..	x	x	..	..	..	..	..	x	x	..	..	..	x	..	x
ECHINOIDEA:																	
Echinus esculentus L.	x	..	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..
Strongylocentrotus droebachiensis (O.Fr. Müller)	..	..	..	..	..	x	..	..	..	..	..	..	..	..	..	..	x
HOLOTHUROIDEA:																	
Cucumaria frondósa (Gunnerus)	..	..	..	..	..	..	..	..	..	..	..	..	..	x	..	..	..
ASCIDIACEA:																	
Styela rustica L.	..	..	x	x	..	..	..	..	..	..	..	x	..	..	x	..	..
Halocynthia pyriformis (Rathke)	..	..	..	x	..	..	..	..	..	x	..	..	..	..	x	..	..
PISCES:																	
Liparis montagui (Donovan)	..	..	x	x	..	x	..	..	..	..	..	..	..	..	..	..	x

er conspicuous and easily noticed by divers.

Omalogyra atomus (Phil.), occurred the first time in 1987. This is the smallest gastropod in Iceland, and it is therefore not strange that it was not found at Surtsey at first, because it may easily be overlooked by the divers collecting and the personnel sorting the samples.

Nudibranchia

The nudibranchs found at Surtsey are not

fully identified. Some specimens are still without given species names. Nudibranchs were one of the first animals to be found at Surtsey (Sigurdsson 1974). The following species have been found there:

Aeolidia papilosa (L.),
Acanthodoris pilosa (Müller),
Adlaria proxima (Alder & Hancock),
Catriona aurantia (Alder & Hancock),
Coryphella sp.,
Dendronotus frondosus (Ascanius),
Doto coronata (Gmelin),
Eubranchus sp.,
Tergipes tergipes (Forskål).

Because nudibranch specimens have not been identified to species from all the collecting years, they are not included in the further analysis of data in faunistic sense.

Lamellibranchiata

Heteranomia squamula (L.), was the first animal to be found on the new bottom at Surtsey. As early as 1965 it was recovered in a dredge sent down to 85 meters depth (Sigurdsson 1974). *H. squamula* has occurred in the samples since and is quite common at depths greater than 10 meters.

Hiatella arctica (L.), occurred in the samples quite early on. It was first found in 1967 and has occurred since. It is very common at Surtsey, and is found at every depth, the only lamellibranch outnumbering it being *M. edulis*.

Mytilus edulis (L.), was also first found at Surtsey in the year 1967, and has occurred since. It is now the most common bivalve at Surtsey, found at every depth, and forming extensive colonies which cover the bottom in many places in the sublittoral zone (see Fig. 2).

Modiola phaesolina (Phil.), was found first in the samples in 1980, at 20–40 meters depths on the west coast. It has not been found every year, so it is probably rare on Surtsey. However its small size may make it inconspicuous and cause the divers to miss it.

Chlamys pusio (da Costa), was collected first in the year 1968, and has occurred since, with the exception of 1984 and 1987. It is not very common occurring as solitary specimens on stones, at the 15–30 meters depth. It has been found at most of the transects, so its distribution is wide although it may be rather rare.

Modiolaria discors (L.), is rare on Surtsey and seems to be a recent inhabitant, because it was first found in 1987, on the east coast at 25 to 30 meters depth.

Chlamys islandicus (Müller), is rare on Surtsey. It was first found in 1987, at 20 meters depth on the east coast.

Cardium fasciatum (Mont.), was first collected in 1968, but has not been found in every year of sampling. It is therefore probably rare. In 1987 it was found at 15 meters depth on the east coast.

Cirripedia

Verruca stromia O. Fr. Müller, was collected as early as 1967 and has occurred since. It is sporadically abundant, being most often found on *Laminaria* stipes and stones. It has been found at most depths and transects.

Balanus balanoides (L.), was the first barnacle to be found on rocks at Surtsey, as early as 1968. This is the most common littoral barnacle in Iceland, but at Surtsey it was found in the sublittoral, as well as littoral zone. One reason for it's occurrence in "deep waters" of Surtsey could be that stones and cliffs, which *B. balanoides* has settled on are broken down by wave action and carried out to deeper waters with the surf. *B. balanoides* could also be using the opportunity and settling deeper on the bare and more stable rocks found there. Since 1980 it has only be found in 1987 on the west coast, at 5 and 15 meters depth. In the littoral zone it settles regularly each year on rocks at the tidal level, but most of the barnacles are destroyed and killed in the heavy surf which hammers the western and southern parts of the island during the autumn and winter, breaking away great parts of the coast each year.

Balanus balanus Da Costa, is the most common barnacle in the Sublittoral zone of Surtsey, as well as elsewhere on the coast of Iceland. It was found as early as in 1968, and every year since. It is found on stones and *Mytilus* shells, at all depths and transects.

Balanus hammeri (Ascanius), was first found in 1968. It is found at from 15 to 30 meters depth, on the south coast. It has not been found since 1980, and is probably not very common on Surtsey.

Ispoda

Janiropsis breviremis Sars, occurred first in the samples in 1974, and has been found regularly since. It is quite common occurring at almost every depth from 5 to 30 meters.

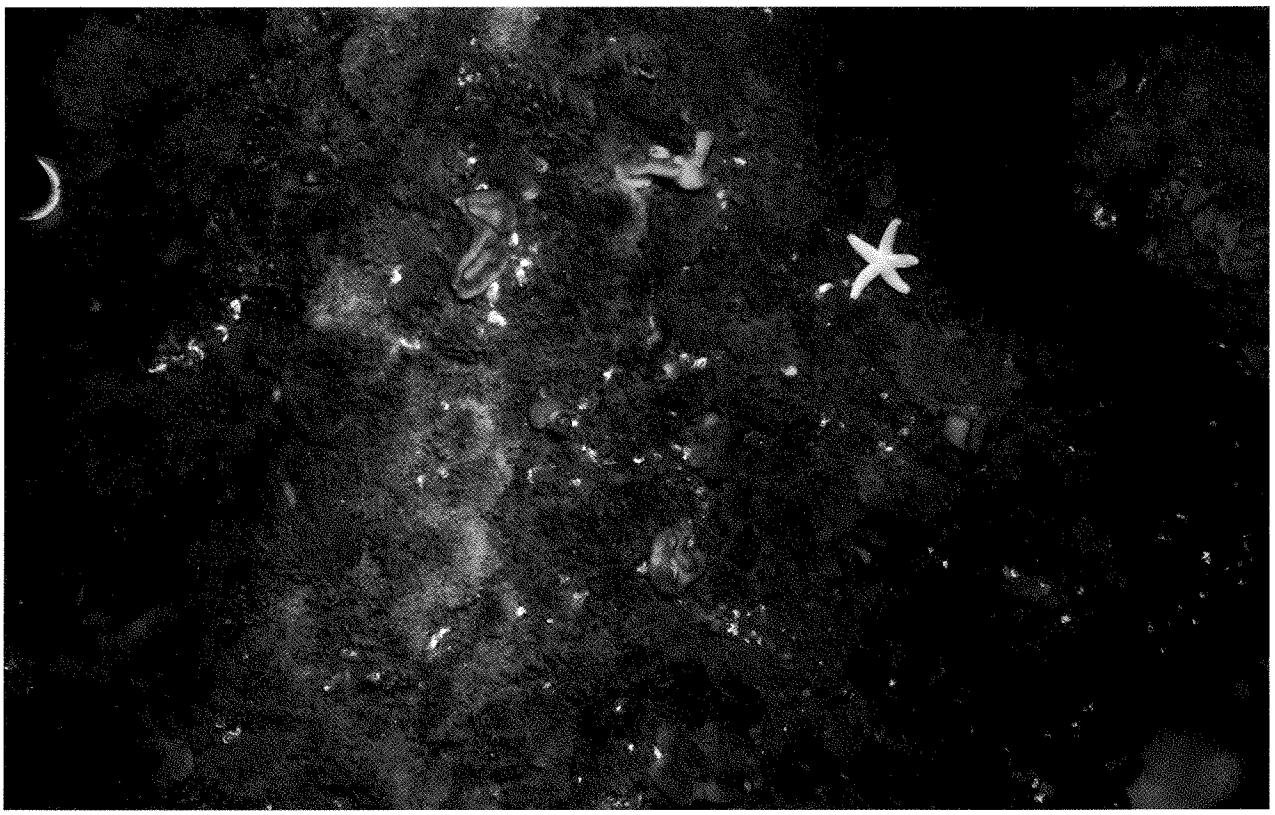

Fig. 1. Underwater photograph showing *Laminaria sp.* on hard rocks with epifauna. Animal species noticable on the photograph are: the star fish *Asterias rubens,* the poriferan *Grantia sp.,* the keelworms *Pomatoceros sp.* and *Hydroides sp.,* hydrozoans most noticeable *Tubularia sp.* and bryozonas (Photogr. Erlingur Hauksson).

Munna kröyeri Goodsir, was first found in 1974 and has most often been found in the years since then. It has been found at depths of 15–30 meters and is usually collected accidentally with other bigger benthic organisms.

Idotea granulosa Rathke, has only been found once on the south coast at 20 meters depth, in 1987. This is a very peculiar depth of occurrence, because *I. granulosa* is a very common intertidal idoteid on Icelandic shores, but does not occur sublittorally elsewhere on the coast.

Decapoda

Eualus (= Spirantocaris) pusiolus (Kröyer), was found as early as 1967. It has occurred in the samples more or less up until 1980 and is found sporadically at most depths.

Hyas coarctatus Leach, was found first in 1967 and has occurred since. It is the most common crab on Surtsey being found everywhere at all diving depths. It is often covered with commensal species of hydroids, bryozoans and algae.

Macropipus (= Portunus) holsatus (Fabricius). Individuals of this species were found in 1964 at 70 meters depth (Sigurdsson 1965) and from 1967 to 1969, but not since then. This may be because *M. holsatus* is a swimming crab and is not strongly tied to the bottom.

Galathea nexa Embleton, occurred first in 1969 and has been found since. This anomura crab is quite common on Surtsey in the depth range 20–40 meters.

Pandalus montaqui Leach, has only been found in 1964 at 70 meters depth on the west coast (Sigurdsson 1965), and in 1974 on the south coast at 40 meters depth. This is however a very common shrimp in shallow waters on the coast of Iceland on various substrata. It is possibly not found more often on Surtsey, because it is an agile animal and readily escapees capture.

Eupagurus bernhardus (L.). This hermit-crab occurred in 1980 samples from Surtsey. It was found at several depths on the west and east coast. On later sampling occasions it has not been found, suggesting that it is probably still scarce at Surtsey. It is however a very common hermit-crab in shallow waters on the Icelandic coasts.

Asterioidea

The only star fish found at Surtsey so far is *Asterias rubens.* L. It was found as early as 1968

Fig. 2. Underwater photograph showing *Mytilus edulis* colonies with associated epifauna. Animals to be noticed on the picture are: the star fish *Asterias rubens* preying on *M. edulis*, hydrozoans and the lamellibranch *Hiatella arctica* (Photogr. Erlingur Hauksson).

and has occurred since. It is quite common being found at almost every depth all around the island. It is especially abundant in association with the common mussel (*M. edulis*), and preys upon it (see Fig. 2).

Ophiuroidea

Ophiopholis acuelata (O.Fr. Müller), is the only brittle star which is very common on Surtsey. It occurred first in 1974, and is now found almost everywhere at most depths.

Ophiura sp. One juvenile was found in 1974, at 40 meters depth on the south coast. A handful of Ophiura species are common on sand- and clay-bottom conditions around the Icelandic coast. *Ophiura affinis* Lütken, has been previously found by W. Nicolaisen (Nicolaisen 1970), making this the most likely species.

Echinioidea

The edible sea-urchin, *Echinus esculentus* L., was the first sea-urchin to be found on Surtsey. It was found in 1980, at almost every depth on the west coast.

Strongylocentrotus droebachiensis Lam., was found first in 1980. It is now quite common around Surtsey at various depths.

Holothuroidea

The only holothurian found at Surtsey so far is *Cucumaria frondosa* (Gunnerus) which was first found in 1987, at 10 meters depth on the west coast.

TABLE 5

Number of species of benthic invertebrates, of the following animal groups, which have been found around Surtsey, since the beginning of investigations: Coelenterata, Gastropoda, Lamellibranchiata, Cirripedia, Isopoda, Decapoda, Echinodermata and Tunicata

Year	Number of species	Number of new species since last investigated	Number of species not recurring since last collection
1965	1	0	0
1967	8	7	0
1968	16	9	1
1969	19	5	2
1974	22	7	4
1980	29	11	4
1983	17	1	13
1984	17	5	5
1987	28	14	3

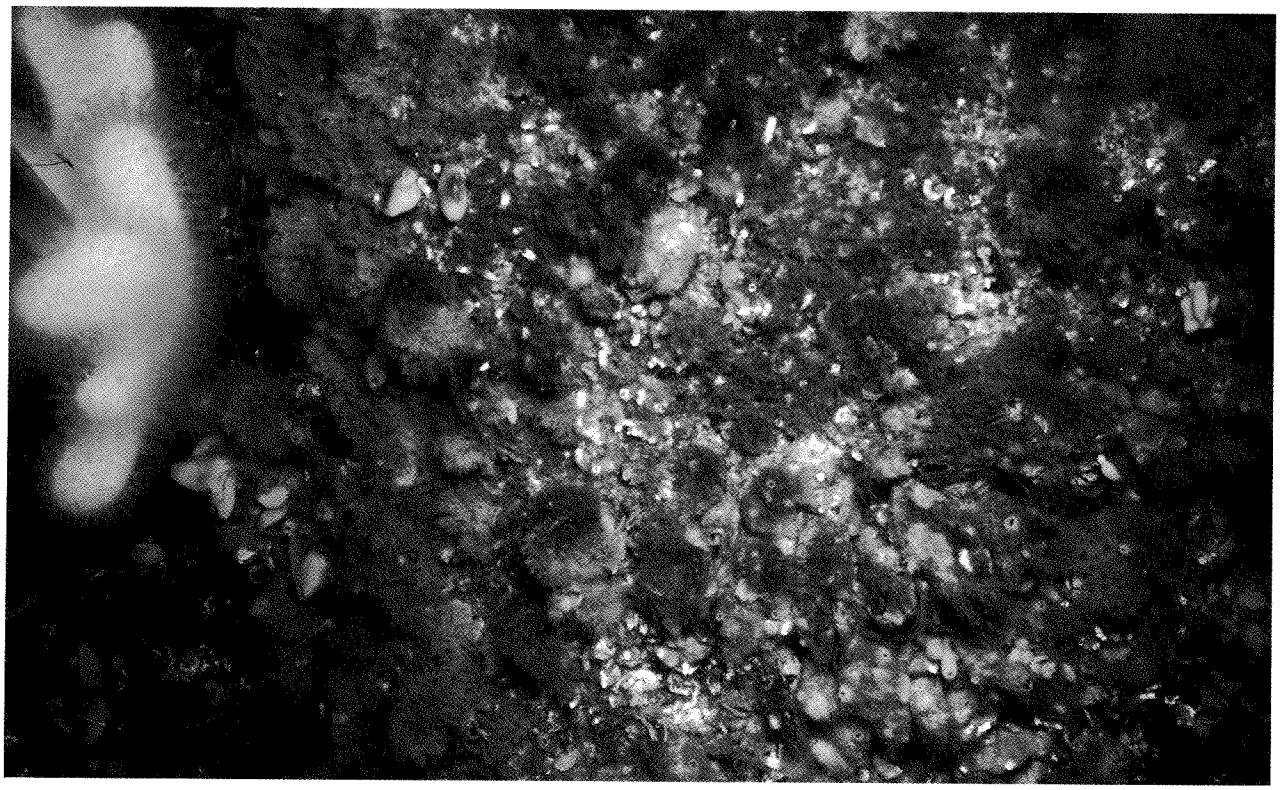

Fig. 3. Underwater photograph showing the *Alcyonium digitatum* epifaunal assemblage. Animals to be noticed on the picture are: *A. digitatum,* the poriferan *Grantia sp.* the keelworms *Pomatoceros sp.* and *Hydroides sp, M. edulis* with the barnacle *B. balanus* on its shell, tunicates, hydrozoans and bryozoans (Photogr. Erlingur Hauksson).

Ascidiacea

Ascidia callosa Stimpson, was the first tunicate to be found on Surtsey, being found in 1968 on the west coast at 17–20 meters depth.

Styela rustica L., is the most common tunicate on Surtsey. It was first found in 1969 and has occurred since being found mostly at depths of more than 15 meters all around the island. It is usually heavily overgrown by commensal bryozoans, hydroids and algae. The gastropod *V. velutina* is also sometimes found on the tunicate.

Halocynthya pyriformis (Rathke), occurred first in 1980 and is now fairly common, especially at depths greater than 15 meters.

FAUNAL CHANGES WITH TIME

Parallel succession in the evolvement of the animal part of the biocoenoses on rocky bottoms around Surtsey has been described by Sigurdur Jónsson & Karl Gunnarsson (1987) for vegetation. Shortly after the cessation of the eruption, in 1964, *Portunus holsatus* and *Pandalus montagui* were found, as the first animal inhabitant. In 1965 *Heteranomia squamula* was found. Two years later *Hiatella arctica, Mytilus edulis, Verruca stromia, Balanus balanoides, Eualus pusiolus* and *Hyas coarctatus,* were found. In 1968 a further handful of species were added to the list, such as *Lacuna divaricata, Chlamys pusio, B. balanus, B. hammeri, Asterias rubens, Acidia callosa, Apporhais pes-pelicani* and *Cardium faciatum.* During 1969 a further number of species were added to the list (Table 5). They are *Alcyonium digitatum, Odostomia unidentata, Galathea nexa, Styela rustica,* and the fishes *Cyclopterus lumpus* and *Liparis montagui.* In 1974 a few species not previously found were added to the fauna, they are: *Buccinum undatum, Velutina velutina, Janiropsis breviremis, Munna kröyeri, Pandalus montaqui, Ophiopholis acuelata* and *Ophiura sp.* Now (1987) it seems that the rate of increase of new species, has slowed down a little. A search for new species in 1987 only revealed a few, the most noticeable being *Margarites olivaceus, M. helicinus, Acmaea testudinalis, Idotea granulosa, Modiolaria discors, Chlamys islandicus, Tealia fealina* and *Cucumaria frondosa.*

DEVELOPMENT OF THE EPIFAUNAL ASSEMBLAGE

Variation in the intensity of investigations

between years can partly affect the results of the faunistic surveys on Surtsey. It could explain why some species of benthic animals are not found in particular years, even though they were found earlier and later. However a lack of species could also be caused by competition with other benthic animals having similar needs. The number of species of benthic animals at Surtsey, seems to have evened out somewhat and the likelihood of finding new species is much less now than at the beginning of the colonization of the bare rock surrounding the island.

As numbers of species increase on the rocks, the fauna assemblages also increase in diversification. On the *Laminaria* stipes and fronds, a rather diverse epifaunal assemblage has evolved. Hydrozoans, bryozoans, *Verruca stromia* and *Lacuna divaricata,* are the most dominant animals (Fig. 1). *Mytilus edulis* has formed an epifaunal matt covering the stones, and provides a substrata for epifauna of *Balanus balanus, Verruca stromia,* hydrozoans and bryozoans (Fig. 2). *Alcyonium digitatum* also covers the rocks contagiously (Fig. 3). On *Styela rustica* a solitary tunicate epifauna has developed on its own, formed of bryozoans and hydroids.

There is evidence of interactions between animals, other than cooperation and commensalism, which at first play the major role in development of the epifauna. This includes predation of the star fish *Asterias rubens* on the bivalve *M. edulis,* the grazing of *Lacuna divaricata* on the microscopical epiphytes on the *Laminaria* blades and the predation of fish such as *Myoxocephalus scorpius scorpius* (L.), *Liparis montagui* (Donovan) and *Cyclopterus lumpus* (L.), on many benthic agile animals which probably play an important role in the development of the epifaunal assemblage on Surtsey.

A functional community has evolved, which makes a demand for new methods of investigation, and a revaluation of the objects of study. A change is necessary from qualitative faunal investigations to quantitative assessments of animals and plants of the community of hard surfaces around Surtsey. This type of investigation was commenced in 1980 and has continued since then, by the use of underwater photogrammetry.

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