"Ostur" - "cheese bottoms" - sponge dominated areas in Faroese shelf and slope areas

During the internordic BIOFAR I programme 1987-90 (Marine Benthic Fauna of the Faroe Islands (NE Atlantic); Nørrevang *et al.* 1994) intensive sampling of the macro-fauna around the Faroes was carried out at depths from about 100 m to 1200 m with different kinds of gear. Already during a pilot cruise in 1987, the occurrence of accumulations of large-sized sponges in certain areas of the outer shelf was noticed, and during the cruises of the following years particular attention was paid to these animals (Hougaard *et al.* 1991, Klitgaard *et al.* 1992, 1997) and to their associated fauna (Klitgaard 1991, 1995, Warén & Klitgaard 1991, Monniot & Klitgaard 1994). As it turned out, the phenomenon had gone unnoticed in earlier faunistic investigations (Brøndsted 1932), but was well known by local fishermen and the Faroes Fisheries Investigations (Fiskirannsóknarstovan) in Tórshavn.

Figure 1.
A trawl sample from an area with ostur west of the Faroes at 480 m (BIOFAR Stn. 540; Nørrevang *et al.* 1994). (© photo A.B. Klitgaard).

"Ostur"

The local name for the sponge accumulations is "ostur" meaning "cheese bottom", a name that seems to refer to the size, form and consistency of some of the sponges, and to the smell of broken specimens.

In areas with ostur, up to 50 species of sponges can occur and of these about 20 can reach sizes exceeding 5 cm in maximum diameter (Table 1).

Table 1. Regularly occurring sponge species that reach > 5 cm in maximum dimension in areas with ostur. (*) marks species that are dominating as to biomass. Besides the listed species, there is a number of smaller, lumpy or thickly encrusting species, some calcareous sponges, and about 20 thinly encrusting species, mainly belonging to the genus *Hymedesmia.*

Geodia barretti *
G. macandrewi *
***G.* sp.** *
Isops phlegraei *
Stryphnus ponderosus *
Stelletta normani
Thenea valdiviae
T. levis
Tetilla cranium
Tethya aurantium
Polymastia mammillaris
Phakellia ventilabrum
P. robusta
P. rugosa
Axinella arctica
Tragosia infundibuliformis
Mycale lingua
Myxilla fimbriata
Melonanchora elliptica
Antho dichotoma
Petrosia crassa
Oceanapia robusta

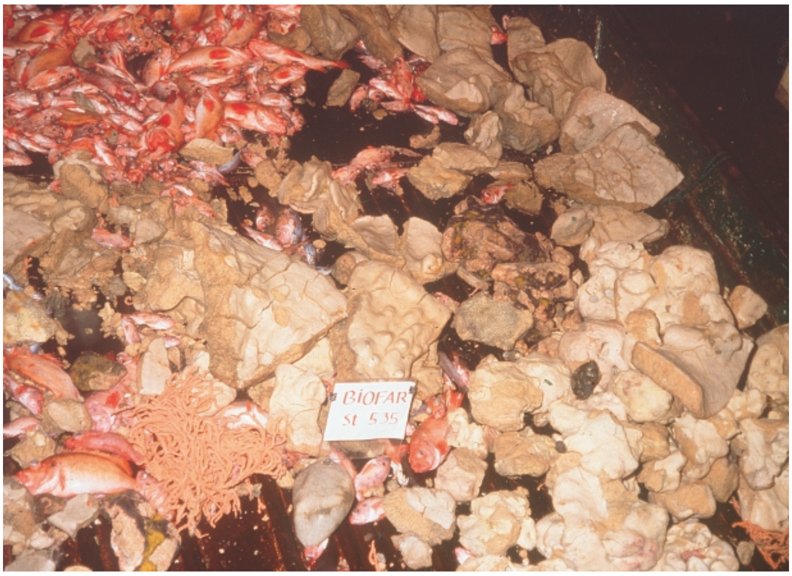


Figure 2.
Trawl haul from 370m depth dominated by *Geodia barretti* and *G.* sp. (BIOFAR Stn. 535; Nørrevang *et al.* 1994). Species of redfish (*Sebastes* spp.) are often caught when trawling in areas with ostur.
(© photo A. Nørrevang).

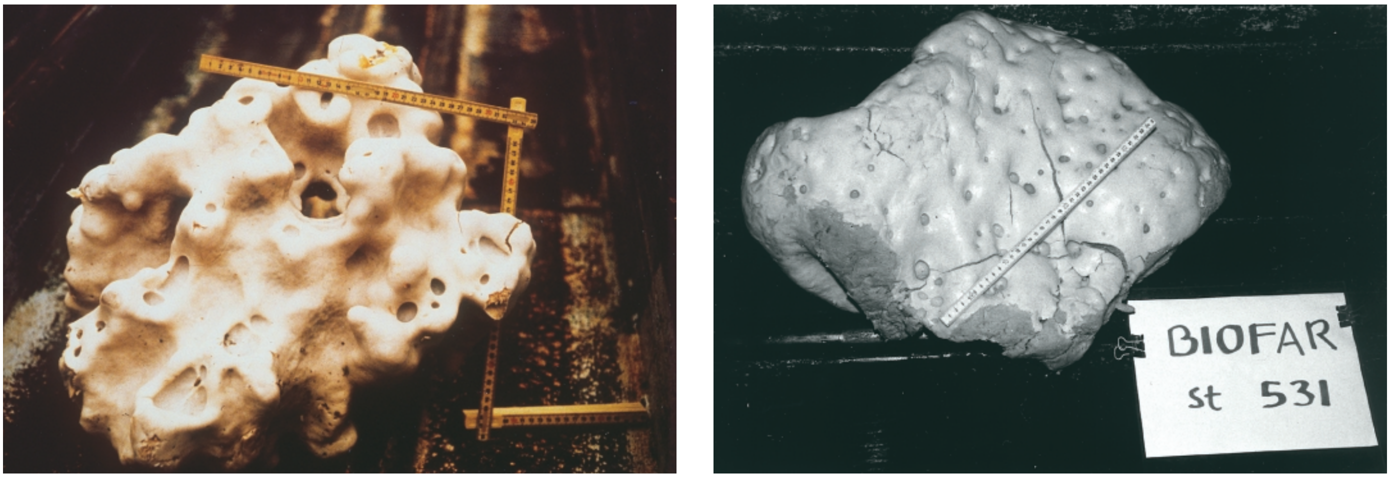
Figure 3.
The authors examining some of the large-sized specimens of *Geodia barretti* and *G.* sp. from a trawl haul from 364 m depth on BIOFAR Stn. 531 (Nørrevang *et al.* 1994). (© photo A. Nørrevang).

Clearly dominant in terms of biomass, and quantity per catch, are four species of the family Geodiidae; *Geodia barretti* Bowerbank, 1858, *G. macandrewi* Bowerbank, 1858, *G.* sp. and *Isops phlegraei* Sollas, 1880, and the stellettid *Stryphnus ponderosus* (Bowerbank, 1866).

These sponge species are all widely distributed in the Northeast Atlantic and reach considerable sizes. We have encountered specimens measuring about 80 cm in maximum dimension and with body weights of about 25 kg (Tendal & Klitgaard in prep.). Faroese fishermen have told us about single sponges that are more than 1 meter in diameter and sometimes almost too heavy for a man to lift. In some areas up to 20 tons of sponges can be caught in a single trawling, the net being virtually filled up and so loaded that there is a danger of damage during the on board hauling.

How do the ostur species look?

Species of the genera *Geodia* and *Isops* can either be more or less irregular lumpy, or funnel-shaped, or they can be round and regular. All species of Geodiidae are characterized by the possession of a cortex composed of a special kind of small, round, siliceous spicules (sterrasters).



Figur 4 A, B
Two specimens of *Geodia barretti* being irregular lumpy to very different degrees but both having numerous openings (osculae) of varying dimensions, each being covered by a sieve-like structure. (© photo O.S. Tendal).

Figure 5.
Specimens of *Geodia macandrewi* generally have a regular, spherical body-form with a diameter larger than the height so the specimens appear somewhat flattened.
(© photo O.S. Tendal)

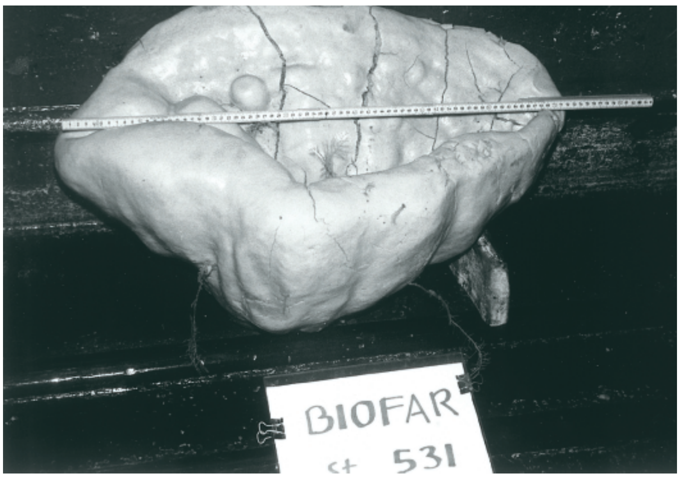


Figure 6.
Large specimens of *Geodia* sp. are often funnel-shaped with a deep cavity.
(© photo O.S. Tendal)

Figure 7.
Specimen of *Isops phlegraei* normally become more and more funnel-shaped when growing bigger. The cortex is sometimes covered by a thick "fur" of spicules. (From BIOFAR Stn. 043 Nørrevang *et al.* 1994).
(© photo G. Brovad)

There is only one species of the genus *Stryphnus* in the Northeast Atlantic, *S. ponderosus*. This is a massive, lumpy sponge characterized by a thick "fur" of vertically oriented siliceous spicules. Often a very deep, narrow excurrent cavity is present making the sponge look like a "chimney".

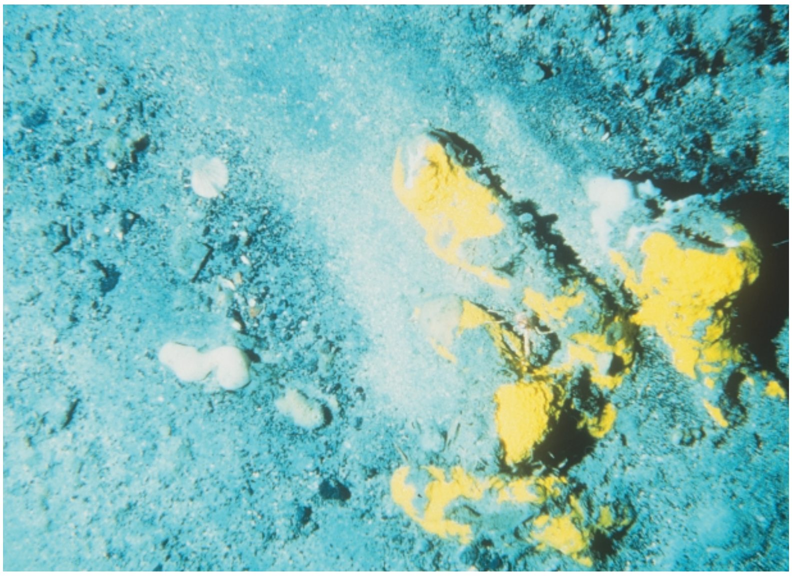


Figure 8.
Underwater photograph from an area with ostur at 400 m depth west of the Faroe Islands (BIOFAR Stn. 664; Nørrevang *et al.* 1994). The sulfur yellow colour of the specimens of *Stryphnus ponderosus* is due to an encrusting sponge species, *Aplysilla sulphurea* Schulze, 1878, which often covers most of the surface of *S. ponderosus.* (© photo J. Gutt).

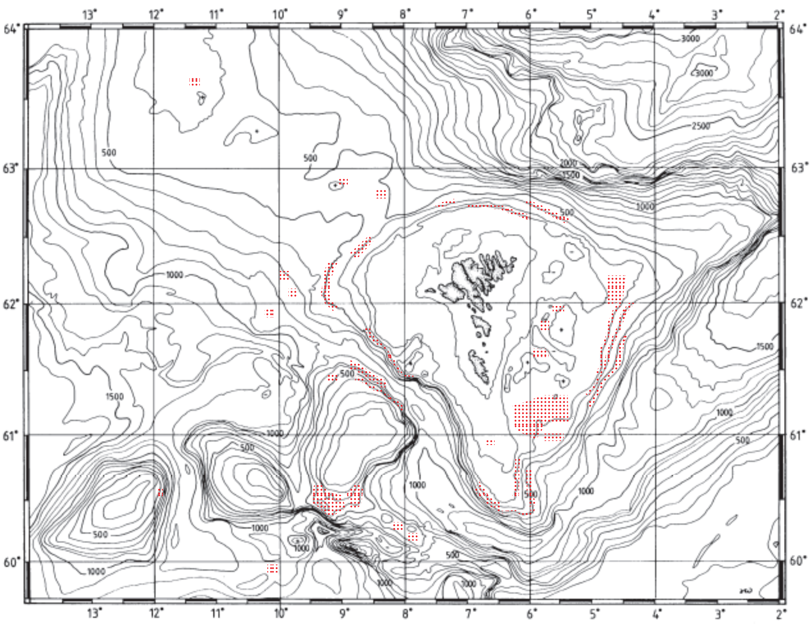


Figure 9.
All known occurrences of ostur at the Faroe Islands. (Redrawn from Klitgaard *et al.* 1997).

The distribution of ostur

We made a special effort during the BIOFAR I program to map in detail the geographic distribution and the bathymetric range of the ostur areas around the Faroe Islands. This included either one or both of us taking part in all 9 cruises and compiling a variety of relevant information (Klitgaard *et al.* 1997).

Ostur was found at 76 BIOFAR I stations at depths between 233 and 833 m, located around the Faroes and the banks to the west. In addition eleven hundred underwater photographs were taken during the BIOFAR cruise in May 1990 at depths between 60 and 1050 m (J. Gutt, Alfred-Wegener-Institut für Polar- und Meeresforshung, Bremerhaven). Some series of these photographs were utilized to supply additional information on the distribution of the sponges and the nature of the bottom in various sections of the shelf and slope.

During BIOFAR cruises in 1987 and '88 with the Faroese R/V *Magnus Heinason* crew members pointed to the widespread experience accumulated among fishermen concerning bottom conditions around the Faroe Islands. Traditionally when trawling, fishermen avoid areas with ostur because of the risk of catching several tons of sponges, overfilling the gear and damaging the catch. Accordingly, trawler captains often mark such areas on their charts and in their log books. Thus, in 1989 and '90, in cooperation with Rune Frederiksen and Andreas Jensen (Zoological Museum, Copenhagen), inquiry schemes with questions on coral banks and sponge accumulations were sent to Faroese trawler captains. A number of informative answers were received, and the information on corals was published in Frederiksen *et al.* (1992) while that on the sponges was used in Klitgaard *et al.* (1997), supplementing or supporting the BIOFAR data.

In addition the Fiskirannsóknarstovan (Fisheries Research Institute) has included some areas with ostur in a book of charts showing the distribution of areas where the bottom is unsuitable for trawling in Faroese waters ("Tóv", Anonymous 1988).

In Figure 9 the above mentioned different types of information are combined into a detailed map of the sponge accumulations around the Faroe Islands.

In view of the very extensive information provided by commercial trawling we find it safe to conclude that areas with ostur are present in long, narrow zones close to and parallel to the shelf break (in depths from about 250 to 500 meters) in various places all around the Faroes, and north-east and south-east on the Faroe Bank. The trawling mostly follow depth contours, but judged both from them, and from the dredge series and photographic transects of the BIOFAR I program, it seems that the depth interval of a zone is often less than 100 m, while the width may in some cases be 1-2 km. Southeast to the Faroes, south of Suðuroy Bank, there is a larger field with ostur, on a plateau-like area which seems to have no topographical relation to the shelf break.

How common is ostur ?

A broad definition of ostur is "a restricted area where large sponges are strikingly common". In the areas described as ostur at the Faroe Islands, sponges are estimated to constitute more than 90 % of the biomass, excluding benthic fish. We have no quantitative samples and the characterization "strikingly common" is based on the fishermen and our own experience. A conservative estimate, based on triangle dredgings taken during BIOFAR 1 cruises, suggests that there is 1 large sponge per 10-50 m^2. Likewise, estimation based on series of underwater photos from areas indicated as ostur at the Faroe Islands suggests a density of 1 specimen per 10-30 m^2 (Klitgaard *et al.* 1997).

What characterizes the distribution of ostur ?

Substratum

The geodiid sponges sampled during the BIOFAR I program often appeared on deck with stones of different sizes incorporated in the cortex (Figure 10). Also, sponges of this family are most often seen in underwater photographs from areas with a gravelly substratum.

Figure 10.
A *Geodia barretti* specimen with several stilt-like projections each attached to a piece of gravel. (Specimen sampled on BIOFAR Stn. 352; Nørrevang *et al.* 1994). (© photo G. Brovad).

Most sampled specimens of *Stryphnus ponderosus* had deposits of sand incorporated in the tissues and specimens seen in photographs sit on sand, sometimes partly covered by the sand (Fig. 8).

The experience from the BIOFAR sampling, the bottom photographs and the limited information in the literature (Spärck 1929) gives the general impression that the sediments in the Faroese shelf and slope areas consist mostly of sand and gravel with cobbles and stones, or even scattered boulders. Accordingly, accessibility of suitable substratum seems not to be a limiting factor in the occurrence of ostur. Current-produced features seen on photographs from ostur areas such as sand fans on the lee side of stones and ripples demonstrate sediment mobility and we suggest that the sponges live in a current-swept environment with a variable current direction.

Hydrography

The sponge aggregations are predominantly found in warm, Atlantic water. The distribution follows broadly those regions on the shelf break where the bottom slope matches the slope of propagation of the internal tidal waves, that is regions with a critical slope. An intensification of the bottom currents is often observed in such areas.

A tendency to aggregate in the vicinity of regions with critical slope seems to be a general phenomenon for large suspension feeders. The BIOFAR results show this for the scleractinian coral *Lophelia pertusa* (L., 1758) (Frederiksen *et al.* 1992) as well as for large octocorals, stylasterids and some brachiopods (pers.obs.).
The elevated bottom current speed at the critical slope is probably as such not beneficial to the suspension feeders. The causal link is thought to be an increased food supply, produced indirectly by processes that are associated with the internal waves. Two mechanisms have been proposed (Frederiksen *et al.* 1992, Klitgaard *et al.* 1997) (Figure 11):

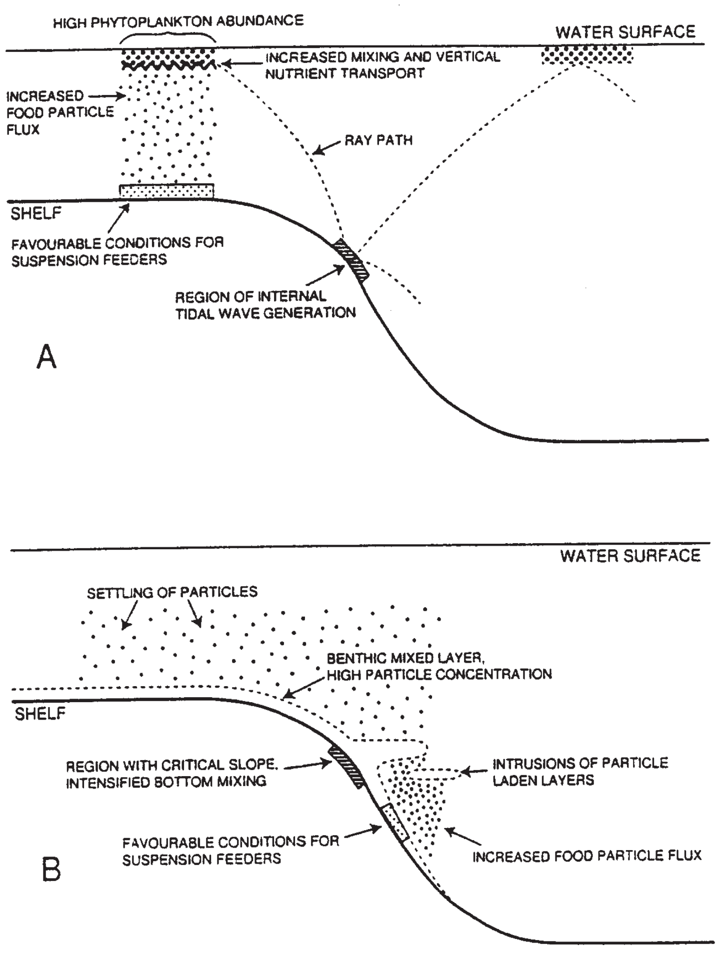


Figure 11.
Two scenarios (A, B) for a connection between internal tidal mixing and an increased food particle flux to the benthos. The thickness of the bottom mixed layer is greatly exaggerated. (From Klitgaard *et al.* 1997).

- An increased primary production where internal wave mixing promotes nutrient flux to the surface (Fig. 11 A)
- A leakage of food-particle rich water from the bottom mixed layer to the stratified ocean interior (Fig. 11 B).

The prominent sponge field southeast of Suðuroy differs from most other aggregations by a large extent and relatively shallow depth. A special case of the first mechanism may explain the presence of this ostur area, which otherwise seems hard to connect to any particular feature of the area.

An important question in this connection is what the exact nature of the diet of the sponges is. Demosponges are generally regarded as unselective suspension feeders, filtering particles from bacterial size to about 6 µm in diameter (Reiswig 1975, Wolfrath & Barthel 1989). Whether this also apply for the geodiid species and *Stryphnus ponderosus* is however presently not known.

Causes of changes in the distribution of ostur

The experience of fishery biologists and fishermen is that although ostur is found in the same general area over long periods of time, the localities where there are the highest concentrations may change; in fact, some fishermen say that "the ostur is wandering".

The large size, low organic content and predominance of large specimens in the catches from ostur areas have lead us to the assumption that the dominant species are slow growing and probably take at least several decades to reach the sizes commonly encountered. The lack of small specimens is remarkable and indicates that reproduction must be an infrequent event. Being suspension feeders the ostur species depend on a constant water current through their system of internal incurrent and excurrent canals to maintain their metabolic activities of respiration, filtering of particles and growth. Thus, it seems reasonable to assume that the sponges are dependent on a certain stability with respect to water mass characteristics and kinds and amount of particles in the water. This makes the ostur species vulnerable both to changes in the local hydrographic regime, and to physical disturbance.

A special kind of physical disturbance occurs when water near the bottom become more heavily loaded with suspended material which sediments out covering the surface of the sponge, and clogging the filtration system. Intense resuspension can occur due to natural causes like sediment slides, violent storms or unusually high internal waves, but additional causes, introduced in modern times, are nearby trawling and oil drilling. Some degree of self-cleaning of the canal system is possible for the sponges. However, if the resuspension event happens too often the sponge may no longer be able to do this and its metabolic activity may be depressed to a level at which the specimens can no longer survive; the sponge is smothered.

A very direct kind of physical disturbance is trawling. Intensive trawling probably rapidly leads to severe depletion of ostur areas. During our investigations around the Faroes, areas indicated as ostur in "Tóv" (Anonymous 1988) were sampled, but we found no sign of the ostur species and Faroese fishermen told us that trawling had recently begun in these areas. Modern trawlers are working deeper than trawlers did before, extending the fishing grounds and so are destroying areas of ostur. Fishermen have told us that certain bottom areas are being "improved" by repeatedly towing the large bobbins gear over the bottom crushing the sponges that would otherwise fill up the trawl, so that gradually the area is "improved" into a reasonable trawling ground.

Biological importance of ostur

The exact nature of the biological importance of the ostur areas is difficult to outline in more detail, and the need of *in situ* investigations is obvious. Nevertheless, on the basis of our experience gathered from the examination of numerous ostur catches and series of underwater photographs from the Faroe Islands, we feel capable of making some suggestions.

The physical heterogeneity of the local area and the number of available microhabitats are clearly increased by the presence of the large-sized ostur sponges. Thus, a very rich fauna (> 242 species) has been shown to be associated with the dominant sponges in ostur areas at the Faroe Islands (Klitgaard 1991, 1995, Warén & Klitgaard 1991). The majority of the associated species are facultative being found also as members of the local fauna outside ostur areas; this seems to be a general phenomenon in temperate/cold waters for sponges (Klitgaard 1995) as well as for *Lophelia pertusa* (Jensen & Frederiksen 1992).

The heterogeneous nature of the ostur areas and the presence of a rich mixed fauna of invertebrates, probably makes them recruitment areas for certain species of fish. Thus, we observed large numbers of redfish (*Sebastes* spp.) in trawl hauls from ostur areas around the Faroe Islands during the BIOFAR program (Figure 2).

Another feature of ostur is that when the sponges die, large amounts of spicules are released. These can either form a local spicule mat on the bottom, or be transported by bottom currents to other localities. A number of such localities with spicule mats were found around the Faroe Islands. The occurrence of large quantities of spicules changes both the composition and structure of the local sediment and this might in turn influence the composition of the local benthic fauna as has been reported for hexactinellid dominated areas in the Porcupine Seabight (Bett & Rice 1992) and from many other areas in the NE Atlantic (Barthel & Tendal 1993).

It seems logical to direct future research towards the potential for designating ostur regions as refuges from which the dispersal of invertebrates as well as fish could replenish the surrounding trawled areas, such as has been proposed already for other types of marine habitats (Dugan & Davis 1993).

Other parts of the North Atlantic

Dense aggregations of sponges are not strictly a Faroese phenomenon but are known to occur in many other places in the northeast Atlantic. Thus, investigations have been performed in the Porcupine Seabight (Rice *et al.* 1990), and off Bjørnoya and West Spitzbergen (Blacker 1957, Dyer *et al.* 1984, Barthel *et al.* 1991). In addition charts and the reports of fishermen and biologists as well as actual samples show that ostur areas also exist in the Barents Sea, along the Norwegian coast and south of Iceland and Greenland (Klitgaard & Tendal in press).

Conclusions

The general results given above, and our other information and experience allow us to draw some conclusions and to state some points of importance:

- ostur, viz. sponge dominated areas, are widely distributed around the Faroes, and in parts of the northeast Atlantic, dominated by warm, Atlantic water.

- such dense aggregations of sponges have always been found close to the shelf break or on places with similar high-energy water movement conditions.

- although dominated by sponges, ostur areas house a rich fauna of other kinds of animals, especially large numbers of filter- and suspensionfeeders, for example corals.

- ostur areas are presumably important recruitment areas for certain stock of fish as food seems abundant and the environment is undisturbed (no trawling or oil drilling activity).

- large amounts of silicious sponge spicules are produced and scattered after the death of the sponges. They are often transported to other localities, and become part of the sediment. Sometimes they are even concentrated in certain local areas forming a kind of loose felt.

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