LÍFFRÆÐISTOFNUN HÁSKÓLANS
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STUDIES ON THE ROCKY SUBTIDAL COMMUNITIES IN VICINITY OF A DUMPING PIT FOR POT LININGS AT STRAUMSVIK, SOUTHWESTERN ICELAND

Jörundur Svavarsson

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CONTENTS

1. INTRODUCTION

During the last 6 years pot linings from an aluminium plant in Straumsvík, southwest Iceland, have been disposed off in a dumping pit on the shore in Straumsvík (64°02'65" N, 22°02'40" W). At the request of the Icelandic Aluminium Co. Ltd. this study was done to evaluate the effects of the dumpings on the marine life in the cove of Straumsvík. The approach used here was to study the distribution of local species and the diversity pattern of the benthic rocky bottom communities in proximity of the dumping pit.

2. MATERIALS AND METHODS

Straumsvík is a small cove on the northern side of the Reykjanes peninsula (Figure 1). It is approximately 500 m long and 600 m wide, with maximum depth of about 13 m. The cove is now semi-inclosed by a large harbour quay located on the outer and eastern part of the cove. The aluminium smelter is located on the shore to east of the cove.

The dumping pit is located on the shore in the southeastern part of the Straumsvík cove. It is surrounded by large boulders. During high tide the pot linings become submerged in water, while being exposed to air during low tide.

The salinity in the bay is high (>33 promill), except for the top 0.5 m layer, which has low salinity (Ingólfsson 1990).

Within the cove a small fish farm operated during the time of sampling. Also at the time of sampling two small sewage outlets from the plant opened into the cove between the dumping pit and the harbour quay. This was, however, treated sewage. The traffic of ships through the harbour is small. No data exist on the amount of airborne pollution into the cove.

Preliminary studies were done on September 9, 1988. The area was studied with an eco-sounder, a triangular dredge and a Van Veen grab. Preliminary studies showed that within a 1 km radius of Straumsvík the bottom was rocky and often covered with large kelp (*Laminaria hyperborea*). In Straumsvík cove the shore is rocky, while much the cove has a flat sand bottom which becomes somewhat muddy in vicinity of the harbour quay on the east side of Straumsvík cove.

2.1 Sampling

Sampling was carried out by scuba diving from R.V. Mímir on May 16-19, May 23, and July 14 1989. Six transects (I-VI) were taken (Figure 1). Transect I-V were placed at roughly 100 m intervals. Transect I was on the outer margin of the dumping pit and the others to the west and northwest of the pit. Transects I and II run in an north-south direction, but transects III to V run in an east-west or a

southwest-northeast direction at the western part of the cove. Transect VI was placed on the distal end of the quay, which is roughly north of the dumping pit.

At each transect samples taken at depths of 3, 6 and 9 m, except on transect III where samples were only taken at 3 m depth and no samples were taken at 9 m depth on transect IV because of sandy bottom and absence of kelp holdfasts.

At each station photographs were taken of three 50 x 50 cm quadrats with Nikonos V underwater camera, using 15 mm Nikkor UW lens, Nikonos SB-102 flash and Ectochrome EC 135-36 film. The camera was placed on a frame and the lens was 37 cm from the surface. Photographs of four quadrats were used in analyzing the community at 3 m on transect I.

At each station larger animals (<0.5 cm) and algae were collected into sampling bags, and later preserved in 5 % formalin. These animals and algae were used to verify identifications of animals and algae on the photographs.

At each station three large holdfasts were separately collected and placed in sampling bags with 200 mm mesh size. The holdfasts taken at each station were among the largest ones available at each depth. These were kept in sea-water for 24 hours and later preserved in 5 % formalin.

After each dive the divers reported on the biota and the general habitat.

2.2. Processing

Photographs were analyzed by projecting the photographs on a white background with one hundred dark points in ten lines. The cover (%) of each species of algae and sessile animal (Porifera, Cirripedia, Tunicata, Mytilidae) was estimated from the points. Each point touching species on the photograph gave 1 % cover of the respective species. Individuals of other animal species were counted.

Low visibility made some photographs unusable for analysis. There is thus no photographic data from 3 m on transect III, and photographs from only two quadrats could be used from 3 m on transect V.

In the laboratory the formalin was washed from the kelp-holdfast samples, and loose animals were captured in a 0.5 mm sieve. Each holdfast was wet-weighed and its circumference measured, and the basal area of the holdfast calculated. Prior to weighing large mussels (*Modiolus modiolus*) and barnacles (*Balanus balanus*) were removed from the holdfast. Afterwards the holdfast was cut into pieces and thoroughly searched for animals.

Specimens retained by a 0.5 mm sieve were counted. The number of the balanoid *Verruca stroemia* was, however, estimated when dealing with large holdfasts or many individuals of the balanoid. This was done by counting certain number (20-50) of *Verruca stroemia* attached to selected branches of the holdfasts, and then using the ratio of the volume of the attached holdfast branches versus the volume of the total holdfast to calculate the total numbers. The patchy occurrence of *Verruca stroemia* made this estimation, however,

inaccurate, and the numbers were therefore smoothened to the nearest 100. The presence of Hydrozoa, Foraminifera, Bryozoa and algae was noted.

Individuals of the groups Polychaeta, Mollusca, Crustacea (except harpacticoid copepods), Echinodermata and Tunicata were identified to species, when possible. Other groups were identified to class or order.

Spearman Rank Correlation Coefficients were used to correlate between different variables. In these calculations the distance from the pit to transect I was set to 0 m, 100 m to transect II, 200 m to transect III, 300 m to transect IV and 500 m to transects V and VI.

Kelp holdfasts have disadvantage as monitors because of their differing sizes, as the species richness within each holdfast may be related to the size of the holdfast. This problem has usually been dealt with by collecting holdfasts of similar sizes and by studying a certain amount of holdfast volume (see Edwards 1980). Here the three holdfasts collected at each station were lumped to provide comparable species lists at each station, and the abundance within each station was compared using a standard unit of holdfast basal area and holdfast wet-weight.

3. RESULTS

3.1. General description of the bottom

The eco-sounder of the research vessel and the observations of the scuba divers showed that the deeper part of the Straumsvík cove has a sandy bottom (Table 1). The deepest parts of transects I to IV were on sandy bottom, often with scattered rocks and large boulders. The shallower portions of the transects were, however, on rocky bottom. The bottom was either a lava-field, or consisted of large boulders. The latter occurred on transects I and IV.

The slope of the transects varied considerably. The deepest stations of all transects, except transect VI, were on flat bottom, and all stations on transect VI were on almost vertical walls.

3.2. Photographic survey

3.2.1. Qualitative collection

Large animals and algae were collected at each station to provide reference for identification of animal and algae from the photographs. A total of 55 species of algae were found (Table 2). In addition the species *Plumaria elegans* and *Chaetomorpha capillaris* were collected at 9 m on transect II. These algae were, however, drifting. A total of 36 species of animals were collected (Table 3, the species are also included in Appendix 1 where all animals are listed).

3.2.2. Number of species

A total of 26 species of algae were identified from the photographs (Table 4). This included Corallinaceae, which the photographs showed to be common, but were not included in the qualitative collecting of algae. Thus considerably fewer species were recorded from the photographs than in the qualitative surveys. This is partly due to the low resolution of the photographs, which makes specimens < 0.5 cm not readily identifiable.

The total number of species of algae at each station is also shown in Table 4. At 3 m the number of species was similar on all transects (range 11-14). At 6 m the number of species was lowest on transect I (5 species), and the number of species increased with increasing distance from the pit, being 8-13 species on the other transects. At 9 m there was considerable variation in the species numbers (7-15 species) with no apparent trend.

Only 32 species of animals were identified from the photographs (Table 5, also listed in Appendix 1) and there is no apparent trend. The lowest number of species, 5 and 6, were, however, recorded on stations on transect I. A number of species were lacking here, but were recorded in the qualitative collection. Among these were the short spined sea scorpion *Myoxocephalus scorpicus* and the shore crab *Carcinus maenas* which probably escaped while the stations were being prepared for photographing.

3.2.3. Abundance and distributional patterns of algae

A total of 9 species of algae had more than 1 % average cover (Table 4), and of those only 2 species exceeded 10 % in average cover, i.e. Corallinaceae (11.3 %) and *Cruoria arctica* (10.9 %). *C. arctica* had the greatest cover recorded on single station of any species, 54 % at 6 m on transect II. A few species had considerable cover on single stations, but a low average cover, e.g. *Phycodrys rubens* with average cover of 3.0 %, but with 35.3 % cover on a single station.

The total algae cover ranged from 40.4 to 75.4 % (Table 4). The algae cover showed no correlation with depth, or with distance from the dumping pit.

Corallinaceae had its highest cover close to the dumping pit, i.e. at 3 and 6 m on transect I and at 3 m on transect II (Figure 2A). Its decline in cover with distance from the dumping pit was not statistically significant.

Cruoria arctica followed similar pattern, but with its highest cover at 6 m depth at transect II (Figure 2B). There was a negative significant correlation (Spearman Rank Correlation Coefficient, $r = -0.565$, $0.01<P<0.05$) between cover of *C. arctica* and distance from the dumping pit.

Other species of algae showed no significant changes in cover with distance from the dumping pit. *Laminaria hyperborea* (Figure 2C) and *Polysiphonia urceolata* (Figure 3A) were fairly evenly distributed and this applied also to *Desmarestia viridis*, which, however, was absent from 6 m of most transects (Figure 3B). *Laminaria saccharina* had considerable cover on transect VI only

(Figure 3C). The cover of *Chorda tomentosa* decreased significantly ($r = -0.575$, $0.01<P<0.05$) with depth.

In some cases there was significant correlation between the cover of different species of algae. Thus there was a highly significant correlation ($r = 0.714$, $P<0.01$) between the cover of *Cruoria arctica* and the cover of Corallinaceae. The cover of *Laminaria saccharina* was, however, highly negatively correlated with the cover of *Cruoria arctica* and Corallinaceae ($r = -0.730$ and $r = -0.766$ respectively, $P<0.01$). The cover of *Desmarestia viridis* was highly correlated with the cover of *Chorda tomentosa* and *Ulva lactuca* ($r = 0.676$ and $r = 0.713$, respectively, $P<0.01$). There was also a number of significant correlations ($P<0.05$) between the cover of different species of algae.

3.2.4. Abundance and distributional patterns of animals

Most animal species were fairly rare on the photographs (Table 5). In no case was a significant correlation found between the abundance of a species and distance from the dumping pit.

The most common non-sessile species was the limpet *Acmaea testudinalis* with an average of 4.8 individuals/0.25 m^2 (Table 5). Second in abundance of non-sessile species was the starfish *Asterias rubens*, which occurred mainly on transect VI. The echinoderm *Strongylocentrotus droebachiensis* was third in abundance of non-sessile species, mainly found at 3 m and declined significantly (Spearman Rank Correlation Coefficient, $r = -0.649$, $0.01<P<0.05$) in numbers with depth. All other non-sessile species had less than 1 individual on the average per 0.25 m^2.

The most common of the sessile animals (including Mytilidae) were the hydrozoans, with average cover of 8.4 % (Table 5). These were observed forming conspicuous mats together with small thread-like algae. These mats were most obvious at shallower depths at transect VI, and their cover had a highly significant correlation ($r = 0.783$, $P<0.01$) with the cover of *Laminarina saccharina*.

Also abundant was the mytilid *Modiolus modiolus*, with an average cover of 2.4 %. The Cirripedia had an average cover of 1.5 % and were most common on transect VI, where the large species *Balanus balanus* occurred. *Halichondria* sp. occurred on a single station only, but here the cover was 19.6 %.

Some species of animals showed significant correlations with other species of animals or algae. The abundance of *Lacuna pallidula* was highly correlated ($r = 0.830$, $P<0.01$) with the cover of the alga *Ulva lactuca*. The abundance of *Acmaea testudinalis* was negatively correlated ($r = -0.806$, $P<0.01$) to the cover of Cirripedia. The abundance of *Strongylocentrotus* was highly correlated with the cover of the Corallinaceae ($r = 0.884$, $P<0.01$). The cover of Cirripedia was, however, negatively correlated with the cover of the Corallinaceae ($r = -0.750$, $P<0.01$).

3.2.5. Classification of stations

All stations were classified using Pearson product-moment correlation to provide the distance matrix. The nearest neighbor was used as a clustering strategy. The classification was based on all algae and animal data from the photographs, and the data were ranked prior to analysis.

The results are shown in Figure 4. Six stations build up a fairly uniform cluster of stations. This includes stations at 3 m on transects I, IV and V, 6 m on transects IV and V and 9 m on transect V. Stations at 6 m on transects I and II are very similar, and build a cluster together with the station at 3 m on transect II. The station at 9 m on transect I is fairly different from the other stations, and the stations on transect VI, together with station at 9 m on transect II differ from all other stations.

3.3. Kelp holdfast community

3.3.1. Sizes of the kelp holdfasts

The holdfasts varied considerably in wet-weight and in size. The holdfasts ranged in wet-weight (here after referred to as weight) from 24 to 561 g (average 151 g, Table 6). The total weight of holdfasts studied at each station varied from 138 to 1046 g. The total weight exceeded 500 g at all stations at 3 m, while the total weight was less than 500 g at all stations below 3 m, with one exception. The lowest total weight was at 9 m on transect VI.

In size (= basal area) the holdfasts ranged from 25.7 to 240.5 cm^2 (average 92.2 cm^2, Table 7). The total basal area of studied holdfasts ranged from 144.1 to 438.7 cm^2. As expected the basal area showed similar variations among stations as holdfast weights. Here, however, the lowest basal area was at 6 m on transect I.

3.3.2. Number of species

A total of 136 animal taxa were found in the kelp holdfasts (Appendix 2 gives actual data, see Appendix 1 for total list of animals collected during this study). The polychaetes were the most species rich group with 53 species. Second in species abundance were the molluscs with 29 species. Of the crustaceans 25 species were recorded. All species recorded during this survey have previously been found in Icelandic waters and most have earlier been recorded from kelp holdfasts elsewhere.

The total number of species recorded from each kelp holdfast ranged from 22 to 68 (Table 8, groups including only juveniles of other recorded species excluded). There were significant positive correlations between the basal area and the weight of each holdfast and the number of species found within the respective holdfast (Spearman Rank Correlation Coefficient, r = 0.731 and r =

0.749 respectively; $P<0.01$). The number of species increases rapidly initially with increasing basal area or weight of the holdfast, but when the holdfasts reach a certain size, the increase in species number slowed down (Figure 5A, 5B). The number of species within the holdfasts in vicinity of the dumping pit was comparable to the number of species found in holdfasts of similar sizes on transects further away from the dumping pit.

The total number of species at each station ranged from 51 to 85 (average 70, Table 8, excluding undeterminable juveniles, i.e. Polynoidae juv. etc.). The lowest total number of species was found at 6 m on transect I nearest to the dumping pit (51 species), but similar low numbers were recorded at 6 m on transect V (53 species) and at 9 m on transect VI (57 species). The explanation of the low number of species is probably the small size of the holdfasts there. There was no correlation between number of species at each station and distance from the dumping pit (Table 9). The total weight and basal area of studied holdfasts were significantly correlated with depth (Table 9).

3.3.3. Number of individuals

A total of 46115 individuals were found in the 46 holdfasts studied in Straumsvík cove. Of this the barnacle *Verruca stroemia* (its number were estimated) was the most common species with 26.25 % of all individuals (Table 10). The second in abundance were the Nematoda with 7118 individuals or 15.4 % of the total. The Mytilidae were third in abundance with 6250 individuals or 13.4 %. This group contained small juveniles of the bivalves *Mytilus edulis* and *Modiolus modiolus*. The fourth most common species was the bivalve *Hiatella arctica* with 4647 individuals or 10.1 % of all individuals. Hence about half of all individuals belong to those three filtering bivalves and the barnacle, also a filtering species. A number of other filtering species are among the 20 most common species, e.g. *Chitinopoma inflata* (618 individuals, 1.34 %), *Heteranomia squamula* (553, 1.19 %), *Pomatoceros triqueter* (417 individuals, 0.9 %), Sabellidae spp. (414 individuals, 0.89 %), Tunicata (376 individuals, 0.81 %) and *Spirorbis* spp. (370 individuals, 0.8 %). In number of individuals the fauna is thus dominated by filtering animals.

The Polynoidae was the fifth most common group, with 2852 individuals (6.18 %). The Polynoidae consisted of juveniles of *Harmothoe imbricata*, *H. extenuata* and *Lepidonotus squamatus*. These are carnivorous polychaetes (Hartmann-Schröder 1971), which presumable prey on spat of other invertebrates in the holdfasts. Some of the other more common species are also predators, i.e. *Syllis armillaris* (Hartmann-Schröder 1971) and the amphipod *Caprella septentrionalis*.

3.3.4. Density

The total number of individuals per station is shown in table 11. The average number found was 3087 (±2108 S.D., range 760-8471). The lowest numbers were found at 6 m on transect I. The total numbers per station were highly significantly correlated with the total weight and the total basal area of the holdfasts, and also negatively correlated with depth (Table 12). To overcome this correlation with the weight and the basal area, the total numbers were calculated to numbers per 100 cm^2 of holdfast basal area and to numbers per 100 g of holdfast weight prior to comparison between stations and the calculations of correlations coefficients.

The average number of individuals was 696 (±325 S.D, range: 376-1527) when the numbers were calculated per unit weight (Table 11). The lowest number was recorded at 6 m on transect I as before. There was no correlation between the weight of the holdfast and numbers per 100 g holdfast weight. There was slightly significant ($0.01<P<0.05$) positive correlation between the number of individuals per 100 g and distance from the dumping pit.

The average number of individuals was 1045 (±504 S.D., range: 527-2121) when the numbers were calculated per 100 cm^2 basal area (Table 11). The lowest number was found at depth of 6 m on transect I. Stations at 6 and 9 m on transect V also had fairly low numbers (554 and 558 individuals, respectively). No significant correlation was found between the basal area of the holdfast and the numbers per 100 cm^2.

3.3.5. Distributional patterns

Analysis of distributional patterns was based on the density of individual species per 100 g holdfast weight. Only four species showed significant increase in numbers with increased distance from the dumping pit. This included the polychaete *Nicomache personata* (Spearman Rank Correlation Coefficient, $r = 0.750$, $P<0.01$, Figure 6A), the Nudibranchiata ($r = 0.748$, $P<0.01$), *Sphaerodorum flavum* ($r = 0.630$, $0.01<P<0.05$) and the ascidian *Halocynthia pyriformis* ($r= 0.525$, $0.01<P<0.05$). These four species are not common and the most common, *N. personata*, is only the 23rd species in abundance (Table 10). Little is known on the biology of *Nicomache* (Hartmann-Schröder 1971), though its occurrence within holdfasts has been noted previously. The Nudibranchiata, *Sphaerodorum flavum* and *Halocynthia* were rare species and were found almost exclusively on transects V and VI.

There were also four species that decreased significantly in numbers with distance from the dumping pit. This included *Odostomia unidentata* ($r = -0.546$, $0.01<P<0.05$, Figure 6B), *Omalogyra atomus* ($r = -0.784$, $P<0.01$, Figure 6C), *Phyllodoce maculata* ($r = -0.557$, $0.01<P<0.05$) and Tunicata ($r = -0.521$, $0.01<P<0.05$). Tunicata was 15th in abundance and *Omalogyra* 25th in abundance. *Odostomia* was 30th in abundance. *Odostomia* is an ectoparasite and has been observed to feed on the polychaete *Pomatoceros triqueter* (Fretter &

Graham 1962), which was also common in the holdfasts. There was a significant correlation between number of *Odostomia* and *Pomatoceros* ($r = 0.674$, $P<0.01$). *P. maculata* was uncommon, and absent from transects V and VI.

The most common species recorded show no correlation with distance from the dumping pit. Some of the common species were fairly evenly distributed, while others such as the Mytilidae, show a more patchy pattern (Figure 7-9).

A few rare species showed a significant decrease or increase in numbers with depth. These species were, however, all uncommon.

3.3.6 Classification of stations

The kelp holdfast stations were classified using Pearson product-moment correlation to provide the distance matrix. The clustering strategy was average linkage, and the data were ranked prior to the analysis. The results are shown in Figure 10. Two large clusters emerge. One cluster includes the stations at 3 and 6 m on transect I, which are fairly similar and in addition the station at 9 m on transect II and the stations at transect VI. The latter are closely related.

The other large cluster includes the stations at 3 m on transect III and at 4.5 m on transect IV which are fairly similar, and the station at 9 m on transect I and at 6 m on transect II which are also fairly similar. These, together with station at 3 m on transect II form a smaller cluster within the larger one. The stations at 7 m on transect IV and stations at 6 and 9 m on transect V form the other sub-cluster.

4. DISCUSSION

Subtidal rocky bottom communities have been studied in Iceland in Arnarfjörður, west Iceland (Gunnarsson 1977), in Eyjafjörður, northern Iceland (Gunnarsson 1979, Hauksson 1979), in Surtsey, south Iceland (Sigurðsson 1972; Jónsson, et al. 1987), in Flekkuvík, southwestern Iceland (Anonymous 1987) and around Kolbeinsey, north Iceland (Fricke et al. 1989). The methods used in these studies have consisted of collecting and later analysis, together with observations in field (Arnarfjörður, Eyjafjörður, animals off Surtsey), or analysis from photographs (algae around Surtsey and Kolbeinsey, and in Flekkuvík), supplemented with collecting. The community of algae in Straumsvík is fairly similar to the community described from Flekkuvík, which is also located on the north of Reykjanes peninsula. In Flekkuvík *Cruoria arctica* was most common, and had considerable cover from 6 to 21 m depth, with a maximum at 15 m. The Corallinaceae were, however, only abundant at depths of 18 to 21 m. Other common species both in Flekkuvík and Straumsvík were *Polysiphonia urceolata*, *Desmarestia aculeata*, *Odonthalia unidentata* and *Phycodrys rubens*. The most common species of algae in Straumsvík are also common in the other studied localities in Iceland, except for the rocky bottoms at Kolbeinsey.

Studies on marine ecosystems around aluminium plants are scarce (see Ellis 1989), and those available have been concentrated on either the fluoride in intertidal animals (Hocking, Hocking & Smyth 1980) and the effects of red mud (residual substance after extraction of Al from bauxite) (Paffenhöfer 1972), rather than the effects of pot linings residuals. Only Rygg and Green (1981) studied the effects of pot linings on the marine life in Husnes, Norway, but here communities of the muddy bottoms were studied.

No exact data exist on the substances that the refuses from the pot linings in Straumsvík cove contain, nor the rate of their dispersal into the surrounding waters. The pot linings do contain both free cyanide and cyanide compounds ($Na_4[Fe(CN)_6]$ when discarded, and the total quantities of cyanide discarded in the dumping pit per annum is around 4000-4800 kg, of which 800-1040 kg is free cyanide (Guðmundur H. Guðmundsson, Icelandic Aluminium CO., Ltd.). Cyanide is highly toxic to crustaceans and molluscs, and in particular to fishes (Nelson-Smith 1977). The cyanide is, however, readily broken down and if any one would expect effects of the cyanide to be in vicinity of the dumping pit.

In case of severe pollution one would expect a low species diversity and possibly a dominance of tolerant, quickly growing opportunistic species. Closest to the dumping pit, however, there is a fairly species-rich algal community, except for the station at depth of 6 m on transect I. This does not indicate any significant effects of the pot linings on the community.

The animal community on the rocky bottom in Straumsvík is fairly similar to what has been recorded in Flekkuvík (Anonymous 1987). There are, however, much less photographic data of rocky bottom animals than algae in Iceland. Judging from the collections in Eyjafjörður and off Surtsey, the fauna at Straumsvík cove is fairly species rich. No indication of pollution from the dumping pit is evident from the distributional patterns of the animals in the photographic survey.

The kelp holdfasts are useful for collecting the smaller animals on rocky bottoms, and have been used in environmental studies during the last 20 years (Jones 1972, Moore 1972, 1973, 1974, 1986, Edwards 1980, Hoare & Hiscock 1974, Hiscock 1987). In severe pollution from bromine extraction works kelp holdfasts have even disappeared (Hoare & Hiscock 1974). Kelp holdfasts have, however, not to my knowledge been used earlier in studying effects of a pot linings on the invertebrate communities on rocky bottoms.

Kelp holdfasts have previously been studied in Iceland in Skerjafjörður, southwest Iceland (Arnþór Garðarsson, manuscript; Agnar Ingólfsson, pers. comm.) and in Flekkuvík (Karl Gunnarsson, pers. comm.). In Skerjafjörður the holdfasts species composition was very similar to what was found in Straumsvík cove.

The kelp holdfasts in Straumsvík cove are highly diverse and only slight changes were found in the holdfast community with depth. The holdfasts were collected within a single cove, where the environment is presumably homogeneous, which may explain the similarity of the species composition between the holdfast stations.

A slight but significant increase in total density of animals with distance from the dumping pit was found, when numbers per 100 g holdfasts were used. No change was found, however, when number per 100 cm^2 basal area was used, suggesting that this may be an artifact. The density of animals as well as species diversity was, however, especially low at 6 m on transect I and the possibility that this may be due to pollution from the dumping pit cannot be evaluated.

5. SUMMARY

The marine ecosystem in the Straumsvík cove is generally highly diverse. There seem to be little if any effects from the dumping pit on the marine subtidal community structure at Straumsvík cove. Only at depths of 6 m at the dumping pit may the community diversity possibly be effected.

These findings, however, do not exclude possible sublethal effects of pollutants and future studies should focus on the possible presence and accumulation of these in the cove, and their low level effects on biology of single species or the community structure.

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Table 1.

Description of the bottom given by divers.

Transect I
3 m: Large boulders with large cover of L. hyperborea. Steep slope.
6 m: Large boulders naked on top, with L. hyperborea on the sides. Small cover of L. hyperborea.
9 m: Large boulders on sandy bottom.

Transect II
3 m: Lavafield. Patchy bottom, with L. hyperborea and echinoids in patches. Corallina officinalis on steep slopes. Modiolus modiolus on holdfasts. Alaria esculenta in between Laminaria. Large cover of laminarians, approximately 1.5 m in length.
6 m: Bottom rough, with large boulders or stones. Small Laminaria (1 m) widely distributed. Bottom slope becomes steep at 6 m.
9 m: Flat bottom at 9 m. Large stones on sandy bottom. Many Pleuronectes platessa between the stones.

Transect III
3 m: Sand with large stones on 3.5 m. Lot of L. hyperborea, L. saccharina, Chorda and Alaria esculenta. Generally small L. hyperborea.
6 m: Sandy bottom.
9 m: Sandy bottom.

Transect IV
3 m: L. hyperborea on Modiolus modiolus on lava ridges, with sandy patches between. Sand on algae. Bottom almost flat. Lot of Alaria and Chorda.
6 m: Similar to 3 m. The fringe of the lava is at 7 m.
9 m: Sandy bottom, with lot of Pleuronectes platessa. L. saccharina present.

Transect V
3 m: Patches of L. hyperborea. Bottom shallower and deeper is sandy.
6 m: Bottom forms ledges at varying depths.
9 m: Fringe of lava at 9 m and flat sandy bottom below 9 m. Rough lava, with small stones.

Transect VI
3 m: Large concrete blocks, with large crevices in between.
6 m: Steep bottom with large boulders, and smaller stones in between.
9 m: Steep bottom with large boulders, and smaller stones in between. The algae sit mainly on top of the boulders.

Table 2
Species of algae collected at each station on transects I - VI in Straumsvik cove

transect / depth (m) / Species	I 3	I 6	I 9	II 3	II 6	II 9	III 3	IV 3	IV 6	V 3	V 6	V 9	VI 3	VI 6	VI 9
RHODOPHYCEAE															
Kylinia virgatula	+			+		+	+		+		+	+			
Rhodochorton penicilliforme									+				+		
Rhodochorton purpureum	+		+		+		+	+							
Cruoria pellita			+												
Petrocelis hennedyi								+	+						
Turnerella pennyi											+				+
Fimbrifolium dichotomum	+			+		+	+	+	+	+					
Chondrus crispus												+			
Peysonelia rosenvingii					+										
Corallina officinalis													+		
Lithothamnion sp.									+						
Callophyllis cristata	+	+	+	+	+	+		+	+			+	+		+
Choreocolax polysiphoniae											+		+		
Palmaria palmata							+	+	+				+	+	+
Antithamnion floccosum					+			+		+		+	+		
Antithamnion plumula var. boreale	+	+		+	+	+	+	+	+	+	+	+			
Plumaria elegans															
Ptilota plumosa				+	+	+		+					+		+
Delesseria sanguinea			+			+						+	+	+	+
Phycodrys rubens	+		+		+	+					+	+	+		+
Odonthalia dentata				+	+	+	+		+	+		+			+
Polysiphonia lanosa					+										
Polysiphonia urceolata	+	+	+	+		+	+	+	+	+	+	+	+		+
Porphyropsis coccinea						+									
Porphyra miniata	+					+					+				
Porphyra purpurea									+					+	+
Conchocelis sp.													+		
PHAEOPHYCEAE															
Ectocarpus fasciculatus	+			+	+				+						
Ectocarpus confervoides								+							
Ectocarpus sp.			+							+	+				
Ectocarpaceae									+						
Entonema aecidioides					+										
Giffordia granulosa						+									
Laminariocolax tomentosoides	+				+										
Leptonematella fasciculatus					+		+								
Desmarestia viridis	+	+	+	+	+	+			+	+	+			+	+
Desmarestia aculeata	+	+			+	+	+	+	+	+	+	+		+	+
Haplospora globosa		+									+				
Pylaiella littoralis	+		+				+	+	+	+				+	
Sphacelaria radicans	+		+		+			+							+
Chorda tomentosa					+				+	+	+				
Laminaria saccharina	+							+	+				+	+	
Laminaria hyperborea		+		+	+	+	+	+	+			+	+		+
Phyllaria dermatodea									+						
Alaria esculenta	+			+				+		+			+	+	+
CHLOROPHYCEAE															
Codiolum gregarium				+											
Derbesia marina	+						+								+
Chaetomorpha melagonium													+		+
Acrosiphonia sonderi		+													
Acrosiphonia arcta				+	+		+	+				+			
Spongomorpha aeruginosa				+											
Urospora wormskioldii				+											
Ulva lactuca								+		+	+			+	+
Ulvaria obscura				+	+	+	+		+	+					
Monostroma grevillei						+				+					
No. of species	17	8	10	16	20	17	14	18	21	14	13	12	15	9	17

Table 3

Species of animals (≥0.5 cm) collected by divers at each station in Straumsvík cove. Small mobile crustaceans are excluded.

Species	transect / depth	I 3	I 6	I 9	II 3	II 6	II 9	III 3	IV 3	IV 6	V 3	V 6	V 9	VI 3	VI 6	VI 9
Halichondria sp.					x									x		
Grantia compressa														x		
Hydrozoa					x				x					x	x	
Alcyonium digitatum		x		x	x							x				
Mytilus edulis														x		
Modiolus modiolus		x	x	x	x	x	x	x	x	x			x			
Chlamys islandica		x	x			x						x	x			
Heteranomia squamula		x										x				
Hiatella arctica											x					
Acmaea testudinalis											x	x	x			
Gibbula tumida												x				x
Margarites sp.		x									x					
Boreotrophon clathratus						x										
Buccinum undatum		x			x	x		x			x				x	
Neptunea despecta												x				
Tonicella marmorea		x		x	x				x		x	x	x			
Polyplacophora sp.		x		x					x							
Harmothoe spp.										x	x			x		x
Nereis pelagica														x		
Pomatoceros triqueter		x		x							x					
Hyas araneus						x	x				x		x			
Eupagurus bernhardus		x	x	x	x	x	x	x		x	x	x	x	x	x	x
Carcinus maenas					x											
Balanus balanus				x									x			x
Cirripedia sp.		x									x					
Bryozoa												x				
Asterias rubens		x	x		x		x			x	x	x	x		x	
Henricia sanguinolenta						x			x		x	x				x
Solaster sp.					x											
Ophiuroidea sp.						x										
Echinus esculentus		x	x		x	x	x			x	x	x	x			
Strongylocentrotus droebachiensis					x			x	x			x				
Cucumaria frondosa					x		x									
Halocyntia pyriformis					x			x		x	x				x	x
Styela rustica						x										
Cottus scorpicus						x										
Number of species		13	5	7	14	11	6	5	6	6	15	13	9	7	5	6

Table 4
Cover (%) of algae on each station on transects I - VI in Straumsvik cove

Species \ transect / depth (m)	I 3	I 6	I 9	II 3	II 6	II 9	IV 3	IV 6	V 3	V 6	V 9	VI 3	VI 6	VI 9	$\bar{x}$
RHODOPHYCEAE															
Rhodochorton purpureum	+			+	+										<0,1
Cruoria arctica	5,2	18,6	11,7	19,8	53,7	1,1	2,7	16,7	0,6	12,3	10,1		+		10,9
Turnerella pennyi								0,8		+	+				<0,1
Fimbrifolium dichotomum						0,4	+					+		+	<0,1
Corallina officinalis											0,3				<0,1
Corallinaceae	21,8	30,4	9,1	31,5	10,8	1,1	10,5	10,6	15,8	13,7	3,2	+	0,3	+	11,3
Callophyllis cristata	+	1,3		1,0	2,3	0,8	1,8	1,9			+	0,3	+	0,8	0,7
Palmaria palmata				0,3			+					0,7		0,3	0,1
Ptilota plumosa	+		+			+								0,4	<0,1
Delesseria sanguinea												1,8	6,0		0,6
Phycodrys rubens				+	1,3	1,9		3,0		+	35,3	+	0,4	+	3,0
Odonthalia dentata	+			1,4		11,8		10,1		2,7		0,3	0,3	3,9	2,2
Polysiphonia urceol.	5,5	4,3	4,1	3,1	2,4	6,3	5,0	7,5	3,0	17,5	10,0	2,8	0,7	2,0	5,3
Porphyra sp.	+												+	1,4	<0,1
PHAEOPHYCEAE															
Ectocarpecea				0,3	+	+									<0,1
Desmarestia viridis	3,0		3,3	5,1		5,8	14,4		9,5	7,6				4,8	3,8
Desmarestia aculeata			2,4	0,4		8,4	3,0		35,6			10,5	6,7	0,4	4,8
Chorda tomentosa	0,8						4,5		1,0	+					0,5
Laminaria saccharina						1,8						0,3	27,8	24,2	3,9
Laminaria hyperborea	2,8	9,8	13,8	10,6	4,9	3,6	9,1	8,8	3,5	2,7	2,5	24,8	3,7	9,1	7,8
Alaria esculenta							0,9		1,0			+	1,3		0,2
CHLOROPHYCEAE															
Derbesia marina												+		1,1	<0,1
Chaetomorpha melagonium												+			<0,1
Acrosiphonia arcta	0,8					+	0,5		+	+					<0,1
Ulva lactuca				0,7			4,1		0,5	0,3			+	0,4	0,4
Ulvaria obscura	0,5					4,9			1,5						0,5
Total cover (%)	40,4	64,4	44,4	74,2	75,4	47,9	56,5	59,4	72,0	56,8	61,4	41,5	47,2	48,8	
Number of species	13	5	7	13	8	15	13	8	11	11	8	14	13	15	

Table 5.
A. Cover (%) of sessile animals. B. Average numbers per station ($0.25m^2$) of non-sessile animals on transects I-VI in Straumsvik cove. + means that cover is less than 0.1%.

Transect	I	I	I	II	II	II	IV	IV	V	V	V	VI	VI	VI	$\bar{x}$
depth (m)	3	6	9	3	6	9	3	6	3	6	9	3	6	9	
Species															
A.															
Grantia compressa												+	+		<0.1
Halichondria sp.												19.6			1.4
Porifera undet.						1.0									<0.1
Alcyonium digitatum						0.3						0.7	2.8		0.3
Hydrozoa	6.1	3.7		3.5		17.1	3.6	10.5	6.9	7.5	2.2	14.3	28.2	13.3	8.4
Mytilus edulis												2.1			0.2
Modiolus modiolus	6.5	0.3		1.7			4.6	5.6	2.2	9.1	2.9	0.3			2.4
Pomatoceros sp.	+		+	+	+	+	+	+		+	+	+	0.4	0.3	0.1
Cirripedia	+		+	+		0.4	+	+		0.3	+	5.6	3.1	11.2	1.5
Bryozoa	+			+								1.0	1.0	+	0.1
Halocynthia pyriformis						+		+					1.1		0.1
Tunicata undet.							+								<0.1
B.															
Heteranomia squamula						0.3									<0.1
Acmaea testudinalis	5.8	5.6	0.5	12.7	33.7	0.3	2.0	1.3	3.5	0.3	0.7		1.0		4.8
Margarites sp.	0.5									0.3					0.1
Gibbula tumida										0.7				1.0	0.1
Lacuna vincta					0.3			1.3				0.7			0.2
Lacuna pallidula				0.3			0.3		4.0				0.7	0.3	0.1
Nucella lapillus				0.7		0.7							0.3		0.2
Trophonopsis truncatus				0.3					0.5						0.1
Buccinum undatum	0.3		0.5	0.3		0.3		0.3	0.5		0.3	1.0	0.3		0.3
Buccinum eggs						2.7									0.2
Gastropod eggs			0.6	1.0		1.0	1.7		1.0			0.7	1.0	1.3	0.6
Gastropoda undet.						0.4								0.3	0.1
Tonicella marmorea	0.5							1.0							0.1
Tonicella rubra										0.7					0.1
Polyplacophora undet.											0.7				0.1
Caprella septentrionalis	0.3					1.0			1.5			2.7			0.4
Eupagurus bernhardus	0.3			1.3	0.3	0.3	0.7	0.3				0.3		0.7	0.3
Asterias rubens	0.3	0.7		0.3	0.7	1.0	0.3	0.7				5.3	14.0	5.0	2.0
Henricia sanguinolenta					0.3							1.0	0.3		0.1
Echinus esculentus	0.5	0.3			1.0		0.3		1.0		0.3			0.3	0.3
Strongylocentrodus droebachiensis	3.8	1.7	1.0	2.7	0.3		1.7	1.4	5.0	1.7					1.4
Cucumaria frondosa	0.3														<0.1
No. of species	15	6	5	13	8	14	11	12	9	9	8	15	13	10	

Table 6 Weight (g) of individual kelp holdfasts and total weight of holdfasts at each station on transects I - VI in Straumsvík

Depth (m)	Transect I	II	III	IV	V	VI
3	163	219	68		415	123
3	210	240	70		423	208
3	129	123	434		208	319
	502	582	572		1046	650
4.5				184		
4.5				207		
4.5				84		
				475		
6	80	84			105	431
6	34	198			56	561
6	88	76			50	39
	202	358			211	1031
7				74		
7				78		
7				65		
				217		
9	125	28			106	37
9	55	227			68	24
9	132	87			51	77
9	83	342			225	138
	359					

Table 7.
Basal area (cm^2) of individual kelp holdfasts and total studied basal area on each station on transects I - VI in Straumsvík cove.

Depth (m)	Transect I	II	III	IV	V	VI
3	108.9	147.0	71.5		97.5	109.0
3	86.6	127.5	97.5		115.0	153.9
3	121.1	97.5	240.5		161.1	175.8
	316.6	372.0	409.5		373.6	438.7
4.5				103.1		
4.5				161.1		
4.5				91.9		
				356.1		
6	31.8	91.9			103.1	168.3
6	25.7	90.6			49.8	153.9
6	86.6	53.8			71.5	58.1
	144.1	236.3			224.4	380.3
7				49.8		
7				91.9		
7				71.5		
				213.2		
9	71.5	31.8			71.5	35.0
9	35.0	62.5			62.5	38.5
9	71.5	62.5			49.8	91.9
9	91.9	156.8			183.8	165.4
	269.9					

Table 8.
Number of animal species found in each holdfast and the total number of species from holdfasts at each station on transects I - VI in Straumsvik cove.

Depth (m)	Transect I	II	III	IV	V	VI
3	48	48	38		68	49
3	55	49	57		55	42
3	63	46	61		62	46
	76	74	83		84	64
4.5				65		
4.5				47		
4.5				47		
				85		
6	29	52			41	64
6	22	48			31	57
6	44	38			23	26
	51	73			53	74
7				41		
7				40		
7				35		
				61		
9	56	27			48	26
9	34	44			42	27
9	35	38			47	39
9	51	60			75	57
	80					

Table 9

Spearman rank correlation coefficients between the total number of species found in the kelp holdfasts at each station, depth, distance from dumping pit, and the total weight and basal area studied on each station in Straumsvík cove.

	Depth	Distance	Weight	Area
Total no. species/station	0.380	-0.041	0.575**	0.640**
Depth (m)	x	0.116	-0.597**	-0.795**
Distance from pit		x	0.239	0.196
Total weight of holdfasts/station			x	0.793**
Total basal area of holdfasts/station				x

** P<0.01, * P<0.05

Table 10

Total number of individuals of each animal species and their proportion of the total number in the kelp holdfasts in Straumsvik cove.

Species	Numbers	%
Verruca stroemia	12107	26.25
Nematoda	7118	15.40
Mytilidae	6210	13.40
Hiatella arctica	4674	10.10
Polynoidae juv.	2852	6.18
Harpacticoida	1054	2.28
Onoba semicostata	969	2.10
Syllis armillaris	666	1.44
Chitinopoma inflata	618	1.34
Heteranomia squamula	553	1.19
Caprella septentrionalis	529	1.14
Corophium bonellii	503	1.09
Pomatoceros triqueter	417	0.90
Sabellidae spp.	414	0.89
Tunicata spp.	376	0.81
Pleusymtes glaber	373	0.80
Spirorbis spp.	370	0.80
Sphaerosyllis longicauda	337	0.73
Lepidonotus squamatus	313	0.67
Munna kröyeri	305	0.66
Margarites spp.	276	0.59
Cirratulus cirratus	274	0.59
Nicomache personata	255	0.55
Polydora cf. caeca	234	0.50
Omalogyra atomus	218	0.47
Ischyrocerus anguipes	215	0.46
Nainereis quadricuspida	212	0.45
Spionidae juv.	209	0.45
Asterias rubens	172	0.37
Odostomia unidentata	167	0.36
Proclea malmgreni	163	0.35
Amphitrite cirrata	158	0.34
Capitella capitata	150	0.32
Harmothoe extenuata	142	0.30
Amphitritinae juv.	127	0.27
Nereis pelagica	119	0.25
Siphunculida	115	0.24
Heteromastus filiformis	109	0.23
Harmothoe imbricata	107	0.23
Metopa sp.	92	0.19
Eulalia viridis	88	0.19
Axionice maculata	79	0.17
Trophonopsis truncatus	77	0.16
Styela rustica	74	0.16
Oligochaeta sp. A	70	0.15
Balanus balanus	69	0.14
Phyllodocidae juv.	68	0.14

Species	Numbers	%
Platyhelminthes	62	0.13
Dyopedes porrectus	62	0.13
Ostracoda	56	0.12
Musculus discors	53	0.11
Nemertini	47	0.10
Eulalia sanguinea	45	0.09
Ophiopholis aculeata	44	0.09
Cerastoderma edule	42	0.09
Sphaerosyllis sp A.	42	0.09
Buccinum undatum	41	0.08
Autolytus sp.	41	0.08
Turtonia minuta	36	0.07
Lacuna palludula	31	0.06
Polycirrus medusa	31	0.06
Janira maculosa	29	0.06
Ansates pellucida	27	0.05
Terebellomorpha juv.	27	0.05
Dexamine thea	27	0.05
Boltenia echinata	26	0.05
Phyllodoce maculata	24	0.05
Tubificoides kozloffi	23	0.04
Munna minuta	23	0.04
Brada inhabilis	22	0.04
Tubificoides benedii	21	0.04
Pholoe minuta	20	0.04
Kefersteinia cirrata	20	0.04
Puncturella noachina	19	0.04
Modiolus modiolus	18	0.03
Amphithoe rubricata	16	0.03
Cyclopoida	16	0.03
Henricia sanguinolenta	16	0.03
Lacuna vincta	15	0.03
Anthozoa	13	0.02
Streblosoma sp. A	13	0.02
Amphipoda juv.	13	0.02
Pycnogonida	13	0.02
Cucumaria frondosa	13	0.02
Halocynthia pyriformis	13	0.02
Polyplacophora	12	0.02
Neremyra punctata	12	0.02
Nudibranchiata	11	0.02
cf. Tharynx sp.	11	0.02
Cricotopus variabilis	11	0.02
Jassa falcata	11	0.02
Eualus pusiolus	9	0.01
Chlamys islandica	8	0.01
Sphaerodorum flavum	8	0.01

Table 10. cont.

Species	Numbers	%
Astarte sp.	7	0.01
Thelepus cincinnatus	7	0.01
Potamilla reniformis	7	0.01
Acmaea sp.	6	0.01
Dodecaceria concharium	6	0.01
Nicolea zostericola	6	0.01
Amphipholis squamata	6	0.01
Kinorhyncha	5	0.01
Eteone longa	5	0.01
Eupolymnia nesidensis	5	0.01
Trichobranchus glacialis	5	0.01
Parajassa pelagica	5	0.01
Gari fervensis	4	<0.01
Thracia sp.	4	<0.01
Bivalvia juv.	4	<0.01
Melinna cristata	4	<0.01
Ophiura sp.	4	<0.01
Baffinia hesslei	3	<0.01
Trophonopsis clathratus	2	<0.01
Diaphana cf. minuta	2	<0.01
Micropthalamus aberrans	2	<0.01
Syllis cornuta	2	<0.01
Gattyana cirrosa	2	<0.01
Acarina	2	<0.01
Echiurida	2	<0.01
Psolus sp.	2	<0.01
Trichotropis borealis	1	<0.01
Marseniella borealis	1	<0.01
Natica sp.	1	<0.01
Velutina sp.	1	<0.01
Syllidae sp. A	1	<0.01
Macrochaeta clavicornis	1	<0.01
Pionosyllis lamelligera	1	<0.01
Eulalia juv.	1	<0.01
Syllis sp. A	1	<0.01
Flabelligera affinis	1	<0.01
Cumacea	1	<0.01
Mysidacea	1	<0.01
Hyas araneus	1	<0.01
Eupagurus bernhardus	1	<0.01
Idotea sp.	1	<0.01
Solaster sp.	1	<0.01

Table 11.
Total number of individuals found on each station, the total numbers/100g holdfast weight and the total numbers/100cm^2 basal area on each station in Straumsvik cove.

	Transects					
Depth (m)	I	II	III	IV	V	VI
3	2649	3143	4420		5650	8471
	528	540	773		540	1303
	837	845	1079		1512	1931
4.5				2938		
				619		
				825		
6	760	2227			1243	5313
	376	622			589	515
	527	942			559	1397
7				1489		
				686		
				698		
9	1552	3326			1027	2107
	432	973			456	1527
	575	2121			558	1274

Table 12

Spearman rank correlation coefficients between the total number of individuals at each station, the total numbers expressed as numbers/100 cm^2 of holdfast basal area, the total numbers expressed as numbers/100 g holdfasts and the depth and the distance from the dumping pit.

	Distance	Holdfast weight	Holdfast area	Total no. ind.	Number/ 100 g.	Number/ 100 cm^2
Depth (m)	0.0116	-0.596^{**}	-0.795^{**}	-0.570^{**}	0.108	-0.111
Distance	x	0.239	0.196	0.364	0.381^{*}	0.250
Total weight of holdfasts		x	0.793^{**}	0.767^{**}	-0.149	0.462^{**}
Total basal area of holdfasts			x	0.783^{**}	0.003	0.280
Total no. of individuals				x	0.396^{*}	0.766^{**}
No. of indiv. per 100 cm^2					x	0.611^{**}

** P<0.01, * P<0.05

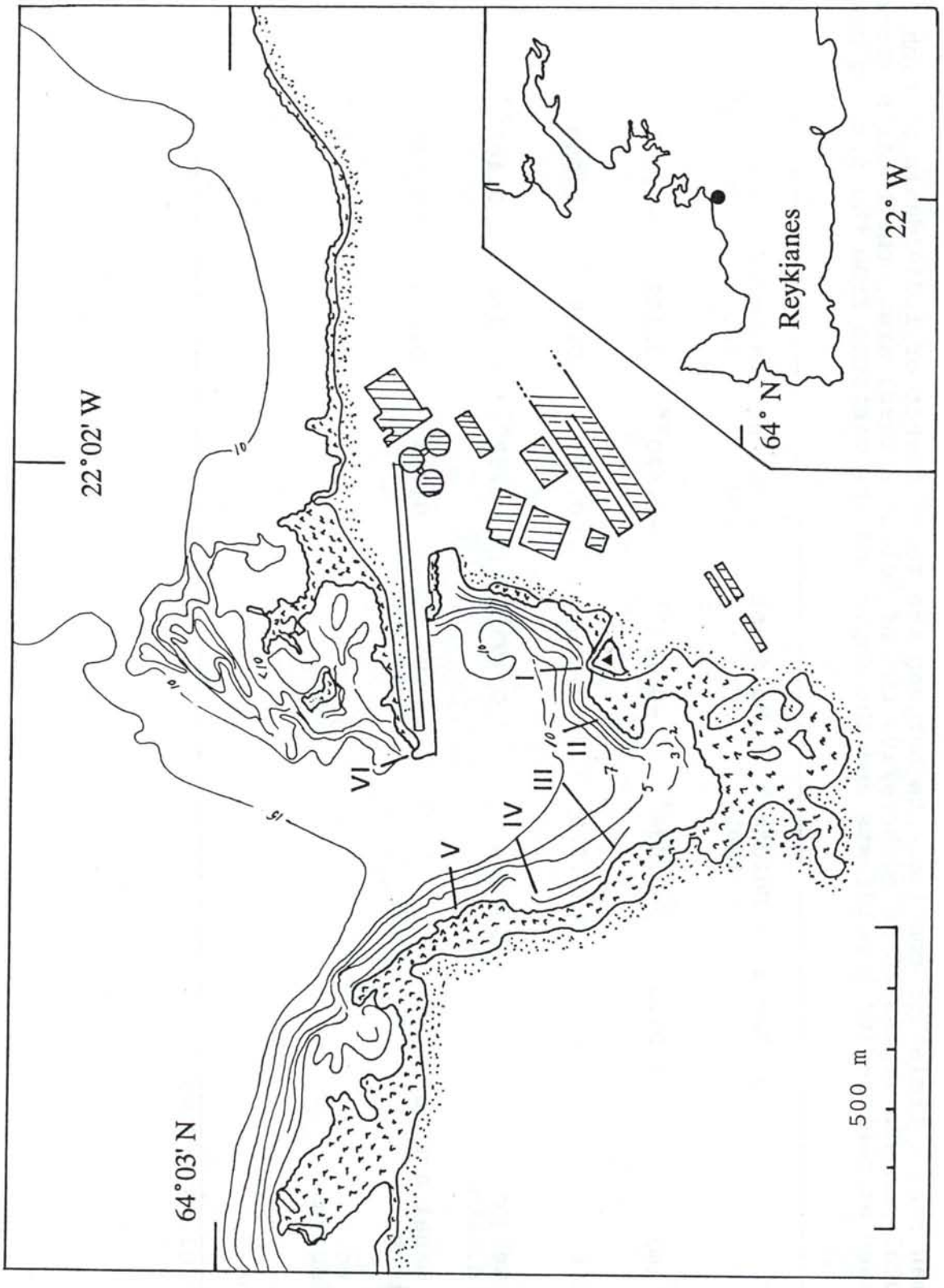

Figure 1. Straumsvík cove. The triangle shows the location of the dumping pit. The dot on the inserted map shows the location of Straumsvík cove on the Reykjanes peninsula.

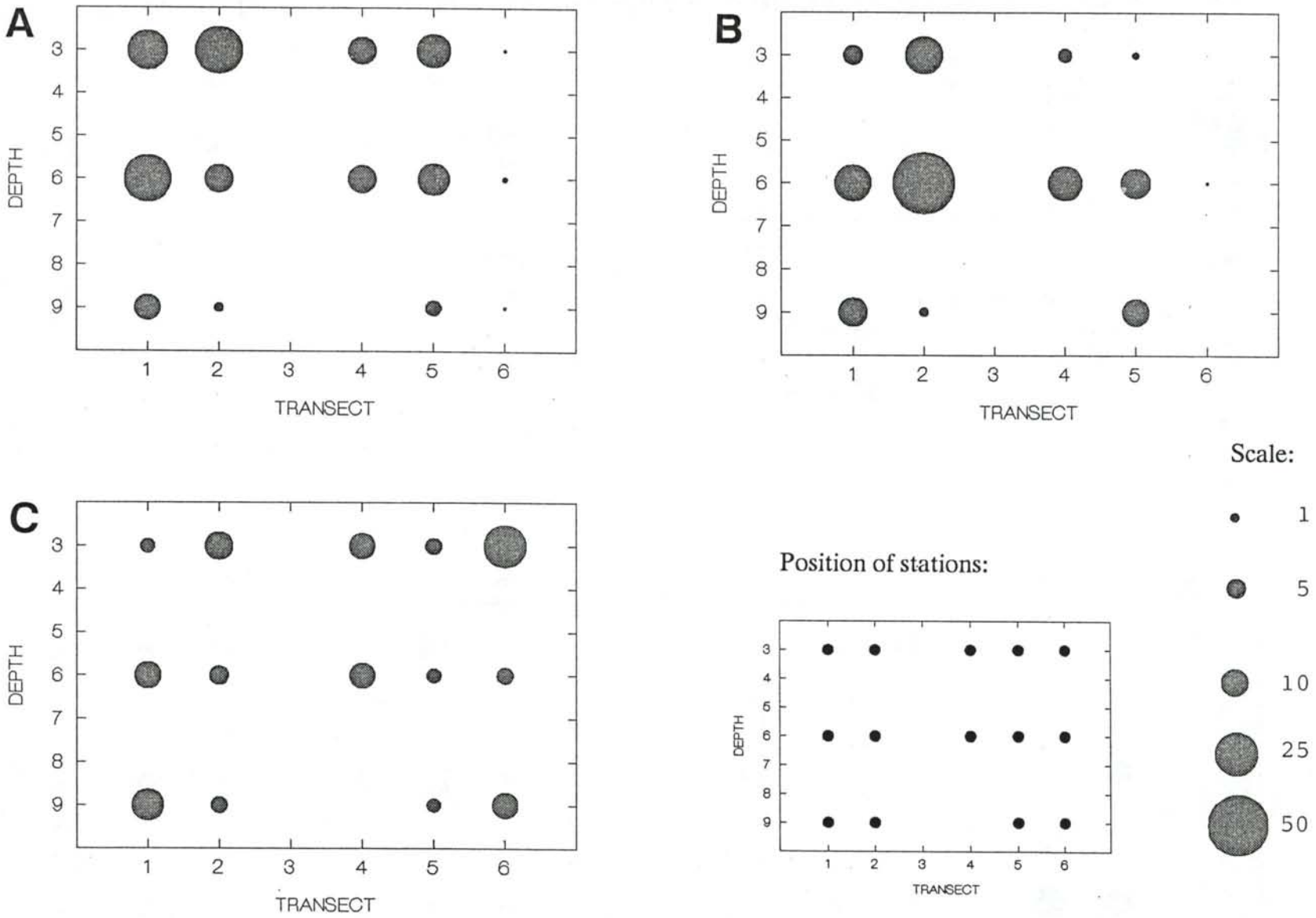

Figure 2. Cover (%) of Corallinaceae (A), Cruoria arctica (B) and Laminaria hyperborea (C) at each station in Straumsvík cove.

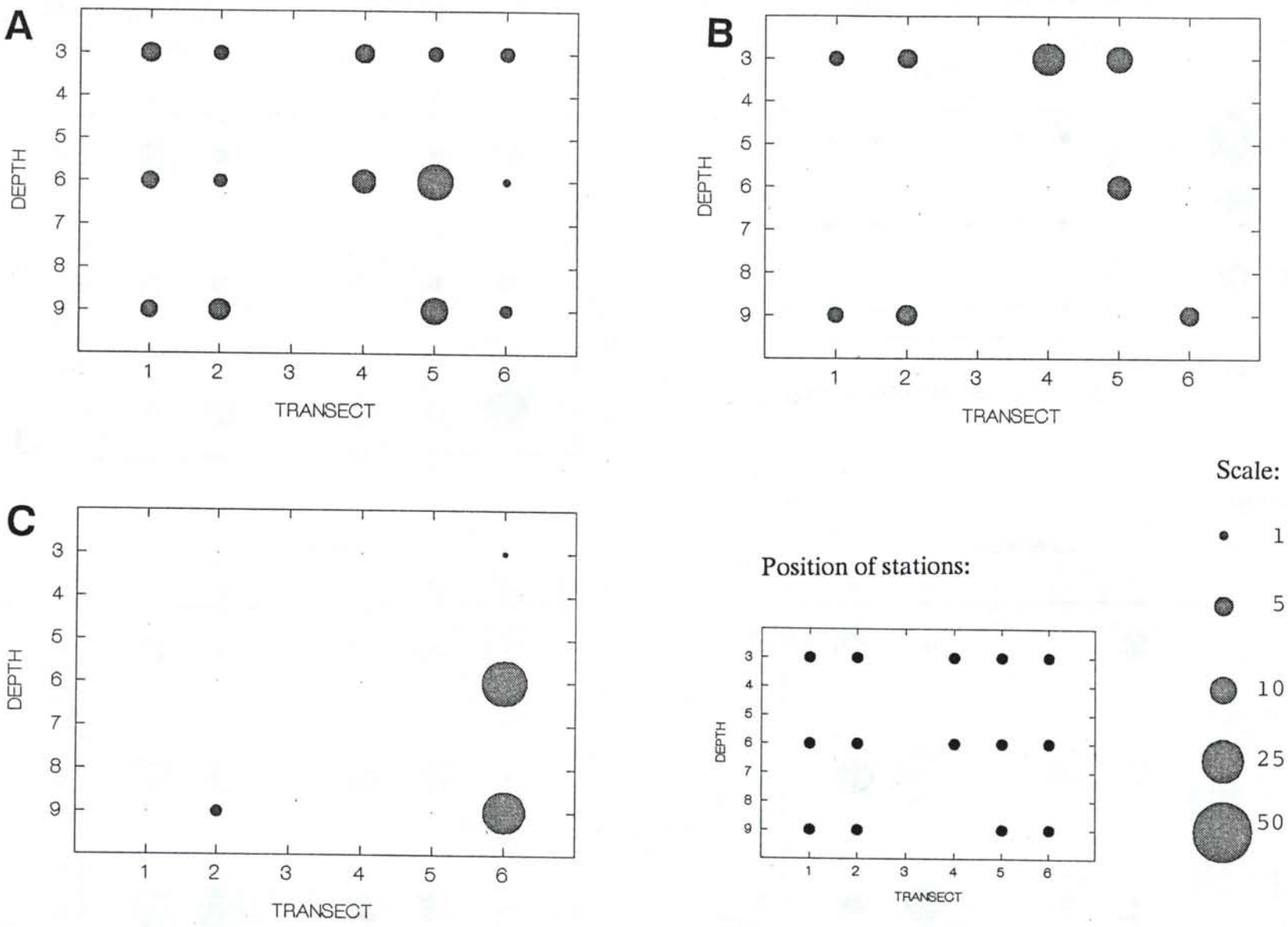

Figure 3. Cover (%) of Polysiphonia urceolata (A), Desmarestia viridis (B) and Laminaria saccharina (C) at each station in Straumsvík cove.

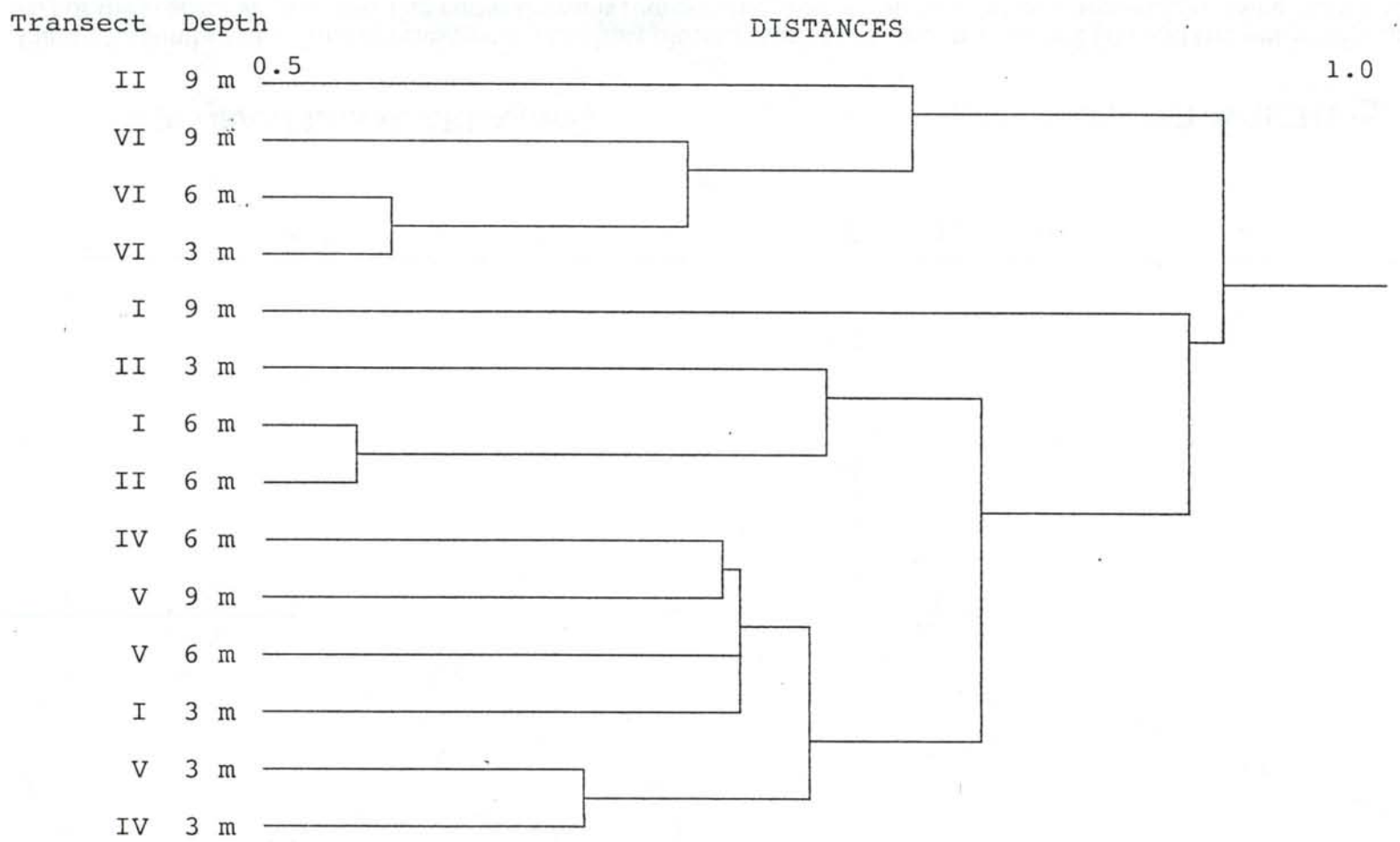

Figure 4. Dendrogram showing classification of all photograph stations, based on cover (%) of all algae and sessile animals and abundance of non-sessile animals. The distance matrix is based on Pearson product-moment correlation and nearest neighbor is the clustering strategy. The data were ranked prior to clustering.

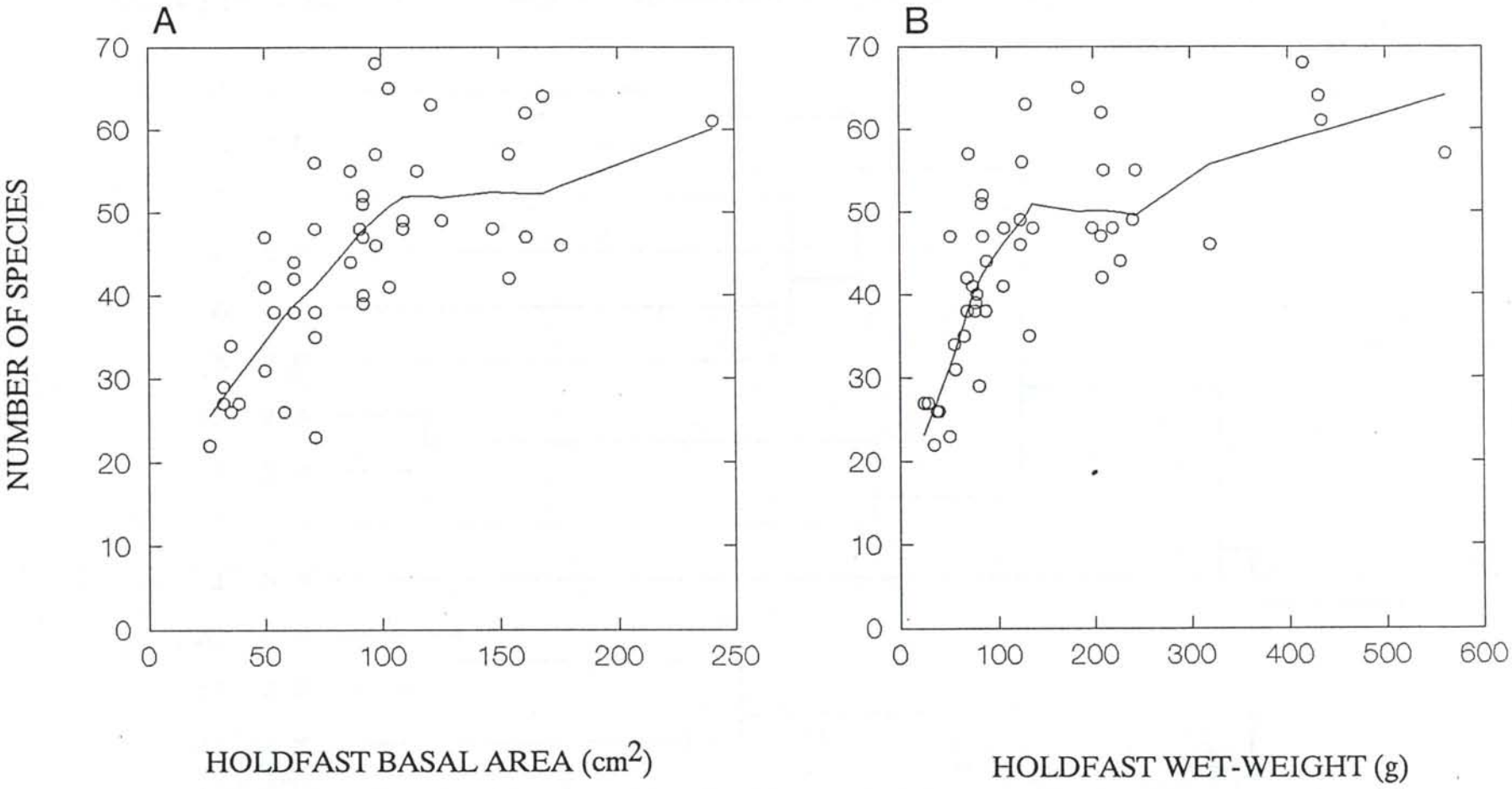

Figure 5. Number of animal species in each holdfast plotted against the basal area (cm^2) (A) and the wet-weight (g) (B) of the respective holdfast. The curve shown is regression of species on basal area or wet-weight, using LOWESS smoothing, which runs along the X values and finds predicted values from a weighted average of nearby Y values.

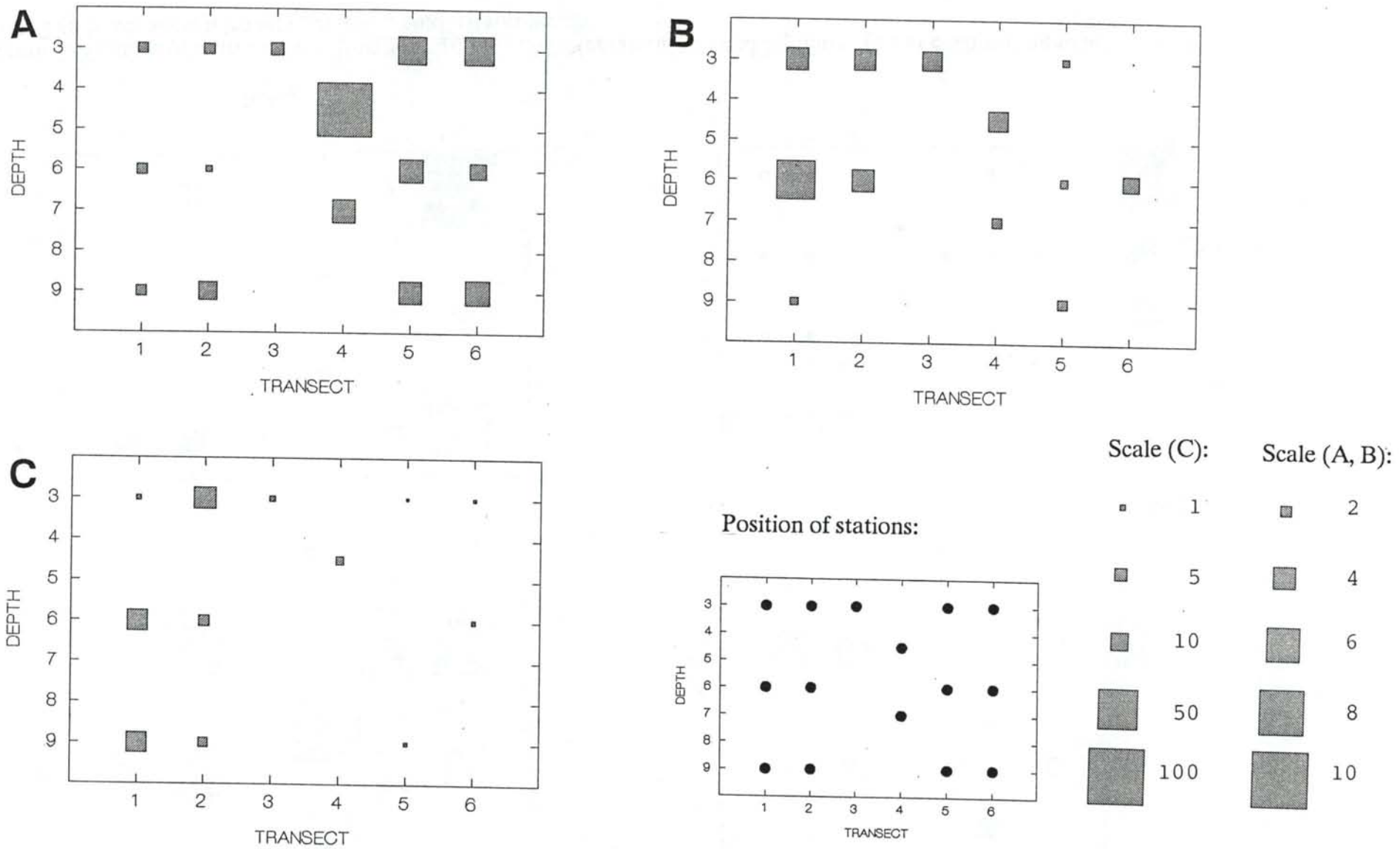

Figure 6. Number of individuals of Nicomache personata (A), Odostomia unidentata (B) and Omalogyra atomus (C) at each station in Straumsvík cove. The boxes show numbers per 100 g holdfast wet-weight.

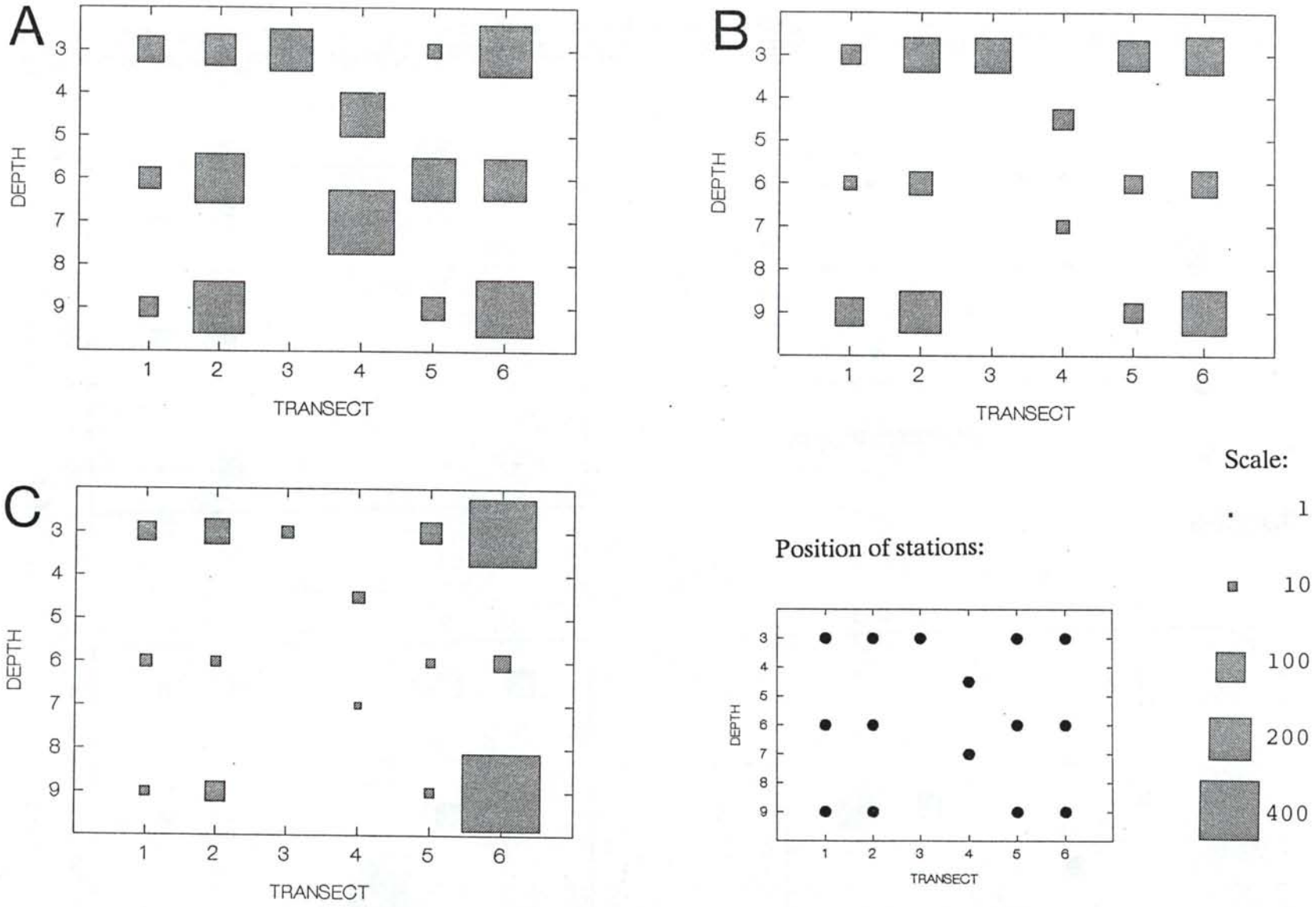

Figure 7. Number of individuals of Verruca stroemia (A), Nematoda (B) and Mytilidae (C) at each station in Straumsvík cove. The boxes show numbers per 100 g holdfast wet-weight.

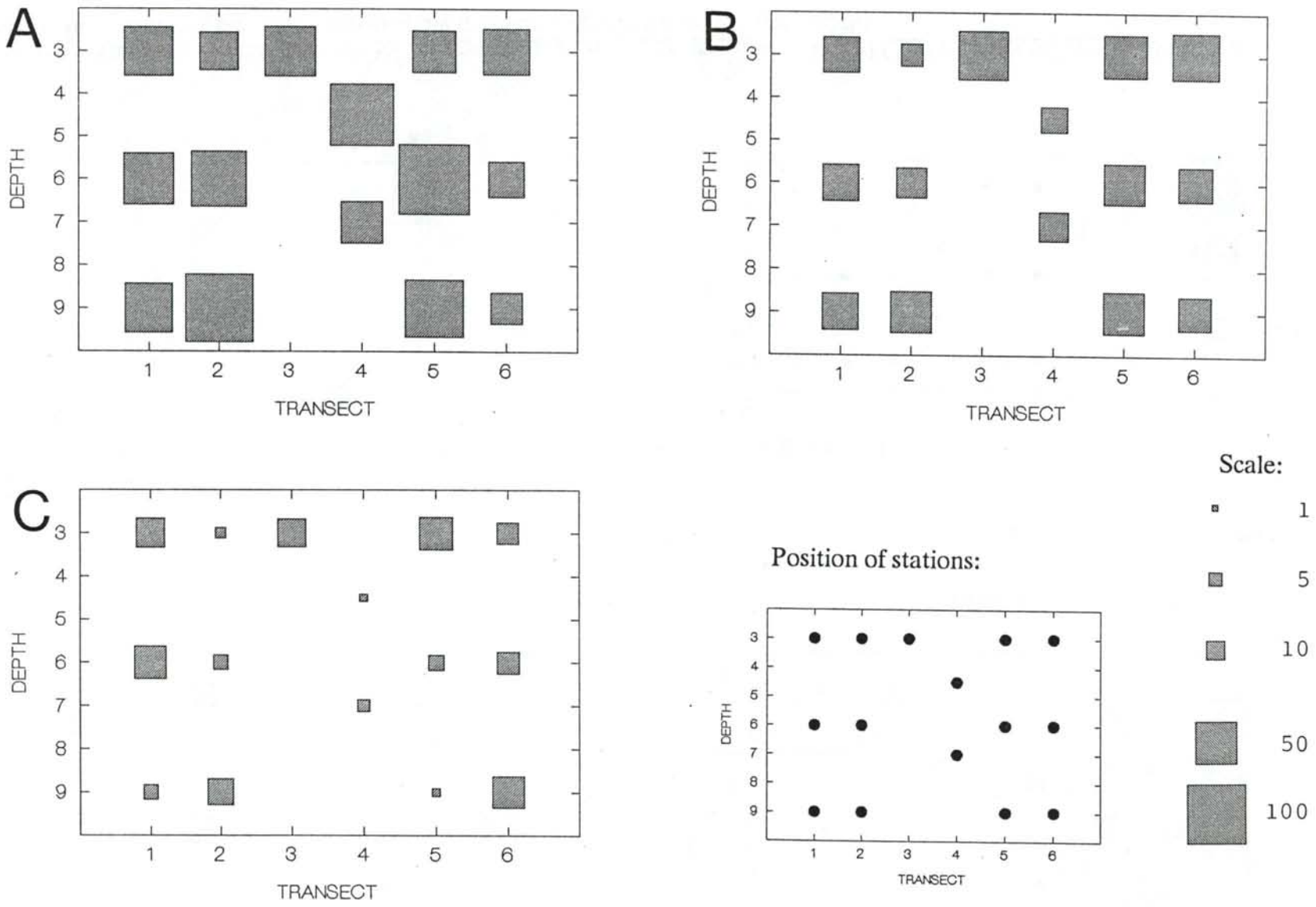

Figure 8. Number of individuals of Hiatella arctica (A), Polynoidae juv. (B) and Harpacticoida (C) at each station in Straumsvík cove. The boxes show numbers per 100 g holdfast wet-weight.

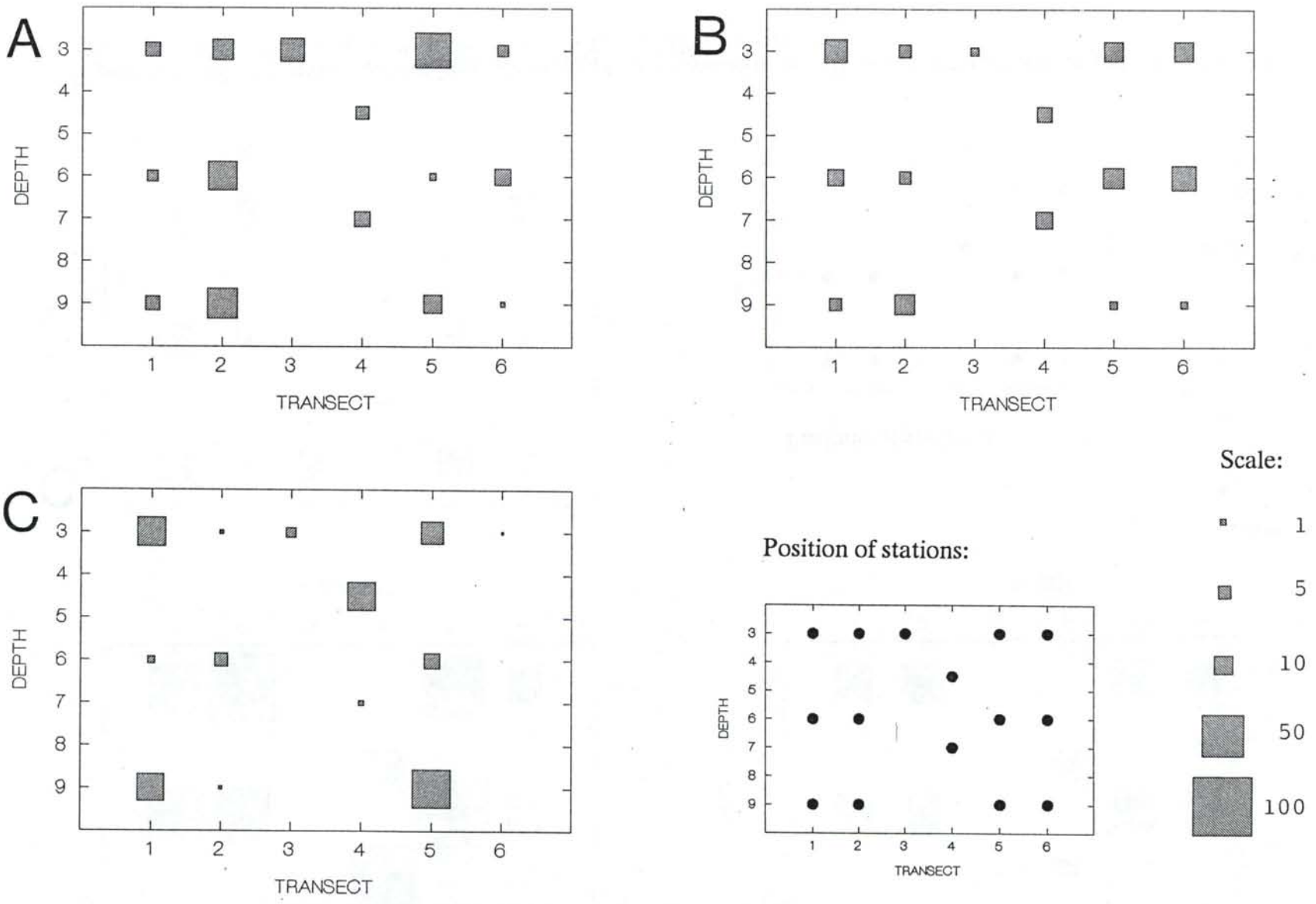

Figure 9. Number of individuals of Onoba semicostata (A), Syllis armillaris (B) and Chitinopoma inflatum (C) at each station in Straumsvík cove. The boxes show numbers per 100 g holdfast wet-weight.

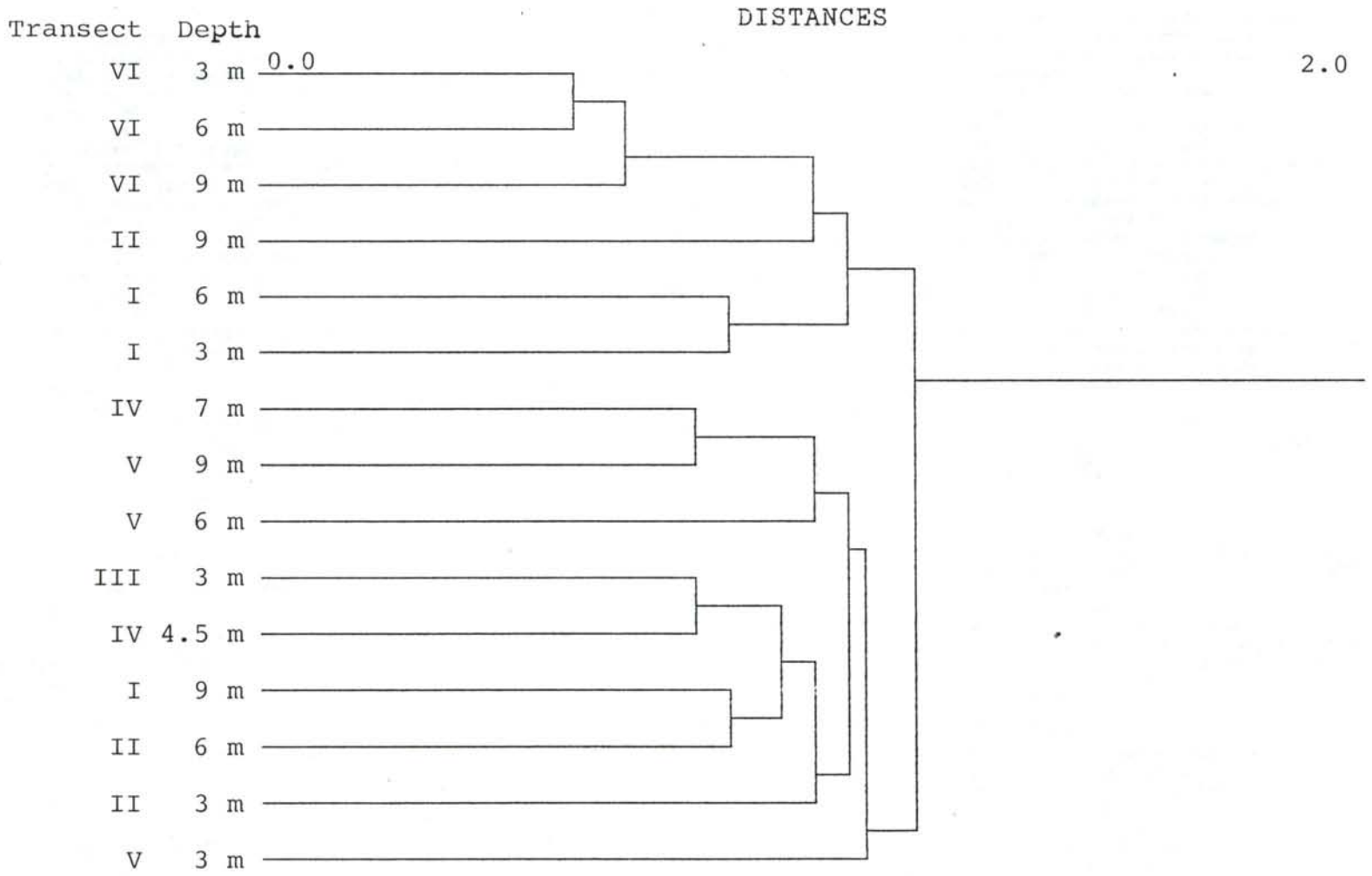

Figure 10. Dendrogram showing classification of kelp holdfast stations in Straumsvík cove. The distance matrix is based on Pearson product-moment correlation and average linkage is the clustering strategy. The data were ranked prior to clustering.

Appendix 1

List of animal species and groups found during this study.

Phylum Protozoa
- Foraminifera

Phylum Porifera
- Grantia compressa (Fabricius)
- Halichondria sp.

Phylum Coelenterata
- Hydrozoa
- Anthozoa
- Alcyonium digitatum Linné

Phylum Nematoda
Phylum Kinorhyncha
Phylum Nemertinae
Phylum Platyhelminthes
Phylum Sipunculida

Phylum Mollusca
- Musculus discors (Linné)
- Modiolus modiolus (Linné)
- Mytilus edulis Linné
- Mytilidae juv.
- Chlamys islandica (Müller)
- Heteranomia squamula (Linné)
- Astarte sp.
- Cerastoderma edule (Linné)
- Gari fervensis (Gmelin)
- Turtonia minuta (Fabricius)
- Hiatella arctica (Linné)
- Thracia sp.
- Bivalvia juv.
- Puncturella noachina (Linné)
- Acmaea testudinalis (Müller)
- Acmaea sp.
- Ansates pellucida (Linné)
- Margarites spp.
- Gibbula tumida (Montagu)
- Lacuna vincta (Montagu)
- Lacuna pallidula (da Costa)
- Onoba semicostata (Montagu)
- Omalogyra atomus Jeffreys
- Trichotropis borealis Broderip & Sowerby
- Marseniella borealis Bergh
- Velutina sp.
- Natica sp.
- Nucella lapillus (Linné)
- Trophonopsis truncatus (Ström)
- Trophonopsis clathratus (Linné)
- Buccinum undatum Linné
- Odostomia unidentata (Montagu)
- Diaphana cf minuta Brown
- Gastropoda juv.
- Nudibranciata spp.
- Tonicella marmorea (Fabricius)
- Tonicella rubra (Linné)
- Polyplacophora spp.

Phylum Annelida
- Lepidonotus squamatus (Linné)
- Harmothoe extenuata (Grube)
- Harmothoe imbricata (Linné)
- Gattyana cirrosa (Pallas)
- Pholoe minuta (Fabricius)
- Polynoidae juv.
- Eteone longa (Fabricius)
- Eulalia viridis (Linné)
- Eulalia sanguinea (Oersted)
- Phyllodoce maculata (Linné)
- Phyllodoce sp.
- Phyllodocidae juv.
- Nereimyra punctata (Müller)
- Kefersteinia cirrata (Keferstein)
- Micropthalamus aberrans (Webster & Benedict)
- Syllis armillaris (McIntosh)
- Syllis cornuta Rathke
- Syllis sp. A
- Pionosyllis lamelligera Saint-Joseph
- Sphaerosyllis longicauda Webster & Benedict
- Sphaerosyllis sp. A
- Autolytus sp. A
- Syllidae sp. A
- Nereis pelagica Linné
- Sphaerodorum flavum Oersted
- Nainereis quadricuspida (Fabricius)
- Polydora cf. caeca (Oersted)
- Spionidae juv.
- cf Tharynx sp.
- Cirratulus cirratus (Müller)
- Dodecaceria concharum Oersted
- Macrochaeta clavicornis (Sars)
- Brada inhabilis (Rathke)
- Flabelligera affinis Sars
- Capitella capitata (Fabricius)
- Heteromastus filiformis (Claparéde)
- Nicomache personata Johnson
- Melinna cristata (Sars)
- Proclea malmgreni (Ssorowiew)
- Amphitrite cirrata Müller
- Eupolymnia nesidensis (Delle Chiaje)
- Axionice maculata (Dalyell)
- Nicolea zostericola (Oersted)
- Amphitritinae juv.
- Polycirrus medusa Grube
- Streblosoma sp. A
- Thelepus cincinnatus (Fabricius)
- Baffinia hesslei (Annenkova)
- Trichobranchus glacialis Malmgren

Appendix 1 cont.

Terebellomorpha juv.
Potamilla reniformis (Müller)
Sabellidae ssp.
Pomatoceros triqueter (Linné)
Chitinopoma inflata (Dons)
Spirorbis spp.
Tubificoides kozloffi Baker
Tubificoides benedii d'Udekem
Oligochaeta sp. A

Phylum Arthropoda
Class Crustacea
Harpacticoida
Cyclopoida
Ostracoda
Verruca stroemia Müller
Balanus balanus Linné
Balanus sp.
Cirripedia spp.
Janira maculosa Leach
Munna kröyeri Goodsir
Munna minuta Hansen
Idotea sp.
Metopa sp.
Pleusymtes glaber (Boeck)
Dexamine thea Boeck
Corophium bonellii (Milne-Edwards)
Amphithoe rubricata (Montagu)
Ischyrocerus anguipes Kröyer
Jassa falcata (Montagu)
Parajassa pelagica (Leach)
Dyopedes porrectus Bate
Caprella septentrionalis Kröyer
Amphipoda juv.
Cumacea sp.
Mysidacea sp.
Hyas araneus (Linné)
Carcinus maenas (Linné)
Eupagurus bernhardus Kröyer
Eualus pusiolus (Kröyer)

Class Insecta
Cricotopus variabilis

Class Pycnogonida

Phylum Bryozoa

Phylum Echinodermata
Asterias rubens Linné
Henricia sanguinolenta (Müller)
Solaster sp.
Ophiopholis aculeata (Linné)
Amphipholis squamata (Delle Chiaje)
Ophiura sp.
Echinus esculentus Linné
Strongylocentrotus droebachiensis (Müller)
Echinoidea juv.
Cucumaria frondosa (Gunnerus)
Psolus sp.

Class Tunicata
cf. Tridemnum sp.
Didemnum albidum (Verill)
Styela rustica (Linné)
Boltenia echinata (Linné)
Halocynthia pyriformis (Rathke)
Tunicata spp.
Subphylum Vertebrata
Myoxocephalus scorpicus (Linné)

Appendix 2. Number of individuals found in each kelp holdfast on transects I - VI in Straumsvik cove.

transect	I	I	I	I	I	I	I	I	I	I	II	II	II	II	II	II	II	II	II	III	III	III	IV
depth (m)	3	3	3	6	6	6	9	9	9	9	3	3	3	6	6	6	9	9	9	3	3	3	4.5
holdfast no.	1	2	3	1	2	3	2	3	4	5	1	2	3	1	2	3	1	2	3	1	2	3	1
FORAMINIFERA	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+		+	+		+	+
PORIFERA	+	+	+	+		+	+	+	+	+	+	+		+		+	+	+	+	+	+	+	+
COELENTERATA																							
Hydrozoa	+	+	+	+	+	+	+	+	+		+	+	+	+		+	+		+	+	+	+	+
Anthozoa																							
A. digitatum																+			+				
NEMATODA	80	88	62	17	9	16	76	23	16	216	376	167	317	80	82	57	50	536	108	23	288	528	124
NEMERTINAE		8				3		1								2		1		1	3	1	1
PLATHYHELMINTES	1	1	3									1		1									1
SIPUNCULIDAE							3				2		1	1	5						2	24	4
KINORHYNCHA	1											2											
MOLLUSCA																							
M. discors			1								4	7	4	1								1	
M. modiolus							2							1							2	3	3
Mytilidae juv.	25	57	116	1	2	30	2	1		35	135	96	194	17	12	14	3	105	51	20	14	62	26
C. islandica										1				1								1	
H. squamula	25	11	9		6	29	4	2	44	15	3	19		4	6	7		7	5	3	47	63	84
Astarte sp.							3				1												1
C. edule			1				4			4		1		2	2			1	1	1	3	1	1
G. fervensis																							2
T. minuta			1							2	6	1	4									2	2
H. arctica	97	149	111	14	7	132	36	23	45	144	52	128	69	191	29	92	60	279	109	46	143	226	442
Thracia sp.																							
Bivalvia juv.																					1		
P. noachina	2		1				1			1			1	1	1							2	1
Acmaea sp.									1													3	
A. pellucida	1		1								1		1								8	3	
Margarites spp.	2	21	11	1		2	2	2	4		27	17	21	10	9	2		2		4	3	8	10
L. vincta																		3					
L. pallidula			1		2	8				1		2		5	1					1		1	
O. semicostata	6	13	13	4		4	6		6	10	46	19	12	54	4	30	2	78	10	11	14	72	19
O. atomus	3	1		12	2	13				48	23	10	55		13			10		4		2	5
T. borealis							1																
M. borealis																							
Velutina sp.																					1		
Natica sp.																						1	
T. truncatus	1	5	1				1					1	5	2	1	3	1	1			5	1	2
T. clathratus																						1	
B. undatum		2	1					2	2		1	1		2		3		3			2		
O. unidentata	7	8	5			14	3	1	1		9	3	10	6	8						10	10	13
D. cf minuta																						1	
Nudibranciata																							
Polyplacophora			1						1			1			2							1	

Appendix 2. Continued.

transect	IV	IV	IV	IV	IV	V	V	V	V	V	V	V	V	V	VI	VI	VI	VI	VI	VI	VI	VI	VI
depth (m)	4.5	4.5	7	7	7	3	3	3	6	6	6	9	9	9	3	3	3	3	6	6	6	9	9	9
holdfast no.	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
FORAMINIFERA	+		+	+	+	+	+	+		+		+	+			+	+	+	+	+	+	+	+	
PORIFERA	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+
COELENTERATA																								
Hydrozoa	+			+	+	+	+	+	+	+	+	+	+			+	+	+	+	+	+	+	+	+
Anthozoa		1														1	1						1	9
A. digitatum	+	+							+				+											
NEMATODA	56	52	23	14	5	684	168	386	56	23	4	24	26	45	140	576	368	421	342	51	12	93	210	
NEMERTINAE		1	2		1							2				4	3	10	2			1		
PLATHYHELMINTES														1	2	16	6	19	6				1	
SIPUNCULIDAE	1	7				56		1				1						3	4					
KYNORHYNCHA			1																				1	
MOLLUSCA																				1				
M. discors						18	1	14				1												
M. modiolus	1			1		5		1																
Mytilidae juv.	25	21	5	4	3	394	44	87	12	5	1	10	8	4	82	410	2807	63	138	133	3	700	234	
C. islandica				1									1	1				2						
H. squamula			4			4	9	4	43	4	12	23	5	8	4	2	15	11	3	1	3	1	4	
Astarte sp.		8				1																		
C. edule		3	1	1		7	1			1		2	2	1				4						
G. fervensis		1																1						
T. minuta						6	1	4							1				5			1		
H. arctica	98	13	36	39	36	245	140	152	221	38	32	114	59	38	37	182	181	181	180	13	13	13	13	
Thracia sp.																4								
Bivalvia juv.								1	1		1													
P. noachina					1	1		1				2												
Acmaea sp.				1										1										
A. pellucida		1		1					2					3										
Margarites spp.	1	1	4	2		34	4	16				3	2	6	4	6	16	9	7				3	
L. vincta					1	11	1					1						1						
L. pallidula			1					1			1			1									1	
O. semicostata	4	1	5	7	3	319	13	51	1	1	1	5	2	16	1	6	18	42	39			1		
O. atomus		5				2	5							1		2			5					
T. borealis													1											
M. borealis									1															
Velutina sp.																								
Natica sp.																		21	8				2	
T. truncatus	1			1		5	2	7										1						
T. clathratus												4				1	1	1	1		1		3	
B. undatum				2	2	1	2	3																
O. unidentata	3	1		1	3	4	2	7	1	2		1	1	2	1			20	10					
D. cf minuta								1																
Nudibranciata						1			2						1	2		1	3		1			
Polyplacophora										1				3			1							

Appendix 2. Continued.

transect	I	I	I	I	I	I	I	I	I	I	II	II	II	II	II	II	II	II	II	III	III	III	IV
depth (m)	3	3	3	6	6	6	9	9	9	9	3	3	3	6	6	6	9	9	9	3	3	3	4.5
holdfast no.	1	2	3	1	2	3	2	3	4	5	1	2	3	1	2	3	1	2	3	1	2	3	1
POLYCHAETA																							
L. squamatus	8	12	14	1		3	1	4	3	7	4	5	11	5	2	5	2	12	12	2	3	60	5
H. extenuata	1	6	1		1	5	2					2	1	6	1	4		6		1	4		6
H. imbricata	1	4	7			4	2		3	1	4	1	1	3	1			8	2	3	5		2
G. cirrosa																		1			1		
Polynoidae juv.	19	104	67	10	2	66	25	13	64	35	8	19	56	24	23	48	9	128	32	14	136	240	78
P. minuta							4				1										1		1
E. longa							1		1						1						1		
E. viridis	1	4								4		3	1					8	6		2		5
E. sanguinea		4									4			2					1	3	6		
P. maculata			1			3				3											5		1
Phyllodocidae juv.										3	8							40					1
N. punctata							2			1													5
K. cirrata			1																				
M. aberrans																							2
S. armillaris	21	22	38	3		13	3	7	5	2	8	15	5	2	1	12	1	7	35			12	17
S. cornuta														1									1
Syllis sp. A																							1
P. lamelligera																							
S. longicauda	5	16	3		1	1	2	2		11		1		16	2	2	4	32			1	24	2
Sphaerosyllis sp. A			4							1						1							1
Autolytus sp. A						1																12	
Syllidae sp. A							1																
N. pelagica	1	4	11	2		6	3	1	2		2	5	1	2				9	1				3
S. flavum																			1				
N. quadricuspida		1				1	1			2	3	1		2	1	2	1	48	7	1	9	24	
P. cf. caeca	13	8	8			2	2	4	1	11		1	8	8				3	1	1	5	36	16
Spionidae spp.	2	8	4				4			3		6			1		10	16		2		36	15
cf Tharynx sp.																							1
C. cirratus	2	6	4	3	1		6	6	1	36	7		7	10	11		22	20	6	2	16	36	3
D. concharium																							
M. clavicornis																							
B. inhabilis											1											2	
F. affinis																							
C. capitata				3	1		2			1			26				7		20	1		24	5
H. filiformis			1				1	14							3			16			24		20
N. personata			9	3		1	4			3	8	3			1	3	5	5	1	1		12	13
M. cristata			1																			1	1
P. malmgreni							1			1					1						13	60	33
A. cirrata	6			5	1		4			1	4		3	3			1	4	5		3	38	7
E. nasidensis																							
A. maculata		2					1	3	2	1	5	3	1	4				1	1			15	
N. zostericóla																			1				
Amphitritinae juv.		16				1		1	10					12				2	2				
P. medusa		1																			1	24	
Streblosoma sp. A																							
T. cincinnatus						1												1					
B. hesslei																2							
T. glacialis		2	1																				
Terebellomorpha juv.			3										24										
P. reniformis											2				3					1			
Sabellidae spp.	2	16	19	1		4				1			56			2			16	1		12	1
P. triqueter	23	21	21	2		8	5	3	3		6	9	31	14	5	2		1		4	8	32	23
C. inflata	3	86	33	1	2		25	1	52			3		13	2	3	1				16		15
Spirorbis spp.	22	32	13	9	4	25			3	2			55	1	2	2	50				8	26	7
T. kozloffi							1								3								2
T. benedii							1			1	1									1	16		
Oligochaeta sp.A							1				16				4								

Appendix 2. Continued.

transects	IV	IV	IV	IV	IV	V	V	V	V	V	V	V	V	V	VI	VI	VI	VI	VI	VI	VI	VI	VI
depth (m)	4.5	4.5	7	7	7	3	3	3	6	6	6	9	9	9	3	3	3	6	6	6	9	9	9
holdfast no.	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
POLYCHAETA																							
L. squamatus	6	6	2		2	10	8	17	7	3	1	6	2	4	2	11	6	23	16				
H. extenuata	3		4	4	2	18	6	4	1			2		1	4	19	14	4	9				
H. imbricata	3			2		2	3	11	1	2		4			4	4	3	7	5			1	3
G. cirrosa																							
Polynoidae juv.	16		15	12	26	378	72	112	80	18	4	38	31	43	49	152	200	198	130	15	5	18	20
P. minuta	1	8					1					1						2					
E. longa		1																					
E. viridis	5		2			2	28	1		1				2		4		1	5		1		2
E. sanguinea	2	8		3				3	1			3		1	1			2	1				
P. maculata		11																					
Phyllodocidae juv.													1					16					
N. punctata	1												1						2				
K. cirrata						19																	
M. aberrans																							
S. armillaris	11	4	10	6	2	36	53	25	22	4	1	1	1	2	15	35	22	99	86				2
S. cornuta																							
Syllis sp.A																							
P. lamelligera													1										
S. longicauda		1	3	1	1	54	8	8		2		4		2	7	24	8	38	32			4	15
Sphaerosyllis sp.A	8						24						1					2					
Autolytus sp. A											1				5	1	10	8	2				1
Syllidae sp.A																							
N. pelagica	1		1		1	18	1	2	2			3	1	1	1	6	9	8	3	1		5	2
S. flavum								1	1			2						2					1
N. quadricuspida						18	1	26		1					3	8	12	5	17	2		13	
P. cf. caeca	5	1	3	2	3	18	11	23	1	1		4	2					21	10			1	
Spionidae spp.	26	7	1	3		36				1		6	5	2				2	2				11
cf Tharynx sp.		5												5									
C. cirratus	5		1	3	1		6	1	1	2			5	8		8	18	4	2			2	2
D. concharium														6									
M. clavicornis		1																					
B. inhabilis		1				18																	
F. affinis								1															
C. capitata			2			36		8				3		3				1	3			3	1
H. filiformis		29																	1				
N. personata	24	9	6	2	1	36	9	8	8	1			6	3	2	8	24	16	14			2	4
M. cristata						1																	
P. malmgreni	9	5				36		3					1										
A. cirrata	28			2		25	4							3			5	2	3		1		
E. nasidensis		1		1	3																		
A. maculata	3					19	6	3	5			3						1					
N. zostericola				3								1										1	
Amphitritinae juv.		8						34	21	3	1		9	1	2	3							1
P. medusa		2					2	1															
Streblosoma sp.A					1											9	3						
T. cincinnatus						1		1			1		1		1								
B. hesslei								1															
T. glacialis		1		1																			
Terebellomorpha juv.																							
Sabellidae spp.	8		9	3	1	90	32	52	19	8		3	2	2			11	19					
P. reniformis	1																						
P. triqueter	28	1	2	2	12		8	21	20	1	3	7	3	3	8	3	8	40	19	5	2		
C. inflata	95			2		18	56	78	14		1	36	49	12	1								
Spirorbis spp.	21			6	4	54	8	6	8				4	1	1				1		3		
T. kozloffi	8	1						8															
T. benedii																		1					
Oligochaeta sp.A		7														8	32		2				

Appendix 2. Continued.

transect	I	I	I	I	I	I	I	I	I	I	II	II	II	II	II	II	II	II	II	III	III	III	IV
depth (m)	3	3	3	6	6	6	9	9	9	9	3	3	3	6	6	6	9	9	9	3	3	3	4.5
holdfast no.	1	2	3	1	2	3	2	3	4	5	1	2	3	1	2	3	1	2	3	1	2	3	1
CRUSTACEA																							
Harpacticoida	19	55	50	11	1	51	6	1		15	3	7	9	16	1	5	11	48	7	4	52	71	8
Cyclopoida		2	1							1											1		
Ostracoda	2	2	1	1			2		1	1		2	1		6				1		2		
V. stroemia	10	300	100	30	72	15	100	30	20	10	500	35	125	500	20	500	750	100	200	200	500	500	50
B. balanus																			16			3	
Balanus sp.																					12		5
J. maculosa	2	10	5			1																	
M. kröyeri	2	6	5			2			1		3	4				3	2		1	3	3		
M. minuta	1	2					1			3	2		16	1				2			1	1	
Idotea sp.																							
Metopa sp.	2	6	1			8		1								1			1		1	3	
P. glaber	1	13	11			12	3		1		2	1	8	2	5	7	3	2	3				
D. thea			1			1			1			1	1					2				2	2
A. rubricata	1		1	1						1		2											
C. bonelli		15	3	1		6	2	1	20	1	3	7	9	5	8	2	3	38	16	6	14	56	16
I. anguipes		17	3	1		2				2				1		3	3			1	1		
J. falcata			8								3												
P. pelagica																							
D. porrectus	2	4				1	4	1		1	1		1	1	1	5		11			2	7	
C. septentrionalis	1	22	170			5		1		2	1		4	1		2		4	18				1
Amphipoda juv.			9					1					1						1				
Cumacea																							
Mysidacea																							
H. araneus																							
E. bernhardus									1														
E. pusiolus		1						2								1					1	1	1
INSECTA																							
C. variabilis														9						1	1		
PYCNOGONIDA													2										
ACARINA																		1					
BRYOZOA	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+		+	+	+	+
ECHINODERMATA																							
A. rubens		2	3		1		2	2		3	11	5	8	3	1		2	2		1		1	
H. sanguinolenta							1			1	2												
Solaster sp.																					1		
O. aculeata	5	3	8						2			1		3	1							2	1
A. squamata							1																
Ophiura sp.							3			1													1
Echinoidea															1								
C. frondosa		2	1							4			3		1								
Psolus sp.														1	1								
TUNICATA																							
cf. Trididemnum sp.	+?																						+
D. albidum			+		+	+		+			+	+	+	+	+					+	+		+
S. rustica	5	6	3			4	4	3	3			2		4	1	2			4		1	6	9
B. echinata										1													
H. pyriformis																				1	2	1	
Tunicata spp.	5	8	7	5	1	6	11	3	3	8	7	33	5	40	10	4		15	3		4	23	12
ALGAE	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+

Appendix 2. Continued.

transect	IV	IV	IV	IV	IV	V	V	V	V	V	V	V	V	V	VI	VI	VI	VI	VI	VI	VI	VI	VI
depth (m)	4.5	4.5	7	7	7	3	3	3	6	6	6	9	9	9	3	3	3	6	6	6	9	9	9
holdfast no.	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CRUSTACEA																							
Harpacticoida			7		2	157	84	74	8	2	4	3		1	11	19	53	65	71	4	1	4	33
Cyclopoida						2					2							3		1	1		2
Ostracoda		3	2			3								1	1			1	2	1		6	14
V. stroemia	1000	30	500	40	500	100	100	40	50	300	100	40	50	50	500	1000	500	1000	1000	40	500		
B. balanus																		4					
Balanus sp.	1														1	1	1		1	10	5	6	3
J. maculosa														1			2	5		3			
M. kröyeri						12	8	2				1			14	54	37	45	62	9	1		9
M. minuta			1			2			1	1		4											
Idotea sp.																				1			
Metopa sp.	1						14	2					1		21		4	19	3	2			1
P. glaber	2		2			1	9	4	1		1		2	5	15	76	64	77	24	5	6		5
D. thea			2			9	3	1				1											
A. rubricata								10															
C. bonelli	7		4	6	3	74	26	84	5		2	19	2		1	5	8	3	1	2	1		
I. anguipes		1	3		1	2	1			1			1		51	39	29	33	11	2	4		3
J. falcata																							
P. pelagica															1		4						
D. porrectus		1	3		1	3		2				7		1	1						1		
C. septentrionalis		2			2	19	8	3	1			2			103	19	79	16	21			1	4
Amphipoda juv.																							1
Cumacea						1																	
Mysidacea						1																	
H. araneus															1								
E. bernhardus																							
E. pusiolus	1																						
INSECTA																							
C. variabilis																							
PYCNOGONIDA							8	2												1			
ACARINA																							2
BRYOZOA	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
ECHINODERMATA																							
A. rubens	2		2	2		1	2		2	2		1	2	2	9	13	10	19	13	9	3	1	30
H. sanguinolenta			1			2		1						1	1		1	2	2				1
Solaster sp.																							
O. aculeata	1		1	1	1		2	2	2			2	2	2			1	1					
A. squamata						5																	
Ophiura sp.																							
Echinoidea				1																			
C. frondosa															1								1
Psolus sp.																							
TUNICATA																							
cf. Tridemnum sp.								+					+										
D. albidum						+	+	+	+		+	+	+	+	+			+			+		
S. rustica	5	1	3			1		1	5								1		1				1
B. echinata						3	4								1			15	2				
H. pyriformis		2				1		3	1						1							1	
Tunicata spp.	4	16	8	1	1	20	9	8	28	3	3	3	2	3	3	10	8	19	10	2		1	1
ALGAE	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+		+